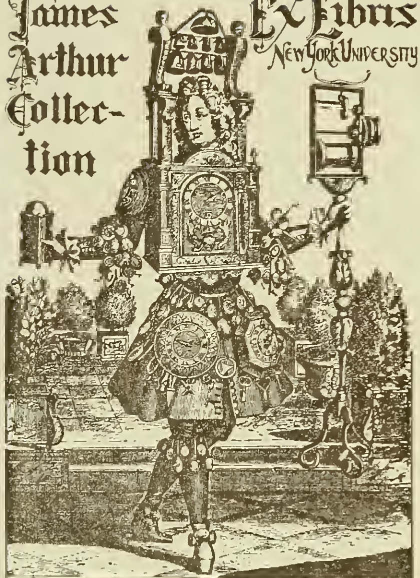

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CONTENTS.

To our Patrons.

Since the last number of the Journal was printed we have concluded to defer to the often expressed wishes of the trade for more advertising space, and have, therefore, made a radical change in that department; and it only needs a glance at its pages to show how it is appreciated on their part. As a result of such liberality we shall be enabled to make such improvements in the present volume as will render it still more worthy of the generous support it has received from the intelligent horologists of this country and of Europe.

This explanation we offer as an excuse for occupying space with matters purely personal; and without any frantic appeals, or claims to be the "only original Jacobs," or extensive promises for the future, we present the present number, feeling it will be appreciated for just what it is worth.

We are under obligations to our London correspondent and agent, Mr. J. Herrmann, for MSS. copy of his lecture on the "Economy of Force," delivered before the British Horological Institute, and which we have published almost entire.

The lecture was rendered much more interesting by the introduction of working models and drawings; but without these there will be no difficulty in comprehending and appreciating the principles so clearly enunciated. Want of space only prevented the introduction of the remarks preceding the lecture, as they are quite as applicable here as in London—a specimen of which we give:

"In selecting the subject of my discourse, I had fears that it would prove as attractive to some watchmakers as a lecture on lamp-posts would to policemen. But the subject of escapements ought to be of deeper concern to watchmakers than mere amusement; and the youth, or apprentice, who will find no more interest in such a discourse, as to the matter, will prove less useful to society than the said agent of illumination. Still, I wish to be perfectly charitable, and make due allowance for close and continued familiarity with this piece of mechanism. 'Familiarity breeds contempt' is a saying superficially true, but no further. The contempt arises, *not* from a close familiarity, but from the want of it. We often hear watchmakers speak very disrespectfully of their trade; but their feelings towards it are generally inversely proportionate to their knowledge of it. Men who have given their closest attention to their trade or profession have also been the greatest lovers of, and ornaments to, it. Therefore, if we wish to lighten our work, we must dive below the ripple of every-day acquaintances, and instead of finding monotony and discord, we shall find mechanical harmony and pleasure."

THE MECHANICAL ELEMENTS

AND

Economy of Force in the Principal Escapements.

BY J. HERRMANN.

The grand problem of Scientific and Practical Horology, is *Motion* vs. *Time;* and as time means *duration* it may be called *Motion for the measurement of Duration.* This problem, which is solved by the circumgyration of our planet, we are attempting to imitate by the pendulum and balance wheel.

The great drawback to all mechanical motion, and especially to accuracy of motion, is resistance by pressure; the more we can overcome this the better we shall succeed; but I fear it can never be disposed of. When we set a pendulum or balance in motion, we impart a momentum. By observing the arcs described, we find that each one is less than the preceding one. If it were not for the resistance no diminution would take place, and consequently they would go on for ever. This decrease in the arcs of the pendulum or balance is the measurement of the momentum expended in overcoming resistance. This proves to us that just as much momentum requires to be imparted, as is absorbed in overcoming resistance. It is not my business now to discuss the nature of balance resistance; it is an existing fact which no watchmaker will dispute. My duty is to examine the contrivance by which the resupplying is effected, namely, the escapement.

In connecting the escapements with the balance or pendulum, there is one other unfortunate fact entering into calculations—a fact which no horologist has been able to dispose of yet: the balance has either to unlock the motive power to receive the impulse, as in the chronometer, lever, remontoir, and gravity escapements, or it has to sustain the pressure of the motive power, as in the duplex, horizontal, and Graham; and in some it has even to overbalance this force, as in the verge and clock escapements. This duty of the balance has, therefore, to be added to the other resistance which must be put in account against the momentum.

Treating of the escapement in relation to this task it has to perform, I advance the following propositions as the basis of my remarks:

First.—The impulse should be given to the balance in such a manner that no extra pressure is created thereby.

Second.—The unlocking should offer the least possible resistance to the balance; and as the force transmitted to the escapement has to be equal to the impulse, plus the force expended in overcoming resistance in the escapement itself, and as the presence of pressure requires a proportionate supply of force, and the action and reaction of such force will create a proportionate variation in the impulse and unlocking, I propose,

Thirdly—That all resistance by pressure should be reduced to a minimum in the escapement, in order to dispense with every excess of force.

It is in reference to this third and last proposition that I apply the term "Economy of Force." It must, therefore, be understood in a negative sense; that is to say, a measured effect with a minimum cause. We have to consider the escapements, as it were, separate and distinct machines, with a view to elicit the conditions upon which they will yield the greatest possible result with the least amount of supply.

By the principal escapements, I mean those which are most extensively applied, rather than those which give the best results, and they may be arranged in three classifications, according to the three distinct properties they possess, viz.:

First.—Arrangement of their mechanism.

Second.—Their geometrical disposition and proportions.

Third.—Their mechanical elements and results.

With regard to the first, I must take for granted that all are acquainted. The second, although not the direct subject for discussion, is yet, to a great extent, involved in the third and last, as the one of which I have principally to treat. Before we can analyze the escapements, as to their mechanical composition and transmittance of force, we must first ascertain what mechanical elements are, and the properties they possess.

The simplest instruments by which any force is communicated from one point to another, so as to set in motion any other body acted on by another force, are cords, rods, and hard planes; and the simplest combination of such instruments are called mechanical powers. Strictly there are only two, the lever and the inclined plane; but these are again subdivided into six, and sometimes seven, viz., the lever, wheel and axle, toothed wheel, pulley, inclined plane, wedge, and screw. The first four are modifications of the lever, and the last three of the inclined plane; and any form of mechanism, no matter how simple or how complicated, be it the verge escapement or Mr. Babage's calculating machine, must be composed of these elements, and can possess no others; and hence we must necessarily first seek their acquaintance ; but I shall only speak of the definitions of the form in which they are employed in the principal escapements.

The lever is a mechanical element extensively applied in all escapements, of which there are three orders. The first order comprises all levers which have the power and weight on the ends, and the fulcrum, or centre of motion, somewhere between them. The second, those which have the fulcrum on one end, the power on the other, and the weight somewhere between the power and fulcrum. The third, those which have the fulcrum on one end, the weight on the other, and the power somewhere between the fulcrum and weight. The length of the lever arms is measured by the distance of the points of application of the power or weight from the fulcrum, and the weight and power, regardless of the order of lever, are inversely proportioned to the length of lever arms.

But there is one other fact connected with the lever—that is, the pressure on the centre of motion—which I particularly wish to notice, because it is a great agent in producing resistance, as we shall see presently. The wheel and axle, toothed wheel, and pulley are mechanical powers not present in escapements — the escape wheel not possessing the kind of teeth that is understood by toothed wheel.

The next mechanical element we have to notice is a modification of the inclined plane, called the wedge, or movable incline. It consists of a plane, called its length, inclined at some angle to a horizontal line, which is called its base, and its height is a perpendicular to the base, meeting the incline; from which we see that, by a constant angle, these lines, no matter what their magnitude, always are in a constant ratio. The mode of application of this mechanical element in escapements is by a force acting at some angle to the plane; and it is on this angle that the conditions of the motions communicated to their plane or wedge depend. A force acting against a fixed incline is exerting its influence in two directions ; part of it parallel to, and part at a right angle to, the plane. The pressure of the weight or force on the incline is proportioned to the base, and the force acting parallel to the incline is proportioned to the height or altitude.

If we now apply a force acting in a fixed direction on to a movable incline, as is the case in escapements, we get different results from the same conditions. The force acting in the former instance parallel to the plane, is now, with the same amount, propelling the plane; and, as stated, the proportion between the force and the result is in the same ratio as the length to the height ; and the pressure or resistance is proportioned to the ratio of base to height.

The point I wish specially noticed is, that we get the greatest result and least amount of resistance when the angle formed by the direction of the force and the incline is at a minimum, and least when at 90°. Therefore, suppose we require to propel a machine with a power of 1, we should economize the force by making the angle of direction with the plane as acute as possible, because here the least amount of force is expended in resistance. The incline may also be applied for raising a weight, as is the case in the horizontal escapements, and in the club-tooth, and other pallet actions, and all unlockings.

We have seen by the movable incline that we obtain the greatest result in propelling the incline when the force makes the smallest angle with the plane. Substituting for this an opponent force, we should require it to equal the result, to keep the machine in equilibrio, or rest; and we have, for the same reason, seen that we could keep the same force in equilibrio by a much smaller opponent force, if we increase the angle formed by the direction of the force with the plane. These two conditions I specially beg of you to bear in mind against their application.

Before doing so, I have to call attention to one other item connected with all mechanical actions, viz., resistance by friction. The conditions of friction are threefold: the hardness and smoothness of the rubbing surface, the force with which such surfaces are pressed together, and, in rotatory motion, the distance of the contact from the centre of motion. For instance, the vibration of a balance will decrease considerably for want of oil to the pivots, or roughness of holes and pivots, by reason of a want of smoothness of rubbing surface. Trying the end shake of a wheel when the watch is wound up, requires force to overcome the resistance of pressure of the rubbing surface. The vibrations of a balance in a horizontal and vertical position are shorter in the latter than the former, by reason of the increased distance of the rubbing surface from the centre of motion. From these examples we see that pressure and friction require an amount of force to overcome them, and hence demand attention in treating of the economy of force.

Of the escapements I shall treat in the following classification:

First.—The mechanical elements of lever pallets, and the conditions of force transmitted through them.

Second.—The lever and roller action by fog, or notch and pin contact.

Third.—The lever and roller action of the so called two-pin principle.

Fourth.—The chronometer roller impulse, and duplex pallet action.

Fifth.—The impulse action of the horizontal escapement and lever escapement, with inclined and locking planes on the wheel.

Sixth.—The resistance to the cylinder and duplex roller, by pressure of the escape-wheel; and last—

The force expended in the inertia of superfluous material in escapements.

In treating of the pallet action, with the pallet staff pivots as the centres of motion for driving and locking planes, the escape wheel giving impulse by 15 fine points, requires none of our attention, except in regard to their relative position on the planes. This class of pallets form a combination of lever and inclined plane. The lever arms are measured by the distance of the wheel contact from the pallet centres alternately, and the roller and lever contact. The impulse imparted by the lever may be considered the weight raised, and the force transmitted by the wheel as the power.

The proportion between the centrifugal power of the wheel and the power exerted against the pallets is conditional to the angle formed by the tangent of the wheel radius of point of contact, being in the ratio of the plane to its height; the resistance being proportioned to the base, to which of course has to be added the absorption of force in overcoming resistance of the rubbing surface, and therefore the force with which the pallet is turned about its centre is equal to the power imparted by the wheel, multiplied by the pallet radius of point of contact; and then this product divided by the distance of roller contact from the pallet centre will give us the proportion between the centrifugal forces of escapement and lever. It follows, therefore, that the impulse force on one pallet is retarding, and on the other, accelerating.

Let us consider for a moment the proportions of the impulse imparted on the two pallet planes when the wheel is near the delivery edge of the pallets, with equidistant lockings. We see here a considerable disparity in the transmission of force; and as by mechanical law no force or power is lost, the force here deficient must be expended in another direction, which we shall find are the pallet centres or pivots.

The angle formed by the direction of the centrifugal force of wheel and pallet inclined plane, when the wheel is on the delivery edge, is 19° 45′. If we consider the wheel force equal 1, the proportion of pressure communicated through the plane on to the pivot would be as .3379 to 1. If the angle were less, this pressure would be less, and impulse greater; hence the advantage of pallets with a small driving angle over those with a large one, is evident. On the outer delivery edge we find the angle equal 16° 3′; therefore the proportion here between force and pressure is as .2765 to 1, and therefore .0634 less than on the other. The difference of the force transmitted is by reason of the different lengths of lever arms, and the consequent absorption of force by pressure. It is therefore self-evident that in escapements which have the scape pallet and staff holes in a right angle, or approximately, considerable pressure is communicated to the pallet staff; and as we have here two rubbing surfaces, at a distance from centre of motion, some considerable amount of force in the escapement must be expended in overcoming this resistance.

It is in the face of this fact that I here wish to call attention to what is called the straight line escapement. Endeavoring to explain the conditions of pressure on the pivots in this arrangement, I fancy I cannot do better than go back to the lever again, in lever of No. 1 and 2 order. We have here maximum and minimum points of pressure, and hence there must be a medium. This, it is evident, must be at a medium point between the two arms, which are at right angles, and which condition is obtained in the straight line disposition.

I have now to deal with the lockings. The relative conditions of the impulse and locking may, I think, be best explained on the principle of two planes, put back to back. As we have seen that a movable incline is propelled by a force in proportion to the angle formed by the direction of the force with the plane, it follows that the tendency of the escape wheel to draw the pallet towards it, is conditional to this angle. The locking is, however, to be considered in a twofold manner. First, the centrifugal power of the escape wheel propels the incline towards it, until its progress is arrested by the bankings, and remains in this position until the vibration of the balance is completed, when a contrary action takes place. The effect by reason of the force of the wheel propelling the plane has to be overcome by the momentum of the balance and elasticity of the spring.

The conditions of this resistance to the balance are proportioned to a weight raised by an incline; and from previous definitions we can easily see that, in proportion to the angle formed by the direction of this resistance to the plane, must the force be required to overcome this weight. The amount of locking resistance to the balance has to be considered in connection with the lever. The distance of the locking edge from the centre of pallet motion, being lever arm, and the distance of roller contact from pallet centre, another; from this it will be seen that the greater the former is in proportion to the latter, the greater the resistance to the balance. It is by reason of this disparity in the magnitude of lever arms to locking resistance, that the pallets with equidistant lockings have been adopted. But I think I shall be able to prove that no advantage is derived.

In locking, the same as in impulse, the angle of direction of wheel force with the plane is continually changing, and, therefore, so must the effect. If we take the outside locking angle of pallets with equidistant lockings at 12°, and consider those pallets to rotate 12° also, all effect of the force of the escape wheel, as regards any angular motion of the pallets, would cease; and, therefore, the locking resistance is reduced in a twofold ratio, by reason of the increase of the angle of direction of the force with the plane, and the diminution of distance from centre of motion. By the inside locking we have the exact opposite effect. The angle of resistance is increased in the same ratio as the other is diminished, while the distance of resistance from centre of motion is increased; and hence, instead of being equal in resistance, the inside is about double to the outer.

Now let us look at the pallets this arrangement is to supersede. I have shown that the outer locking diminishes, and the inner increases in resistance; this holds good in both pallets. We must bear in mind, however, that the radius of outer lockings is greater; but as we have seen that the resistance depends on the angle of direction of the force with the plane, we can equalize the difference of lever arms of resistance by increasing the angle on the shorter, and diminishing the one on the longer, and as we require the locking resistance on the pallets with equidistant lockings to be equal, we have to come to the same thing; while on the former we have the advantage of greater impulse equality than on the latter.

I now proceed to the lever and roller action of the "lever notch and roller pin arrangement." By this arrangement, which is a simple lever action, I think I shall be able to prove that there is an amount of force expended in pressure, and that the pressure so created reduces the momentum of the balance, which, of course, in turn has to be supplied by increased motive force. If we consider the relative conditions of the lever and roller radii of contact, both before and after the line of centres, to be such that they form a right angle, it is evident that all the centrifugal power of the lever is expended in pressure on the ruby pin, which, before the line of centres, may be considered pressure in reference to the roller radius, and after or past line of centres, tension. It follows, therefore, that there must be a medium between pressure and tension, and at this point the impulse power is at its maximum point; and by the deviation from this point or line of centres, the impulse force diminishes proportional to the angle of the radius of contact with the line of centres, and also by the lengthening of lever radius of contact.

It may be observed in connection with these facts that the angle of impulse engagement is never equal on both sides of the line of centres, which of course increases the angle on one side; hence the error proportionately. If we take the angle of penetration as 2° when the escape wheel drops on to the locking incline, and the angle of the lever radius with the line of centres is 6°, it follows that the impulse cannot commence at the same angular point, but at an angle of 4° with the line of centres; and hence, if the impulse angle of the pallets is 10°, we should have an angle 4° before line of centres, and 6° past line of centres; and so the impulse diminishes as the resistance of the balance increases.

I will now consider the third point, which I believe is technically called the "two pin principle."

There are several modifications which I will class in two, viz.: Those which receive impulse by an indenture in the roller, and those which receive impulse by a projecting roller pin at right angle to the staff. We shall readily see the advantage of these roller actions, as we here have a constant lever impulse radius. The lever impulse may be given, either by a gold pin or stone, set vertical to the plane of the lever, or applied in other ways; but the principle does not alter—it being a combination of lever and inclined plane in all cases. At the point where lever and roller radii are in line of centres, there is a pure lever action; but the moment that the radii deviate from the line of centres, we have the inclined plane added. The radius of the roller to point of contact forms the plane, and the direction of the force is the tangent to lever radius of contact. We know by the inclined plane that the effect of the force is greatest when the angle of the force and the plane is smallest. Here, therefore, we have this angle diminish as the action deviates from line of centres, in addition to which the distance of the contact from the roller centre increases, and therefore the force transmitted to the roller increases in proportion to the impulse angle, and in an approximate ratio to the resistance of the pendulum spring; while, as we have seen, that in the action last described, the force transmitted diminishes.

The mode of lever and roller action, by which the impulse is imparted to the roller by a projecting pin, is distinguished from this in the fact of its having to unlock the wheel by the greater disadvantage, which unlocking is effected by the projecting impulse pin. If we consider for a moment the radii of lever and roller so placed that they form a right angle, as in the first roller action, we see that the whole momentum would be expended in pressure; as here it is at its maximum point, and in line of centres at its minimum, it follows that the expenditure of momentum in pressure is proportioned to the angle of unlocking with the line of centres.

I have now to draw your attention to one more roller action, which has in it the properties of creating the least amount of pressure, or giving a maximum impulse with a minimum resistance, and, therefore, is, as I think I shall be able to prove, the best roller action that can be applied, and is the invention of Mr. J. Jarvis. The mechanism of this action is as follows: The lever has an opening in its plane, the centre of which lies in the line drawn from the centre of motion and point of contact, sufficiently large to admit the balance staff and a free pallet movement; and the impulse contact, which in all other arrangements takes place between the balance and pallet centres of motion, lies here on the opposite side to the pallet centres. The impulse action that would impart momentum without again creating resistance, would evidently be that one which moved concentrically with the balance. Mr. Jarvis's arrangement is certainly an approximation, and hence he calls it concurrent.

The advantage consists in a reduction of rubbing surface, and is proportional to the difference of depths of a lens and a curve described with the same radii. If we take, for instance, an escapement of former description, with 8° of pallet and 30° of roller impulse arc, the amount of rubbing surface in proportion to lever would be .086 to radius of 1, while the ratio in Mr. Jarvis's arrangement will only be .056 to 1.

When I saw this roller action last, the unlocking was effected by the impulse pin, and, therefore, at a disadvantage, as we saw just now; but there is no obstacle in the way of giving impulse by placing a pin in the lever, and then it would undoubtedly be the best arrangement.

I will now consider the fourth point, viz.: "Chronometer and duplex impulse actions."

The essential points of the impulse in the two pin-roller and lever action apply so nearly to the chronometer that little need be said additional.

It is, as in the last lever, a combination of lever and inclined plane, and the minimum and maximum impulse is dependent on the same condition. There is, however, one special point in connection with this action to which I wish to call attention, and this is the angle of the impulse pallet which we see sometimes rectilinear with the radius, and others almost forming a hook. We can easily understand that if a body has to move over a foot of space in half a second, it will require less force than if it had to move over double that space in the same time. Now, let us keep this fact in view while we analyze this pallet arrangement.

The shortest way between two parallel lines must be a line at right angles to either; and the shortest way between two concentric circles must be the greater, minus the lesser radius; and any line drawn in any other direction must be of greater magnitude.

Therefore a pallet in a chronometer roller, placed at an angle with the radius diverging from the circumference, must entail the necessary greater amount of rubbing surface in the same time, require more force to overcome it, and therefore goes against the momentum of the balance. This, however, is not the only disadvantage. I have shown that in propelling an incline, we get the greatest result when the direction of the force with the plane is the smallest. Here that angle is increased, and therefore, in addition to requiring greater power to overcome resistance, we get less force transmitted to the balance by the diminished angle the direction of the force makes with the plane of the pallet; therefore there can be no doubt that a roller with the pallet face rectilinear with the radius, gives a maximum result with minimum absorption of force in resistance.

The duplex impulse is so similar in its conditions, that the definition of the chronometer may be applied. It is, however, by reason of this coincidence of principle, and yet difference of arrangement, that I wish to notice a point of error existing in the shape of the wheel. The arc of impulse in the duplex, as in the chronometer, is bisected by the line of centres; the only difference in the impulse arc before and after line of centre, arises from the mechanism. The pallet or roller must penetrate the wheel's periphery before the drop takes place, and which, in a proper wheel, would not make the difference more than 1°. Now, as an intersection of arcs is a physical necessity, which is at its maximum at the line of centres, it follows that a rubbing of surfaces is unavoidable; and therefore we must have either the cog moving up the plane of the pallet, a soft substance over a hard one, or the pallet move up the face of the cog, a hard sharp substance over a soft and rough one, and in ninety-nine out of one hundred duplex escapements this is the case. The proof of this error exists in the fact that while one chronometer escape wheel is the worse for wear, there are, I may say, ten of the duplex. If the escape wheel cogs could be quite hard, so that the amount of friction by rubbing of these surfaces could be reduced, then most decidedly this arrangement would be best, because we should get a greater amount of force from the escape-wheel by reason of the reduced wheel radius of contact, and a greater amount of leverage impulse, by reason of the increased pallet radius of contact. That this described error is apparent to some watchmakers, is evident from the fact that they have endeavored to remedy it; which, however, I have seen done by the introduction of another error, that is, the pallet face is formed at such an angle, that the edge of the cog has to move up the face of the pallet. The error here introduced consists in the fact that the magnitude of the rubbing surfaces are increased, as I have shown in the angular form of the chronometer impulse pallets.

I pass now to the fifth point, "the impulse action of horizontal escapements," with which I connect lever and pallet actions which carry the inclined teeth. In this escapement we have a combination of lever and inclined plane, or wedge, the impulse being applied here on the same principle as the unlocking in the wheel and pallet action, viz.: a weight has to be raised by a force acting against an incline. Therefore, the force transmitted as impulse depends upon the angle of direction the weight has to take with the incline. As I have already described, the direction of force in a rotating body is the tangent to its radius. Consequently, the direction of the weight or impulse is the line drawn at right angles to the cylinder radius of contact. The greatest amount of weight can be raised by an inclined plane, or wedge, when this direction forms the greatest angle ; therefore the maximum amount of impulse is transmitted when the tangent drawn to the cylinder radius of impulse contact approximates to a right angle with the plane of the tooth.

The cylinder radius of contact is constant, which, however, is not the case in the wheel, because the radius of contact radiates from the centre of the wheel, and hence the impulse diminishes as the resistance increases. To counteract this error many escape wheels have that part of the tooth curved which gives impulse, which curve may be considered as a number of distinct inclines. The height of the inclined plane, as a whole, is determined by the degrees of impulse and ratio of thickness of cylinder. Therefore, as long as we do not increase its length, the impulse arc is not affected. If, therefore, the tooth is curved, we diminish the impulse in force during the action on the first half on the incline, and increase it on the latter, and so approximate the transmittance of force to the ratio of pendulum spring resistance, by reason of increase and diminution of the angle of direction with the plane or planes of the tooth.

In the light of this fact, we can easily see the advantage derived from a thin cylinder over a thick one. A thin cylinder permits a larger plane, with the same altitude; and for this reason the angle of direction of the weight to be raised, which is identical with the impulse, the greater the result obtained with the same amount of impulse force. Lever escapements have been constructed simply by applying a lever instead of a balance to the cylinder ; from which it follows that a description of lever escape wheel, with inclines on the end of the teeth, would only be a repetition of the conditions stated. There is, however, one which I may briefly notice, and that is the club-tooth action, which is a combination of the two modes of pallet actions. It has this advantage, that it admits of a closer escaping, and hence less trap, and therefore the same advantage as a thin cylinder.

I will now consider the sixth point, namely, "the resistance to the momentum of the balance in the cylinder and duplex roller by pressure during the free arcs of the balance."

The pressure in both instances is communicated by the point of the tooth, and the direction of the force is, as before stated, the tangent to the radius of the point. We have seen that the greatest result is obtained in propelling an incline plane when the direction of the force makes the smallest angle, and therefore the greatest pressure must ensue. Now, the same conditions exist as regards the pressure on the cylinder or duplex roller. The plane is identical with the tangent to the cylinder or roller radius of contact, and therefore the more acute this angle is, the greater the pressure; while the approximation to a right angle reduces it to a minimum. The resistance to the cylinder is, however, dependent upon another condition, namely, the radius of pressure, or the distance of pressure from the centre of motion. It is this pressure and resistance to the free arc which constitutes a compensating element in the horizontal and duplex escapements, and makes them, in this sense, more adapted to the going barrel than any other escapement.

My seventh and last point brings me to the inertia of matter, or the force expended in moving superfluous material in the escapements. If we look around we see in everyday occurrences hundreds of illustrations that the force required to set a body in motion is proportioned to its mass; or the resistance of a body to a force acting so as to set it in motion is proportioned to its mass. This is a fact holding good in all cases, and therefore applies to the parts of an escapement. If, therefore, we have an escapement with a lever with double the amount of matter in another, it is evident the inertia of the first requires double the force to overcome it of the latter, which proves to us that its economy of force demands a maximum stability with a minimum amount of matter.

This item approaches the condition existing between long and short levers. The large or smaller rollers can not, in this regard, be considered as part of the escapement, as the increased amount of matter goes to the momentum of the balance. The immediate point to consider is the inertia of the increased amount of matter, and for this reason it is certainly a drawback ; in another sense, however, it is an advantage. The same amount of freedom necessary in an escapement with a short lever, will suffice for a long one; and therefore the error arising from excess of shake, by the roller action or pivots in the holes, is in a smaller ratio in its bearing against impulse, than in an escapement with a short lever; and therefore its choice should be guided by the care and labor expended on the escapements in fitting the points of contact and the pivots.

We see from these facts that the design in escapements is as much superior to the mere finish of parts, as mind is to matter. A verge escapement, finished with the best skill of the finest workman, will be a verge still, and never can give the result of a chronometer. The horological workman will do well to remember that there is a law governing the production of his labor, on which the result depends. Polish may beautify, and may diminish friction, but mechanical laws and geometrical forms govern the chief design of the escapement, viz.: the economy of force in its transmittance to the balance.

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Reminiscences of an Apprentice.

CLEANING CLOCKS—FIRST DAWN OF IDEAS—MY FIRST EXPERIMENT AND THE RESULT.

After the severe and protracted ordeal I, and also "our maister," went through in teaching me to make large pins, and the *art* of turning the hand-vice regularly, and the proper method of handling the files necessary for the operation, I was put to cleaning clocks, which, to me, was a great relief. The clocks were all of the old English type, in tall cases, and when "our maister" had to go to a customer's house he always took me with him to carry the clock back to the shop, should it require cleaning, or any special repairs. On entering the house of the customer we received a welcome, mixed with a respect greater than was given to the carpenter, the blacksmith, or the tinsmith, and not generally accorded to any class of visitors, except it was the doctor, or the minister. The usual salutations being over, the object of the visit was introduced, and I remember the fabulous stories that were told of the going of the clocks up to the time that they had gone wrong, and it was still supposed that there could not be much the matter now, seeing that they had always gone so well before. Every clock was the best in a circle of many miles, in the eyes of the owner, and "our maister" listened patiently to the story of every one, while I stood, cap in hand, at a respectful distance. Generally the clocks were tolerably well made ; some were first-class ; but again others were inferior. When they did go, good and bad all went well enough for the ordinary purposes of life, and pleased the owners till once they stopped, and then "our maister" would sometimes spoil one and make it worse than ever it was before. I used to think it strange that such a clever man should spoil so many decent people's clocks ; but now I understand the secret.

I remember of an instance that "our maister" ruined an excellent clock, beyond remedy. It belonged to a maiden lady in our town, and was made by her father, who was a watchmaker. He disdained all modern appliances or conveniences to assist him in his work, and he showed his contempt for them in practice, for he had neither used a lathe nor a turning machine of any description in making the clock. The wheels were all divided by using wheels belonging to other clocks, and the teeth he cut in them with a hand-saw. The materials the clock was made from were such as one will find in the scrap box of a tin or blacksmith's shop in a country town. It was a centre seconds clock, too, and it struck the hours ; and with such tools as may be found in the shops where he got the materials he actually made this clock, which went for a long time, but finally stopped one day, after its maker was dead. "Our maister" did his very best, but he only made it worse and worse every time he went to it, which showed he did not understand it ; in fact it was a proof that he knew nothing at all about it ; and the grief and rage of the owner was great at the result of the misplaced confidence in the professional ability of "our maister."

Like all great artists, this departed Horologist had left but few monuments which might be taken as a fair sample of his transcendent genius. True, he had made and repaired many kinds of machines, but the clock that "our maister" had spoiled, was his masterpiece ; and the owner believed that even its maker, were he alive, could not produce another like it, which is quite probable. However, it was fortunate that there remained another, almost a duplicate, which was not in use because it had not been quite finished. This one was intrusted to an artist belonging to the same school as its maker, and of course he completed the work satisfactorily. All immediately concerned were delighted at the result, and every one who, from principle, was opposed to the systematic spoiling of time-keepers in order to extract more money from their owners, felt an inward satisfaction at this total discomfiture of "our maister."

But although he was sometimes discomfited and put in the shade, "our maister" would not in the least change his ways, or his manner of doing work. He was as particular about my motions, when he taught me to take such clocks as I speak of, out of the case, as the drill sergeant afterwards was with us when going through the platoon exercise after I joined the Volunteers. He would place his right knee on the front of the case, and slide the head gently off with his hands, first examining if all the wood-work of the head of the case was firm, lest, in the act of taking it off, the head might fall out of his hands. Then he would examine the suspension of the pendulum, and see if the back fork fitted to the pendulum properly. Next he would take the pendulum off, catching hold of it with the one hand a little above the middle, raising it up a little, and with the other hand disengage it from the suspension, and let it slide down and settle comfortably in the bottom of the case, leaning it in a corner at the back, if it had not to be taken away. Then the weights were taken off by catching the pulley with one hand, and unhooking the weight with the other ; but before doing so, I had to put my hand on the seat board, lest the clock should tumble down when the weights were taken off, should it be badly fitted to the case. The clock was lifted off and dusted down, in a convenient place, and the cords wrapped round the seat board. The head was put on the case again, the weights put in a safe place, the clock was set in my arm, with the dial towards me, and I was marched off to the shop, while "our maister" was getting his parting instructions to be sure and have it soon back again. I was not allowed, at first, to take the clocks to pieces. "Our maister" did it himself, as follows:

He first made me clean down the bench ; and when that was done he set the clock upon it, and commenced by taking off the bell, which was made to serve as a receptacle for holding the small pieces of the clock, but a piece of paper was first put into the bottom to prevent the very small articles from falling through the hole. After examining the escapement, and taking out the pallets, the back cock was put on again to prevent the frames from getting scratched when they were laying on the bench. The clock was now turned over on its back, and laid on the bench, and the hands taken off; next the dial, and then the seat board was taken off. Then the dial work and the repeating work was examined, and the pins all taken out, and if it was not a clock that he had cleaned himself, last, he generally threw the old pins all away. I used to feel mad at him for throwing away the old pins, because he had to use the new ones that I had made, and which had cost me so much unpleasantness; but how dare I to remonstrate with "our maister" on the subject? When the pins were taken out, all the loose parts were removed, the front frame taken off, and the wheels inside the frame were exposed and lifted out, the scape wheel put in a safe place, the cords disengaged from the barrels, and put up in a coil, and I was set to work to clean the clock. This was not so difficult as making pins, yet it was a long time before I could please "our maister." I had to clean them over and over again, for he would not tolerate a spot of rust or dirt to be left, and after I had done them as well as ever I could he would do them over himself; and the small holes, that I could see no use in cleaning, he was the most particular about, for after I had done them with a feather, and, as I thought, well enough, he would do them by pressing in small pieces of wood and turning them round in the holes, and then he would scrape the wood and put it in the hole again and again, till the brass did not alter the color of the wood in the least degree.

There is a class of cheap clocks made in Germany that hang up on the wall, and have the chains, weights, and pendulums exposed to view. I soon noticed that "our maister" had a special antipathy to them, but why, I could not tell. His opposition to them was so strong that he would not allow them to come into the shop for repairs. I had now seen the inside of an eight-day clock, and wanted to see the inside of a German one, and the more "our maister" said against them, the more it made me anxious to have my curiosity gratified; and when I could not see one in the shop I made up my mind to see one somewhere else. A clock of this kind was in the house of one of my comrades, and one evening when the folks were out he and I went about examining it. It was a cuckoo clock, and the little wooden bird came out at the end of the hour, flapped its wings, bobbed its head, and made the usual cries. I climbed up, opened the doors at the side, and looked in. This was my first exploration into the wide domains of clock-work, and I soon saw that this class of clocks differed as much in its general arrangement from the eight-day clocks that I had seen before, as the eight-day clocks differed from "our town clock;" but what puzzled me most, and which was most difficult for me to comprehend, was the mechanism that caused the bird to cry "*cuck-oo.*" I noticed that there was a small pair of bellows connected with it, and I suspected that they must have something to do with producing the sound; but I could not tell exactly, because I could not wait and look long enough to see the clock strike, for the look into the works was a stolen one. We expected my comrade's parents to come in soon, and it would never do for them to know we had climbed up and opened the door of the clock, for it was too sacred an article, in their estimation, even for a watchmaker's apprentice to meddle with. I had known about the clock for about as long back as I could remember, and had seen the bird come out often, but I never thought about how the thing was done till my interest was awakened on seeing the inside. A strong passion to study cause and effect early developed itself in my nature, and I could not rest till I found out what made the little bird cry cuck-oo. I experimented with my mother's bellows in various ways, trying to produce a sound, but could obtain no satisfactory result; still the subject uppermost in my mind for a long time was how to produce a sound like that the bird in the cuckoo clock made.

Here I must digress and mention that there was a travelling musician made periodical visits to our town. He was a large and powerful old Highlander, and had been a soldier, and had lost both of his legs. He, however, dressed himself in full Highland costume, and was driven about in a small carriage that was drawn by six dogs ; and, although the martial music of the bagpipes did not sound to the best advantage in the close streets of a town, he was a general favorite, and we all welcomed him when he came round. The boys were fond of the dogs, and gave them bread to eat, and the dogs licked the boys' hands, while their master was making the most noise that he could with the bagpipes.

One summer evening, as I was pondering over the bird in the cuckoo clock, and the relation the small pair of bellows bore to the rest of the mechanism in producing the sound, this musician drove up to the front of our house, and commenced to play. All at once the idea struck me, and I ought to have thought of it before, that the instrument he was performing upon was a pair of bellows of a peculiar shape, and there was certainly plenty of sound issuing from them. The player was squeezing the bag under his arm, as I thought, to serve the purpose of bellows; still I had a doubt, because he was also blowing with his mouth, and that might have something to do with producing the sound. I concluded to test the thing by stopping up the hole in the end of one of the pipes that lead to the bellows. We all looked on the man, his dogs, and his pipes as common property, and although I would perhaps momentarily spoil the music, I did not expect it would be much harm. I got a piece of putty, crossed the street, and, elbowing my way to the inside of the crowd, took up a position at the musician's back, and just as he was squeezing the bellows the most, I put the putty into the end of one of the pipes. The effect was instantaneous, and there was no longer doubt but what sound came from the bellows, and I was delighted. But there is never a pleasure without a pain, for when I took away the putty from the end of the pipe, a piece remained in the hole, and the sound was stopped longer than I had intended. The old man frowned, and then reprimanded me, in language neither complimentary nor polite, for spoiling his music; and to make things worse, the more he tried to take the putty out, the further it went in, and at last his instrument became temporarily disabled. Some of the crowd cried "for shame," others laughed, while the old man became more violent in his language than ever. It was no use for me to offer any explanation that I did not intend mischief. It was plain that I had committed mischief, so I beat a retreat, and got to the outside of the crowd as quick as possible, and at that particular moment I was really glad that the old Highlander had lost his legs.

After this, the mysteries connected with producing the sound from the little wooden bird gradually became clear to me, and I soon discovered that exactly the same principles were involved in the operation as there are in making the sound in toys representing barking dogs, mewing cats, and crying babies. In the course of time my comrade's parents had sufficient confidence in me to allow me to clean their clock once when it went wrong, and, of course, I then saw all about it. Upon the whole, I think that there exists too much prejudice among a portion of our craft against German clocks. These clocks certainly have no claim to fine workmanship, but still they have been the means of supplying many poor people with time, who could not afford to pay for a higher priced clock, and who, before the advent of the Yankee clock, would not have enjoyed that convenience.

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On the Management and Cleaning of French Clocks.

There are probably no class of clocks used for the ordinary purposes of life that are capable of giving better satisfaction to the public, or less trouble to the dealer and repairer, than those known by the name of French clocks. Their comparative moderate cost, when real worth is taken into consideration, and the beautifully artistic design of the cases, has been the means of creating a demand for them in refined communities, all over the globe. Works of art in this line, which were at one time only to be found in the palaces and castles of kings and noble-men, have found their way into the dwellings of those possessed of less affluence, and in various grades of quality they are gradually being introduced into the homes of all possessed of a cultivated taste, and a moderate income.

The cleaning and management of these clocks, although simple, and requiring care and a little experience, more than any other qualification, is seldom done in a manner that gives full justice to the clock; and it is our object, in the present paper, to impart a few hints to those who may not have had the necessary experience; and we will begin by making a few remarks on new, or newly imported clocks.

It occasionally occurs in newly imported French clocks, that a movement has been fitted to a case that is not high enough to allow the pendulum to swing free when the clock is regulated to the proper time. Sometimes filing a little off the bevelled edge of the ball will allow the pendulum to clear the bottom of the case or stand of the clock, and allow it to be brought to time. Should any more than just a little taken off the edge of the ball be required, there is no use troubling with it further. You must either get a new movement, or alter the train, or make a new pendulum ball of a peculiar shape. The train is easiest altered by putting in a new scape-wheel pinion containing one leaf less than the old one. In all large cities, where pinion wire can be had, putting in a new pinion is not much trouble to the practical workman; but if this cannot be done, and a new movement cannot be had, a new pendulum ball of an oblong shape may be used. For another method, see page 233, second volume of the Journal.

After they are unpacked, whether they are apparently in good condition or not, it is always well to take the movements to pieces, and to examine every action in the clock. You may begin by taking off the hands and the dial, first trying if the hands move freely, then examine the drops of the escapement to see if they are equal, and if they are not exactly equal, they can easily be corrected by moving the front bush of the pallet arbor with the screw-driver, making a light mark across the bush with a sharp point, which will show how much the bush has been moved. The fly pitching may next be examined, and adjusted by a movable bush in the same way. The object of this bush being left movable is to admit of the depth to be set so that the fly will make the least noise possible, and also to regulate the speed of the striking train. The dial work and the repeating work may now be removed, and the *springs let down,* and the end and side shakes of the pivots in their holes carefully tried, and all the depths examined; but as a general rule they will be found to be correct. The pivots will, in some instances, be a little rough, and it will not be much trouble for a watchmaker to smooth them a little. After examining the main-springs, and noticing that the arbors are free in the barrels, the clock may be cleaned out and put together. This will be most conveniently done by placing all the wheels first on the back plate, putting the front one on the top. Get all the long pivots into their holes first, and as soon as possible put a pin into the bottom pillars. The locking of these clocks are very simple, and all the pieces are marked that are necessary to be marked. All the workman has to do is to follow the marks and he cannot go wrong; but should he begin to bend or twist anything, he will soon find himself in serious trouble.

There are a few items that we wish to direct special attention to. Be sure that the arbors in the barrels are oiled, and that the main-springs are hooked before you put them in the frame, and be sure there is oil on the pivots below the winding ratchets before they are put on, and that the wheel that carries the minute hand moves round the centre pinion with the proper tension, before you put on the dial. After the dial is put on, this cannot be remedied without taking it off again, and if the hands are loose, results fatal to the character of the clock are sure to follow. We can recall an instance where a customer left an order at one of the most celebrated watchmakers in the United States to have a French clock put in order. One of the workmen, who had the name of being a good watchmaker, was sent to examine the clock, and he brought it away, cleaned it, and took it home again. For months complaints came in that the clock went slow, and the man who cleaned it always went and altered the regulator, but with no good result, and the clock was a second time brought to the store. It was examined, and the small wheel on the top of the regulator was found to have been wrenched off. The regulator was a Breguet one, and when the piece that slides on the pendulum spring was raised as far as it could go, of course any farther turning of the regulator square at the point of the dial, wrenched the wheel off, as we have stated. Now the real cause of all this trouble and annoyance to every one concerned, was nothing more or less than the hands were loose in some positions in which they were set, and when the clock was in the act of discharging the striking part every half hour,the hands sometimes fell back a little, and the clock appeared to be going slow.

In regulating one of these clocks, especially if you have to go a distance to do it, and are not conversant with all its peculiarities, it is always safest to turn the case round, examine the regulator, and if it is a Breguet one, put a slight mark with a sharp point across the regulator, and when the regulating square is turned you will see exactly how much the regulator is altered; because there is sometimes a want of truth in the screw that moves the sliding piece, which deceives people as to the value of the amount they may have moved the regulator. There are various kinds of regulators, but probably the Breguet one is the most common of those of modern construction. Those that have silken thread regulators should always be regulated with caution, and when small alterations have to be made, it is well to use an eye-glass and notice how much the pendulum is moved up or down. When a clock with such a regulator has to be moved or carried about, when it is out of the case, it is always safe to mark the place where the pendulum worked in the back fork when it was regulated to time; for, should the thread be disarranged, it can be adjusted so as to bring the mark on the pendulum to its proper place, and the regulation of the clock will not be lost thereby.

On fastening one of these clocks in its case they are generally put in beat by moving the dial round a little till the beats become equal; but it sometimes occurs that when the clock is in beat, the dial is not square in the case. When this happens, it is always best to take the clock out of the case and bend the back fork *at its neck* till you get it to move exactly as far past the centre wheel pivot on the one side as on the other, when the pallets allow the scape wheel to escape. If this is done, the dial will be square when the clock is in beat. Some French clocks have their back forks loose, or rather spring tight, on their arbors. This is sometimes done in movements that have plain as well as jewelled pallets. If the pallets are exposed in front of the dial, you can at once detect by the eye if the clock be out of beat; but if they are inside, you cannot tell without close listening. One of the objects of the loose crutch spoken of is that the clock can be put in beat by giving it a shake; but it is evident that if a shake puts it in beat, another shake will put it out of beat again. We have seen great annoyance arise from these loose crutches, and long journeys made to examine clocks, when nothing was the matter with them more than they were out of beat, caused by the housemaids moving them in their dusting operations. The crutches ought always to be rigidly tight, except, perhaps, when the pallets are jewelled, and the clock not liable to be moved.

As to cleaning these clocks, there remains but little to say; they seldom if ever require any repair, except perhaps the pallets get cut, but they are generally made so as to admit of the action being shifted, and which is easily done. Cleaning the brass, of course, is done in the usual way. Buffs should be used for the large pieces, when very dirty; but if they are only slightly tarnished, a little cyanide of potassium dissolved in alcohol will be found very suitable.

The cases require to be handled with care, and special care should always be taken to prevent finger marks. In the very highest priced clocks this precaution is perhaps not quite so necessary, because then the cases are either real bronze, or gilt and burnished; but in the cheaper qualities, and also in some expensive patterns of cases, the gilding is easily damaged. A little cyanide of potassium and ammonia, dissolved in water, will often clean and restore it, if the gilding is not rubbed. There is a preparation sold in the form of a paste that renews the lustre of black marble cases if they have become dim. If the preparation cannot be got conveniently, a little beeswax on a piece of flannel is a good substitute.

Although we have known some instances where there was much trouble and little satisfaction in the going of newly imported French clocks, in almost every instance the trouble could be traced to the mismanagement of those persons who were intrusted to put them in order and adjust them. A little care, and the exercise of sound judgment on the part of the workman, would prevent many annoyances that sometimes happen with pendulum French clocks.

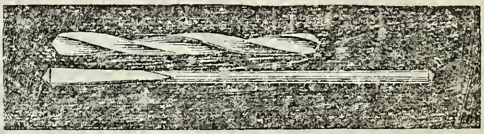
Forming and Tempering Drills.

EDITOR HOROLOGICAL JOURNAL:

The subject of drills presents claims for consideration as endless and various as any one in the mechanic arts. The best form and proportion, and the best mode of construction of these tools, are still unsettled questions—their various uses requiring almost infinite diversity. One of these requirements has scarcely ever been discussed, or even noticed. In drills for working hardened steel we must have every possible advantage. None but the very best quality of steel will serve, and the most careful manipulation is equally imperative; for, let it here be understood that the degree of hardness that can be imparted to a piece of steel, greatly depends on the *manner of working* it, as well as on the *process of hardening.* Density, or hardness, strength and toughness, are the points aimed at, and these properties are not incompatible, as is often considered.

Steel is simply carbonized iron. In cast iron we have one extreme of this compound, and in wrought iron the other. Of course both have impurities. In the one we have the coarse, bright, angular crystals, with considerable hardness, while the other is soft, tough, and fibrous. Some grades of steel show, under the microscope, the grain coarse and crystalline, or sometimes almost globular, like fine shot adhering together. Such steel may be comparatively hard, but it lacks strength and toughness. The best tool steel shows a very fine crystalline, silky grain; of course these qualities are important for many other tools besides these special drills, but for these the need is absolute; and now comes the inquiry, what form and proportion must we give them to be most effective?

Having selected the steel, it should be carefully forged at a low red heat, and finally finished, with light blows, at a black heat, so as to condense it as much as possible without destroying the grain or cracking the steel. When forging the cutting end of the drill it should be left large enough, so that in flattening for a drill, while it is hardly visibly red, or just at a black heat, the thickness of this flat part shall be one-half or two-thirds of the intended diameter of the finished drill; and on no account should it be hammered edgewise, as this opens the pores of the steel, breaks up the grain, and greatly weakens it. The drill is now to be finished to size and shape by turning or filing, forming the cutting angles at the end at about 130°, also thinning the point down to about one-sixth of the whole diameter, and leaving on the back just enough to give a projecting edge.



The best angle for the cutting end of a *hard* drill is about 130°, and 90° is as pointed as is often desirable in drills for common use; but the kinds of work, the materials used, and the objects aimed at, are so various that only a varying rule, so to speak, can be given, which may be stated thus: *The cutting angles should be carefully shaped so as to wear equally at the point and corners,* else, if the drill is too pointed, this grows dull before the corners; and if the angle is too obtuse the corners fail first. Much care should also be used to sharpen the drill equally, so that each edge is the same, and the point exactly central. If one edge is sharper than the other there is a liability to run off from the central point. Twist drills, as they are found in market, have the spiral groove extending to the point. These operate well in steel or iron, but for brass or other soft or thin sheet metal, the front edge should be ground flat, and lengthwise of the drill for a short distance (at least the depth of the chip or cut), otherwise the tendency is to run in on the twist like a screw. The cutting edge should not be too thin, as it would be more likely to "chatter" (not making a smooth hole), and also more apt to break. This is especially true in very hard drills, for under such heavy pressure as is required in drilling hard steel, the least chatter would be fatal to the edge; and to obviate this, as well as to give strength, it should have greater thickness than is useful in softer drills. Hard drills should also be finished before hardening, as the surface can be made, by the use of the following powder, slightly harder than the internal part, thus adding hardness to greater strength and toughness:

6 oz. Prussiate Potass.
6 oz. Bichromate "
22 oz. common salt,

all finely pulverized and thoroughly mixed.

Heat the drill to a dull red, and cover it with a thick coat of the above powder, which, when again heated in the fire, melts, runs over the steel, and protects it from burning; when brought to a cherry red, plunge into cold water, and it is ready for use.

The reader who may have had patience to follow me thus far, may say, "What has all this to do with pivot drills?" Very much, as I have found by nearly thirty years' experience. But to the point: Suppose we have a broken staff of a fine, nicely adjusted watch, and we find the balance uninjured; now, if a new pivot can be inserted without disturbing the balance, we may perhaps save readjusting, or in part at least. The temper of the staff may be as hard as if drawn down to a *dark* yellow or reddish color. Now to drill this requires a good tool, and some care and patience, and such a drill, on a small scale, as described above for hardened steel, is well adapted to the work. To make these fine drills, file down the wire (or narrow slips cut from thick pieces of main-springs of fine wire steel) a little tapering, to nearly the proper size, and flatten the end till it cracks open; then file back just enough to cut off the cracked part. This insures the utmost condensation possible to the metal. Now file up to size and shape, so that when finished the thickness will be about one-half the diameter. Have the lamp flame small, so as not to overheat, and when red thrust into a piece of tallow held as close to the lamp as possible, so as to cool the drill in the tallow instead of the air. If the drill is carefully made and hardened, it can be used without drawing the temper, and should be as short as possible to allow the needed pressure in drilling, and *used without oil.* With slow speed and strong pressure, a drill made as above will enter any staff or pinion that is safe to use. Hollow joint makes the best handle, and fasten in the drill with shellac.

A strong solution of the hardening powder, in soft water, will give a harder temper than tallow. By using the powder, fine steel as well as iron can be case-hardened, if it is not too hot, when plunged into cold water. A lower heat that would not harden at all without the powder, will *case-harden* when the higher temperature would *harden through.* It will need a few trials to properly adjust the heat so as to surface harden, and not harden through.

L. F. Munger.

Rochester, N. Y.

Queries.

Editor Horological Journal:

At the risk of appearing rather inquisitive, I venture to ask through your columns a few questions on matters not altogether, I hope, uninteresting to many of your subscribers; and in the event of answers being given to any or all of them, I hope they may be of such a nature as to be practical and really useful. In adding this stipulation I am willing to admit that "beggars should not be choosers;" at the same time I mildly protest against the custom so often indulged in by many, whose ignorance or carelessness gives their intended kindness more the effect of actual insult than real assistance. For instance, in a late number of a periodical in my possession, in answer to a correspondent about the method of coloring gold, he was informed that "gold was colored by the chemical effect of acids," which of course was true and wholly unsatisfactory. Again, a receipt is "going the rounds" for a "valuable cement" that among other things will unite leather, and is not affected by water or moisture. The ingredients are principally good glue, acetic acid, white lead, etc. I tried this carefully in various proportions, and after the loss of temper, time, and money, found it worthless to withstand moisture.

The celebrated "Armenian Diamond Cement" I got carefully prepared by a chemist (to avoid mistake), and although a fine cement for polished and hard surfaces, a few days' contact with cold water rendered it useless. The simple white lead paint cement is the only thing that I am acquainted with that remains unaffected by water as far as I have tried it; the only trouble is the length of time required for drying.

Years ago I had difficulty with "fly up" springs, trying useless recommended methods of tempering; but one lately noticed in your columns I found very good, and used till I got from an Englishman a method that I have never known to fail: Heat the spring on a piece of charcoal, with the blowpipe, till a bright red; plunge into cold water; when dried, wrap loosely with thin binding wire, and dip into olive or sweet oil; then hold (with the small end up) over the flame till the oil begins to burn; dip at once in the oil again; repeat *six* times. When I had put in quite a number by this method I thought six times rather unnecessary, and tried *three*. The spring broke in a month, and I have stuck to six ever since.

ONTARIO.

Hamilton, Canada.

The foregoing letter clearly enunciates the experience of many craftsmen, who, grasping for knowledge, find in their hands only ashes. It is a cruel disappointment; it shakes one's faith in the assertions of men, and confirms previous doubts of the truth of what "the papers say." It is much like "feeding the hungry with husks," or bestowing upon blind beggars spurious coin. One of the moving causes in establishing this JOURNAL was the knowledge that there was a longing for useful trade information by thousands of our craft who were deprived of the advantage of a regular trade education; and it has been our constant endeavor from its birth to the present moment, to make it the vehicle of *reliable* information. We cannot be expected to stand responsible for all the opinions, or the processes, which correspondents communicate, although we feel pride in the conviction that none of the correspondents of this JOURNAL have been the means of misleading any in the pursuit of information on the various topics treated of. We have long lamented the loose method which many adopt of expressing themselves in their descriptions of ways and means. Modesty is one fruitful source of unsatisfactory delineation of processes; as a rule, men who know most are backward in displaying that knowledge. Such men will usually be deficient in the minutiæ necessary to convey to the ignorant the complete knowledge of any method; their modesty fears being accused of assuming that the person he addresses knows nothing, not even the *little things* that to him seem trifles, but that are really indispensable to the doing of the thing in hand. When a man knows how to do any given thing, only one rule is necessary for him to follow if he would communicate his method to another, and this rule is best given in the specifications of a patent, where it is required that "the description shall be in such words and terms that any one skilled in the use of tools can, from such description, *construct* the article or machine." It is very easy to tell how to make a boot, thus: Lay the leather down, put the pattern on it, and cut the leather according to the pattern, sow up the leg, stretch it on a last, peg on the sole, trim and finish—but a sorry boot would be produced from such a description of the process.

We have done our best to get those who have favored us with communications to be minute. We intend the JOURNAL to be preeminently practical, and removed as far as possible from the Encyclopædia style of literature, which is mostly "glittering generalities." We are persuaded this peculiarity enhances its value to the workman, and we know it adds much to the labor of conducting it. We must depend largely upon the generous interchange of ideas among our patrons. "Freely ye have received, freely give," is most excellent doctrine, and conduces to general knowledge in the same way that compound interest accumulates.

There being really no practical works on Horology and correlative subjects, and as no one man knows all that is to be known on that or any other subject, the JOURNAL was started with the hope that it might prove an "omnium-gatherum" of the fragmentary knowledge widely dispersed among individual members of the trade. The anticipation that each would contribute something to the growing mass of facts has been largely realized, and a fund of information is being in this manner accumulated, and put in a form to supply those who choose to draw from it in the future, making the path of knowledge much easier to travel to those who follow than it has been to us.

Every gray-headed watchmaker knows that all the skill he has acquired in the art has been by his own hard experience, aided a little by such chance counsel and instruction as accident threw in his way. This practical experience of each individual was almost wholly lost to every other individual, thus rendering progress exceeding slow. In the future of the HOROLOGICAL JOURNAL we intend, with the aid of our peers, to go on gathering together such practical information as no book ever contained, and no man ever acquired; and there seems to be no more direct road to attain this desirable end, than "questions and answers."

Every man is lacking in some particular item of knowledge that some other man can supply; and he, in his turn, can, through the same medium, get such information as he desires on points of interest to himself. The same plan seems largely in use in other branches of business. Scientific, mechanical, and literary papers have their "Answers to Correspondents." Since the year 1849, there has been published in London in each succeeding year, two volumes, of 500 pages each, entirely made up, as its title indicates, of "Notes and Queries," with that celebrated motto of Capt. Cuttle's on its title-page—"When found, make a note of." It being "a medium of communication for literary men, artists, antiquarians, geologists," etc., an intensely interesting and valuable work, bringing to light items of information widely scattered in private hands, that would never otherwise have been made public, has been the result. Just here we would cordially thank our friends for what they have done in the past; and, for the future, we hope that none will refrain from coming to the aid of those who ask for information.

Our correspondent, who has so unintentionally drawn us out on this subject, would like to know:

1*st.* How good plastic "modelling wax" is made, that will work as easily as soft putty?

2*d.* A good material for moulds for fine castings of gold, copper, or silver?

3*d.* How is copperplate printing ink prepared?

4*th.* What is the material used for painting the figures on gilt dials?

5*th.* Is there any soft enamel that will melt with a spirit lamp, for sale; or how can such be prepared?

6*th.* Are copper-plates for visiting cards kept prepared for engravers' use, and how and where are they sold, and how is the ink prepared?

7*th.* Is pure nickel used for plating, and what is it worth per lb.?

——o——

Well Ordered Benches.

We have been kindly furnished by Mr. E. L. May, of Defiance, O., with the drawing of an excellent work bench, but, as we have seen several others very similar, think it unnecessary to publish it. His communication gives us the occasion to express our gratification at the efforts we see being made in all directions by members of the trade to become possessed of every facility that good tools and convenient shop appliances can furnish; and we feel a pride in the thought that the HOROLOGICAL JOURNAL has been more or less instrumental in bringing about this change. Those persons who have a laudable ambition in their profession—a pride that is not only ashamed of ignorance in themselves, but mortified at the disgrace which unskilled members bring upon the profession—have been, in some degree, brought in contact with that class who are lacking in ambition to become skilful mechanics. We do think the Journal has promoted a spirit of emulation, which cannot but result in general advancement.

Honest, helpless ignorance—that is, ignorance which results from no lack of inclination to be informed, but from the want of access to proper means of instruction—is not to be blamed, only lamented. In the interchange of ideas which the Journal seeks to promote, the mechanically uneducated can see for the first time a way open to a better knowledge; learn, perhaps for the first time, that there are other and better ways than their own. Dishonest ignorance—ignorance that seeks no enlightenment, and is content with the wages its unskilled labor brings—is abashed, compelled to be more modest in its pretentions, and to take a back seat in public estimation, where it properly belongs.

There is no more sure indication of an ambitious desire to excel as a workman, than good tools on a good bench, and their proper and orderly care. We never see a shop bench which has the confused, disorderly appearance of a lock, gun, or blacksmith's shop, without suspecting that the man who presides over it has the same confusion in his head; that his ideas, his knowledge, his experience, are all "topsy-turvy," like his tools; in fact, it can hardly be otherwise, for it is the outward visible evidence of his inward mental condition. A dirty bench, covered with a miscellaneous "hodge-podge" of large and small tools, nails, bit stock, screws, wood hammer, watch-glasses, parts of movements, jewel screws, and door butts, Yankee clocks and Frodsham watches, all in a pile, show unmistakably a workman—it may be ingenious and skilful enough—but too careless and heedless, and disorderly, to be trusted with fine work; such artisans are always in trouble,—can't find screws—wheel lost in the general confusion—monkey-wrench falls on and breaks some delicate part—half a dozen jobs are half done, and half a dozen more are begun at the same time, and the bench is strewed with paper-boxes, and watch-glasses, and inverted tumblers, and broken wine-glasses, all containing parts of things that are partly done. Ugh!! It's enough to craze one to look upon such a sight. Some workmen seem to fancy that all this confusion looks like business—they are always so drove—no time to "slick up." The fact simply is, that a good share of their time is spent in search for lost parts, and in repairing, as best they can, damage of their own doing. A good bench, with a sufficiency of drawers down to the floor on either hand, and all unnecessary tools kept out of sight and out of the dirt, shows a workman that is clear-headed, cleanly and careful, and you may feel perfectly sure that he will do a watch no *damage*, if he does it no good.

—o—

Saving Gold Filings—Making Gold Rings—Short Clock Cases—Watch Bezels, Etc.

Editor Horological Journal:

I beg leave to suggest to yourself and numerous readers that making a department of short practical items in your Journal would be an interesting way of disseminating information amongst us. There must be many of your readers with numerous valuable ideas and scraps of general information that can be written out in a few lines, and be of great service to many a one. May I, with your approval, ask every one to help to establish such a department? Absolutely original items cannot, of course, always be expected. There are plenty of workmen to whom they will not only be new, but of considerable benefit. My object is in a measure selfish, as I contribute my mite, hoping for a greater return. B. F. H.

Egg Harbor, L. I.

Gold Filings.—The following process is very useful for working up filings and scraps of gold, gold-plated jewelry, etc. It does not, of course, refine the gold, as in the usual process of quartation. It merely destroys the filings of copper, silver, german-silver, brass, and other metals acted upon by the acid. It will "eat" the solder or brass out of hard soldered and plated goods, leaving the thin shell of gold. The iron filings are thoroughly separated from the mass by the repeated use of the magnet. All pieces of soft solder and lead should be picked out, and if there is much soft solder in any of the plated articles it should be melted out, and the residue then placed in a shallow glass or china vessel and rather more than covered with good nitric acid. When the bubbles cease to agitate it, the acid should be poured into another cup, and if there is any base metal left, more acid should be added, and the mass stirred occasionally with a strip of glass. When no bubbles appear on adding new acid, that may also be poured off, and the filings washed two or three times, or until perfectly clean, letting them stand a minute or two to settle before pouring off the water. They are then dried and melted.

The filings and scraps treated in this manner seldom require more than one melting to make them easily worked and fit for jobbing. There is no skill required, only considerable care in the handling. The silver remaining in the acid may be precipitated in the ordinary manner with common salt. The chloride obtained is fit for the repairer's plating solution, or may be melted into a button, and, being pure silver, used as an alloy for other gold.

Soldering Fluid.—The ordinary "soldering fluid" or "acid" used by tinsmiths and others answers a very good purpose in preparing small articles to be electro-gilded or plated. In spite of the best efforts of the amateur, the work will sometimes strip or peel off. But if the article, after having been cleaned, is washed over, or dipped into this "acid," the coating applied will be found to stick as effectually as it does in soft soldering.

Making Solid Rings.—The country watchmaker, who has neither rolls nor draw-bench for making plain rings, can do very well by using a swedge made of any suitable piece of steel or iron, with a half-round groove filed across the face of it. The swedge should be held firmly in a stout vice, and may have a number of grooves corresponding to different shaped rings. The gold should be got out to the right thickness, and a little narrower than the ring is to be, and hammered evenly into the groove until it is the proper shape. It is much better to make a single ring in this way than to form it with square edges and then turn it up in the lathe, or to round the corners with a hammer. Even as many as a dozen rings can be made in this way at a time to very good advantage.

Short Clock Cases.—A great number of "Yankee clocks" have such very short cases that the pendulum rods cannot be over three or four inches long. These clocks, in many instances, will not run regularly, and sometimes will stop without any apparent cause. The cause will be found in the pendulum spring, which is almost always too thick and stubborn, and must be reduced by rolling, or, where that is not practicable, by filing and scraping. The springs, as a general thing, are left thicker than they ought to be, in order to avoid twisting and breaking by careless handling. A clock that would stop every day or two was treated in the above manner, with the following good results: The pendulum rod was $3\frac{1}{4}$ inches long. The spring was reduced by rolling to one-half its former thickness, and replaced in the clock, with exactly its former length. The clock then "moved off" as though it had received new life, and continues to go, showing no signs of its ever stopping till worn out. Although the pendulum was the same length as before, the clock lost 30 minutes a day on its previous rate.

Watch Bezels.—It is often found necessary to alter the groove in the glass bezel of a watch. It may be injured or bent so badly as to require truing, or it may be found convenient to enlarge the groove to fit a glass. In either of these instances it is a work of no little time to turn and fit it to a wood chuck, which has been the ordinary way. A much simpler, and quite as correct a process, is to fit a brass face plate to the live spindle of a lathe, of a sufficient diameter to take on a large bezel. The chuck must be turned perfectly true on its face, and may have holes cut through the plate to receive the hinge or any other projection on the under side of the bezel. In working with this chuck it is only necessary to shellac the bezel to it, and guide it to truth by a slip of wood applied either in the groove or to the outside of the bezel.

Fitting and Repairing Balance Staffs.—In the latter part of the 3d Chapter of

"Grossman's Treatise" there is described a balance-staff that is a plain arbor without collet or shoulders for hair-spring or balance, the spring collet fitting to a part of the balance, and the staff fitting tightly into a long small hole through the balance. The advantage to be derived from this plan is in being enabled to adjust the height of the balance, especially in English watches, as this staff can be driven either way. This plan is only applicable when a new balance is to be made. The same advantages can be obtained by the repairer in replacing a broken staff only. Fit a piece of brass wire, large enough to make the staff collet, into the drill chuck, or in any other manner to the lathe; turn the socket for the spring collet, also for the balance, and fasten the balance on with a burnisher, before removing from the lathe. Drill the hole the size of the staff, and cut the collet from the lathe with a fine saw. The staff is but a straight arbor fitted tightly into this hole. Besides the advantages of making little alterations in the height of the balance, this staff is easier to fit, even the first time, than the very poor ones sold by the shops; and if ever broken again, it is only necessary to fit the straight arbor. As good steel as any for this purpose is a sewing needle of the right size, the temper drawn to a deep blue.

——o——

Putting in Hair-Springs.

Editor Horological Journal:

I have read many different ways of putting in hair-springs, but think my way is an improvement.

I select a hair-spring of proper size, fasten it on the upper pivot of the balance with a small piece of beeswax, then, with my tweezers, taking hold of the coil that lies between the regulator pins, I vibrate the balance, resting the lower pivot upon the glass top of a movement box, in which there is a movement running. I select a movement, the balance of which vibrates the same number of times as the one I am at work on. You see the result. The going balance is directly under the glass, and the balance you hold is directly over, and the least variation can be detected instantly. Move the tweezers until the vibrations are alike. The right place for the regulator pins is a little in front of the point where you grasp the hair-spring.

Since using the above method I have never had to pin a hair-spring a second time.

Frank A. Newell.

Bradford, Pa.

——o——

Query.

Editor Horological Journal:

Sir,—I have been shown a fine English chronograph, made by Dent, London, of which the owner complains, that in setting the hands (by the stem), when they are in certain positions, the minute hand will fly backward or forward a minute or two at the moment he pushes in the bolt that makes connection with the hand work.

The intermediate wheel which moves the hands is attached to a swinging arm, and is in constant contact with the ratchet wheel, and consequently, when the watch is fully wound up, the hands can only be turned in one direction. This is not a serious difficulty, but the changing of the hands two minutes by the act of moving the pendant into gear with the dial work, is a grave defect; so in releasing it the minute hand will shift from the position you wish to have it, and you must wait till the minute wheel is in such position as to allow the intermediate wheel to swing in and out without disturbance.

I should like to know why so eminent a maker has adopted such a clumsy device, when there are plenty of better modes in general use, and if any one can suggest a remedy for the defect, short of a new arrangement of the parts. Z.

Chicago, Ill.

——o——

Answers to Correspondents.

G. R., *Omaha.*—There may be two causes why the minute hand on the watch you complain of does not point to the proper divisions, or, in other words, does not coincide with the second hand. The reason may be, that the spacing of the dial is defective; on common dials this is not unusual. We have seen some dials with an error, in some of the minute spaces, of 30 seconds; if such exist, there will be no uniformity in the error; but if it arise from the dial being put on eccentric to the centre pinion—that is, the centre pinion must be the exact centre of the dial circles—then the errors will gradually increase or diminish. If the centre of the dial be above the centre pinion, the minute hand at a quarter past any hour will indicate $15\frac{1}{4}$ or $15\frac{1}{2}$ minutes; sometimes an error of a whole minute can be detected. On the contrary, at $\frac{3}{4}$ past the minute-hand will be the same amount too slow, but at 12 and 6 the indications will be correct. If it be set on to the right or left of the centre pinion, these errors will show at 12 and 6.

Again, they are sometimes put on with the seconds pivot and hole correct; but the 12 is out of perpendicular. When that condition occurs, the greatest errors will occur each side of 12 o'clock, but no error will be detected at 6 o'clock.

Yes, dial feet can be soft soldered on so as to answer a very good purpose, and where there is no possibility of getting a dial with feet in, or nearly in the proper places, you can cut off the feet, and at the place you wish them, grind off the enamel very carefully (with a small emery wheel if you have one), till you have a bright copper surface an eighth of an inch in diameter. Make your new dial foot, by taking a piece of copper wire the proper size, and riveting a head on it; then drive it through a wire plate, so that you can flat out the head very thin, and large enough to cover your bright copper spot on the dial, then soft solder on the new foot, by heating the dial very gradually and carefully, so slowly that the enamel can expand as much as the copper, otherwise the enamel is liable to crack and the dial ruined. After soldering, clean off all the solder, and wash thoroughly in alcohol to remove every vestige of the soldering fluid, the fumes of which, if the least particle be left, will pervade the whole watch, and attack every bright steel surface. Many a watch has been spoiled by that same "soldering fluid," through carelessness or ignorance, and it should never be permitted to stand on or about the watch bench.

R. S., *Ohio.*—Theoretically the pins in the regulator should hold the hair-spring immovable—not permitting any vibration between them and the stud. But practically this is impossible, for the reason that the pins must slide on the hair-spring whenever it is necessary to move the regulator. The pins should be as close together as is possible, allowing only sufficient freedom to prevent cramping the hair-spring by moving the regulator. When the pins are wide apart, their proper action upon the hair-spring is quite uncertain, and depends much upon the extent of the arcs of vibration of the balance; if they are small, and the pins unreasonably wide apart, the running of the watch for the time such small vibrations are made, will be at such a rate as it would go if *no* pins were there, for they are either not touched at all by the lateral excursions of the hair-spring, or so very slightly as to produce little effect. On the contrary, when the angular motion of the balance is large, the lateral excursions of the spring are arrested by such sudden contact with the pins as to produce a recoil which must react upon the balance, producing a motion which is detrimental to good timekeeping.

Neither can the action of the balance be as uniform as is desirable, when the hair-spring is set hard against one of the pins; for then it has a "see-saw" action across the pin as a fulcrum, the part between the pin and the stud acting and reacting upon the spring beyond the pin with a violence and irregularity proportionate to the extent of the vibrations of the balance. This mode of setting the spring is also very liable to crowd the mass of coils eccentric to the balance staff, and to distort it whenever the regulator is moved forward or back.

In the case you speak of, the reason for your success was, that there was *less* irregularity of action with the spring hard against one pin, than when vibrating between two that were wide apart. We think the better practice would have been to set the regulator pins the proper distance apart.

M. K., *St. Louis.*—We give you directions for gilding watch movements as they were given us by a practical gilder. We have seen gilding said to have been done by this method, which was to all appearance new work. He strenuously insisted that the material should be *pure*, otherwise the results would not be satisfactory.

For old work, it must be prepared by first scouring off all the remains of the old gilding with ground pumice-stone, a stiff brush, and water; after washing clean, the surface must be "matted" to give it the rough granular appearance of fire gilding. This is done by leaving it in the following solution while you can slowly count five:

Matting Solution.

1 oz. Pure Nitric Acid.
¼ oz. Sulphuric Acid.
3 dwt. Rock Salt.

Dissolve the salt in the sulphuric acid, then add the nitric acid slowly. The articles must then be thoroughly washed in clean water.

Gold Solution.

1 quart Rain Water.
3 dwt. Dentist Foil (pure gold).
6 grs. Pure Copper (watch dial).
1½ oz. Cyanuret of Potash.

To Prepare the Solution.—Dissolve the gold in ½ oz. of nitro-muriatic acid (2 parts hydrochloric, 1 part nitric). After the gold is dissolved, add the copper; leave the solution to stand on a warm sand bath till evaporated to a thickish red liquid. [The chloride of gold of commerce will not do, because it deposits the gold in a *greenish* color, which is not desirable.] Then add the cyanuret of potash to the water, and add the dissolved gold.

To Gild the Articles.—A convenient way is to take a strip of clean zinc, say an inch in width, drill half-a-dozen or more holes in the lower edge, and attach in these holes fine copper wire, which can be left permanently attached for convenience. Then twist a wire around each little piece to be gilded, in such a manner as to make a perfect connection, and yet not interfere with the proper gilding of the part of the movement to be seen. After all are attached which you wish to gild at once, immerse them in the gold solution, allowing the zinc to dip into it from ⅛ to ½ an inch, depending on the *total surface* of the articles to be gilded. The amount of zinc surface exposed to the action of the solution determines the quantity of electric current induced (in this matter practice must be your guide); leave in the solution from five to eight minutes, as your judgment and experience dictate.

In gilding wheels, the pinions need not be removed (they must not be put in the "matting" solution), as the gold that attaches to the polished steel-work can be easily removed. After the necessary handling, previous to gilding, it is well to rinse off the articles in alcohol to remove any impurity that may have attached to them. A chemically clean surface is desirable to render the deposit of gold perfect and uniform. Finish with fine scratch-brush and soap-suds, or slippery-elm water.

F. A. N., *Pa.*—If the escape wheel, as you say, is finely finished, it would hardly seem possible for *some* of the teeth to strike on the incline of the pallet jewels and not all of them do so; the probabilities are that the escapement is a little too shallow. It may not have been so originally, but through accident or carelessness the pallet jewels have been moved a little; the proper remedy is to loosen them by gentle heat, move them a little out, and fasten again. Any attempt to alter the escape wheel teeth arc in the way of correction will but lead to trouble.

The complaint you make of meeting with so many table rollers that have had the edge damaged by being seized with steel plyers to remove it from the staff, is not peculiar to your locality—it is everywhere the same. Perhaps on some accounts these *watch breakers* are not such useless members of the community—for were they not busily at work day and night spoiling good watches, what would the skilled artisan find to do? Watches never wear out—the owners and users never (with few exceptions) spoil a watch—it's the tinkers that do the business; these are the "little foxes that spoil the vines," and so long as the community support them, community must pay for it. Your plan of using a pair of plyers lined with bell metal to fit the edge of the roller is excellent, and much more convenient than a stake for that purpose; the only objection is, that there are instances when it is driven on so tight as to turn the staff and the balance, or when a compensation balance has the roller tight on its staff there is danger of injury to the balance by a grasp sufficiently firm to hold it and turn the roller ; in such cases the punch and stake are safest, and a good maxim in watch work is, "The safest way is the best way." We think a lining for your plyers softer than bell metal would be better ; it would hold equally well, and there would be no possible danger, bell metal being quite as hard as soft steel. Fine delicate steel or gold hands are, as you say, very safely and quickly removed in the same way without the possibility of damage.

G. A. S., *Mass.*—"When the lever is too short," the proper way, if a fine watch, is to put in a new one ; but it often happens that the owner of a cheap watch will not incur that expense, in which case the best plan is to draw the temper from the fork end, and then with a screw head file cut a slit on each side just back of the "fork," then place the edge of a knife or scraper in the slit, and give it a slight tap with the hammer, which will elongate that side of it ; treat the other side in the same way, then file out the fork to fit the roller jewel, and remove the bluing, either with a pickle composed of equal parts of elixir vitriol and muriatic acid, or by polishing ; if you use the "pickle," you must rinse in water, then in alcohol immediately, to avoid rust.

L. F., *R. I.*—The trouble that you experience in "letting down the spring" in an English lever watch is easily overcome.

First remove the balance bridge and the fuzee arbor ; now turn the movement face up, (first having removed the dial), holding it between the thumb and first finger of the left hand, tightly grasping the pin vice with the remaining fingers, placing the second against the nut of the vice to prevent its turning, and then remove the third bridge and third wheel ; now take the pin vice in the right hand, still holding the movement in the left, and carefully let the spring down.

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All communications should be addressed,

G. B. MILLER, *P. O. Box* 6715, *New York.*

EQUATION OF TIME TABLE.

GREENWICH MEAN TIME.

For July, 1871.

Day of the Week.	Day of Mon.	Sidereal Time of the Semi-diameter Passing the Meridian.	Equation of Time to be Added to Apparent Time.	Diff. for One Hour.	Sidereal Time or Right Ascension of Mean Sun.
		S.	M. S.	S.	H. M. S.
Saturday......	1	68.80	3 26.50	0.483	6 36 23 49
Sunday.......	2	68.76	3 37.95	0.473	6 40 20.05
Monday.. ...	3	68.72	3 49.14	0.461	6 44 16.60
Tuesday......	4	68.68	4 0 06	0.449	6 48 13.16
Wednesday...	5	68.64	4 10.67	0.4'6	6 52 9 72
Thursday......	6	68.59	4 20 96	0.422	6 56 6.28
Friday........	7	68.54	4 30.91	0.408	7 0 2.83
Saturday......	8	68.49	4 40 51	0.393	7 3 59.39
Sunday.......	9	68.43	4 49.74	0.378	7 7 55.95
Monday.......	10	68.37	4 58.58	0.361	7 11 52 51
Tuesday......	11	68 31	5 7.02	0.344	7 15 49.07
Wednesday. ..	12	68.25	5 15.05	0.326	7 19 45.63
Thursday.....	13	68.18	5 22.65	0.307	7 23 42.19
Friday........	14	68 11	5 29.80	0.288	7 27 38.74
Saturday......	15	68 04	5 36.47	0.268	7 31 35.29
Sunday.......	16	67 97	5.42.64	0.247	7 35 31 85
Monday.......	17	67.89	5 48 31	0.227	7 39 28.41
Tuesday......	18	67.82	5 53.47	0.205	7 43 24 97
Wednesday...	19	67 75	5 58.09	0.182	7 47 21.52
Thursday......	20	67.68	6 2.15	0.158	7 51 18.08
Friday.......	21	67.60	6 5.65	0.134	7 55 14.64
Saturday......	22	67.52	6 8.59	0.110	7 59 11.19
Sunday.......	23	67.44	6 10.93	0.085	8 3 7.75
Monday.......	24	67.36	6 12.66	0.060	8 7 4 31
Tuesday	25	67.27	6 13.80	0.035	8 11 0.86
Wednesday...	26	67 19	6 14.33	0.010	8 14 57.42
Thursday.	27	67.10	6 14 25	0.015	8 18 53.98
Friday........	28	67.02	6 13.56	0.040	8 22 50.53
Saturday.....	29	66.93	6 12.26	0.066	8 26 47.09
Sunday.......	30	66.85	6 10.35	0.091	8 30 43.65
Monday......	31	66.76	6 7.83	0.117	8 34 40.20

Mean time of the Semidiameter passing may be found by sub tracting 0.19s. from the sidereal time.

The Semidiameter for mean noon may be assumed the same as that for apparent noon.

PHASES OF THE MOON.

		D.	H.	M.
☉	Full Moon........................	2	1	36.1
☾	Last Quarter......................	9	1	9.1
●	New Moon........................	17	5	27.3
☽	First Quarter......................	24	17	51.1
☉	Full Moon........................	31	9	16.8

		D.	H.
☾	Perigee..........................	1	3.2
☾	Apogee..........................	13	15.3
☾	Perigee..........................	29	8.0

	°	′	″
Latitude of Harvard Observatory.........	42	22	48.1

	H.	M.	S.
Long. Harvard Observatory..............	4	44	29.05
New York City Hall.............	4	56	0.15
Savannah Exchange..............	5	24	20.572
Hudson, Ohio..................	5	25	43.20
Cincinnati Observatory.........	5	37	58.062
Point Conception................	8	1	42.64

		APPARENT R. ASCENSION.	APPARENT DECLINATION.	MERID. PASSAGE.
	D.	H. M. S.	° ′ ″	H. M.
Venus.....	1	9 46 39.06....	+14 59 57.2.....	3 10.3
Jupiter....	1	6 37 13.41....	+23 10 3.8.....	23 57.9
Saturn....	1	18 27 42.73....	−22 32 38.0.....	11 49.2

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CONTENTS.

Pinions—Their Shape and Diameter.

INTRODUCTION—PITCH CIRCLE EXPLAINED—REASONS THE SIZES OF PINIONS VARY FOR WHEELS OF DIFFERENT NUMBERS OF TEETH—THE SHAPE OF THE LEAF.

Watch and clock-making, or the art of constructing and executing time-keepers, seems not to hold that rank among the mechanical arts which its connection with the sciences, particularly that of astronomy and navigation, and also which the many ingenious improvements it has undergone, by the help of scientific men, entitle us to expect. The custom now so prevalent of working piecemeal from established models, which, it must be allowed, contributes greatly to expedition and cheapness, has, no doubt, conduced to exclude calculations and geometrical principles from the workshops of the present day.

The practical departments of our profession being frequently confined to the obscurity of a garret, it is no wonder that a dexterity at performing certain manual operations, such as hammering, filing, drilling, turning, soldering, tempering, polishing, etc., should be considered as the perfection of the art, and that the reason is frequently not understood by the workman himself, and seldom by his employer, why the numbers of his wheels and pinions, and the shape, size, and disposition of the different portions of his mechanism, are deemed preferable to others, which he might have adopted as easily, if, in his apprenticeship, he had been so instructed.

We have not as yet in the English language, or in any other language that we are aware of, any regular instructions for all the successive portions of work to be performed in the construction of a good time-keeper, whether it be a watch or a clock; which want is much to be regretted, for until the workman can proceed in his work on scientific principles, he must be content to be a mere slave of imitation in an art which is capable of affording him genuine pleasure, from the opportunities it affords of calling in science to his aid in every step that he takes through an infinite variety of practical constructions.

The question of calculating the number of teeth in a wheel, or leaves in a pinion, so that the one will make a given number of revolutions more or less than the other, has already been noticed in the columns of the Journal, and for the present we will assume that the desired numbers in the wheels and pinions have been made out, and noted down. The next stage of the work will be to ascertain the proper diameter of the pinion in relation to the size of its wheel, or the proportioning the diameters of the wheels and their respective pinions, so as to transmit the power from the barrel or fuzee to the scape-wheel, in a uniform manner, without the leaves of the pinions butting against the backs of the teeth, or the teeth dropping from off the one leaf of the pinion on to the next; both of these defects causing an irregularity, and a waste in the power that is transmitted through the wheel-work; and on this special subject we would add a few remarks in addition to those we have already published.

If a wheel and pinion were to be made

like two rollers, without any teeth in them, pressing their edges against one another, and by the aid of friction producing a rotary motion, it is plain that their diameters ought to be in geometrical proportion, exactly as their calculated number of teeth ; as for example, a wheel of 96 teeth, working into a pinion of 8 leaves, would, if it could be made in the above manner, require to be exactly 12 times larger than the pinion, because 12 revolutions of the pinion to one of the wheel are desired.

But it is evident that to rely upon friction as a means of causing two rollers, or plain wheels, to revolve with precision, would be impracticable, and would prove a certain failure if applied to watch and clock work ; therefore we must make teeth on the wheels. Let us imagine the points of contact of two wheels without teeth, and made to turn each other by the aid of friction. The points of contact of these wheels, or what we will call the pitch circle, is exactly the size of the diameter of the respective wheels, and is the circular pitch line. From this pitch line let us conceive a number of small projecting levers or teeth, fixed at proper intervals from each other around the circular pitch line of each wheel, and then we shall have a true idea of two wheels properly proportioned to act together, when of the same diameter. When they are of unequal diameters, they cannot be in geometrical proportion to each other, by reason of the little levers or teeth of equal length that have, in both cases, been added to the diameter of each wheel separately, after they were in exact geometrical proportion ; and the greater the difference between the size or numbers of the wheels, the greater will be the deviation from the originally accurate proportion, when they were in the condition of plain wheels or rollers ; for the pinion of eight leaves, which we referred to in the last paragraph, will have had an addition made to its diameter exactly the same as the wheel of 96, which is 12 times larger in diameter. Hence it will be readily conceived that the due proportioning of wheels and pinions is an important object in Horology ; for, supposing the teeth of the wheel and the leaves of the pinion to be of the true epicycloidal form, unless their respective diameters be properly adjusted the transmission of the power, and communication of motion, will both be unequal, and the mechanism subject to rapid destruction.

One method of proportioning or sizing wheels and pinions, as it is often called, which still lingers in practice at the present day, is, first to make both a little too large for the proposed calliper, and then having rounded all the teeth of the pinion, and a few of the wheel, to reduce the diameter of the latter gradually, until, by successive trials, they are found to act correctly. This mode we reprobate as calculated to destroy the due practical proportions, and hope to see it banished from every workshop by the adoption of better methods.

In proportioning wheels and pinions, after the numbers of their teeth and leaves are determined upon, two particulars are to be attended to : the coarseness, or solidity, and the shape of the tooth. The former may be expressed by the number of teeth per inch in the circumference of the wheel, and the latter by the term epicycloidal. If a tooth were rounded in a circular shape, which we do not recommend, but only suppose the case, the pitch line would be considered as at one-half the breadth of the tooth from the extreme edge ; but when it is rounded, as we shall hereafter recommend, in an epicycloidal shape, or, as some workmen call it, the *bay leaf* form, it has been found from numerous experiments that the depth or distance of the pitch line from the circumference of the wheel will generally be .75 of the breadth of the tooth in any wheel or pinion.

We have just stated that when an epicycloidal tooth is used, the distance of the pitch line from the end of the tooth is equal to .75 of its breadth ; and if we suppose the tooth and space cut to be reciprocally equal, we shall have the true *acting* diameter of any wheel or pinion greater than the geometrical diameter, which we call the pitch circle, and which *Camus* calls, also, the *primitive* diameter, by .75 of a tooth or space on each side of the centre, or 1.50 in the whole diameter. Let now a space or a tooth be called a *measure*, and there will be double the number of measures there are teeth in any wheel. Also let these measures of the circumference be reduced into measures of the diameter, by the usual ratio of 3.1416:1, and then 1.50 added to such geometrical measures of the diameter, will give the proper acting diameter, and which may be expressed in inches and parts when the measures per inch are known.

For instance, let a wheel of 96 teeth, and a pinion of 8 leaves, be taken at 12 teeth per inch at the pitch line ; the number of measures of the wheel is 192, namely, 96 teeth and 96 spaces, each measuring $\frac{1}{24}$ of an inch; then as 3.1416 : 1 : : 192 : 61.1 ; therefore, if to the geometrical diameter or pitch circle expressed by 61.1 measures, there be added 1.5, the sum 62.6 or $62\frac{6}{10}$ will be the acting diameter in the same denomination, whch are so many 24th parts of an inch, and $\frac{62.6}{24}$ gives 2.6 inches for the full acting diameter of the wheel in question. Again, the pinion of 8 has 16 similar measures, to which if 1.5 be added the acting diameter will be $5.09 + 1.5 = 6.59$; or, with sufficient accuracy, $6\frac{6}{10}$, which divided by 24, as before, will give the same .27 of an inch, or somewhat more than a quarter of an inch for the acting diameter of the pinion.

In the use of the sector for sizing wheels and pinions, the practice of its inventor was to add $2\frac{1}{2}$ measures of the geometrical diameter to the wheel, and $1\frac{1}{2}$ to the pinion, in watch work, when the wheel is the driver; and $1\frac{8}{10}$ *to each* when the pinion is the driver, which does not often occur in watch work or clock work of any description.

The reason why a wheel or a pinion ought to be somewhat larger than according to its calculated proportion when it is the driver, is, that in those cases where the teeth are actuated both before and behind the line of centres, the impulse of the tooth before line of the centres takes place later than it otherwise would do, as well as occasions a smaller shock at the commencement of the impulse.

Hatton, of London; *Berthoud*, of Paris; *Ried*, of Edinburgh, and all the old writers, make a distinction in the size of a pinion when it is used in a clock and when it is used in a watch. We never supposed that this distinction was made solely for the reason that the pinions were to be used for a clock or for a watch ; but from the fact that the relative geometrical diameters, or the pitch circles of a pinion in a watch differed from those in a clock, from the fact that the numbers of the wheels were not in the same proportion to the numbers of the pinions in both cases ; and therefore the pinions had to be sized accordingly, agreeable to the explanation we have above given in regard to the geometrical diameter of a wheel and pinion.

We think that it was a Danish astronomer and mechanist who first pointed out the utility of the epicycloidal curve, when applied to delineate the shape of a tooth, which we presume our readers are familiar with. Others took up the subject after him, and demonstrated that if a tooth of either a wheel or pinion be formed by portions of an exterior epicycloid, described by a generating circle of any diameter whatever, the tooth of its fellow will be properly formed by portions of an exterior epicycloid described by the same generating circle; which curious circumstance allows of an infinite variety in the two corresponding curves that form the teeth of the wheel and pinion, if they were practicable. Further, it has been shown that if the teeth of any wheel be triangular, circular, or of any regular figure, a uniformity of force and velocity may be mutually imparted, provided the teeth of the corresponding wheel or pinion have its teeth or leaves formed compounded of the epicycloid and said figure, which has further been shown to be the method of effecting motion in a variety of cases, not however adapted for practice.

Whether the workman may choose to use his exterior and interior epicycloids jointly in the same tooth, or separately in different wheels acting together, this practical rule never ought to be lost sight of, namely, the outer end of the interior, and also the inner end of the exterior epicycloid, should universally commence in the primitive or geometrical circle of the wheel of pinion.

The reader is already prepared to be told, what otherwise might have appeared a contradiction, not only that the same pinion, of eight leaves for instance, will require the teeth of a wheel of thirty to be somewhat differently rounded at the ends, from those of a wheel of sixty, or any other number, in order to have the same action in both cases; but that, however accurately the teeth of wheels are rounded, all numbers are not equally good to be used indifferently for wheels and corresponding pinions. This latter part of our subject has not been much attended to in practice, but is curious, and may contribute to great utility in Horological instruments, where an equable transmission of force and velocity is desirable.

The whole of what we have hitherto said respecting the action of epicycloidal teeth, has been upon a supposition that the impelling force begins at the line which joins the centres of a pair of wheels, or of a wheel and pinion, and is exerted outwards always on one side of this line, until the teeth escape one another, which mode is allowed to be the best, when it can be effected; but there are many ratios, and those in common use between a wheel and its pinion, which will not admit of that kind of action, however good the shape of the teeth. Indeed *Camus* has shown that no pinion less than one of eleven leaves, will entirely answer the purpose of acting always on one side of the line joining the centres, and consequently the common pinions of six or eight leaves are very ill calculated to effect an equable transmission of velocity and force, by reason of their leaves acting alternately before and behind the line of centres.

It is impossible for a wheel of 50 to move in a uniform manner; a proportionate pinion of seven leaves impelling them only behind the line of centres. A wheel of fewer teeth than 50 will be still less proper, and one of a greater will not leave space enough for sufficient thickness of a leaf in a pinion. Hence it appears, that when a pinion of seven leaves is used, it will be impelled by its wheel, partly before and partly behind the line joining the centres. If a wheel of 57 were made to drive a pinion of eight, the whole arc for both the tooth and space would be 6° 18′ 57″, of which 5° 7′ 40″ would be occupied by the tooth of the wheel, and only 1° 11′ 17″ by the space or by the leaf of the pinion, which quantity is not enough for an acting tooth; therefore, if the teeth of the wheel are made nearly equal to the spaces, they will drive the pinion of eight both before and behind the line of centres. Also, if a wheel of 64 were to drive a pinion of nine leaves in such a way that the impulse might be only behind the line of centres, the arc of the pitch line of the wheel, for both tooth and space, will be 5° 37′ 30″, of which the tooth will occupy 3° 45′ 42″, and the space only 1° 51′ 48″, which will not leave room for a leaf sufficiently thick for a pinion.

Likewise, where a wheel of 72 drives a pinion of 10 leaves, behind the line of centres, the arc of the wheel tooth is 2° 47′ 16″, and of the space between two teeth 2° 12′ 44″ only; therefore here the tooth and the space cannot be equal.

In pinions of 11, 12, etc., the action may take place entirely behind the line of centres, and the extreme ends of the teeth might be taken away, and in those cases where the pinion is always driven by an impulse made only behind the line of centres, the addition to its tooth beyond the geometrical diameter may, as we have said, be nearly dispensed with; that is, the acting and the geometrical diameters may be almost the same, provided the angular points be a little rounded to prevent their catching or scraping the teeth of the wheel, though it is safer to give a little addition for the curves.

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Repairing and Restoring Old English Clocks.

In our large cities, and also in the populous districts of the older settled States, a great many of these clocks are to be found, that were either imported into the country in its early history, or have been manufactured here after the English model. In Massachusetts, especially, these clocks are to be found in large numbers, and are becoming quite fashionable among the wealthy classes in all our large cities. Although they are cumbersome, when it becomes necessary to move them about, no piece of household furniture adorns a hall or staircase better, or is more useful than an old English eight-day clock.

A student of Horology can find no better model for the elementary studies of his business than one of these clocks; although, when we look from a high standpoint, in some instances the workmanship of these clocks, whether they have been executed in the United States or in England, is open to criticism. Still, the *construction* of the whole machine is the best that has yet been designed for reliable time-keeping. The solid construction of all its parts, and the regular geometrical proportions of the wheels, so far as their numbers and revolutions are concerned, and above all the seconds pendulum, and the long fall given to the weights, combine qualities which, notwithstanding the rude execution we may sometimes meet with, give better results than any other class of clocks made for household purposes.

Very few of the younger portion of the present generation of watchmakers, wherever they may have served an apprenticeship, have had sufficient opportunities afforded them to learn to repair one of these clocks thoroughly. In fact, of the many who undertake the repairs of these clocks, we know of only one firm in the country where they are thoroughly and conscientiously repaired with a view to restore them to their original condition, and in the repairing study to retain as much of the old parts as is possible ; for, when the clocks are relics, their owners generally desire this to be scrupulously attended to. To those of our young readers interested in the subject, and lacking the necessary experience, we propose to give a few hints on repairing this class of clock.

If the clock be very old, it is very likely that the repairs necessary to restore it to its original condition will be very heavy ; because it is characteristic of these clocks, that if made in a manner only moderately accurate, and set going under conditions moderately favorable, when once set going they will run themselves almost to pieces before they stop. The pivot holes, the pivots, and the pinions, and the pallets, will all be found to be badly cut and worn. It is but seldom a new pivot will require to be introduced, because, as a general thing, the pivots were all left thick enough originally to allow them to be reduced and polished when worn ; but should a new pivot be necessary, either from the effects of wear, or from being broken accidentally, there are none of the pinions in a clock but what will admit of a new one being inserted. If the new pivot has to be put at the end of the arbor where the pinion head is, it will be best not to soften the pinion; but if at the other end, a small part of the arbor may be softened with impunity. If you have not a lathe with a chuck that will take hold of the pinion, to centre and bore the hole for the new pivot, you may centre it with a hollow drill, or in a ruder method by using a common drill, or a centre punch, always trying if the arbor and its pinion be true. Before you commence to bore, try it in a pair of turns, with sharp centres, and alter the centre of the new pivot hole till it be true ; but care must be taken in this rude method, which must only be resorted to when no other means can be used, not to take anything from the shoulder of the old pivot, because too much end-shake to the pinion will be the result. After the pinion is centred, if it cannot be bored in the lathe, catch a split collet on it and turn it round with the drill bow, with the drill stationary in the vice. A very good idea of the best manner of making drills hard was given in the communication of Mr. Munger in the last number of the Journal. Bore the hole well up, and clean the oil and chips of steel out of it thoroughly, and fit in the steel that is to make the new pivot. Fit it very carefully, and in such a manner that, when put in its place, one tap from a light hammer will send it home, and be tight enough for every purpose. If fitted too tight, the arbor will be liable to be split ; and if too loose, it will not hold ; therefore the necessity for fitting it with care in the first instance will be apparent. Should an arbor happen to get split, there is no other remedy but to put on a collar or ring over the split part, or solder the pivot in; but do not solder a pivot unless as a last resource, and when you do solder it, be sure always to dip the soldered part in oil before it cools, to prevent rust from breaking out. The piece of steel being fastened in its place, from which the new pivot is to be formed, the rest of the operation will be comparatively easy. Centre it in such a manner that the pinion, or its arbor, will run exactly true, then turn the new pivot to the desired size, polish it smooth, and round off the centre.

In clock-work, when pivot holes are wide, never attempt to close them with punches. The frames are usually so thick that a solid hole cannot be made all the way through if they are punched. We have seen old clocks that had the pivot holes closed by making deep marks with a centre punch all round the hole in order to close it. This kind of treatment is "botching" in its worst form, and under no circumstances should it be resorted to. If a pivot hole be so wide that a smaller one is desirable, the object will be accomplished more satisfactorily, and a naturally expert workman will do the work about as rapid, by putting in a new bush. The best way to proceed is to make the old pivot hole three or four times larger than its original size, being careful to have it a straight and round hole, widest towards the outside of the frames, and the edges of the hole carefully indented with a small round file. The hole is now ready to receive the bush, which should be made encentric, so as to admit of it being turned round to that position that will make the depth between the wheel and pinion most accurate. An encentric bush can be made with ease and great rapidity, in any lathe that has a chuck that will hold a piece of wire. Catch the wire, which ought to be tough brass wire, in the chuck, and turn it to fit the hole already made in the frame; then set it a little out of truth, just as much as the bush is desired to be encentric, by tapping it with a hammer, or otherwise; next centre the bush, as it runs in its new condition, with a graver, and bore up a hole of the desired size; now cut off the newly made bush by turning the end of it just a little longer than the thickness of the frame, undercutting it a little at the same time ; afterwards open up the hole with a broach till it fits tight on to its pivot, and put the new bush in its place, and the necessary wheels into their places, and turn round the bush till the depth be right. The bush may now be riveted, and if fitted well, and not left to project too far above the level of the frame, a few taps of the hammer will tighten it, and the whole operation may be done in less time than it takes to write these directions. After riveting, the hole must again be broached out to give the necessary freedom to the pivot, and afterwards the hole polished with a round broach, the new bush properly countersunk, so as to retain the oil, and the frame polished, where the bush was inserted, with blue-stone, and afterwards with rotten-stone and oil on a woollen cloth.

If the leaves of the pinions are badly cut, there is no use filing the marks out, because if the pinion has been right at first, filing will make them too thin, and the pitching will be bad any way you can set it, and it is better to shift the action of the wheels that work into them. This is easiest accomplished by turning the necessary quantity off the shoulder of one of the pivots, and putting in a *raised* bush to fit the pivot at the opposite end. By this method two actions can often be shifted by one alteration, and it is always better than disturbing the wheels or their arbors, which in old clocks are usually fastened to collets soldered with hard solder.

Sometimes it happens that a leaf gets broken out of a pinion, which is a serious matter when it is desirable that the old pinion be retained. In this class of clocks, where small solid pinions of 7 and 8 leaves are used, there is no other way of saving the pinion except by fastening two rings near to the pinion-head, and to these rings fasten a new leaf to take the place of the broken one. In the case of the centre and third pinions, where the wheel is riveted on to the pinion head, it will only be necessary to fasten one ring to hold a new leaf, because the wheel itself can be used to take the place of the other ring.

In the very oldest clocks we seldom see much wear on the teeth of the wheels, if the depths have been right when the clock was new. Sometimes a tooth, or a few teeth, get broken by accident, and these can be easily replaced in most instances. When a tooth or teeth have to be replaced, the most desirable method is to dovetail a piece of brass into the rim of the wheel, of the requisite size, and fasten it by soft solder that will flow at a moderate heat. We must confess that soldering, in the present instance, is better than riveting, because in riveting, an inexperienced person, and also the most experienced in some instances, will stretch the wheel and put it out of round, whereas soldering, if a moderate heat be used, is entirely harmless ; and if care has been taken to fit the brass exactly to the dovetail, the solder will not show much when the sides are polished off. The tooth or teeth may now be formed in the new brass that has been inserted in the wheel, and if done agreeable to the above instructions, the wheel, for all practical purposes, will be equally as good as when new. Sometimes, when a tooth or teeth are broken, small holes are drilled in the edge of the wheel, and pins driven in to take the place of teeth. This plan is very good as a temporary method, and we have ourselves practised it in temporarily repairing a clock when it could not at the time be removed to a workshop ; but although proper under such circumstances, it is not to be commended as an example to follow when a clock has been removed to a workshop for thorough repair.

In repairing the escapement, probably in some instances there will be a difficulty in retaining all the original parts. If the escapement has been in action for a long time without oil, the points of the teeth of the scape-wheel may be worn. In most cases the wheel can be restored and rendered as good as new by putting it in the lathe and topping the teeth with a smooth file or a graver till they are all of equal length, and then dress them up with files to the proper shape ; but should the wheel have any inequalities in the division of the teeth, there is no use troubling with it. Make up your mind to put in a new one at once, for this part of the clock can not be saved and do justice to the other parts. A new wheel can be made very easily by any person who has a cutting engine, and understands how to use it. The pallets will be sure to be badly cut, because invariably they are the first part of these clocks to wear out. Still, if they are recoiling pallets, in most instances they can be repaired, if judiciously managed. First soften, if they be hard, and file out the marks that have been worn in them. Then close the pallets by bending them till they closely embrace the number of teeth they originally did. This is done with the greatest safety by placing them between the jaws of a vice and closing the vice gently. It will be noticed that by this method of closing pallets, the part nearest the movable jaw of the vice will bend first; so, after closing them a little, it will be well to reverse the pallets in the vice that they may be closed evenly. We consider this method of bending to be better than that of using a hammer ; the strain does not come on the steel so suddenly, and we very seldom, if ever, saw pallets break when closed in this manner. After the pallets have been filed and closed in the above manner, when they are placed in the frames along with the scape-wheel, it will be found that the " drop " on the perpendicular pallet will be considerable. This drop can only be reduced by altering the front pivot hole of the pallets, or by taking the steady pins out of the back cock and moving it down, or by both methods, care being taken to steady-pin the back cock in its new position after moving it. The " drop" of the horizontal pallet can only be altered by bending the pallets in the manner already described. The acting faces of the pallets, if it be a recoiling escapement, should be shaped so as to produce a slight recoil, or retrograde motion of the scape-wheel, after a tooth has escaped from the one pallet on to the other.

It is difficult to describe in writing just exactly the precise shape that these pallets should be. The shape is one of great importance, and if the workman is not conversant with the subject, his safest course is to notice and preserve the precise shape these acting faces were *before the pallets were bent*, and file them to the same shape afterwards. If this be carefully attended to, and the drops adjusted, as we have described, the escapement will be as good as it was when the clock was new. If the escapement be a dead-beat one, and the pallets be much cut on the circular part, it will be difficult to make a good escapement and retain the old pallets ; for after the marks are taken out of the acting faces they will be too thin—a certain amount of thickness being necessary. In some instances, when they are not deeply worn, they may be repaired so as to last many years. The same directions for closing the pallets and altering the drops apply to this form of pallets as well as to recoiling ones ; and the inclined planes, or impulse faces, have to be filed so that the teeth of the wheel will strike just beyond the edge of the angle. For further directions on the subject of dead-beat or recoiling escapements, see the articles on the pendulum in the May and June numbers of the second volume of the JOURNAL.

The time part of the clock having been repaired, it will be necessary to take a look at the striking part; and this part may be found to be considerably out of order. The method of lifting the hammer is one of importance, and the action of the hammer spring is but seldom right, especially if it be a spring bent over to a right angle at its point. If there are two springs, one to force the hammer down after the clock has raised it up, and another shorter one, fastened on to the pillar, to act as a counter-spring, and prevent the hammer from jarring on the bell, there will seldom be any difficulty in repairing it; and the only operation necessary to be done is to file out worn parts, polish the acting parts, set the springs a little stronger, and the thing is done. But if it be one of the first mentioned construction, some further directions will be necessary, because the action of the one spring answers the purpose of the two in the last named method; and to arrange it so that the hammer will be lifted with the greatest ease, and then strike on the bell with the greatest force, and without jarring, requires some experience. That part of the hammer stem which the spring acts on should never be filed beyond the centre of the arbor, as is sometimes done, because in such a case the hammer spring has a sliding motion when it is in action, and some of the force of the spring is thereby lost. The point of the spring should also be made to work as near to the centre of the arbor as it is possible to get it, and the flat end of the spring should be at a right angle with the edge of the frame; and that part of the hammer stem that strikes against the flat end of the spring should be formed with a peculiar curve that will stop the hammer in a particular position, and prevent it jarring on the bell. This curve can only be determined by experience; but a curve equal to a circle six inches in diameter will be nearly right. The action of the pin-wheel on the hammer tail is also of importance. The acting face of the hammer tail should be in a line with the centre of the pin-wheel, or a very little above it, but never below it, for then it becomes more difficult for the clock to lift the hammer, and the hammer tail should be of such a length as to drop from the pins of the pin-wheel, and when it stops be about the distance of two teeth of the wheel from the next pin. This allows the wheel-work to gain a little force before lifting the hammer, which is sometimes desirable when the clock is a little dirty. We might also mention that in setting the hammer spring to work with greater force, it is always well to try and stop the fly with your finger when the clock is striking; and if this can be done it indicates that the spring is stronger than the power of the clock can bear, and it ought to be weakened, because the striking part will be sure to stop whenever the clock gets the least dirty.

The repeating work, or that part of the mechanism that regulates the number of blows to be struck on the bell, may be in disorder, and worn in some parts. The rack, which must be considered as the sequent of a wheel, should have its first tooth a little longer than the others, so that the other teeth will not grate on the point of the rack catch, and make a disagreeable noise when the clock warns before striking. The "tumbler," or gathering pallet, that works into the teeth of the rack, will be very likely to be split or worn out. The figure 6 is a good model to make a new one after, and it should be made so as to lift one tooth and a very little of the next one at each revolution. It is necessary to cause the tumbler to lift a little more than one tooth, and let it fall back again, to insure that one will always be lifted; because if such was not the case the clock would strike irregular, and would also be liable sometimes to strike on continually till it ran down. If the striking part is locked by the tail of the tumbler catching on a pin in the rack, the tail of the tumbler should be of such a shape that will best prevent the rack from falling back when the clock warns for striking the next hour; and of course the acting faces must be perfectly smooth and polished. A guard pin ought to be put in the frame, if one does not already exist, to prevent the rack from going farther back than is necessary for it to strike twelve o'clock; for sometimes, when the clock runs down, and the striking part happens to run down first, the rack-arm rides on the snail on the hour wheel, and the teeth of the rack are then in some instances allowed to go out of reach of the tumbler, and when the clock is wound up, of course it will keep on striking till it runs down, or the weight is taken off, or the rack again put in action. It is necessary for the rack-arm to be made so that it will ride on the snail easily, if the striking part, from any cause, should be stopped and the other part going, because if it did not ride, the clock would stop altogether between the hours of 12 and 1. Therefore, we recommend a guard pin, as already stated, because in our business it is necessary for our fair fame to guard against every possible contingency. The teeth of the rack may require dressing up in some cases, and to allow this to be done the rack may be stretched a little at the stem, with a smooth-faced hammer, on a smooth anvil ; or, if it wants much stretching, take the pin of the hammer and strike on the back, with the front lying on the smooth anvil. The point of the rack catch will be much worn, and when dressing it up it will be safe to keep to the original shape or angle. The point of the rack catch is always broader than the rack, and the mark worn in it will be about the middle of the thickness ; so enough will be left to show what the original shape or angle was.

The collet in front of the hands is a little thing, but it is seldom that we see one right ; one that will hold the hands firm, and allow them to be moved small portions of space with ease and certainty.

Before making a collet, first straighten the minute spring, and put it on its place on the centre pinion, and put the minute wheel on its place on the top of it, and then the minute hand on its place ; you will now see the space there is from the surface of the hand to the pin hole in the centre pinion. Make the collet so high that it will just cover the hole, and then cut a slit in the collet just as deep as the hole is wide ; make the slit to correspond with the hole in every way, and in such a manner that when the pin is put in it will fit without shake. A collet made in this manner will last as long as the clock, and when the minute spring is set up the hands will always be firm, and at the same time move easily, and not affect the motion of the clock when they are set backward or forward. The square on the pipe of the minute wheel sometimes projects through the minute hand, and the collet presses on it in place of the hand. When this is the case it should be filed down, because the minute hand can never be held firm unless the collet be very much hollowed at the back, which it is not always advisable to do.

The suspension of the pendulum, the pendulum spring, and the action of the crutch or back fork on the pendulum, are all of the most vital importance. The spring should be perfectly straight, and should fit into the slit of the cock without shake, and the slit should be perfectly straight, and at right angles to the front of the dial, or frames of the clock.

The back fork should fit easily and without shake, and the acting part stand at right angles to the frames. The pendulum bob should swing exactly in a plane with the frames and the dial; and after a clock has been put in its case, before putting on the head, it is well to get up high enough and look down to see that all these parts work as has been described.

In restoring the dials and brass work on the cases of these clocks, we do not advise those unexperienced in the processes to attempt doing the work, but get the bright work, especially, done by a brass founder, or in particular cases the brass work may be gilt. Those who are not afraid of spoiling their clothes, or making their hands yellow, may dip the brass pieces in nitric acid, and rinse in clean water, after the old lacquer has been taken off by first boiling them in potash. The nitric acid will clean and bring the brass to its original color, and which must be lacquered afterwards. The silvering of the other parts of the dial can be done to advantage by following the instructions in the communication from Mr. John Bliss in the present number, and various methods of bluing the hands, after they have been thoroughly cleaned, are mentioned in the article on Heat in the March number of second volume.

Such are some of the hints necessary to an inexperienced workman when repairing and restoring an old-fashioned clock. We have never seen a clock of this class, however old, but could, with judicious care, be put in condition to do service for another generation, and preserve to their owners all the hallowed memories of the past that may be associated with the old clock.

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Reminiscences of an Apprentice.

A BATTLE OF THE BOYNE ANNIVERSARY AND ITS CONSEQUENCES—A VICTORY FOR "OUR MAISTER."

I have already remarked that "our maister" frequently spoiled people's clocks, and I soon noticed that he often spoiled their watches too, and charged them a large price for doing so; at least some of the people thought he did, and could not be persuaded to think otherwise. Sometimes, however, he did a watch some good at a cheap rate, and once in particular he displayed extraordinary *skill*, which in justice to him I am bound to notice.

There was a character in our town called Paddy. He came originally from a county in the north of Ireland, but had resided in our town for many years. Paddy was a tailor by profession, and honest when compared with the popular notion of the doings of tailors of his day. When you gave him cloth to make a garment he made it faithfully, as big as the cloth would make it, whether the cloth was large or small, and without any regard to the size of the person that was to wear it. If a boy went to him with a piece of cloth to get a jacket made, Paddy would never take his measure, but would look at him and tell him he had his measure "in his eye already." When the boy returned at the appointed time for the jacket he would make him try it on, then he would praise up his work and make him stand before a little cracked looking-glass for him to see himself; and although the jacket might be large enough for a man, he would try to convince the boy that it was just the thing for him, and that he looked much smarter with his new jacket. Should the boy gently remonstrate with him and say it felt somewhat loose, Paddy would make him button up the jacket in front, and then gather the loose parts in his hand at the back, look at him all over, and remark that it might be a little large, but it was not "bastely," and that he was a growing lad and would soon fill it up.

I do not know if Paddy belonged to any religious denomination; at least he never went to any church, or made any outward profession of religion, but for all that he was an Orangeman of the stanchest kind. Usually he was an industrious and peaceable resident of the town, but the Twelfth of July was too much for him, and whatever business he had on hand had to lay over so that he might celebrate the glorious anniversary. He generally commenced the proceedings of the day by drinking to the memory of William of Orange, and his enthusiasm was always so great that he got pretty lively and demonstrative by the middle of the day. Then he would dress himself up to have a procession through the streets of the town, which he invariably performed all alone, marching majestically to the tune of "Boyne Water;" and as he was the only individual in the procession, either civil or military, with the exception of some boys that were attracted by the oddness of the scene, he supplied the music all himself by whistling; but occasionally the music would stop, and by way of a change he would flourish his shillelah round his head, striking it against his side or legs, and send the Pope to perdition in language suitable for the occasion.

During one of these celebration days, he came into our shop, looking rather sorrowful, and after a little preliminary talk, he told us that he had murdered his best friend; one that had never told him a lie; and he commenced to pull a large, double-cased, verge watch from his pocket, with a bunch of seals almost as big as his goose, attached to it by a broad orange-colored piece of ribbon. He handed the watch over the show-case to "our maister," telling him he was much afraid that there was no use opening it, that it was "kilt entirely;" and here he began to tell us how he had struck it a little while before with "this tool," pointing to his shillelah, that was now laying on the show-case, and as soon as he felt that he had struck it, he stopped the procession, and took the watch out of his pocket to look at it. He said that the cases were all right, and that the glass was not broken either ; but he saw the hands spin round the dial at the rate of an hour in the minute, and when he put it to his ear, he heard it make a cry and then it died, as he said, like a man that had all the blood let out of him, and he was sure that there was no more life left in it.

"Our maister" opened the watch and looked into it, and in a little I saw him smile ; then he took his screw-driver and loosened the balance cock screw, raised the cock a little, and guided the balance till the verge pivots went into their holes, and afterwards turned the cock screw tight again, and the watch went on as usual. Paddy was astonished at the magical result of what he termed raising his old friend from the dead, and when he was told that there was nothing to pay, he was more surprised than ever, and said that if he had taken it to the other watchmaker in the town, he would have kept it a week and charged him fifteen pence; but there "our maister" had done the work in half a minute, and had charged him nothing. William the Third of Orange was for a time put into the shade by this brilliant achievement of "our maister," and after a pressing invitation to go out to have a little something to drink, just to remember the occasion, which "our maister" respectfully declined, Paddy again constituted himself into a procession, and to his own music went on his way rejoicing.

The practical workman will at once comprehend what the trouble was with Paddy's watch, when it was so easily corrected. Had the teeth of the scape wheel been torn off when it was running down, or had the verge been broken by the patriotic blow that he gave the watch, the outward signs of destruction would not have been a bit more apparent to his sense of seeing or hearing in the one instance than in the other. The cases might not be damaged, or the glass broken, and the hands would spin round the dial at the rate of "an hour a minute," just the same in the one instance as in the other, and he might also hear it give a cry, like a man that was going to die, when all the blood was let out of him ; but the effect on Paddy's purse and patience would have been much more serious, and probably "our maister" would not have so profitable a job doing the extensive repairs as he had making the trifling correction. I wonder if that millennium for watchmakers will ever arrive, when their customers will be able to discriminate between trifling corrections and serious repairs, and when watchmakers shall receive the credit that is due to them for their vexatious labors, as readily as is granted to artists of other professions, whose labor does not require more educated skill, patience, or natural ability.

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Time Signals.

In the June number of the JOURNAL, in answer to a correspondent, we briefly noticed the question of time signals. As an interest has been awakened in the subject we propose to discuss the question more fully, and describe what has already been accomplished in other parts of the world, as a guide in the erection and establishment of accurate time signals, so far as we may learn from their experience. Time signals are not of modern origin. For hundreds of years we have had bells rung to announce that a certain period of the day had arrived, and was passing away. In military and in naval communities the sound of the bugle at a stated time, or the sunrise and sunset gun, are institutions that have long been established. These time signals, however, in most cases, make no pretence at being accurate, but simply give the time of the clock or watch that regulates the post, and may or may not be within several minutes of the true time of the locality in which they are situated.

Outside of military or naval circles the first plan that had any pretence to accuracy was that of dropping a ball at a given instant. This plan consists of a straight pole, like a flag-staff, erected on the top of some suitable building, on which a large hollow ball, made of wood or metal, slides up and down, the pole passing through its centre. The ball sometimes has a piston connected with it, that works into a cylinder filled with air, which acts as a spring, or rather as a cushion, when the ball falls, and prevents it from rebounding, or any injury being done to the roof of the building by the repeated falling of the ball. At a certain hour of the day, generally five or ten minutes before the time that is fixed, for the ball to drop, it is hoisted up a certain distance on the pole, which indicates that it is so many minutes from the time it will drop ; and as the time for its falling draws nearer, it is hoisted up to the top, which indicates that it is only a small portion of time before it will fall ; and those watching are thereby notified of the exact time to look earnestly for its falling; and when the exact second arrives it is liberated. There are two methods of effecting this. One is for an attendant to stand with a chronometer at his side, the errror of which is accurately known, and at the appointed instant releases the ball mechanically, and it drops. The more modern plan is to bring electricity as an aid, and to cause a standard clock to automatically close the electric circuit used to disengage the ball at a given instant of time. This again is accomplished in various ways ; but the method most usually adopted, and which is the most reliable in its action, is the following :

Take an ordinary astronomical clock, where the hour hand makes but one revolution in 24 hours; pass a wire from the galvanic battery into the clock, and arrange it in such a manner that there will be three open circuits, which all require to be closed at the same instant before a current can pass over the wire. One of these circuits is closed by the revolution of the axis to which is attached the second hand, another by the axis that carries the minute hand, and the third by means of the revolution of the axis that carries the hour hand. Now it will be evident that one circuit will be closed once a minute at every revolution of the seconds hand, and two circuits will be closed every hour by the regular revolution of the seconds and minute hands; but it is not till the arrival of the hour hand at a given point that all the circuits can be completed at the same time, and allow the current to pass over the wire that disengages the ball at a given instant, thereby indicating the precise second shown by the clock it is connected with.

Although the question of accurately closing the electrical circuit at the precise moment, is a difficult and important one in any automatic arrangement for dropping a time-ball directly from the clock, through the agency of electricity, perhaps the casual reader will, at the first glance, suppose that there is no necessity for having three electric circuits in the above arrangement, and that to have only one, and close it every revolution of a 24-hour wheel, is all that is necessary. On taking a second thought it will appear plain that such an arrangement, owing to the slow motion of the hour wheel, would contain no element of accuracy; and instead of closing the circuit at the precise second, it could not be adjusted to close nearer than several minutes. From this it will be plain that, to secure accuracy, a seconds, minute, and hour circuit must exist, and be arranged in such a manner that all the three can only be closed at one instant during the 24 hours.

Of late years, the report of a gun accurately fired off has come into common use abroad as a time signal. The city of Edinburgh, Scotland, affords the first example of true mean time being announced at a stated hour by an audible example. The arrangements connected with the discharge of the time-gun at Edinburgh are mechanical, not electrical, and may be described as follows : Placed on the ramparts of the Castle, and in the immediate vicinity of the gun, is a clock, the movement of which is under electrical control (by Jones' method) of the standard clock in the Royal Observatory, on Calton Hill, the two clocks being connected by a wire passing over the city from the Observatory to the Castle. The Castle clock indicates, therefore, the exact time of the Observatory clock, beat for beat. Attached to the movement of the Castle clock is a detent and lever arrangement, which is mechanically liberated by the mechanism of the clock at the precise moment necessary for the discharge of the gun. The accuracy with which this arrangement has been adjusted by Professor Piazzi Smyth, the Astronomer Royal for Scotland, is such that a failure in the discharge of the gun rarely occurs; and certainly the value of an audible time signal can nowhere be more fully demonstrated than by the accurate time kept in that city, in place of the miserable discrepancies that most usually are found to exist in cities and towns between tower clocks and watches ; a variation sometimes so wide as to frequently cause endless annoyance in loss of time and punctuality of appointments. The daily one o'clock time-gun signal in Edinburgh alike controls the accuracy of railroad, church, and other timepieces, and at every corner the accuracy of the local time registered can be trusted. Perhaps there are few cities in the world where time is so accurately kept as in Edinburgh.

In New York, as well as in many other important cities, there is no means of indicating time with accuracy, available to the general mass of the inhabitants. Taking even the standard clocks in our public buildings, and comparing the time one with another, how very frequently grave discrepancies are apparent. It will even be found that those ostentatious "regulators" of the jewellers' stores that are so much confided in for showing accurate time will vary many seconds from each other, and none of them be right, if tested by transit observation.

In the year 1863, during the meeting of the British Association at Newcastle-on-Tyne, Mr. Nathaniel J. Holmes conceived the idea, and in conjunction with Professor Smyth, practically carried out the first electrical time-gun, giving true Greenwich mean time by the passing of an electric current direct from the Royal Observatory, Edinburgh, to the touch-hole of the gun. The mode of firing this gun differed, therefore, from that of the Edinburgh time-gun, by discarding all mechanical contrivances, and igniting the charge by the passing of the electric spark direct into the fuze ; the precise moment of discharge being under the control of the Observatory clock, 120 miles distant. Practically, it was found that the time consumed in the passing of the current, and the ignition of the powder and discharge of the gun, was about one-tenth of a second ; an interval so small as virtually to be of no importance in ordinary life.

The success attending the Newcastle time-gun led to the temporary establishment, by Mr. Holmes, of experimental time-gun signals at North Shields and Sunderland. Those at Newcastle and North Shields have been placed on a permanent footing, by special grants of money to provide for powder, fuze, and attendance in loading and cleaning the gun. Early in 1864, Mr. Holmes temporarily established several time-guns at Glasgow. One, a 32-pounder, on the high ground near Port Dundas, gave the time to the surrounding district ; a second was erected in St. Vincent Place, near the Royal Exchange, which served to mark true time for the merchants in the neighborhood ; and a third, placed at the Broomielaw, amongst the shipping, registered mean time for the adjustment of chronometer rates ; a fourth gun was placed at the Albert Quay, Greenock, some 25 miles down the river Clyde, and true time was registered to the shipping lying in the docks, and out in the stream. These guns were all discharged simultaneously, by the current passed from the clock at the Royal Observatory, Edinburgh.

A time-gun has been for some few years established in Liverpol, and signals the time to the shipping lying in the Mersey. It was established, and is maintained, by the Mersey Dock Board, and is under the charge of Professor Hartnup. The electrical current, to discharge the gun, comes from the Observatory at Bidston, and every thing is so accurately adjusted that if a person stand near the clock that closes the circuit, he can, in favorable weather, when the atmosphere is clear, observe the flash from the gun at the same instant the seconds hand of the clock passes the sixtieth second. The gun is therefore the true exponent of the time of the clock, at a given second, each day ; but of course the clock that closes the circuit is liable to a slight variation, and is corrected by the following method, which is in use in all observatories when it is desired that the error of a clock should not accumulate, and the hands kept correct.

A very small brass cup, containing a few small-sized shot, is placed on the top of the pendulum bob. The clock is closely watched by Transit observation, and should it show indications of gaining a few tenths, the smaller cup is lifted from the pendulum bob, without disturbing its motion, and a small shot is taken out, and the cup replaced. This is equivalent to lengthening the pendulum, and it affects the rate of the clock accordingly;

and by this means, whether the clock shows symptoms of gaining or losing, it is at once corrected, and the hands of the clock are thereby kept always at the right time. It is to be regretted that even our best clocks are inadequate for all the requirements of automatically transmitting time signals, and require great care in their adjustment, but it is to be hoped that Professor Hartnup, in conjunction with Messrs. Wm. Bond & Son, will obviate this difficulty through the agency of the clock invented by the late Mr. R. F. Bond, and which is specially designed for working the telegraphic operations at present in use in all that relates to modern practical astronomy.

Comparing the respective merits of audible and visible time signals, it is remarked that a great majority of the population where these signals are erected, care but little for visible time signals, such as time balls and time clocks. Wherever the time ball and time gun are in daily use, and are both discharged from the same source, most persons prefer to set their clocks and watches by the gun. The sound travels over a radius of some ten miles, and by allowing a correction for the travelling of the sound, say one second for each quarter of a mile, the signal becomes equally available for accurate purposes. It is found, moreover, that on a clear day the firing of the gun constitutes a phenomenon that can be seen as well as heard; and not only so, but that it is far more conspicuous and decided to the eye, than the visible signal of the time ball.

It is greatly to be desired that accurate and convenient time signals should be established in all populous and maritime communities—the want of such a standard being greatly felt in all localities where it does not exist. During the past twenty years quite a number of large and well appointed Astronomical Observatories have been established among us, and these institutions are doing a quiet and unostentatious work, valuable in many branches of Astronomical science. With them the question of correct time is a regular part of the business of the observatory, and is indispensable in all their calculations; and we know that many of the directors of these observatories are willing to afford every facility for sending such signals, and we will be pleased to see any movement inaugurated that will eventually confer on us all the advantages of accurate and reliable time signals.

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Spectrum Analysis.

The Horological Journal having its circulation as well among the uneducated as those who are well informed on all the modern phases of science, it must not be thought improper for us to give such of our readers as have but limited access to scientific intelligence, glimpses of what is transpiring from time to time.

Probably very many of our young subscribers would find it rather difficult to give a tolerably intelligent description of "Spectrum Analysis;" and possibly to a few it is supposed to be a scientific something quite beyond their comprehension. Like astronomy, although its results are eminently practical, the investigations which have brought about such beneficial results, reach into the most profound depths of philosophical research. Already have practical minds seized and appropriated the first fruits of this new investigation of the properties of light, and none may at present venture to say what limit can be fixed to this practical application of philosophical study.

We will endeavor to give, in as lucid and brief a manner as possible, an idea of "Spectrum Analysis," and the beneficial practical results that already have, and are likely to accrue from its discovery, for which facts we are largely indebted to Prof. Henry E. Roscoe, of Manchester.

It is known to all that light is composed of different colored rays, which are easily separated by a prism, and shown distinctly, each by itself; which effect is produced by the difference in the refrangibility of each of these rays. Sir Isaac Newton discovered this property of light as early as 1675, when he enunciated the fact that "light, which differs in color, differs also in refrangibility." The band of colors thus produced he termed the Solar Spectrum. At this time it was supposed that the various shades of color in the solar spectrum were produced by the overlapping, as it were, of three distinct colored rays—one red, the second yellow, and the third blue—the maximum of which are situated at different points ; that of the red and blue at the extremes, and that of the yellow in the middle.

This theory has, however, proved to have been fallacious ; for Heimholtz has shown that the green ray, for example, is not made up of blue and yellow light superposed, and we cannot separate anything else but green out of it. Hence it is concluded that each particular ray has its own peculiar color, and that light of each degree of refrangibility is monochromatic. There are also rays extending beyond the visible red and blue, which, although they do not produce on the retina the impression which we call light, yet they play a most important part in the nature of the solar light, and by certain devices we can make ourselves aware of the existence of these invisible rays. The heating effects are mainly produced by those rays which are situated at the red end of the solar spectrum; the maximum heating effect being produced at a point beyond that at which we see any red light. The maximum of the rays affecting the eye exist in the yellow.

By means of a thermopile and a delicate galvanometer, it is found that the heating effect produced in the yellow and green portion of the spectrum gradually diminishes toward the violet, where it becomes a very insignificant amount ; but there exists in this end of the spectrum a new and striking peculiarity, the power of producing chemical action.

Now this solar spectrum does not consist of a continuous band, passing without interruption from red to violet, through all the shades of color which we know as rainbow tints, but is found interspersed with certain dark lines which may be regarded as shadows in the sunlight—spaces where certain rays are absent. Dr. Wollaston, in 1802, first observed these dark lines. Newton did not observe them, for the reason that he allowed the light to fall on his prism from a round hole in a shutter. In this way he did not obtain a pure spectrum, but a series of rays, one overlapping the other, owing to the light passing through different parts of the round hole. Had he allowed the light to pass through a fine vertical slit, and if this thin slit of light had fallen on the prism so placed that the refracting angle was parallel to the slit, he would have observed that the spectrum was not continuous, but broken up by permanent dark lines, which invariably maintain the same positions in the spectrum. The exact mapping and observation of these lines in the solar spectrum is a matter of as great importance to astronomy and physical science generally, as the mapping the stars in the heavens ; because, by knowing the exact position of these dark lines, we can ascertain that iron, sodium, and other well-known substances exist in the solar atmosphere. The first careful examination of these lines was made by the German optician Frauenhofer, by whose name they are generally known.

Frauenhofer mapped no less than 576 of these lines in the year 1814, many of which are as fine as a spider's web, and are so crowded together as to make the spectrum appear shaded, and yet each one a distinct line. He employed the letters of the alphabet to designate some of the principal lines, beginning with A in the red, and passing over to H in the violet, which lines are present in every kind of sunlight and moonlight, as well as the light of the planets. Venus and Mars exhibit the same dark lines, the relative distance between any given lines remaining constant, whether it be direct sunlight, or sunlight reflected from the moon or planets. Frauenhofer also made another important observation, namely—that the light from the fixed stars, which are self-luminous, also contained dark lines, but different from those which characterize solar light. The conclusion he arrived at was, that whatever produced the dark lines—and he had no idea of the cause—was something which was acting outside of our atmosphere, and not an effect produced by the sunlight passing through the air. This deduction of Frauenhofer has been proved correct by subsequent investigation, and is the foundation of solar and stellar chemistry.

We now come to treat of artificial lights of incandescent gas—that is, gas heated till it becomes luminous. Every different chemical element, when so heated, gives off a light peculiar to itself. The spectrum of every element in the state of glowing gas is broken up into bright bands and lines, indicative of the presence of the particular elementary gas in question. It is well known that certain substances, when brought into a colorless flame, have the power of imparting to it peculiar tints. For instance, if the alkali soda be brought into such a flame, it becomes bright yellow; potash gives a pale violet tint, strontium will produce a crimson flame, and barium gives a green color.

A most important fact is, that all the salts of sodium give off this yellow light when brought into the flame; so, too, all the litherous compounds tint the flame crimson; and this property of emitting a peculiar kind of light, is one of the means by which these various chemical substances can be detected. In fact, this property belongs to matter in general; and if the heat to which any matter be subjected is sufficient to render the vapor luminous, the light emitted is peculiar to itself, and is distinctive of that peculiar body, whether under ordinary circumstances the element be gaseous, solid, or liquid. These are the principles upon which the science of spectrum analysis are based, and by means of which the presence of any of the elementary bodies can be detected, if in the condition of glowing gas.

Some may ask, " What improvement is this upon the ordinary chemical methods ? What benefit is it that barium gives these peculiar bands, and that calcium produces others? We already know that the chemical reactions of these bodies are very different, and we can detect these substances by ordinary analysis." The answer is, that the new method is far more delicate than anything heretofore employed ; so delicate as almost to pass belief, and affording a means of examining the composition of terrestrial matter with a degree of exactitude hitherto unknown. For example, the spectrum analysis shows that sodium is present in every thing; that there is not a speck of dust, or a moat in the sunlight, that does not contain chloride of sodium. Two thirds of the earth's surface is covered with salt water, and the fine spray, which is constantly carried into the air from various causes, contains minute particles of salt. If a piece of platinum wire be heated in a colorless flame, the spectrum of that flame will show the presence of sodium. Rubbing the hands together near such a flame will set particles of sodium flying about, sufficient to give plainly the sodium lines in the spectrum. This constant presence of sodium perplexed the earlier observers, they thinking these constantly recurring lines in the spectrum due to the presence of water, because vapor of water was supposed to be omnipresent in the atmosphere; and it is only recently that this yellow reaction has been found to be due to the presence of sodium. Lithium, a substance which was supposed to be rare, has been found almost as universally distributed as sodium, and gives a beautiful red flame. The reason why the red flame was not always seen, is because, when seen by the eye alone, it was masked by the presence of soda, salts, and other substances, so that the red flame produced by the lithium was unseen. But when the flame is examined with the prism, then all these lines arrange themselves in due order, no one line interfering with the other ; and the presence of lithium may thus be detected, though mixed with ten thousand times its bulk of sodium compounds. By this means it has been found to occur in many minerals, in the juices of plants, in the ashes of the grape-vine, in tea, coffee, and milk, and in the human blood and muscular tissue. If the end of a cigar be held in a colorless flame, the red lithium line will at once appear in the spectroscope.

Practically, great use is now made of the spectroscope in the manufacture of steel by the Bessemer process. The admission of air into the converter must be shut off at the moment the carbon disappears. This point was only known by inspection of the flame by the practised eye of the workman, and mistakes often occurred in the exact instant. But by watching the spectrum of the flame, the carbon lines are seen to disappear, and this is the instant to shut off ; and it is only by means of the spectroscope that this point can be exactly determined.

The flame produced by the Bessemer process shows sodium, potassium, lithium, iron, carbon, hydrogen, and nitrogen ; a result which any other mode of analysis would scarcely be able to arrive at with any certainty. But the most wonderful achievement is the facility it affords for investigations into the character of the celestial worlds.

Hereafter we will give the readers of the Journal the modes and results of Spectrum Analysis as to the physical properties of the starry worlds, untold millions of miles away.

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An Old French Watch.

We were shown a few days ago, by Mr. E. A. Sweet, an old French centre seconds watch, made by Breguet & Sons, of Paris, which is quite a curiosity in its way, and forcibly illustrates the ideas of watch work that prevailed at the period of its manufacture. It has a detached lever escapement, with the teeth projecting from the side of the scape-wheel, instead of being cut in the edge, as is commonly practised—an arrangement not well suited for the modern taste for flat watches. The seconds hand moves exactly once every second, and this is accomplished by making the balance so large in diameter as to vibrate once a second, and the train as slow in proportion. In fact the balance is placed in the centre of the movement, and is over one and a fourth inches in diameter, and nearly as large as the movement, and is made of gold.

It is also a keyless watch, although not a stem-winder; the winding being done on the same principle as a ratchet and lever drill is worked. You open the glass of the watch and the end of the lever presents itself to view, projecting from under the dial. The centre of motion of this lever is on the barrel arbor, and on the lever and near to this centre is placed a click and spring, which works into a ratchet fixed on the fuzee arbor, and consequently a motion of the lever backward and forward winds the watch. We have seen this principle often applied to certain kinds of clock-work when the situation would not admit of a crank key being used in the usual manner, but its application to watch-work is rare. The mechanical execution of the watch, like most all watches made at that period, is very accurate.

The construction of this old time-piece is quite an interesting curiosity when compared with the modern theories of quick vibrations of the balance, and the modern construction of centre seconds and stem-winding watches.

Mr. Sweet says that the watch performs very well when kept steadily in one position.

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Painting Figures on Gilt Dials—Isochronous Pivots—Value of Old Gold and Silver, etc.

Editor Horological Journal:

The material used for painting figures on gilt dials, either watch or clock dials, is sometimes India ink, ground in water in which a little gum-arabic has been dissolved; but this ink is not suitable for the purpose, as it can be washed off. The proper article is prepared by adding dry lampblack to any good copal varnish. This ink should be thin enough to flow from a pen, but no thinner than is necessary for that purpose. In painting metal watch dials there is something more required than merely written instructions. The skill of the artist is the most essential. Gilt or silvered clock dials may be lettered in the same manner that painted dials are. The circles are struck with a good ruling pen and a pair of compasses. The figures previously sketched with a pencil, are outlined with the ruling pen guided by a straight edge. The top and bottom lines of the figures being arcs of a circle, are also struck with the pen and compasses. If the circles are struck before the figures are outlined, it will be necessary to dry the work to avoid blotting the circles. The work should also be dried after the outlining is completed, and finally the body of the figures filled in with a brush.

There is "a soft enamel that will melt with a spirit lamp" in various colors. It is about as hard as gum shellac, and may answer as an expedient in repairing injured work, but is not at all suitable for new articles. It will not retain the polish. It can be had of the material dealers in small boxes of assorted colors.

Pure nickel is used in plating with very great success. The processes are, however, covered by various patents, and are well worthy of legal protection, which they are not allowed in Canada. In No. 2, Vol. I., of the Horological Journal is given a comprehensive history of the art, to which scarcely anything can be added. The pure nickel is worth about $2 gold per pound. L. L. Smith & Co., No. 6 Howard street, N.Y., are reliable men to deal with in the nickel plating line.

Isochronous Pivots.—A great many English and American watches have very large balance pivots and deep holes in the jewels, and although they may be hung up at night, they are subject to a constant change of position while in the wearer's pocket. To a watch adjuster this is quite an ordinary matter, and of course is the first thing to be corrected; but there are a great many persons not able to have their watches adjusted, who would like to have the daily variation from a vertical to horizontal position reduced. By many careful experiments the friction can be increased in the horizontal by flattening the ends of the pivots; but sometimes it is difficult, on account of very deep bearing in the jewel hole. Instead of putting in a more shallow jewel, and thus reducing the friction in an upright position, the pivots may be altered in this way: With a round graver cut away the bearing of the pivot *next* to the shoulder, so as to reduce the length of bearing in the jewel hole; one-third of the surface, or one-half, or any amount found to be necessary may be turned off. The depth of the cut may be very slight indeed, only just sufficient to clear the bearing of the jewel without impairing the strength of the pivots. It is said that the amount of friction is of little consequence provided it is equal; still it is better to equalize it by reducing it in one position than by increasing it in another.

A very little time and patience will serve to improve many a watch in this respect, and tend not only to the profit but the reputation of the workman. By this process the friction can be made exactly equal, and so that the time will not vary more than a few seconds in the two positions, without regard to the hair-spring. It is not necessary to polish the cutting, as of course it cannot touch the jewel.

The Value of Old Gold and Silver.—Watchmakers, and others who are in the habit of receiving quantities of old gold and silver, are frequently disagreeably surprised to find that they cannot dispose of it at a suitable profit to themselves. In fact it would seem as though gold itself is worth less than paper. Frequently the buyer does not exercise good judgment in regard to the quality, and is naturally disappointed at the small returns. The fairest way is to send to the U.S. Assay Office, in New York. They will receive gold and silver, either or both worth apparently in all $100, and return in a few days the exact and full value in coin. The better way to send it is to cast each metal by itself into an ingot, without regard to quality, as upon assay the actual fineness will appear. Private dealers and assayers generally look upon this method with suspicious eyes, as though there was an attempt to cheat them by adding base metal to the ingot, and despite their own judgment will offer a smaller price for an ingot than for the articles unmelted. This, however, is a matter of no account at the Assay Office. Where the accumulations are small it will afford a very good interest to wait until the value of $100 is reached, before disposing of it.

To Sharpen a Pivot Burnisher.—Prepare a flat piece of pine board a foot long and about two and a half inches wide; make one side of it as flat and smooth as possible; coat the surface with good glue, but do not use it too thick; cover it with emery, about No. 4 from the very finest will do. To sharpen a burnisher, push it steadily from one end to the other of the emery stick, being careful to keep the burnisher perfectly flat, so as to avoid injuring the corners. One burnisher, kept in order in this way, will last a lifetime, with the additional advantage of being always fit to use.

Hands Off.—A handy little tool for the watch bench, to remove the hands from watches in the easiest manner, and with no possibility of injuring the hands, can be made from a strip of saw plate one inch and a half long, and of a suitable width. The end should be slotted and *turned up*, just like the claw of a carpenter's hammer used for drawing nails. Three sizes are required—a small one for the seconds hand, one for

Ancre hands, and a large one for other watches. They are fitted to pass on each side of the socket of the hands, between the dial and the hands, so that by pressing down the handle the hands are lifted off.

Barrel Arbor Ratchet.—Mr. Grossmann has written enough on the subject to convince watch manufacturers of the worthlessness of the barrel arbor with a solid ratchet. It is liable to the annoying accident of the stripping of the teeth, either from being too hard or too soft. The proper remedy is, of course, in substituting a new arbor, but it is not the only one, consistent with good work. A plain ratchet wheel of the right size may be selected and placed in the shellac chuck, and the whole of the centre turned out, leaving a ring stout enough to support the teeth. The ratchet on the arbor is then turned off for the ring to fit tightly, a small notch being made on its edge with a round file, and a corresponding notch on the inner edge of the ring, so that a rivet may be inserted to prevent the ratchet slipping. Soft solder is then run through the joint, and if the work has been done carefully it will be nearly as good as a new arbor, at a small part of the expense.

B. F. H.

Sag Harbor, L. I.

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Electro-Metallurgy.

Editor Horological Journal:

Although several valuable articles have appeared in your Journal upon this subject, I doubt if a novice could without some *further explanation of details,* not even after a careful perusal of Smee and Napier, succeed in electroplating or gilding any article until after he had made repeated experiments and failures, costing no small amount of time and materials. Now I propose to give a few practical directions that will be of value to those who know nothing of this subject, and enable them to gild or plate such articles as a jeweller is usually called upon to do. Although I would, by all means, advise every one who intends to use a battery for this purpose, to get a copy of "Napier on Electro-Metallurgy," or some other good work upon the subject, that a knowledge of the "why" and "wherefore" of the various proceedings and results may be obtained.

The first thing to be done is to obtain a "Smee" battery, and for our purpose a single cell or cup, with a pair of zinc plates about $2\frac{1}{2} \times 4$ inches, with a platina plate between them, will answer as an exciting fluid; use sulphuric acid, 1 oz. to 12 oz. distilled or filtered rain water, always keeping an ounce or so of quicksilver in the bottom of the glass jar that contains the battery, that the zincs may always be amalgamated. The next thing in order is to make your solutions.

To make a silver solution:

1*st.* Take 8 dwt. silver or a silver half dollar and dissolve in a solution of 1 oz. each nitric acid and soft water.

2*d.* Make a strong solution of common salt and hot rain water, which add to the acid as soon as the silver is all dissolved, and agitate for a moment or so, then let stand a short time, when the silver will settle to the bottom.

3*d.* Carefully pour off the liquid and then add clean soft hot water, and again pour off; repeat this operation several times, until the precipitate is free from acid, which can be ascertained by application of the tongue.

4*th.* Dissolve the precipitate in a solution of 1 oz. cyanide of potassium to 2 oz. of hot soft water by adding a little of the solution at a time and decanting off, so as to add as little of the cyanide as will dissolve the silver.

5*th.* Add one quart of distilled or filtered rain water, and let stand eight hours before using, then decant off, or filter.

To make gold solution:

1*st.* Dissolve a five-dollar gold piece in a solution of 2 oz. muriatic and 1 oz nitric acid (if the gold is not all dissolved, add a little more of the nitro-muriatic acid).

2*d.* Evaporate the acid, leaving a dry powder in the bottom of the dish.

3*d.* Wash with boiling hot water, same as for silver.

4*th.* Dissolve the precipitate, same as silver.

5*th.* Add 1 quart filtered rain water, same as for silver.

Another good method for making a "gold solution" is to dissolve the gold in three parts muriatic and one of nitric acid, add 1 pint hot rain water, and digest with calcined magnesia, which will precipitate the gold ; now boil this *oxyd* of gold in strong nitric acid to get rid of any magnesia that is in union with the gold, wash and dissolve with cyanide as directed for the other gold solution. However, I do not propose to give a number of different methods for preparing the solutions and the good and bad qualities of each, but simply state that any man will be well pleased with the silver solution and the first gold solution that I have given directions for making.

Now that we have a battery, and a quart each of gold and silver solutions, we are ready to go to work. Our solutions are called (gold) "auro-cyanide of potassium," (silver) "argento-cyanide of potassium.

1*st*. Prepare the battery, by putting as much of the diluted sulphuric acid as is needed into the glass jar, then put in the battery. (The acid must not come up to the wood that separates the zincs.)

2*d*. Take two pieces of copper wire, 18 inches long, more or less, connecting one to the zincs, and the other to the platinum. (The *outside* plates are the zincs.)

3*d*. Put your gold or silver solution into any convient shaped glass dish or pitcher, and to the wire connected with the platinum, attach a plate of fine gold, if gold solution is used, and a plate of silver, if the silver solution is the one you wish to use, and suspend it in the solution. The metal to *receive* the deposit, must be thoroughly cleaned, either with chalk and alcohol, with a brush, or by cold or in boiling "pickle." Then wash and rinse in cold water, and suspend the article to be gilded in the gold solution, attached to the wire that connects with the zincs of the battery, always being careful to avoid as much as possible getting the fingers on the article to be gilt, as cleanliness is a very important consideration, if the best of results would be obtained; after the article has been in the solution for five or ten minutes, take it out and rinse in water and brush with chalk and alcohol ; or, if the article will permit of it, use the "scratch brush" and plenty of sour beer, keeping the article covered with the beer while brushing; then rinse and put back into the solution, where let it remain half an hour, more or less, according to the thickness of deposit required, when it is to be taken out and cleaned as before, and thoroughly washed in soap and water, and rinsed to get rid of the cyanide; it may be necessary to take the article out and clean it two or three times before it has a sufficient coating. The *positive* plate, the one connected with the platinum, which is the one being acted upon by the gold solution, must never exceed in size—*i. e.*, the portion immersed in the solution—the negative plate or article to be gilt, as the deposit will be of a dark brown, or some other color, from the bright metallic one desired. If the positive electrode is the largest, or if the battery is too strong, the same phenomenon will be observed.

The above directions are for gilding gold, silver, copper, brass, etc.; but if we wish to gild or plate steel and iron, or britannia metal, we must prepare for receiving the deposit as follows : To prepare steel or iron, make a solution of 1 oz. cyanide potassium to 2 oz. soft water, dip the article in pure sulphuric acid one minute, clean with pumice-stone, and brush, rinse, and immerse the article to be gilt in this solution for three minutes, or until it is thoroughly coated *white*, then put the article in the solution, when it will readily receive the gold or silver, as the case may be. For britannia metal you must dip the article in a solution of hot potash water, rinse, and scour with pumice-stone, rinse, and then put in the solution, same as with any other metal. When not in use, the gold and silver solutions should be kept bottled, tightly corked, and properly labelled. The acid should also be kept in a bottle, and the zincs can remain in the empty jar until the battery is wanted again. After using the battery a good many times its action will become very weak, and, in fact, will in course of time utterly fail to produce any effect upon the solutions. When this is the case a new solution of sulphuric acid and water must be made. When the acid solution becomes worn out it will be noticed that, when the zincs are put in the jar containing the same, it fails to make the zincs look bright, and when such is the case a new solution must be made.

The "Manual of Electro-Metallurgy," by Napier, and published by Henry Carey Baird of Philadelphia, is, I presume, considered one of the best and most complete works extant upon this subject; yet, if we wish to find out how to plate iron, tin, or lead, and turn to page 612, we find this language: "Iron, tin and lead are very difficult to gild direct; they, therefore, generally have a thin coating of copper deposited upon them by the cyanide of copper solution, and immediately put into the gilding solution." As you see, such language is very unsatisfactory; besides, the above articles *can* be plated without first coating them with copper. It is very evident that the various manufacturers of plated ware in this country do not follow Napier's method. I do not wish to be understood as finding fault with Napier's work, but simply to call attention to the fact that what is considered one of the *best* works upon this subject, is incomplete in some of its details, but withal a very valuable book, and one that every man should possess who dabbles in electro-metallurgy. A battery can be obtained from any of the manufacturers of such goods, among whom I would mention Dr. Jerome Kidder, 544 Broadway, who makes a first class battery and at a reasonable price. In ordering a battery it would be well to state for what use it is intended, size, etc., *without a machine.*

JAS. FRICKER.

Americus, Ga.

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Silvering Dials.

EDITOR HOROLOGICAL JOURNAL:

I give you the following as the method I have found to succeed well in silvering chronometer dials. I have not been accustomed to observe any accuracy in the matter of weights and measures in compounding the materials used; indeed, I do not think exact proportions are essential.

I purchase nitrate of silver sold by the druggists in the form of sticks about three-sixteenths of an inch thick and three inches long, such as is used for medicinal purposes, and called lunar caustic.

Dissolve such a stick in half a pint of rain water in a perfectly clean tumbler; add two or three table spoonfuls of common salt, which will at once precipitate the silver in the form of a thick white curd called chloride of silver. No harm will ensue if an excess of salt is used. Let the chloride settle until the liquid is clear; pour off the water, taking care not to lose any chloride; fill the tumbler again with water and thoroughly stir with a clean bit of wood and again pour off, which process repeat till no trace of salt or acid can be perceived by the taste. After draining off the water, add to the chloride about two heaped table spoonfuls each of salt and cream of tartar and mix thoroughly into a paste, which, when not in use, must not be exposed to the light.

To silver a surface of engraved brass, wash the surface clean with a stiff brush and soap. Heat hot enough to melt black sealing wax, which rub on with a stick of wax until the engraving is entirely filled, care being taken not to burn the wax. With a piece of flat pumice-stone and some pulverized pumice-stone and plenty of water, grind off the wax until the brass is exposed in every part; the stoning being constantly in one direction. Finish by laying an even and strait grain across the brass with blue or Scotch water stone. Take a small quantity of pulverized pumice-stone on the hand and slightly rub in the same direction, which tends to make an even grain; the hands must be entirely free from soap or grease. Rinse off the brass thoroughly, and before it dries lay it on a clean board and gently rub the surface with fine salt, using a small wad of clean muslin.

When the surface is thoroughly charged and covered with salt, put upon the wad of cloth, done up with a smooth surface, a sufficient quantity of the paste, say to a dial three inches in diameter a piece of the size of a marble, which rub evenly and quickly over the entire surface. The brass will assume a grayish streaked appearance; add quickly to the cloth cream of tartar moistened with water into a thin paste; continue rubbing until all is evenly whitened. Rinse quickly under a copious stream of water; and in order to dry it rapidly, dip into water as hot as can be borne by the hands, and when heated, holding the brass by the edges, shake off as much of the water as possible and remove any remaining drops with a clean dry cloth. The brass should be then heated gently over an alcohol lamp, until the wax glistens without melting, when it may be covered with a thin coat of spirit varnish, laid on with a broad camel's hair brush. The varnish or lacquer must be quite light colored—diluted to a pale straw color.

There is a certain dexterity and judgment required, which may, however, be easily acquired with practice.

J. B.

110 *Wall st., N. Y.*

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Tempering Fly-up Springs.

EDITOR HOROLOGICAL JOURNAL:

From time to time I have noticed various methods of hardening and tempering fly-up springs given in the JOURNAL. "R. C." hardens the spring in the usual manner, and attaches it to a piece of binding wire, then smears it over with viscid oil, burns the oil off, and plunges it in cold water. "J. F., Americus, Ga.," first hardens the spring in oil, and then puts it in a spoon filled with oil, and burns the oil all out of the spoon. "Ontario" hardens in cold water, and then dips it into olive or sweet oil, burns off the oil, and dips it into the oil again. This operation he repeats six times, having found springs to break when they were tempered with a less number of operations.

There are many peculiarities about the hardening and tempering of steel, especially articles of irregular shape. Much depends on the preparation of the article, and on the regular application of the heat in the first instance. Probably oil is the most convenient liquid on a watchmaker's bench to cool it in; yet soft water, not colder than 60 degrees, is for this purpose equally good. Tempering irregular-shaped articles to a spring temper is certainly easiest and best done by placing them in oil or fat, and burning it off; and if done thoroughly produces an equal temper, the same as that produced by a blue color. The peculiarity in this method of tempering, and which makes it so valuable, is that if it be necessary to burn the oil off several times, so that the heat may penetrate into the thick parts of the article, the thin parts will never get softer than that produced by a blue color, however often the operation may be repeated.

The fact that "R. C." dips the spring in cold water after burning the oil off, appears to be based on the supposition that the spring will be too soft if allowed to cool gradually; but from the above explanation it will be obvious that it cannot become softer than blue, unless heat be applied to it in some other manner than by the means of hot or burning oil or grease. The method practised by "J. F.," of placing the spring in a spoonful of oil, appears to be the most thorough manner of tempering a spring with one operation.

For more exhaustive remarks on the subject, see the article on "Heat" in the March number of the Second Volume.

CLYDE.

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Modelling Wax.

EDITOR HOROLOGICAL JOURNAL:

Perhaps the following method of preparing modelling wax, or sculptor's putty, which I read in the *Druggists' Circular*, may be of service to "Ontario:"

It is a well known fact that powered gypsum, when freed by calcination from its water of crystallization regains to a great extent its original hardness when incorporated with water enough to form a stiff paste. In order to attain this end, there is at least thirty-three per cent. of water required, twenty-two per cent. of which is held as water of crystallization; the rest evaporates, and thus brings about the porosity of the hardened gypsum. In working up a small quantity of gypsum one has only a few minutes time for using the paste, or moulding, or puttying, as it soon becomes hard. In larger quantities the making of the paste requires longer time, and the mass hardens sometimes before the operation is completed. According to Mr. Puscher, of Nuremburg, this inconvenience may be got rid of by mixing with the dry powdered gypsum, from two to four per cent. of finely pulverized althea root (marsh-mallow), and kneading the intimate mixture to a paste with about forty per cent. water. In consequence of the great amount of pectine which is in the althea root, and which in fact amounts to about fifty per cent., a mass similar to fat clay is obtained. This mixture begins to harden only after the lapse of an hour's time. Morever, when dried, it may be filed, cut, turned, bored, etc., and thus become of use in making dominoes, stones, dies, broaches, snuff-boxes, and a variety of things of a similar character. Eight per cent. of althea root, when mixed with the gypsum, retards the hardening for a still longer time, but increases the tenacity of the mass. The latter may be rolled out on glass, in thin sheets, which never crack in drying, may be easily detached from the glass, and take on a polish readily on rubbing them. This material if incorporated with mineral or other paints, and properly kneaded, gives a very fine imitation of marble. They bear coloring when dry, and can then be made water-proof by varnishing.

The artisan, in the practice of his trade, will probably find it to his advantage to make use of this prepared gypsum, in place of that usually employed by him ; the manufacturer of frames need have no fears that his wares will crack if he uses a mixture of the above-indicated composition ; moreover, the chemist and chemical manufacturer will find that it does excellent service in luting vessels of every kind. The proper proportion of water to be made use of cannot be given exactly, as it varies within a few per cent. according to the fineness and purity of the gypsum employed. The althea root need not be of the very best quality, the ordinary kind serving the purpose perhaps equally well."

N. Y. City. A. T. M.

Fastening Main-spring Hooks.

Editor Horological Journal :

Here in Toronto we have placed in our hands for repairs very many English watches which, as you know, have the main-spring in a box, or barrel, as some call it, and the hook is attached to the main-spring—taking hold of the box by a hole in its side. I find a good many of these main-spring boxes with the gilding filed off by workmen who have put in a new spring, and leaving the hook to stick through the box more or less ; and in finishing it off flush (and a little more) with the outside of the spring box they take off the gilding. I should be very much obliged to any of your correspondents for a good way to finish off these main-spring hooks *without* marring the outside finish of the barrel. X.

Toronto, Ca.

Answers to Correspondents.

A. S., *San Francisco.*—It is quite a common practice for watchmakers to remove blue from the surface of polished steel by dipping the article in muriatic acid, or spirits of salt, which is the same thing. You can try the experiment with a piece of broken main-spring. Dip the end of it in the acid and the blue will immediately disappear. You must rinse it in clean water afterwards, so as to stop the further action of the acid on the steel, which would finally produce rust. It is better that the water be warm, because warm water imparts a heat to the metal and causes it to dry sooner. It is advisable to rub the articles with an oily brush afterward. If equal parts of muriatic acid and elixir vitriol be used, glossed surfaces are not so liable to have their lustre dimmed by a careless use of the acid.

H. N. R., *Leavenworth, Kansas.*—In the shading of nickel movements a special tool is required, of which a precise description cannot be given at the present time. We believe that the marks are made either by the aid of small and very fine wire circular brushes, or by stones. The office the machine has to perform is to alter the position of the brush or stone, or alter the position of the work so to produce the desired pattern, and the machine is so constructed as to be able to produce many varieties of patterns. We think that an ingenious workman who was determined on making such a machine could contrive one to answer the purpose if he had business enough for the machine to recompense him for his labor in making it. In shading clocks, no tool is used. The parts are first polished as usual, and the marks are afterwards produced by hand, with a suitable piece of charcoal, or a piece of bluestone. Dexterity and practice only are necessary.

The edges of clock frames, and the edges of clocks and similar parts, are sometimes ornamented with agreeable patterns, both of circular and diamond shapes, by means of the dexterous use of the emery stick. Vienna lime, such as can be procured from the watch material dealers, can be used with advantage in polishing small steel articles, whether they are hard or soft. The method of using the lime has been often referred to in the columns of the JOURNAL.

F. G. C., *Glenn's Falls, N. Y.*—Your ambition to be able to make an entire watch, all with your own hands, in this the last year of your apprenticeship, is a commendable one, and we will gladly give you such advice and information as you may require. The discrepancies that exist in the comparative size of the pinions, in the different watches that you have examined when searching for one to serve as a model for your new watch, may be considered to be accidental, or arising from the different methods the manufacturers had of sizing the pinions. Different makers have different methods of determining the size of pinions, and the results given by the various methods often vary a little, although in many instances not so much as to immediately show their defects in the running or wear of the watch. When using any rule or table for finding the diameter of a pinion, the intelligent workman should know the geometrical basis upon which the rule is founded. In the present number we publish an article on sizing pinions which may be of service to you, and should you desire further information we will be happy to give it to you.

G——, *Washington, D. C.*—The shading of Swiss nickel movements and the graining of the gilding are at present trade secrets, but, like every other trade secret, they must sooner or later be exploded.

We describe the supposed method in answer to an inquiry from Kansas, which is published in the present number.

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EQUATION OF TIME TABLE.

GREENWICH MEAN TIME.

For August, 1871.

Day of the Week.	Day of Mon.	Sidereal Time of the Semi-diameter Passing the Meridian.	Equation of Time to be added to / subtracted from Apparent Time.	Diff. for One Hour.	Sidereal Time or Right Ascension of Mean Sun.
		S.	M. S.	S.	H. M. S.
Tuesday	1	66.67	6 4.69	0.142	8 38 36.76
Wednesday ...	2	66.58	6 0.95	0.168	8 42 33 31
Thursday......	3	66 49	5 56.62	0.193	8 46 29.87
Friday	4	66.41	5 51.69	0.217	8 50 26 42
Saturday......	5	66.32	5 46.17	0.242	8 54 22.98
Sunday........	6	66.24	5 40.07	0.266	8 58 19.54
Monday........	7	66.15	5 33 39	0.290	9 2 16.09
Tuesday	8	66.07	5 26.14	0.313	9 6 12.65
Wednesday....	9	65.98	5 18.33	0.337	9 10 9.21
Thursday	10	65.90	5 9.96	0.360	9 14 5.76
Friday.........	11	65.82	5 1.93	0.383	9 18 2.31
Saturday......	12	65.74	4 51.55	0.406	9 21 58.87
Sunday........	13	65.66	4 41.53	0.429	9 25 55 42
Monday........	14	65 58	4 30.96	0.451	9 29 51.98
Tuesday	15	65.50	4 19 85	0.473	9 33 48 54
Wednesday ...	16	65.42	4 8.22	0.495	9 37 45.09
Thursday......	17	65 34	3 56 07	0.517	9 41 41.64
Friday	18	65 26	3 43 40	0.539	9 45 38 20
Saturday......	19	65 18	3 30.22	0.560	9 49 34.75
Sunday	20	65.10	3 16 53	0.581	9 53 31 30
Monday........	21	65.04	3 2 34	0.601	9 57 27.86
Tuesday	22	64.98	2 47 67	0.621	10 1 24.41
Wednesday ...	23	64 91	2 32.53	0.640	10 5 20.97
Thursday......	24	64 85	2 16.96	0.659	10 9 17.53
Friday.........	25	64.79	2 0.94	0.677	10 13 14 08
Saturday	26	64 73	1 44.48	0.695	10 17 10 63
Sunday	27	64.67	1 27.61	0.711	10 21 7 18
Monday	28	64 62	1 10.35	0.727	10 25 3.74
Tuesday.......	29	64.57	0 52.72	0.742	10 29 0.29
Wednesday ...	30	64 52	0 34.74	0.756	10 32 56 84
Thursday	31	64.47	0 16.42	0.770	10 36 53 40

Mean time of the Semidiameter passing may be found by subtracting 0.18s. from the sidereal time.

The Semidiameter for mean noon may be assumed the same as that for apparent noon.

PHASES OF THE MOON.

		D. H. M.
☾	Last Quarter....................	7 16 23.7
●	New Moon.......................	15 19 1 7
☽	First Quarter..........	22 23 35.4
☺	Full Moon........................	29 18 20.8

		D. H.
☾	Apogee	10 6.7
☾	Perigee	25 22 5

	° ′ ″
Latitude of Harvard Observatory	42 22 48.1

	H. M. S.
Long. Harvard Observatory..............	4 44 29.05
New York City Hall..............	4 56 0.15
Savannah Exchange...............	5 24 20.572
Hudson, Ohio	5 25 43.20
Cincinnati Observatory	5 37 58.062
Point Conception......	8 1 42.64

		APPARENT R. ASCENSION.	APPARENT DECLINATION.	MERID. PASSAGE.
	D.	H. M. S.	° ′ ″	H. M.
Venus.....	1	11 33 58.25....	+ 1 20 14.4.....	2 55.2
Jupiter....	1	7 7 10.99....	+22 35 45.2.....	22 25.8
Saturn....	1	18 18 48.06....	− 22 40 59.1.....	9 38.5

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CONTENTS.

Formation of Pinion Cutters.

In the article on the Diameter and Shape of Pinions, in the last number of the Journal, we considered the action of the wheel with its pinion to be perfect, and that the velocity and force at the circumference of every wheel is truly and constantly imparted to its respective pinion; which is supposing not only the wheelwork to be proportioned with the utmost exactness, but also their teeth shaped in the best manner. There are, however, very common causes of bad action. First, whenever the wheel is too small for the pinion, though ever so well set to depth, its teeth will pitch against the ends or tops of the pinion's leaves, and more than ordinary force will be consumed in their motion. Secondly, when the wheel is too large for the pinion, it will impart to it too much velocity during the action, and part of the force will be expended in the drop that will take place before the action commences against each following leaf of the pinion, after it has ceased to act with the leading leaf. And thirdly, if the curve of the tooth be ill-formed, the transmitted force will considerably affect the isochronism of the regulating medium of the timepiece, *with ordinary escapements*, whether the regulating medium be a balance and spring, or a pendulum.

Various methods have been proposed and employed to form the curves on small wheels and pinions with mathematical accuracy; but the whole question resolves itself into the subject of making the finishing cutters so that the desired curve will be produced. For although we have met with workmen who had the natural gifts and the necessary practice to be able to file pinion leaves and the teeth of wheels with great accuracy, the operation is so difficult, and especially so slow, that it becomes desirable, and in this age of cheapness it becomes imperative, that a quick and certain method of forming these curves with accuracy should be practised. Although filing the teeth with files is a primitive means of gaining the desired end, the work done in some instances in this manner will stand favorable comparison with many engine rounded teeth of greater pretentions to accuracy; and even in some of those that pass for our best time-keepers, the curves of the teeth of the wheels and leaves of the pinions will be found, on being put to the test, to vary more or less from the mathematical curves that ought to be followed. Hence the necessity of having the cutters made so as to produce the desired curve with certainty.

That talented horologist, the late Richard F. Bond, of Boston, was the originator of a very simple and effective method of forming the curves on cutters with certainty. A piece of steel, suitable to make a cutter, is selected and prepared, and turned in the lathe to the proper diameter, and to nearly the proper shape. A turning tool, having its point of the same shape, and of the same curve, that is desired to be given to the leaves of the pinion, is now fastened in the slide rest exactly square, or at right angles to the centres of the lathe, and the screws of the slide rest are moved till the cutter is brought to a proper position to turn the groove or curve on one edge of the circular cutter that is under construction. The work is then taken out of the lathe to allow the tool in the slide rest to be moved along to a proper position to turn the other side of the new cutter, and the work replaced in the lathe, and the groove or curve is formed on the other side the same as on the first, and the new cutter brought to the proper thickness. At first Mr. Bond fastened a stop on the slide rest, so that in the working of it, the turning tool would only be allowed to move a certain distance towards the centre; but this plan he afterwards abandoned, because it was found that if the tool was moved out or in from the centre at all, even with the aid of the stop, it never could be got so exactly to the position that would make both sides of the new cutter perfectly equal; and afterwards he only used the parallel motion in working the slide rest, and never disturbed the other, after it had been first set, during the entire operation of forming the curves on the cutter.

On reflection, the reader will perceive that if the turning tool that is fastened in the slide rest be made with the same curves that the leaves of the desired pinion are required to have, and that if the tool be set square in the slide rest, and the parallel motion of the slide rest be true with the centres of the lathe, the curve formed in both sides of the new cutter will be exactly the same on both sides, and the reverse of those of the fixed cutter; and when the new cutter has got teeth cut in it, it will produce a leaf in the pinion exactly the duplicate of the shape of the fixed cutter that was in the slide rest of the lathe in the first instance. By this means the process of forming the curves in cutters, and also of making them of the proper thickness, is reduced to a simple operation, which any one possessed of a good lathe can practise. The mathematical part of the operation lies in forming the cutter fastened in the slide rest, and in this part some knowledge of drawing cycloidal curves is necessary; and those who desire to put this method of making the curves on cutters into practice will find much assistance by referring to the article on page 126 of the second volume of the Journal.

The proper curves being formed, and the cutter brought to the desired thickness, the next question to be considered is the formation of suitable cutting edges; for at this stage the cutter is simply a steel disk with no teeth. And here we will make a few remarks on the general subject of cutting edges. We all have observed that cutting edges vary according to the material the cutting tool is designed to cut. We do not grind a graver that is to cut steel in the same manner that we grind one to be used exclusively on brass; neither do we grind a chisel that is to be used on wood in the same manner as we grind one to be used on a harder material. It is generally acknowledged by machinists that the cutting angle of a lathe turning tool operates best, is most effective, and has the greatest strength, when ground to an angle of about 60°, and which in tools of this kind may be called the angle of strength, and can be used to advantage in all tools which are used to cut iron or steel. The teeth of cutters operate as a series of revolving chisels, and in order that the cutters should work to advantage the cutting edges must be formed according to the same rules that govern cutting edges in general. A cutter to cut a steel pinion, should have the teeth formed at about an angle of 60°; and one to cut brass, from about 45° to 50°, according to the hardness of the metal.

The teeth of cutters are easiest formed by cutting them on a cutting engine with cutters kept for that special purpose. The faces of the teeth of the cutter ought to be in a line with its centre; and in order to give the necessary clearance, and produce a proper cutting edge, the tops or points of the cutter teeth must be formed so that they will make an angle of from 45° to 60°, according to the kind of metal the cutter is designed to cut. This is easily and accurately accomplished by fastening the cutter on an eccentric arbor, placing it in a lathe, and working the spindle backward and forward by hand till the necessary clearance be given by the action of a cutting tool fastened in the slide rest. We believe that Messrs. Brown & Sharp, of Providence, R. I., own or control a patent for making cutters after this system. We have practised the method ourselves for many years, and we know it is a favorite plan used by certain clockmakers both in the United

States and in Europe. Mr. Bond had a novel method of giving clearance to single tooth cutters. Instead of turning the cutter on an eccentric arbor he simply bored a new hole a little out of the centre, which answers the same purpose when only a single tooth cutter is required. Cutters with only one tooth are very convenient to use for some purposes, because of the simplicity of making and hardening them ; but they possess no other advantage, as is generally supposed, over cutters having a number of teeth. When used on steel a single point cutter soon wears out, and they are principally used for small brass wheels, for which purpose they are admirably adapted when a sufficient speed can be given to the cutter spindle, because it is plain that a cutter having only one tooth must move ten times faster than one that has ten. A description of the manipulations necessary in the various processes of cutting and polishing pinions has already been given in the first and fourth numbers of the first volume of the Journal, to which we refer our readers for information on that part of the subject.

——o——

Chronometers and their Use.

MOTIONS OF THE EARTH—SIDEREAL AND MEAN TIME—TABLE TO REGULATE A CLOCK OR CHRONOMETER BY TRANSIT OBSERVATION—CONVERTING TIME INTO LONGITUDE, ETC.

Chronometer, in its comprehensive signification, may mean any kind of machine which measures time, and of which there have been various kinds, such as clepsydras, clocks, watches, regulators, etc. Rousseau mentions, in his dictionary, that, 130 years ago, an instrument appeared, under the title of chronometer, constructed purposely to regulate the bars and measures of music ; by which means the original time in which every movement of a composition was conceived, could be recorded by numerical signs at the beginning of each strain, by the composer himself.

The application of the term chronometer has, of late years, been confined more particularly to that class of horological machines designed to measure time with precision and reliability, and to admit of being carried about without affecting the regularity of their performance. The name was first applied by Arnold, of London, to the instrument he constructed to find a ship's longitude at sea ; and to Arnold's instrument, and the various improvements that have been made upon it, the name box or pocket chronometer is the technical appellation by which only such machines as we have described are known to the trade at the present day.

The construction of chronometers differs from ordinary watches, principally in the escapement and balance ; but those designed for maritime purposes are usually placed in a series of boxes, so constructed that the works will always remain in the same position, and not be affected by the motion of a ship when at sea, and, at the same time, be as near as possible air-tight, so that the balance-spring, or other parts of the steel work, will not be liable to become oxidized by contact with a damp atmosphere. The construction of a marine chronometer requires much care, inasmuch as the act of navigating vessels over the extensive oceans of the universe is greatly indebted to their accurate measurement of time, in all the variations of heat and cold, from the highest navigable latitudes to the equinoctial line. In navigating a vessel over the trackless deep, the great desideratum is to know at any given instant the relative longitude, or distance from the first meridian, and the latitude, or distance from the equinoctial line ; a knowledge of which will always suffice to direct to what point of the compass, where the variation is known, a vessel is to be steered, if no current interfere, in order to gain a given harbor. The present latitude can always be obtained, independently of the ship's reckoning by the log-line, by an observation of any of the heavenly bodies when at its greatest altitude, or even with sufficient accuracy by two successive altitudes, taken at a distance from meridian, provided the intermediate lapse of the time be accurately noted. The other requisite, however, the present longitude, is not so readily obtained; the lunar method requiring tedious calculations, not generally understood, and the occultations of the stars by the moon, and the eclipses of the sun, moon, and Jupiter's satellites, not occurring with sufficient frequency to be of much benefit, even if they could be observed with accuracy and convenience on board a ship. The method of obtaining longitude by a chronometer is, however, not only simple in its application, but at all times readily attainable; and the past and prospective benefits which its invention has bestowed on navigation and commerce, can scarcely be overestimated.

The earth, as is generally understood and believed, revolves on its axis, in every part of its annual orbit, in a uniform and equal manner; and, on this account, the period of its rotation was fixed upon as the most proper standard of our measure of time; and indeed is the only invariable standard with which we are acquainted. This period, according to our mode of reckoning, is divided into 24 equal parts, as the rotation has a reference to the sun; and each of these 24 parts is called an hour, or sometimes a *solar* hour, by way of distinction from the *sidereal* hour, which is the 24th part of a rotation as it regards a fixed star; hence an hour, or solar hour, means one 24th part of the time elapsed since any spot on the globe passed the sun on the meridian, and arrived again at the same point. Two hours means twice that space of time, and 24 hours the whole time of a solar rotation, which is longer than a sidereal rotation by 3′ 55.9″ of solar time, by reason of the sun having advanced apparently 59′ 8″ 10‴ in the ecliptic during a rotation; so that a solar, being only a relative rotation, is more than a sidereal or absolute rotation, by such as, taken collectively, amounts to an entire rotation in each annual revolution of the earth, to which cause the apparent motion of the sun in the ecliptic is owing; and to this cause is to be attributed the reason why there is a sidereal more than a solar day in each year.

As the stars make 366 revolutions in 365 days, each star comes to the meridian 3′ 55.9″ each succeeding day or night sooner than it did on the day or night before; and for the benefit of those of our readers who have Transit instruments we insert the following table for regulating clocks and chronometers by the revolution of the stars. The first column denotes the number of revolutions from the meridian to the meridian again in a common year of 365 days. The next column shows the times in which these revolutions are made, and those on the right hand part of the table show how much any star gains daily upon the time shown by a well-regulated clock or chronometer. Therefore, to know whether the clock or chronometer goes true or not, observe the time when the star crosses the wires of the telescope, and if the same star passes on every succeeding night as much sooner as to agree with the times shown in the right hand part of the table (as suppose 39′ 19″ in 10 days, or 1 hour 18′ 38″ in 20 days), the clock or chronometer goes true; otherwise they do not, and must be rated or regulated accordingly.

Revolutions.	Days.	Hours.	Minutes.	Seconds.	Hours.	Minutes.	Seconds.
1	=0	23	56	4.1	0	3	55.9
2	1	23	52	8.2	0	7	51.8
3	2	23	48	12.3	0	11	47.7
4	3	23	44	16.4	0	15	43.6
5	4	23	40	20.5	0	19	39.5
6	5	23	36	24.6	0	23	35.4
7	6	23	32	28 7	0	27	31.3
8	7	23	28	32.8	0	31	27.2
9	8	23	24	36 9	0	35	23.1
10	9	23	20	41.0	0	39	19.0
11	10	23	16	45.1	0	43	14.9
12	11	23	12	49.2	0	47	10.8
13	12	23	8	53.3	0	51	6 7
14	13	23	4	57.4	0	55	2 6
15	14	23	1	1.5	0	58	58.5
16	15	22	57	5 6	1	2	54.4
17	16	22	53	9.7	1	6	50.3
18	17	22	49	13 8	1	10	46.2
19	18	22	45	17.9	1	14	42 1
20	19	22	41	22 0	1	18	38.0
21	20	22	37	26.1	1	22	33.9
22	21	22	33	30 2	1	26	29.8
23	22	22	29	34 3	1	30	25.7
24	23	22	25	38 4	1	34	21.6
25	24	22	21	42.5	1	38	17 5
26	25	22	17	46 6	1	42	13.4
27	26	22	13	50 7	1	46	9.3
28	27	22	9	54 8	1	50	5.2
29	28	22	5	58.9	1	54	1 1
30	29	22	2	3.0	1	57	57.0
40	39	21	22	44.0	2	37	16 0
50	49	20	43	25.0	3	16	35 0
60	59	20	4	6.0	3	55	54 0
70	69	19	24	47.0	4	35	13.0
80	79	18	45	28 0	5	14	32.0
90	89	18	6	9.0	5	53	51.0
100	99	17	26	50 0	6	33	10.0
200	199	10	53	40.0	13	6	20 0
300	299	4	20	30 0	19	39	30.0
360	359	0	24	36.0	23	35	24 0
365	364	0	4	56 5	23	55	3.5
366	365	0	1	0.6	23	58	59.4

The period of a solar rotation of the earth, or any portion of it, may be, and frequently is, reckoned in other terms, implying space passed through in a rotation, instead of the time occupied by the motion through that space. Mathematicians have long been in the habit of dividing a circle into 360 equal parts, one of which is called a degree ; and an equatorial section of the earth would be a circle. Geographers and astronomers have supposed the equinoctial line divided into 360°, and each degree divided into 60′, or geographical miles, which minutes are again subdivided into 60″, as we divide an hour into 60′, and each of these again into 60″; hence, as the whole 360° of the earth's circumference pass the sun's meridian ray in 24 hours, we know that 15° must pass the same in one hour, or 1° in 4′ of time, as also 1′ in 4″; consequently, when we know the time that has elapsed since any given spot on the globe has passed the meridian sun, we know also, by allowing 1° to 4′ of time, how many degrees of the equinoctial have passed in the same time ; hours, with their divisions and subdivisions, and degrees, with their divisions and subdivisions, being mutually convertible one into the other by direct proportion, or more readily by tables constructed for the purpose.

It is necessary, however, that we should notice the difference between a *real* and an *apparent* rotation of the earth as it relates to the sun ; partly by reason of the earth's axis being inclined to an angle of nearly 23½° to its annual orbit, causing thereby a necessary reduction of apparent motion in the ecliptic, or earth's path, to real equable motion in the equator, and partly by the alternate acceleration and retardation of the earth's motion in her orbit at different times of the year, which irregularity requires a correction called the "Equation of the Centre." These two causes of apparent irregularity in the earth's rotations have their joint effects allowed for by what is called "Equation of Time," which is inserted in a table with this title in every number of this Journal, and also placed in the column of "Clock Fast" or "Clock Slow" in the Almanacs ; the quantity, therefore, corresponding to any given day in the year, in the Equation Table or Almanac, must always be added to or subtracted from the time shown by an accurate chronometer, to make it agree with *apparent* time.

From these remarks on time, and its connection with, or rather dependence on, the earth's rotation on its axis, it is easy to conceive that all places on the globe which pass the sun's meridian ray soonest, count their 12 o'clock, or noon, earlier than those which follow in succession. As the eastern parts pass first, they have their time more advanced or earlier than the following or more western parts have ; and the difference is, as we have said, at the rate of 4 minutes for every degree of distance. This distance is called *longitude* by reason of the equatorial diameter of the earth being *longer* than the polar diameter, in the direction of which latter the breadth or *latitude* of the earth is counted both ways from the middle. The longitude may have its reckoning to commence at any assignable point on the globe, and all the other points will be called east or west from that point, which is called the first meridian, accordingly as they precede or follow it in each rotation of the earth ; and the quantity will either be so many hours, minutes, and seconds of time, or so many degrees, minutes, and seconds of space, as correspond to that time.

Now it is very obvious that, if we could at the same instant know the time accurately, as counted at each of two different places situated respectively east and west of one another, the difference of those two times, so indicated, if converted into degrees, minutes, and seconds, would be their difference of longitude in this denomination; from which, in a known latitude, the actual distance of the two respective places may, by calculation, be ascertained. What, therefore, a chronometer has to do is, *to tell at all times the hour, minute, and second, as counted at the first meridian*, whether New York, Greenwich, or any other place, to the time of which it was accurately put previously to the commencement of a voyage. For, as the time of any island, or place of a ship, can be had by means of a quadrant or sextant, or more accurately by means of a Troughton's reflecting circle, from a celestial observation, the quantity that this time exceeds or falls short of the time indicated by the chronometer, as being the time at that moment at the first meridian, will be the island's or ship's comparative longitude, in time, east, if the chronometer is behind, or west, if before the time by a celestial observation.

In all ships that are navigated through the medium of books or tables printed in the English language, the chronometer is a kind of travelling companion which tells, whenever consulted, what the exact time is at Greenwich. It is not indispensably necessary that it should keep time exactly with the clock at Greenwich Observatory, provided the daily gain or loss, called the *rate*, be ascertained and applied as a correction accordingly as it accumulates. It is, however, an indispensable requisite that the daily gain or loss should not differ materially from itself at different periods, or under the changes of temperature experienced in different climates; and the fulfilment of this condition constitutes any portable horological machine a marine chronometer, whatever be its construction or price.

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Reminiscences of an Apprentice.

LEARNING TO TURN.

"Our maister" was one of those old-fashioned kind of workmen who would not allow his apprentices to make anything till they first understood the use of the tools, and how to handle them. I thought, when I went to be a watchmaker, that I was to be put to making watches right away. I was not so openly rebellious, but my notions were about as far wrong as those of the boy of our town that went to sea, and at the end of the first voyage refused to go back for the reason that he did not go to sea to do the kind of work they gave him; that he went to learn to be a captain.

"Our maister's" tools were all of the finest description. The large lathe was a good one, and all the different chucks and centres were arranged in convenient order; and all were always ready for immediate use. The small lathes and turning benches were all of the same quality, and in the same good condition. The turning tools, too, were all fixed in handles of fancy woods, and, with the files, filled up a rack that extended the whole length of that end of the shop. Every tool had its special duty to perform, and every one had a proper place in which to be put when not in use; and if a person acquainted with the shop should go into it in the dark in search of a tool, he could lay his hand upon it at once. The orderly arrangement, and clean, bright appearance of all the tools was quite an attractive feature of the shop; and visitors of all classes, whether merchants, farmers, mechanics, or sailors, universally acknowledged that they saw no such tools as "our maister's." Only one person claimed to have a better tool than he could produce, and that was a carpenter that had a favorite saw. Of course a watchmaker was not to be expected to have a wood saw that excelled one belonging to a regular carpenter; and I only mention this to show how jealous the carpenter was of the possibility of "our maister's" tools detracting from the merit that was due to his saw. This saw was a fabulous one; it never needed setting or sharpening, and it would cut through any nail that stood in its way as easily as it would cut through a wooden pin. If any strangers went into the carpenter's shop, whenever he could get an opportunity of introducing the subject the saw was brought down, and its qualities discussed, and while in the act of talking he would bend it till the handle and point met each other, so as to give ocular demostration of the splendid quality and temper of the steel. But one day, as he was discoursing to a crowd of admiring listeners, the saw broke in two while he was in the act of bending it. The carpenter stood in astonishment, with a piece in each hand, and could not account for the unexpected occurrence; but as a proof of his sincerity and continued faith in the qualities of his saw, he innocently assured his listeners that he had never seen it break before, and did not think it would do so again. However, after this accident "our maister" was left in undisputed possession of the honor of having the best tools all round that part of the country, undisturbed by the pretentions of any jealous rival.

I very soon discovered that learning to turn would be a far greater source of annoyance to me than learning to file or to make pins; and certainly I thought that they were bad enough. First of all I had to cut up a rod of round half inch iron into lengths of six inches, and then had to file squares on one end, and sharp centres on the other. It appeared to me that on iron as thick as half an inch hollow centres might do, and I suggested the idea, but only got a rebuke for an answer, and was told that before I could turn small articles I must first learn to make sharp centres, and I could learn to do that best by making centres on large iron first. I had to catch the iron in a hand-vice, lay the iron on a block, and file the centres on, after the same manner as making pins ; but although I could handle a seven-inch file tolerably well when making pins, I found it to be a more difficult task to handle a heavy fourteen-inch one with one hand when roughing down centres on half-inch iron. Sometimes I would catch the iron in the vice, and use the file with both hands ; but this method was contrary to "our maister's" ideas, and he could tell by the sound that was made whether I did it his way or not ; and if I did not proceed exactly in the manner he directed, was immediately corrected.

After all the centres were roughed down and smoothed, "our maister" proceeded to examine them. Some of them were not round, others were not in the centre of the iron, some were too long, some too short, others were not flat, and there was not one centre among the whole lot that pleased him. I filed them all over again, and this time some of them would do ; but the greater portion had to be altered a third time, and some a fourth, and even more times, before the entire number would suit him. The squares had now to be made ; and this, too, was a vexatious operation, because they had all to be the same size, and be square, and flat, and had to fit the chuck exactly; and I think I had to do them a dozen times over before they were correct. At length I either got them right or "our maister's" faculties for finding fault with my work failed him, for when I did not expect it he said they would do ; and then I had to turn the pieces of iron in the large lathe.

I thought that this would be an agreeable change; but a difficulty presented itself which was much against my being able to work the large lathe to advantage. Only a few months before, I was not tall enough to reach up to the vice when learning to make pins, and in the short interval that had elapsed since that time, I had not grown high enough to reach to a proper height to be able to hold the turning tool to advantage, and to have a proper command over it. My legs were too short to work the treadle without moving my whole body up and down with each motion of the treadle, and I am afraid that the picture of my first attempt at turning was not a graceful one, with my body jumping up and down, my head inclining to one side, and bobbing up and down, and my tongue hanging out, while I vainly tried my best to hold the turning tool steady. The resources of "our maister" were, however, sufficient for the occasion, and he got a stool made the proper shape to answer for the lathe, and of a sufficient height to raise me to a proper level; and at the same time he had the treadle altered so that it could be set to suit the height of either a boy or a man, and I could then learn to turn under less disadvantages; but it was a long time before I could drive the lathe and keep my body as steady as "our maister" insisted that I should do—such a terrible torment he was to me and my awkwardness.

When the iron was running round in the lathe "our maister" would take hold of the turning tool by the handle with his right hand, clasp the upright portion of the rest with the four fingers of the left hand, bringing the thumb above the horizontal portion of the rest, and holding the tool firmly down on the rest with his thumb. "Now," says he "this is the way: Present the edge of the tool to the metal that is running round, and let the highest parts strike the edge till all inequalities are removed, and the iron is perfectly round and true ;" but I could not make it cut at all, and only scraped the iron, or broke the turning tool. Then "our maister" would turn a little piece, and I would begin where he left off, and would have a little better success, although at times, when I thought that I was doing finely, my foot would slip from the treadle, and I would tumble down underneath the bench. After a severe trial of the patience of all concerned, I could hold the tool steady, and turn an untrue piece of iron true; and after learning to hold tools in various positions, and learning that peculiar kind of motion by which the turning tool is moved from one end of the rest to the other, without taking the point of the tool from off the work, I was set to learn to make large screws; but I noticed that "our maister," at first, was more particular about my making square shoulders on the screws than anything else about them. I was now able to turn a little, and my great desire was to turn some fancy articles, for at that period I had no taste for plain patterns, my taste being of that kind that inclined to those designs that had most inequalities on the surface. When I could not invent a design myself, I generally found something to suit me on the pillars of bed-posts, or the legs of tables, or on the pillars of very old watch frames. These patterns I mixed up together and, at odd hours, made little articles for my sisters, and also for some little girls who were not my sisters.

After becoming partly master of the large lathe, I was set to work on a smaller one, and afterwards had to learn to work the "turns" with a bow. No professor of the violin could be more particular in learning a pupil to handle the bow than "our maister" was with me. "Come," says he, at one of my first attempts, "don't act like a blind fiddler, but use the whole of your bow;" and then he would take hold of it with the forefinger and thumb of the left hand, just a little above the coil of catgut, and raise the bow till the end of the whalebone almost touched the split collet; then bringing it down again till the collet nearly touched the other end of the bow, would again immediately raise it up, moving only his left elbow and wrist. I soon learned to do that, but raising the tool off the work when raising up the bow, and then placing it in a proper position when bringing the bow down again, was more difficult, and I was bending and breaking things all the time, while "our maister" unweariedly put things to right for me to begin again. One day, while he was instructing me, a customer was looking on; there was a stout piece of steel in the turns, and long spiral chips came from the edge of the tool. "Eh!" says the customer, "that is good steel!" "No!" answers "our maister," "it shows good turning." In a few weeks after that, becoming more proficient, I was making some very long chips, which I saved, and when "our maister" came to see how I was getting on, I showed him the chips, and asked if that did not show good turning. "No," says he, "it shows good steel." Although I was but a boy, I did not like that remark, and all day I could not forget it. I was trying to do my best, and now when I could make as good chips as he did, he gave the credit to the quality of the steel in my case, and took credit for good turning in his own; and his chips were no longer than mine were. The more I thought over the matter, the worse I felt; and at last I resolved to run away. My heart was not in the business any way; my inclinations leaned to a seafaring life; and, without informing my parents, I left the service of "our maister."

It is said that if a married couple live unhappily, and resolve to separate, and both leave the house at the same time, and go in opposite directions, they will meet each other some time. It was equally fated that I was to be a watchmaker; and the first day after I left work, and when I was preparing to leave the town, my father heard of my intentions, and determined to frustrate them; but I heard that he was after me, and was equally determined to get out of his way. So I started to get out of the town without delay, but on turning a street corner I came right up against my father. Of course I was taken home, and dealt with in the manner that I deserved, and next morning was taken back again to "our maister." The good man acted with much tact and judgment. He made no reference to my running away, but acknowledged frankly that the long chips showed good turning in my case as well as in his own, and that confession satisfied me. "Our maister" and I began now to fairly understand each other, and a love for mechanical pursuits began gradually to dawn upon me, and increased with increasing years.

I think that the use of the hand tool is not so generally understood by watchmakers, and, in fact, by all mechanicians of the present day, as it should be. The facilities which a slide rest presents for turning plain surfaces renders an extensive use of the hand tool less necessary than it was a generation ago. Still, in fine work, when irregular surfaces have to be turned, a resort to the hand tool becomes absolutely necessary; and hence the skilful use of the hand tool becomes an important part in the training of watchmakers; in fact, it is a fundamental one. A slight touch with a sharp, smooth-edged graver, in the hands of a skilful workman, will produce results which, in their way, are not to be excelled by the brush of the painter, or the chisel of the sculptor.

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Spectrum Analysis.

NUMBER TWO.

Having established with certainty, by repeated and carefully conducted experiments, that the lines which break the continuity of the solar spectrum are at fixed distances, and perfectly constant in either direct or reflected sunlight—whether reflected from Venus, the moon, or a mirror—and knowing from innumerable experiments that hydrogen, magnesium, iron, sodium, etc., produce each their own peculiar lines in the spectrum, we are somewhat prepared to investigate the character of light which comes from the sun and stars, millions and millions of miles away. Fraunhofer found, on examination of the light from *Sirius* and other fixed stars, that in some of these fixed stars the same lines existed which occurred in sunlight; and that other lines, which are always present in sunlight, are absent from the light of the stars. Thus, in *Procyon* and *Capella,* he saw the two solar lines, *D*; but other well known solar lines were wanting.

The exact mapping of these lines becomes a matter of very great importance, and for the purpose of measuring with the utmost accuracy the position which each line occupies, micrometers are attached to the spectroscope. Having briefly explained the composition of sunlight, it is now necessary to call attention to the first of Kirchoff's discoveries, and by which the cause of these dark solar lines is explained. So long ago as 1814, Fraunhofer discovered that the dark lines, *D*, in the sun's light, were coincident with the bright sodium lines. The fact of such coincidence is easily rendered visible if the solar spectrum is allowed to fall in the upper half of the field of the telescope, while the sodium spectrum occupies the lower half. The bright lines produced by the metal, as fine as the finest spider web, are then seen to be exact prolongations of the corresponding dark solar lines. From a series of experiments and deductions, which a mere sketch will not permit us to follow, it appears that glowing gases have the power of absorbing rays of the same degree of refrangibility as they emit; and that the spectrum of such a gas can be reversed—the bright lines turned into dark, and the dark lines taking the place of bright ones. In mapping the position of the bright lines of the various metals, Kirchoff employed the dark lines of the solar spectrum as fixed points of measurement, and was astonished to find the dark solar lines occupy positions exactly coincident with all the bright iron lines; for each of the 460 iron lines a dark solar line was seen to correspond, not only in position, but in breadth and degree of shade. He argued that this coincidence must be produced from some assignable cause, and the supposition was entertained that the rays of light which form the solar spectrum have passed through the vapor of iron and have suffered the absorption which the vapor of iron must exert upon such passing rays. These iron vapors might be contained either in the sun's atmosphere or that of the earth. It seems hardly probable that our atmosphere should contain such a quantity of iron as to produce the distinct absorption lines of the solar spectrum; and it is not improbable that the high temperature of the sun's atmosphere might produce such vapors.

The presence of one terrestrial element in the solar atmosphere being established, it seemed reasonable to suppose that others might be found there ; and subsequent numberless experiments have proved such to be the case. In speaking of the constitution of the sun, Kirchoff says :

"In order to explain the occurrence of the dark lines in the solar spectrum, we must assume that the solar atmosphere encloses a luminous nucleus producing a continuous spectrum, the brightness of which exceeds a certain limit. The most probable suppositition which can be made respecting the sun's constitution is, that it consists of a solid or liquid nucleus heated to a temperature of the brightest whiteness, and surrounded by an atmosphere of a somewhat lower temperature. This supposition is in accordance with Laplace's celebrated nebular theory respecting the formation of our planetary system. If the matter now concentrated in all the heavenly bodies existed in former times as an extended and continuous mass of vapor by the concentration of which suns, planets, and moons have been formed, all these bodies must necessarily possess mainly the same constitution. Geology teaches us that the earth once existed in a state of fusion, and we are compelled to admit that the same state of things has occurred in other members of the solar system. The amount of cooling which the various heavenly bodies have undergone, in accordance with the laws of radiation, differs greatly, owing mainly to the difference in their masses. Thus, whilst the moon has become cooler than the earth, the temperature of the sun has not yet sunk below white heat. Our terrestrial atmosphere, in which now so few elements are found, must have possessed, when the earth was in a state of fusion, a much more complicated constitution, as it then contained all those substances which are volatile at a white heat—a constitution which the sun now possesses."

Mr. James Nasmyth has given the solar surface very careful examination, and with remarkable results. He finds that the mottled appearance of the sun's surface is due to peculiar willow-leaf shaped masses which are constantly moving with great velocity over its surface. The same phenomenon has heen observed by astronomers generally, but the cause none can at present explain. The very careful observations made upon the wonderful protuberances of red flame observable during a total eclipse may lead to further knowledge of the physical constitution of our great luminary. Although the moon and planets do not reveal, through the spectroscope, the nature of their composition, yet much can and has been learned from their examination.

It will be impossible to give, in this brief sketch of the mode and results of spectrum analysis, an intelligible description of the delicate instruments used, and their skilful adaptation to stellar observations. Perhaps some idea of the difficulties attending them can be formed by remembering that the light of a star emanates from a point having no sensible magnitude ; that the image of the star must be constantly kept upon a slit only the 300th part of an inch in breadth, and that the effect of the constant motions of the earth must be counteracted ; also, that the amount of light given off by the star is very limited, and is still farther diminished by being spread out into a band by a cylindrical lens; and considering also the very few nights when the stars are shining brilliantly, and the air free from such undulations as give a tremulous, flickering spectrum, we can partially understand the difficulties observers have overcome, and the debt of gratitude the public owe those gentlemen whose devoted labors have brought us this interesting knowledge.

To get an idea of the chemical constitution of the stars, it is not only necessary to use delicate mechanical arrangements, allowing the starlight to pass through the prisms, but also the light of such incandescent substances as are suspected to be either present or absent in the stellar light, that the lines produced by each may be compared and measured, and their exact position ascertained.

The first fact to be noticed is, that the spectra of the various stars differ very widely from each other ; also that the constitution of starlight, though not identical with sunlight, is yet similar, being a continuous spectrum, intersected by dark shadows or bands, the sun giving us the same kind of spectrum, but with different lines of intersection. The obvious inference is that the two bodies are similarly constituted ; their light emanating from intensely white hot matter passing through an atmosphere of absorbent vapors; in fact, that the stars are suns of different systems.

It is found, for instance, that in the spectrum of *Aldebaran* and *a Orionis* the D line, caused by sodium, exists ; the three lines known as *b* being produced by the luminous vapor of magnesium. The lines of these substances exactly agree in position with the dark stellar lines; hence there is no possibility for doubt but that sodium and magnesium exist in those far-away stars. In *Aldebaran* the two hydrogen lines C and F are present; but in the spectrum of *a Orionis* both lines are wanting. Hence the conclusion is inevitable that hydrogen exists in the sun, and in *Aldebaran*, but not in *a Orionis*.

Seventy or more lines have been observed in the two stars. Huggins and Dr. Miller have found in *Aldebaran* evidence of hydrogen, sodium, magnesia, calcium, iron, bismuth, tellurium, antimony, and mercury. Neither bismuth nor tellurium has been found in the sun; but all the stars examined, except *Betelgeux* and *β Pegasi*, contain hydrogen. These results are vastly interesting, because they show the visible universe to be mainly composed of the same elementary substances, and an intimation that the physical constitution of the fixed stars consists of a white hot nucleus, giving off a continuous spectrum, and surrounded by an incandescent atmosphere in which exist the absorbent vapors of these particular metals. By means of such interesting analyses the cause of the differences in color of the various fixed stars is ascertained with tolerable certainty.

Not unfrequently it has occurred that stars of small magnitude have, within a few days, come to be as brilliant as those of the first magnitude. In May, 1866, an almost unknown star in the constellation of the *Northern Crown* suddenly blazed out nearly equal to the first magnitude. Huggins and Miller investigated this unusual phenomenon at frequent intervals, and were astonished to find, instead of dark lines upon a bright ground, as in the ordinary stellar spectrum, bright lines coincident with the hydrogen lines. It soon began to decrease in brilliancy, and finally died out, diminishing to the 10th magnitude; the bright lines dwindling away for twelve days, when they became invisible. The only possible rational explanation of this phenomenon is, that it was due to a sudden conflagration of hydrogen evolved by some chemical or other change, and that the star was actually on fire. From recent observations it has been clearly established as a fact that the red protuberances or prominences that, during a solar eclipse, are seen to blaze up, wafted upward and about apparently by the fierceness of their own combustion, and thousands of miles in extent, are hydrogen flames; and should our sun prove to be a variable star, and suddenly burst out in a similar conflagration, the intensity of its rays would be augmented nearly 800 fold; a degree of heat that would dissipate our solid earth into vapor, like a drop of water in a furnace. That such a dire calamity will ever befall our beautiful world is not at all probable. Geological investigations seem to indicate that our conflagration has occurred previous to human history; and any fear may be cast to the winds that, in our day, "the elements shall melt with fervent heat, and the heavens be rolled together as a scroll."

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Manufacture of American Clocks.

INTRODUCTION—DIFFICULTIES IN ROLLING BRASS—PUNCHING FRAMES AND WHEELS—DESCRIPTION OF CUTTING ENGINE USED—CUTTERS AND CUTTING WHEELS.

Among all the dealers, repairers, and owners of American clocks, very few of the number understand the details of the peculiar system adopted in their manufacture, or realize the constant care and anxiety of those manufacturers who produce the most elegant, sound, and reliable time-keepers. As is the case with all manufactures where special machinery is employed, or where special systems of working are adopted, the foundation of the manufacture of American clocks rests upon the machine shop, where the mechanical skill and inventive power of the factory is largely concentrated, and where all the special tools and machinery are made that will duplicate with accuracy and expedition the various parts of a clock of the particular kind desired to be produced; the special construction of which has all been previously determined on, and the first one made by an expert clockmaker by hand. One conspicuous and distinctive feature in this system of clockmaking is, that in all the various stages of the manufacture of the different parts that constitute a Yankee clock, there exists no necessity for the use of a file in any of the operations, with the single exception of forming the taper on the brass wire which connects the pendulum with the pallets; and this little exception we expect to see done away with soon. An elaborate system of pressing, punching, and swedging, and a skilful application of cutters and cutting tools, is the sole means by which the different parts are formed. The original smooth surface of the brass or wire is not damaged in any of the operations, and when the parts are once formed, it only becomes necessary to subject the brass pieces to the action of weak acids in order to clean and give an agreeable color to the surface, and afterwards to cover them with a slight coating of lacquer to prevent tarnish, and to enable the clock to be more easily cleaned when it becomes necessary to do so.

As rolled brass enters largely into the construction of these clocks, most of the manufacturers are interested in rolling mills ; for, in addition to the economy of the arrangement, by having a controlling influence over a brass rolling mill, they are the better able to procure brass of the composition best suited for their purpose, and of that equality in thickness that is so desirable to obtain. It is a remarkable fact that brass, although rolled between the most accurately made rollers that can be constructed, always has a tendency to be thickest in the middle of the sheet; and the wider the sheet, the greater is the tendency to inequalities. The rollers are made very strong, and are usually highest or thickest in the centre in order to avoid the inequalities just mentioned in the thickness of the brass ; but still much care and skill are necessary in the rolling operations to obtain even an approximate equality in the thickness of the sheet. For this reason the brass is rolled into sheets no wider than is just necessary for the purpose for which it is intended. That designed for frames being just the width necessary for the particular style of frame that is to be formed, and that intended for wheels is usually about the breadth of two ordinary sized wheels, while the smaller brass pieces are formed from the scrap brass that is left from the frames and the various wheels. Although we have stated that brass cannot be made of absolutely equal thickness by the means of rollers, owing to the tendency of the rollers to spring, and also on account of the difficulty in making the rollers and their pivots perfectly round, yet no extreme accuracy is required in the equality of an entire sheet ; it only being necessary that for this purpose it should be nearly equal, because if a wheel blank should be slightly unequal in thickness it can generally be made equal in the process of flattening, which will hereafter be described.

The method of punching and stamping the various parts of an American clock does not materially differ from the system of punching brass for other purposes. The presses are usually very powerful, and are designed with a special view to rapidity of action. A die is placed on the bed of the punching press, and has a hole through it of the converse outline desired to be given to the article intended to be produced. This hole is slightly taper, being wider at the bottom, so that the pieces will drop through readily after they have been pressed out. The face of the punch itself is made exactly of the same outline as the article desired to be produced, and fits exactly into the die ; and a motion is imparted to it by connecting it with a perpendicular moving slide in a frame worked by a crank. In this manner the various pieces are rapidly crushed or pressed into the desired shape from sheets of brass previously prepared. In pressing wheels two operations are generally practised. The arms or crosses and the centre holes are first pressed out with dies and punches of the shape suitable for the purpose, and the wheel itself is pressed out afterwards by a plain steel cylinder, the size of the intended wheel, descending and pressing it into a die of the same form and size. The two sets of dies and punches are fastened on the same press, and so arranged that at every downward motion of the punches a complete wheel blank is produced—being cut out at the rate of about thirty thousand a day.

The frames are pressed out in the same manner, but being larger and thicker, more than two operations are necessary to press out some patterns. The first operation presses out the frame in a solid state, and the subsequent ones make the openings in the centre—each operation being done separately, and about ten thousand of the largest sized frames are an average day's work. After the brass work has been pressed out to the proper shape, it is necessary that the various pieces should be flattened; and to effect this purpose they are subjected to the action of a drop press, which consists of an anvil perfectly smooth and flat, and a large weight or hammer, the face of which is also perfectly smooth and flat, one blow of which usually flattens a wheel, and removes any inequalities that may be in its thickness; but the frames of the finer grade of clocks, being somewhat thicker, are usually flattened by hand with a small hammer, in addition to being subjected to the action of the drop press. These wheels and frames, when it is necessary to raise a groove on the one side to give them the necessary amount of stiffness, are subjected to the action of dies or cresses of suitable form, and the grooves are raised, and the wheels or frames made flat with great rapidity.

The wheels having been formed and flattened, the next operation is to make the holes in the centre all of the same size, so that they will fit exactly on the arbor of the cutting engine. This is done by a broach or reamer which is placed perpendicular with the work-bench, and rotated at great speed by means of a band from the shafting that propels the rest of the machinery. The operator places the hole of the wheel on the point of the reamer, and runs it up to the top; the reamer being so shaped that it not only makes the holes equal in size, but any burr that may be on the edges of the hole is removed, so that a number of wheels can be firmly and securely fastened on the cutting engine, which is done by means of a nut and washer.

The cutting engines are of a peculiar and original construction, and are made on the principle that the frame in which the cutters run always remains stationary, while the index plate and arbor to which the wheels are attached are arranged in a frame which is movable on V-shaped slides, and the motion of a crank handle brings the wheels in contact with the cutter, instead of the usual system practised of bringing the cutters in contact with the wheel. The axis of the index plate is horizontal, so that the edges of the index plate and the edges of the wheels that are being cut are uppermost. There are three cutter spindles, which are placed close together at right angles to the axis of the index plate. Sometimes the whole three cutters are used in cutting a wheel; as, for instance, the locking wheel on the striking part of the clock. The cutter that comes first in contact with the wheel is a plain, straight one, and roughs out the tooth; the next finishes the tooth, and the third makes the deep teeth by which the striking work is locked; but unless in special cases only two cutters are used, and water is kept continually dropping on them to prevent their heating. The cutters are generally about three inches in diameter, or thereabouts, and they contain a number of teeth, and in some factories clearance is given to the cutting edges in the same manner as is practised in making Brown & Sharp's patent cutters, which method is described in the article on pinion cutters in the present number of the Journal; although we know that for a long time before the patent that Brown & Sharp controls was issued, this system of giving clearance to the cutting edges of cutters was practised in the workshops of the Seth Thomas Clock Company, and is used there at the present day. In this factory another ingenious manner of making cutters is in use. Every one who has had any experience in the matter realizes how difficult it is to harden a large cutter, and prevent it from springing or twisting; for although one be ever so well acquainted with the nature of the steel, and exercise ever so much care in working it into shape and hardening it, the cutter will often be found to twist. To obviate this difficulty the cutter is made in sections of one tooth each, and fastened together at proper intervals by binding them between two collars on the cutter spindle. Some think the alteration that is likely to take place in the thickness and shape of the different pieces of steel in hardening is likely to amount to nearly as much as if the cutter was one solid piece; and this objection might be valid if it was necessary to harden every part of each section; but as only the points have to be hardened, and as the pieces are more likely to hold firm between the collars on the cutter spindle when they are soft at that part, the necessity of hardening them all over does not exist, and therefore no trouble can arise from that source, and we incline to think well of this system for making large cutters. In the system adopted for making cutters that are intended to cut a long, square tooth, such as are used in calenders, the faces of the teeth of the cutter are cut at an angle of about 45° with the sides of the cutter, and each alternate tooth is angled in opposite directions, which arrangement secures a greater extent of cutting edge, and a consequent addition to the power of the cutter, while the teeth are smoother, and the cutter itself lasts much longer with the teeth made in this manner than when they are made in the old way.

In the Seth Thomas factory, in addition to the cutting engines they formerly used, and which are yet in continual use and performing good service, they have lately constructed two engines on the same principle that we have already described, only more solid and better proportioned for the special duties they have to perform than those of the old patterns. The large horizontal frame upon which the frame of the index plate moves, when the wheels are being cut, and the trough which holds the water and the chips that come from the cutters, are cast in one piece; which arrangement not only tends to strengthen the frame itself, but obviates any tendency to leakage of water from the troughs, as sometimes happens when these troughs are made separate. Besides the property of solidity, these engines contain several original adjustments, not to be found in other machines, and by which means the cutter frame and cutters can be adjusted to any desired position with great precision and rapidity. Another peculiarity consists in having the cutters fastened on projecting pivots outside the frame, instead of being placed in the inside of the frames, as is usual. This new arrangement presents greater facilities for removing a cutter in order to sharpen it than the old plan affords. In clock factories the cutting engines are not usually automatic, the pin being removed from one hole in the index to the next by hand, but the mode of shifting is so rapidly and easily managed that thirty-five thousand of the average sized wheel are usually cut in a day.

Such is a resumé of the system of making frames and wheels as is practised in American clock factories. The machinery and the interesting manipulations used in producing the other parts will be described in succeeding numbers of the Journal.

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Depthing—Practical Hints.

Volumes have been written on the proper pitch of wheels and pinions, scientific curves for the shapes of wheel teeth and pinion leaves, and mathematical demonstrations of the proper forms are endless; all of which are necessary and proper for every mechanic to know, though he may never be called upon to produce them. Where there is one who will have occasion to apply such theoretical knowledge there are a hundred who are daily and hourly called upon to change the depthing of wheels and pinions ; and of these practical workmen most of them (if they deserve the name of workmen) know by inspection whether the depthings are correct. No man living, be he ever so well versed in the theory and practice of laying out the proper curves of wheel teeth, and giving them the proper pitch, can tell by the eye, aided as it may be by a glass, whether the minute teeth on a wheel which is only three or four millimetres in diameter, conform to the established curve. But he can tell, by good judgment and a little experience, whether the depthing of such small wheels and pinions will work to the best advantage which their shape (whatever it may be) will permit.

Any practical hints which will facilitate the correction of such errors in depths as are constantly troubling the practical repairer, may be of benefit to somebody, and whoever feels the want of such hints will be grateful for them.

The present shiftless manner in which cheap watches are constructed is the fruitful source of the troubles referred to. Wheels and pinions are cut, jewels set, and the whole construction of the watch executed with the sole view to *sell.* The universal practice, in modern cheap watch manufacture, is to jewel the escapement, second, third and fourth wheels. The laying out of depths being careless, there is no possible mode of correcting them by the means usually resorted to where the pivot holes are brass. These swindling watches permeate the whole country, and after falling into the hands of buyers, it is soon discovered that repairs are necessary, and the watchmaker is at once appealed to for relief. Nine times out of ten the principal faults are in the depthings. When too deep the remedy is simple : reduce the wheel the requisite amount in size, and round up again; if too shallow, there is no remedy but to increase the diameter of the wheel by some means; the usual way, where no special tools are to be had for the purpose, is to stretch the web of the wheel, true up the points of the teeth in the lathe, and round them up by hand. Theoretically these plans are incorrect, as the proper proportion between diameters has been altered (supposing they were originally correct), and theorists would say nobody but a "botch" would do such a job; don't do it. But the thing *must* be done —the watch must be made to go—the owner won't pay much for the repairs—and to refuse to do it in such a cheap way as you know will answer the owner's purpose, is but taking bread out of the children's mouths. Consequently it must be done, and the cheapest mode of doing it the best, is what is wanted. The neatest and really the quickest way of stretching the teeth, in the absence of a regular stretching tool, is to turn up on the lathe a disk of brass, tin, or any thin metal, a little smaller in diameter than the bottom of the wheel teeth; through the centre of this disk must be a hole large enough to allow the pinion to pass. Slip the disk over the pinion and it will nearly cover the web of the wheel; then with a chisel-shaped punch, the end of which must be a little rounded, go carefully around the disk (the wheel lying flat on a stake), driving the punch into the web slightly, which forces the teeth outward, thus enlarging the wheel's diameter, and leaving only a slight groove in the surface of the wheel, which does not disagreeably mar its appearance, particularly if the end of the punch be polished. True up the wheel teeth on their points, round up nicely, and the job will do you no discredit, and will not consume much more time than flattening the teeth on a stake—in fact, not so much, if the wheel be so much hammered as to make it necessary to go through the wheel with an equalling file.

On the whole, it is perhaps true economy to buy a stretching tool, which can be had for from $3 to $5. A rounding-up tool, to follow the stretching tool, is exceedingly convenient, and gives excellent results, but is too expensive for many small repairers, costing from $30 to $50. The principles upon which such tools operate were described in the Horological Journal, Vol. I., page 235. Rounding up teeth by hand is a very tedious process, but when carefully done may give very fair results. A piece of wood should be held fast in the vice, and a slit cut in it deep enough to allow the pinion to slip down till the top of the wheel is only a little above the wood ; hold the wheel firmly, and be careful to carry the round-up file at right angles to the plane of the wheel ; a little practice in rolling it in the fingers will give a very good shape to the wheel teeth. It is a little strange that among the multitude of small tools which tool makers have devised for the convenience of workmen, no one has got up a set of round-up files, on the same principle as the round-up cutters on an engine. A straight file, with a smooth knife edge, but the two sides file-cut to the proper curve, would be a very useful tool for the mass of workmen, and would greatly reduce the time consumed in the present mode. Not only would time be economized, but regularity and perfection in the shape of the teeth be promoted, and less practice would be required to do good work. Who will produce them?

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Putting New Watches in Order.

Outside the large importing cities there are very few watchmakers who are called upon to do new work. The term new work does not refer to the making of new watches, but to the work necessarily bestowed upon the thousands of watch movements which are imported to be put up in American cases. The duties upon foreign watches being *ad valorem*, the value of the metal in the case is chargeable with duty; and this, where the cases are gold, and of considerable weight, so enhances the cost of the watch as to make it profitable to import only the movements, and make the cases here. In case-making for foreign watches, where each watch is just a little different from every other, each case must be fitted to the movement it is designed to contain. To do this the only mode is to "cut and try," which process requires the constant handling of the movement by the case maker; the result of such treatment, were it suffered to pass the ordeal unprotected, can be easily imagined. For this reason all watch movements, before being put in the case maker's hands, are carefully taken down, the hands, dial, wheels, escapement, third and fourth wheels, the balance and its adjuncts, are taken out, carefully wrapped in tissue paper with the number of the movement marked upon it. The cocks are usually taken off and placed with the other parts. The main wheel and bridge, the centre wheel with its arbor, cannon pinion and bridge, are left in place, and the dial fastened on, and is then covered with shellac varnish to protect the gilding from injury while in the hands of the case maker. In taking down dozens of movements in this manner it is of the utmost importance that no mixing of parts occur; for if the various parts become misplaced there is no end of trouble.

After the cases are done, then all these movements must be freed perfectly from the shellac, which is no slight job ; the varnish must be softened in alcohol and cleaned off in the most careful manner, the least scratch or the slightest defacement ruining the watch for the purpose of sale ; not a screw must suffer abrasion by the screw-driver; all the old oil which may have been drying and hardening for months previous to the sale of the movement, must be removed; every pinion and screw-hole pegged out thoroughly, and every end stone removed and cleaned. There is no branch of watch work requiring more painstaking labor than the putting up of new work ; very few having the patience to do it thoroughly and well. If a screw breaks, a jewel is cracked, or the pallets are broken, they must be restored equal to new, so that no one can detect the replacement.

Then, again, there is a large class of movements made expressly *to sell.* Importers buy them cheap, and besides the careful taking down and putting up of such movements, the further duty is imposed of making them go; and often this is the hardest task of all, demanding first rate mechanical skill, and bringing to the workman no reward of fame. If a large proportion of the watches imported were placed upon the market in the condition they were received, they would never find buyers; they must be in going order to insure sale. Of course *fine* watches leave the manufacturer's hands properly put up; but those of which the highest expectation is to sell, need most careful scrutiny.

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Practical Adaptation of Scientific Principles.

Probably no people are so ready and eager to adapt the abstract theoretical truths of science to the necessities and elegances of life as the American nation. Whatever is newly discovered in science and published to the world, is the next day seized upon by some practical mind, and forthwith elaborated into a new means for making money; and the basis of all money making is to minister to the real or imaginary wants, or appeal to some prominent desire, of the community. Until within a few years past no one dreamed of keeping ice constantly in the house during the torrid summer months; the only known mode of preserving it even for a few weeks was to wrap it in old carpet or bury it inaccessibly in saw-dust. The laws which govern the conduction of heat have been seized upon and practically applied in numerous ways, with greater or less success, to the preservation of the winter ice harvest. At the present day no family is so poor as to be without a refrigerator, and so rapidly do luxuries grow to be necessities, that invention was taxed to devise ways by which ice water might be constantly kept on the sideboard without the annoyance of repeatedly filling the pitcher with ice; and not until within a few years was it deemed practicable to apply the principle of non-conduction on so small a scale as an ice pitcher. Little acorns from tall oaks have grown; the mammoth ice-house has showered down upon us myriads of little water coolers and ice pitchers, each successive season developing new forms, if not new principles. The latest one is in which the property of metals to flow under pressure is seized upon and used in connection with wood or other non-conductors, to produce a most elegant and substantial ice-pitcher, not only using philosophical principles in its construction, but delving among the Greek roots for a name—*Cryptochylon Ice Pitcher;* from *Cryptos*, concealed, and *Hylos*, wood; literally, concealed wood.

The mode of manufacture is simple and easy, and the resultant product certainly obviates many of the objections heretofore made against this beautiful and useful utensil. First a pitcher is turned from wood, or any other non-conducting material, and upon this an outer metal covering is spun in the lathe, fitting it as closely as the bark fits the tree. The lining is also spun in, the upper edge turned over to meet the outer metallic shell, and then soldered, hermetically enclosing the wood lining, which, being one of the best non-conductors, preserves the ice the longest possible time. This mode of construction produces a pitcher entirely free from liability to external injury, nor can it be punctured by dropping ice into it. Is it possible to take another step ahead in this direction?

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Business Deportment

In all well-regulated female academies there is a department devoted to instruction in that most vital of all feminine accomplishments—deportment. In a business college where young men are educated in a course of study preparatory to commercial life, a Professorship of Business Deportment would be a proper and eminently useful chair. Whether it could be reduced to a "science," or elaborated into positive rules, is matter of some doubt; the ten thousand combinations of circumstances which envelop business transactions, whatever the amount involved, whether cents, dollars, or millions are concerned, indicate that positive directions for conduct would be impossible under all circumstances that arise in daily life. Still, enough might be gleaned from the experience of successful and unsuccessful commercial men to form a basis for general direction in the ordinary daily routine of business.

Business men are as various in their lines of deportment toward customers, as they are in their lines of goods; every merchant and mechanic in behavior toward patrons acts solely upon the suggestions of his own "sweet will," doing as he fancies will be most profitable, or as the humor of the moment prompts.

One approaches a customer all smirks and smiles; asks after his health, his family's health, and completely envelops him in a fog of sweet nothings. Another, with a jovial slap on the back, and a shake of the hand that threatens the dislocation of every bone, conveys the unmistakable idea that he has the hand of his best and only friend. Others will simply nod a recognition, never opening their lips unless addressed—giving the impression that "speech is golden" and not to be squandered—civilly enough answering questions, nothing more. Then again, another class will growl out, with a frown, "What's your business?" and there seems to be written in black letters across the forehead of such men, "No admittance except upon business." Each of these various classes of men meet the want of some one, and not one of them but will have their friends and personal customers, and who think them just exactly right in their business deportment. The keen, shrewd, ready-witted, successful salesman must possess the rare combination of all these qualities, and the faculty of readily adapting all these various phases of humor to the known or suspected caprices of the customer. It requires a tact and judgment in the discrimination and ready reading of character that few possess, eminently. In the daily transaction of business but a moment's time is given for this study of the "human nature" of a new customer; the estimate of character must be formed while he is passing from the door to the counter. A phrenologist will require time to examine the head, look in the eye, sound the chest, etc., before pronouncing the character; the ready merchant must do it at a single keen glance. True, when conversation is entered upon, there is opportunity to correct the errors of first impressions; still further acquaintance affords opportunity to judge more correctly of the idiosyncrasies of the individual.

The ways of a salesman with a customer are as various and as past finding out, as Solomon says are "the ways of a man with a maid." To say what is the proper or the most successful method is quite impossible. What succeeds admirably with one, with another will be a miserable failure. The whims and caprices of customers are as numerous, and more so, than the humors of merchants, and no place affords such favorable opportunities for the study of character as the store.

There is the witty customer, full of stale jokes and funny sayings. The grave and sombre one, who watches the slow moving pendulum, and suggests to the frivolous perfumed clerk, "that our hearts, like it, are beating funeral marches to the grave," and that "a moment lost is lost for ever." There sometimes comes up the utilitarian customer, who remarks that all this display is vanity—vanity of vanities—no utility—no real value—all nonsense – ministering to the folly and frivolity of the giddy world. The suspicious one, who trusts nobody's word; intimates that gold is not as honestly wrought in these latter days as in the good old times; that goods are all a cheat—nothing but gilt; smells of every article to detect the odor of brass; lifts every article which is asserted to be gold, to assure himself of its specific gravity; gives long-winded narratives of fraudulent transactions with jewelry peddlers in which his *neighbor* was a victim,—he can't be fooled—he has his eyes about him—he won't believe anybody. Country aristocrats, who do business in the constant fear that the gentlemanly clerk will suspect they do not know the latest styles; so very particular to give the impression that they want only the newest and the best,—can't endure shams in anything. Fearful lady customers, who bring two friends to stand, one on each side, and support her during the fearful ordeal of deciding between two articles. Thankfully can it be said there is also the honest, confiding buyer, who believes there are yet left in the world honest merchants, and who says truthfully: "I confess myself ignorant of these goods; I want such and such a thing—please select for me, and charge a fair price; I trust you implicitly." Occasionally there is a church committee of seven of the most influential members of the congregation, with a purse of $15, intent upon buying a solid silver communion set, or with $5 to buy a solid gold-headed cane for the organist. Sometimes a rosy school girl will wish to select a ring, which a perfumed clerk succeeds in fitting her with, only to be informed that she don't want it *just now*, but her mother has promised to get her one some time. These are only specimen bricks from an immense commercial structure. The shifts and dodges to which tradesmen resort in order to convert all this heterogeneous mass of human depravity into profitable customers, is only known to themselves. Profitable results are sometimes obtained from the funny customer, by laughing loudest at his dullest witticisms, and wishing he would call every day and enliven the tedium of trade by his lively sallies. The robust, jovial customer will usually ask you out to take something, which gives an inkling of his make-point. The serious are often induced to "call again," by leaving upon their minds the impression that the solemn TRUTHS they have enunciated have taken hold; that the seed sown has fallen upon good ground, and they may call to see the fruit of their labor, and so an acquaintance springs up which shrewdness may profit by.

A parsimonious, utilitarian customer, the regretful proprietor of five unmarried daughters, whose ages ranged, as nearly as nature would permit, from twenty upward, was brought to a realizing sense of the folly of his tirade against "gew-gaws," and the folly of dress, by a quick-witted salesman, somewhat in this wise: "Hold on! just listen to me a moment, Mr. B.; if you had been less stingy, had spent a little more money for this trash, as you call it, and had dressed up those five daughters of yours in fitter style, you would not have had the whole of them on your hands now."

"Well! well!" says Mr. B., "may be that's so; but if my daughters are not wanted for themselves, they can stay with me."

The suspicious are sometimes successfully combated by badinage, and sometimes by argument; as a class, their weak point is their egotism; "they know a thing or two; haven't lived for nothing." A railroad engineer of this class, desirous of buying a watch, and not daring to trust any dealer, was captured through this weak point in his character. The watchmaker comprehended his case, offered him a really good watch at a fair price, but the fear of being swindled still held him in check ; "he could get just as good a one for less money," etc., etc. "Now," says the man of wheels, "you want a good watch; you are a machinist, and you know good work when you see it; please allow me to show you this watch, every part of it, and you can then judge for yourself ; just come around the counter, sit down at my side, and I'll show you just how you might be deceived if you did not see for yourself." So the watch was taken all in pieces, each part that was out of sight when the watch was together was shown him; the polish, and shape, and arrangement of the various parts called to his notice, and his judgment and knowledge of the mechanical art appealed to. By the time the watch was reconstructed he was so full of his own good judgment that the trade was completed by the addition of a fine chain, and a watch for his wife.

The timid, fearful woman (or man) who has so little confidence in her own judgment as to require two or three friends to decide upon a trifling purchase, is the most difficult to deal with; the trouble lies in this, that the two or three "friends" differ from each other, and each from the purchaser; and it is a work of consummate art to harmonize the three. The method that succeeds as often as any other, is, to ascertain as near as possible the taste and wish of the purchaser, and override boldly the opinions of the friends ; join your professional knowledge and experience to the timid desire of the customer, and victory will be yours.

Committees are not so difficult to deal with; the whole secret lies in discovering, at the earliest moment, the controlling member (for there always is one, one to whom the others will yield their prejudices); join forces with this delegate, and you have things all your own way.

Of all customers those are entitled to the greatest consideration, and the most concientious and honorable treatment, who throw themselves entirely upon the honor and honesty of the shopkeeper. The dealer who would, under such circumstances, take the most trifling advantage deserves the severest anathemas ; there is no suitable word to apply to such despicable meanness.

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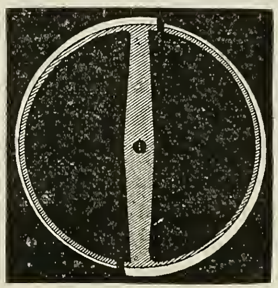
Compensation Balances.

Editor Horological Journal :

The ordinary compensation balance does not compensate for all temperatures, but only accurately for the two extremes to which it may have been adjusted, and gaining in intermediate temperatures.

To obviate this error a large amount of time and experimenting has been given, with more or less success, but I believe perfection has not yet been obtained. The usual proportion of the brass outside of the steel rim is about 3 to 2, this giving nearly twice the thickness of brass that there is of steel. I have frequently asked the question, What is the brass for, unless simply to alter the curve of the rim by its greater expansion and contraction in different temperatures? If this is the sole reason, there seems to be an error in the usual construction. I have seen some rims where the brass was no thicker than the steel, and these were much more sensitive to changes of temperature, and were more readily adjusted. In a very thick rim there is a tendency in the brass to set more or less, from the unequal tension, and the rim is not so sensitive to moderate changes of temperature, and seems to act more irregularly than thinner rims.

This subject is one that I have given much thought to for several years; and to obviate some of these irregularities, I propose the construction herewith presented, which has the brass at first turned down to about 3 to 2, and then cut through the brass where the rim is to be cut open, and turn the brass a true taper from the arm to this cut, leaving it no thicker than the steel at the cut. By placing the balance out of centre (in the direction of the arm), just enough to make the required difference in the thickness, it can be readily turned with a fixed tool in the slide rest, swinging or turning the mandrel forward and back, the notch in the rim allowing the chip to run out. With a lathe properly arranged for this purpose, the mandrel could be run as in ordinary turning, and about as rapidly. If the screws are so placed as to divide the weight into two or three masses, say one part at the end of the cut rim, another at about the centre, and the rest used to correct and finish the adjustment, I believe that an accurate adjustment for all temperatures can be made by means of this balance; the thin part being so much more sensitive, that the principal adjustment for temperature can be made near the cut end, and the adjustment for extremes made in another part of the rim.



The screws to all compensation balances should have small or conical shoulders, so as to bring as small a surface in contact with the rim as possible; for if the bearing against the rim is at the outside diameter of the screws, it will interfere with the free action of the rim until the expansion and contraction frees them from their bearing, and then perhaps they are found to be loose. The balances are (many of them at least) hammered or rolled before the final turning, to condense the brass and add to its stiffness. It seems to me that either of these processes cannot make the density uniform; and to obviate any error that may arise from these defects I would use a series of holes, made as for drawing wire, and force the disc of steel and brass through them by means of a flat end punch that just filled each hole in the plate. But few sizes would be required for this purpose.

L. F. Munger.

Rochester, N. Y.

A Barber-ous Watchmaker.

Editor Horological Journal:

Commercial travellers, in their wanderings up and down the earth, do occasionally encounter strange people. Being formerly a watchmaker, I learned, among other things, that more adaptability was required of them than of any other class of tradesmen; that they must possess in an eminent degree that combination of mental qualifications which no single word so aptly expresses as "gumption." As a proof of the requirements necessary to carry on business in some localities, I enclose you the business card of a man who will hereafter not be "unknown to fame" if you thus advertise him gratuitously in the Journal.

J. E. B.

Lincoln, Nebraska.

GEO. V. HAZARD,

PRACTICAL

WATCH AND CLOCK REPAIRER,

AND

FASHIONABLE BARBER,

Wishes to say to the public that he holds himself in readiness to wait upon all who may wish anything in the above-mentioned lines, on short notice, and for very reasonable compensation. He is also competent to do many little jobs, such as mending Sewing Machines, Fitting Trunk and Door Keys, and in fact almost everything in the Tinkering Line.

Shop next door to the Grocery Store, up-stairs.

A call is solicited. G. V. HAZARD.

Watkins, Jan. 26, 1870.

Free Springs.

Editor Horological Journal:

I have tried the working of Grossmann's free spring where the hook is gone from the barrel, and like it much. I have appropriated the idea given by one of your correspondents, in making a centre for filing conical pivots, on a Jacob lathe, by fitting a collar close on the mandrel which comes with it, taking the end used for rounding which in mine is secured with a screw. The collar is about $\frac{3}{8}$ in. long, and is undercut so as to take well over. Its advantage is, that a piece of steel of proper size and quality is not easily obtained out of a city, and when found is hard to temper and finish properly on account of size, and it also saves fitting the brass stop for holding in place.

Thos. H. Clapp.

Lawrence, Mass.

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Watch Bezels.

Editor Horological Journal:

In No. 1, Vol. III., a method for truing up watch bezels is given. The damage which they suffer is almost always from being bent out of round; thick, strong ones never give trouble; it is only very thin, light ones; and by the method there given of cementing them on the face of a chuck they are only got flat, not round. I have found it a good way to chuck a piece of thin brass on the lathe, sufficiently large to contain the defective bezel, turn it down till the bezel will *snap* on, as it does on the watch-case, then you have it both round and flat, and you can turn or burnish out the groove for the glass at your pleasure. If it should be a little loose and turn down on the chuck, shellac will remedy the difficulty.

J. H. S.

N. Y. City.

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Replacing Screws.

Editor Horological Journal:

A short time since, in repairing one of the old style English lever watches, I had the misfortune to lose one of the screws to the bridge over the main-spring box. It was a beautiful blue screw, with a bright polished ring around it, about midway from centre to circumference. I was put to it to match it, and did not succeed to my liking, although the owner did not apparently discover the difference. I should be obliged to some one if they would tell me how they are made.

N.

Pittsburgh, Pa.

Fit the new screw to its place, leaving the head flat and projecting very slightly above the level of the bridge; select an old-fashioned round watch-glass, as flat as you can find, and on the convex side apply a little stone dust and oil; set the head of the screw on this, and with a piece of peg wood pressed firmly on the point of the screw, move it about in all directions until you have a concave in the screw-head of a diameter equal to the bright circle on the old one; then inverting the watch-glass, grind the screw-head convex until the two curves meet. After hardening and tempering the screw, again grind the two curves bright, and polish on the same glass, and proceed to blue; after bluing it, polish the top on a flat polishing-block and you will have the bright circle where the concave and convex curves meet.

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Removing Blue from Steel.

Editor Horological Journal:

Under the head of "Answers to Correspondents," I have noticed that strong acid, and sometimes a combination of strong acids, is recommended for removing the blue from steel. I have never found any difficulty in removing the color with very dilute acid, or, more properly, acidulated water—say one drop of muriatic acid to from four to eight drops of water, and instead of immersing the article (with few exceptions), I sharpen a piece of pith and moisten the end with the acid water and use it the same as in cleaning, which removes the color instantly, and only brings the acid in contact with the part colored; follow up with clean pith moistened with water, and finally with alcohol. This will be found a much neater and safer way, as strong acid takes rank hold of the steel; even the fumes are injurious to any steel work with which it may come in contact.

Occasional.

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Answers to Correspondents.

B. F. W., *Ct.*—This young reader of the Journal writes us that he is getting up for himself, from time to time, as he has opportunity, a nice set of ivory tool handles, with silver ferules, etc. It is a praiseworthy endeavor to possess yourself of a nice set of tools, and no ambitious young workman can do a better thing; but from long experience we have found uniformity of tool handles to be a source of hindrance to rapid manipulation. Where tools are necessarily taken up and laid down hundreds of times in a day, any means by which they are quickly and easily found and seized is advantageous. Now, if your files are all identical in handle —as they are almost in appearance—you are obliged to give a closer inspection of the file itself, to be certain it is the one you wish, than would be necessary were some of the handles of such different appearance as to readily catch the eye. Very quickly this individual difference becomes fixed in the memory, and the eye instantly recognizes the desired tool, and the hand goes at once for it without hesitancy. We would suggest that you make some of them of ebony, others of ivory, some octagon, and others round, which will give you four varieties—sufficient for all practical purposes.

G. N. L., *Baldwinsville.*—Ten dollars paid for learning how to make a nice conical pivot is cheap, if there were no other way to get the information; but so long as the Horological Journal answers questions "without money and without price," it was dear. Your plan is good, and the one most in use, viz.: Turn the pivot to the proper shape and length, then finish with a pivot burnish, one corner of which has been rounded off by repeatedly forcing it crosswise over a piece of emery cloth made fast to a bit of hard wood, or by crushing coarse emery into the surface of a copper plate and using in the same manner.

In regard to tempering steel, there is no end to experiments. Hardening in mercury has been long known; some according to it great virtue, others again finding no peculiar advantage from it. If, as some claim, steel, at a high temperature, has an absorbent power, we can see no good reason why mercury should confer upon it any beneficial properties; the only office it could subserve would be to more rapidly conduct away the heat from the article to be hardened. Water, or any liquid, at the instant the hot steel is immersed in it, is converted into steam, a thin film of which envelops the metal, momentarily forcing the liquid away, thus preventing thorough contact. On the same principle the wet finger may be thrust, for an instant, into molten iron. Any solution, mixture, or compound that, by heat, would develop any substance capable of being absorbed and assimilated by the heated steel, *might* affect its quality favorably or otherwise.

So long as people will write what they know nothing about, printers (for pay) will print it, and other people will read it and be deceived. Here is a sample on the same subject we have seen in several papers:

"It was long supposed that the effect of dipping a razor in hot water was to remove a kind of resinous substance which was thought to injure its sharpness; such, however, is not the real effect. The fine edge is given to all blades of steel by tempering them, that is heating them and plunging them in cold water. Now, it has been proved by experiment that heat at 212° is the exact heat at which razor edges are tempered admirably, and, as the heat of boiling water is 212°, by dipping a razor into it, you as it were again temper, or give a new edge to the razor."

Workers in steel will smile at this piece of information.

The vexations attending the fitting of a new locking spring to a hunting-case can be avoided, in many instances, by mending the old one. Fit on each side of the broken part a piece of stout main-spring and bind them securely together. Braze it with pieces of a common brass pin, used with borax, the same as in hard soldering. The work should be heated up very quick and until the brass flows freely. After finishing the spring, it may be hardened at a *dull* red heat, not high enough to start the brazing, and tempered in the usual manner. As there is so little action required from a locking spring, one mended nicely, in this manner, will be as good as new.

W. L. M., *Mass.*—The discoloration of which you and all dealers in plated ware complain of, is the sulphide of silver, which when permitted to attain considerable depth or thickness on the metallic surface, produces colors varying all the way from the faintest tinge of yellow to a dark irridescent purple. When at this latter stage, the coating seems to possess the character of an enamel, and the tenacity with which it adheres is well known to shopkeepers. That active chemist, C. Parche, of Nuremberg, proposes coloring metal surfaces by means of these metallic sulphides, which can be very quickly and cheaply produced, and are not affected by ordinary agents. According to Parche's method, in five minutes there may be imparted to thousands of brass articles a color varying from a beautiful gold to copper red, then carmine red, then dark, and then light aniline blue, according to the length of time they remain in the solution used. The colors possess the most beautiful lustre, and if the articles to be colored have been previously thoroughly cleaned by means of acids and alkalies, they adhere so firmly that they may be operated on by the burnishing tool. To prepare the solution dissolve ½ oz. hyposulphite of soda in 1 lb. of water, and add 1½ oz. acetate of lead dissolved in ½ lb. of water. When this clear solution is heated to 190° to 210° Fahr., it decomposes slowly, and precipitates sulphide of lead in brown flocks; if metal is present, a part of the sulphide is deposited on it, and according to the thickness of this deposit the before-mentioned beautiful lustre colors are produced. To produce even color the article must be evenly heated. Iron treated with this solution takes a steel blue color; zinc, a brown color; in the case of copper objects, the first gold color does not appear. If, instead of acetate of lead, sulphuric acid (equal weight) is added to the hyposulphite of soda, and the process carried on as before, the brass is colored a very beautiful red, which is followed by a green, which is not in the first-mentioned scale of colors, and changes finally to a splendid brown with green and red iris glitter. This last is a very beautiful coating, and may find special attention in manufactories. Very beautiful marblized designs can be produced by using a lead solution, thickened with gum tragacanth, on brass which has been heated to 210°, and is afterwards treated to the usual solution of sulphide of lead. The solution may be used several times, and is not liable to spontaneous change.

Why may not brass tools, fine clock movements, and all polished brass articles pertaining to our trade, which are so easily discolored by use, be rendered permanently beautiful by this process? It certainly deserves the attention of the manufacturers of such goods.

Enquirer, *Galva, Ill.*—Wishes to know the cause of the breakage of main-springs, and says that in his experience more have been found broken in or about the month of June than at any other time in the year. We have asked the same question of hundreds of practical watchmakers, and a somewhat similar reply is generally given. Some assert that more broken springs may be expected during damp, sultry, non-electrical conditions of the atmosphere; others say that there is more tendency to breakage during a highly electrical condition, as during thunder-storms, etc. Dealers in springs, who have the curiosity to give the matter any attention, seem to think most are sold to resident watchmakers during the early part of summer; but that orders from the country are more general later in the season, indicating that the stock in the hands of country workmen has been considerably reduced during the early summer months. Facts bearing upon this unexplained phenomenon are not numerous enough, nor sufficiently well authenticated, to afford data on which to base even a theory for their explanation. It would be an exceedingly valuable addition to horological science if watchmakers generally would take the trouble to record the facts as far as it is possible to obtain them regarding every breakage of this kind which comes under their observation; such facts forwarded to the Journal from time to time could be tabulated, and from them might be deduced a probable general cause of the breaking of main-springs.

F. G. C., *Glenn's Falls.*—The swing-frame attachment to the lathe requires the grinding and polishing wheels to be turned on the arbor which carries them, to insure truth in their circumference; for in grinding a pivot which is very small, any deviation from a *true* circle would probably be the ruin of the pivot. The grinding wheels should be of iron or copper, or a metal soft enough to hold the abrading material whatever it be, and the polishing discs of type-metal, bell-metal, or any metal of which straight polishers are made. They may be all fitted to one mandrel, or each may have its own arbor, as is most convenient; the only requirement is truth.

J. M. G.—It would be quite as difficult to decide upon the relative merits of the various safes in the market, as to determine which is the best watch manufactured. Like almost everything else, the one most liberally and judiciously advertised, will sell the best, but unfortunately that is no test of real merit. All afford more or less protection from fire, but none are burglar-proof, provided an accomplished burglar has sufficient time to operate. We noticed Messrs. Freund, Goldsmith & Co. getting in three large safes a few days since, which they informed us were manufactured by Mr. Hendrickson, of Brooklyn. As they were designed for protecting a valuable stock of goods, we presume they thought they were getting the best.

L. H. F., *St. Louis.*—On page 187, Vol. I., you will find a comparative table of the English inch with the French line and millimetre. We cannot spare the space necessary to reprint the table; an English inch is 11.2595 French lines; consequently a line is equal to $\frac{1}{11,2595}$ of an inch.

Amethyst is too hard to be affected by a file.

"*Bassined Edges*" is simply a French term, literally meaning edges like a basin, or an old-fashioned warming-pan, and has no reference to the style of ornamenting the edge.

J. H., *Ill.*—Use jewellers' rouge and chamois letter for your metal show-case. If pure rouge be too expensive you may try some of these rouge pastes that are sold for cleaning silver-plated ware.

C. L., *Fort Atkinson.*—The best way to remove every trace of the soldering fluid is to wash thoroughly in water (soft water if possible), using *no soap*, as the acid in the soldering fluid decomposes the soap, leaving the fatty part of it free. Every one has experienced this when washing the hands after using the fluid; they are dirtier than before. After washing in water, a bath in alcohol will clean it entirely.

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EQUATION OF TIME TABLE.

GREENWICH MEAN TIME.

For September, 1871.

Day of the Week.	Day of Mon.	Sidereal Time of the Semi-diameter Passing the Meridian.	Equation of Time to be subtracted from Apparent Time.	Diff. for One Hour.	Sidereal Time or Right Ascension of Mean Sun.
		S.	M. S.	S.	H. M. S.
Friday	1	64.43	0 2.21	0.783	10 40 49.96
Saturday.	2	64.38	0 21.12	0.794	10 44 46.51
Sunday	3	64.34	0 40 31	0.805	10 48 43 06
Monday	4	64.30	0 59.77	0.815	10 52 39 61
Tuesday	5	64.27	1 19.45	0.824	10 56 36.16
Wednesday ...	6	64.23	1 39 34	0.833	11 0 32 72
Thursday......	7	64 20	1 59.42	0.841	11 4 29 27
Friday	8	64 16	2 19.69	0.848	11 8 25.82
Saturday......	9	64.14	2 40.13	0.854	11 12 22.38
Sunday.......	10	64 12	3 0.69	0.859	11 16 18.93
Monday.	11	64.10	3 21.37	0.864	11 20 15 48
Tuesday	12	64.08	3 42.16	0.868	11 24 12.04
Wednesday. ..	13	64.07	4 3.05	0.872	11 28 8.59
Thursday	14	64.06	4 24.02	0 876	11 32 5 14
Friday........	15	64.05	4 45.05	0.878	11 36 1.69
Saturday......	16	64 05	5 6.12	0.879	11 39 58 25
Sunday.......	17	64.05	5 27.23	0.880	11 43 54 80
Monday.......	18	64 05	5 48.34	0.880	11 47 51.35
Tuesday	19	64 06	6 9.44	0.879	11 51 47.91
Wednesday ...	20	64.07	6 30.52	0.877	11 55 44.46
Thursday......	21	64.08	6 51 56	0.875	11 59 41.01
Friday	22	64.09	7 12.54	0.872	12 3 37.56
Saturday......	23	64.11	7 33 44	0.868	12 7 34.12
Sunday	24	64.13	7 54.23	0.863	12 11 30.67
Monday.......	25	64.15	8 14.88	0.857	12 15 27.22
Tuesday	26	64.17	8 35 39	0.851	12 19 23.78
Wednesday ...	27	94.20	8 55.72	0.843	12 23 20 33
Thursday.	28	64.23	9 15.87	0.834	12 27 16 88
Friday........	29	64.27	9 35.79	0.824	12 31 13.44
Saturday	30	64.31	9 55.46	0.814	12 35 9.99

Mean time of the Semidiameter passing may be found by subtracting 0.18s. from the sidereal time.

The Semidiameter for mean noon may be assumed the same as that for apparent noon.

PHASES OF THE MOON.

		D.	H.	M.
☾	Last Quarter....................	6	10	9.9
●	New Moon......................	14	7	9 5
☽	First Quarter....................	21	5	12.3
⊙	Full Moon.......................	28	5	44.4

		D.	H.
☾	Apogee	7	0.8
☾	Perigee	20	7 0

	°	′	″
Latitude of Harvard Observatory	42	22	48.1

	H.	M.	S.
Long. Harvard Observatory..............	4	44	29.05
New York City Hall..............	4	56	0.15
Savannah Exchange..............	5	24	20.572
Hudson, Ohio	5	25	43.20
Cincinnati Observatory	5	37	58.062
Point Conception......	8	1	42.64

		APPARENT R. ASCENSION.	APPARENT DECLINATION.	MERID. PASSAGE.
	D.	H. M. S.	° ′ ″	H. M.
Venus.....	1	12 28 38.33....	– 9 56 30.7.....	1 47.8
Jupiter....	1	7 34 9.90....	+21 47 9.9.....	20 50.6
Saturn....	1	18 14 20.73....	– 22 46 57.2.....	7 32.3

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CONTENTS.

Manufacture of American Clocks.

FORMING THE PALLETS—SYSTEM OF TURNING PRACTISED—MACHINES FOR STRAIGHTENING AND CUTTING WIRE IN LENGTHS—MAKING PILLARS—MAKING THE LOCKING WORK, GONGS, ETC.—METHOD OF MAKING LANTERN PINIONS—INSERTING THE PIVOT HOLES IN THE FRAMES—MILLING SQUARES ON THE WINDING ARBORS—PUTTING THE MOVEMENTS TOGETHER, ETC.

In the last number we described the manner of punching out the frames and wheel-blanks, and also the method of cutting the teeth in the wheels that is usually practised; but probably those parts of American clock movements that are most interesting to the general watchmaker, and the formation of which is clouded in the greatest mystery to people outside of the factories, is the processes by which the pillars, arbors, and pinions are made, and the methods by which the pallets and the other parts of irregular shape are so rapidly and yet so accurately formed, and which, when finished and put together with the wheels and the frames, go to make up a complete clock.

Pallets are made by first punching steel of the necessary thickness into pieces of the desired length and breadth. The pieces, one by one, are put into a very powerful machine, and held against a piece of steel of the same shape as the inside of the pallets. A strong bar of steel then moves in a perpendicular direction, and the point of it comes in contact with the straight steel from which the pallets are to be made, and bends the one end to the proper shape; and then another bar moves with a horizontal motion, and bends the other end to the desired form. They are afterwards ground square on the points, and into the desired shape, by a milling machine constructed for the purpose. After the holes are put in them, they are hardened in the points, and polished on vulcanite wheels and emery belts; and as they are not usually hard in the middle, they can be closed or opened a little, should the scape wheel require it. All the different operations are done by different persons, and large quantities are done at a time.

The system of turning, as adopted in these clock factories, is of a peculiarly novel nature. The turning tools are not held in the hand, in the manner generally practised, neither are they held in a slide rest, but are used by a combination of both methods, which secures the steadiness of the one plan and the rapidity of the other. A knee is fastened to each of the heads of the lathe, which answers the purpose of a rest; both the perpendicular and horizontal parts of these knees being fastened perfectly parallel with the centres of the lathe. A straight round piece of iron, of equal thickness, and having a few inches in the centre of a square shape, is laid on these knees, and answers the purpose of a handle to hold the cutting tools. On every side of the square part of this iron bar, or what we will now call the turning tool handle, a number of cutting tools are fastened by binding screws, and the method of using them is as follows: The operator holds the tool handle with both hands on to the knees that are fastened to the heads of the lathe, with the turning tool that is desired to be used pointing towards the centre, and which is allowed to come in contact with the work running in the lathe in the usual manner practised in turning.

If a plain straight piece of work is to be turned, the tool is adjusted in the handle so that the work will be of the proper diameter when the round parts of the handle come in contact with the perpendicular part of the knees or rest; and while the handle is thus held and moved gently along in the corners of the knees, the work is easily turned perfectly parallel, smooth and true. In turning a pinion arbor, for instance, the wire having been previously straightened and cut to length and centred, and the brass collets to make the pinion and to fasten the wheel having been driven on, one end is held in the lathe by a spring chuck fastened to the spindle of the lathe, while the other end works in a centre in the other head. One turning tool is shaped and adjusted in the handle for the purpose of turning the brass collets for the pinion to the proper diameter, another turns the sides of the brass work, while others are adapted for the arbors, pivots, and so on. After the brass work has been turned, the positions of the shoulders of the pivots are marked with a steel gauge, and by simply turning round the handle of the turning tool till the proper shaped point presents itself, each operation is accomplished so rapid, and the cutting is so smooth, that even for the pivots all that is necessary to finish them is simply to bring them in contact with a small burnisher. The article is not taken from the lathe during the whole process of turning, and when completed, the centres are broken off, having been previously marked pretty deep at the proper place with a cutting point. All the pinions, arbors, and barrels, in fact every part of an American clock movement that requires turning, is accomplished in this manner, at long rows of lathes in rooms, and by workmen set apart for the purpose. But perhaps it may be well to mention that in the machine shops of these factories, where they make the tools, the ordinary methods of turning with the common hand tool, and by the aid of ordinary and special slide rests, is practised the same as it is among other machinists.

Pillars and arbors are but simple parts, yet much costly machinery is used in making them. The wire from which they are made is brought to the factories in large coils, and is straightened and cut into lengths by machines. The principle on which wire is straightened in a machine is exactly the same as a slightly curved piece of wire is made straight in the lathe by holding the *side* of a turning tool between the revolving wire and the lathe rest, which is an operation most of our readers must have practised. The rapid revolution of the wire against the turning tool causes its highest side to yield, till finally it presses on the turning tool equally all round, and is consequently straight. However, in straightening wire by machines the wire is not made to revolve, but remains stationary while the straightening apparatus revolves around it. Wire-straightening machines are usually made in the form of a hollow cylinder, having arms projecting from the inside towards the centre. The cylinder is open at both ends, and the arms are adjustable to suit the different thicknesses of wire. The wire is passed through the ends of the cylinder, and comes in contact with the arms inside. A rapid rotary motion is then given to the cylinder, which straightens the wire in the most perfect manner, as it is drawn through, without leaving any marks on it when the machine is properly adjusted. The long spiral lines that are sometimes seen on the wire work of clocks is caused by this want of adjustment; and they are produced in the same way as broad circular marks would be made in soft iron wire if the side of the turning tool was held too hard against it when straightening it in the lathe.

After the wire has been straightened it is cut off into the required lengths, and this operation is worthy of notice. If the thick sizes of wire that are used were to be cut by the aid of a file or a chisel, the ends would not be square, and some time and material would be lost in the operation of squaring them; and as economy of material as well as economy of labor is a feature in American clock manufacture, wire of all sizes is sheared or broken off into lengths, the same as a steady pin is broken when a cock or bridge gets a sudden blow on the side, or in the same manner as patent cutting plyers work, while the wire is not bent in the operation, and both ends of it are smooth and flat. The wire for the pillars is then taken to a machine to have the points made and the shoulders formed for the frames to rest against. This machine is constructed like a machinist's small lathe, only there is a revolving spindle running in both heads. In the ends of these spindles, that point towards the centre of the lathe, cutters are fastened, and the one is shaped so that it will form the end and shoulder of the pillar that is to be riveted, while the other is shaped so as to form the shoulder and point that is to be pinned. Between these two revolving cutters there is an arrangement, worked by a screw in the end of a handle, for holding the wire, from which the pillar is to be made, in a firm and suitable position. The cutters are then made to act simultaneously on the ends of the wire by a lever acting on the spindles, and the points and shoulders are in this way formed in a very rapid manner, while they are all of the same length and diameter. These machines are in some points automatic. The pieces of wire are arranged in quantities in a long narrow box that inclines down towards the lathe, and the mechanism for holding the wire firm is so arranged that when its hold is loosened on the newly made pillar, the pillar drops out into a box beneath, and a fresh piece of wire drops in and occupies its place. In some of the factories, clocks are now manufactured having screws in place of pins to keep the frames together, and the pillars of these clocks are made in a different manner than that we have just described. The wire that is used is not cut into short lengths, but a lathe with a hollow spindle is used, through which the wire passes, and is held firm by a chuck, when a little more than just the length that is necessary to make the pillar projects through the chuck. The other head of the lathe is circular, and has cutting tools projecting from it at several points, like guns in the turret of a monitor, and, like it, can be turned round. One tool is adapted to bore the hole for the screw, and when it is bored the head is turned round a little and another tool taps the hole to receive the screw, while another forms the point and shoulder; and after that end of the pillar is completed another tool attached to the lathe forms the other shoulder, and prepares that end for riveting, and cuts it off at the same time. One thousand of these pillars are in this manner made in a day. The screws that screw into them are made on the same kind of lathe and nearly in the same manner, and two thousand of them are an average day's work.

The pinion arbors, after they have been cut to length, are centred on one end by a milling machine having a conical cutter made for the purpose. The collets for the pinion heads, and the one to fasten the wheel by, are punched out of sheet brass, and a hole is drilled in their centre a little smaller than the wire; and to drive them on, in most instances, is all that is necessary to hold them. At one time it was the practice to drive these collets by hand. One was placed on the point of the arbor, and the point was then placed over a piece of steel, with a series of holes in it of such depth that the collets would be in their proper position on the arbor when the point was driven to the bottom of the hole, but this method has now been superseded by automatic machinery. It is impossible to give an intelligible description of these machines without drawings. All we can say at present is that they perform their work in a very rapid and effective manner, and are in use by the Waterbury and other clock factories.

The barrels of weight clocks are mostly made from brass castings, and slight projections are raised on the surface of their arbors by swedging, so as to prevent the arbors from getting loose in the barrels after repeated winding of the clock. This swedging, and all the other operations in making arbors, are usually done on separate machines; but the Seth Thomas Company have constructed a powerful and comprehensive machine lately that works automatically, and straightens any size of wire necessary to be used in a clock, cuts it to the length, centres it, and also swedges the projections on the barrel arbors, or any of the other arbors that may be necessary. A roll of wire is placed on a reel at one end of the machine, first passing through a straightening apparatus, and afterwards to that portion of the machine where the cutting, swedging, and centring are executed, and the finished arbors drop into a box placed ready to receive them. The planning and the arrangement of such a machine must not only require rare ingenuity, but also much patient study, as well as a sound knowledge of the fundamental laws of mechanics, and we are pleased to know that Mr. Naughton, the master mechanic, has been so successful in the designing and constructing of this important machine. The saving effected by the use of this machine is very great, and in some instances amounts to a thousand per cent. over the method of straightening, cutting, swedging, and centring on different machines, at different operations.

Boring the holes in the arbors of the locking work, to receive the smaller wires, and the pin holes in the points of the pillars, is done by small twist drills, run by small vertical boring machines. The work is held in adjustable frames under the drill, and when more than one hole has to be bored this frame is moved backward or forward between horizontal slides to the desired distance, which is regulated by an adjustable stop, so that every hole in each piece is exactly in the same position. In arbors where holes have to be bored at right angles to each other, the arbor is turned round to the desired position by the means of an index. The holes in the locking work arbors are bored just the size to fit the wire that is to go into them, and these small wires are easily and rapidly fastened in their place by holding them in a clamp made for the purpose, and riveting them either with a hammer or with a hammer and punch. Bending the small wires for the locking work, the pendulum ball, etc., is rapidly effected in the following manner: Suppose we draw a triangle on the bench, and drive stout pins into the bench at each corner of the triangle, and if we then take a piece of small wire and hold the end of it to one of the pins with a pair of plyers, and wind it round the outside of the other pins, a piece of wire of a triangular shape will be formed. In a like manner small wire, which has first been straightened and cut to length, is formed into any of the shapes necessary for the various parts of a clock, by winding it round the outside of stout pins that have been fastened into a metal plate at points necessary to produce the form desired to be given to the wire. As no objectionable marks have been made on the surface of either the thick or smaller wires during any process of construction, all that is necessary to finish the iron work is simply to clean it well, which is done in a very effective and rapid manner by placing a quantity of work in a revolving tumbling box, which is simply a barrel containing a quantity of saw-dust.

Gongs, or what are popularly known by the name of wire bells, are turned up against the side of a flat circular plate, which has a centre fastened on to it of the shape necessary to form the centre of the gong or wire bell. One coil is wound upon the other, which gives the wire a set, and they are all finally adjusted by hand.

The lantern pinions of an American clock have long been a mystery to those unacquainted with the method of their manufacture, and the usual accuracy in the position of the small wires or leaves, combined with great cheapness, has often been a subject of remark. The holes for the wires in these pinions are drilled in a machine constructed as follows: An iron bed with two heads on it, like a peculiarly arranged lathe, one of which is so constructed that by pulling a lever the spindle has a motion lengthwise as well as the usual circular motion, and on the point of this spindle the drill is fastened that is to bore the holes in the pinions; the other head has an arbor passing through it with an index plate attached, having holes in the plate, and a point attached to a strong spring going into the holes, the same as in a wheel-cutting engine; on to this head, and on the end of it that faces the drill, there is a frame fastened in which the pinion that is to be bored is placed between centres, and is carried round with the arbor of the index plate, in the same manner as a piece of work is carried round in an ordinary lathe by means of a "dog," or carrier; only in the pinion-boring machine the carrier is so constructed that there is no shake in any way between the pinion and the index arbor. This head has a motion at right angles to the spindle of the other head, by which means the diameter of the proposed pinion is adjusted. The head is moved in a slide by an accurately cut screw, to which a micrometer is attached that enables the workman to make an alteration in the diameter of a pinion as small as the one-thousandth part of an inch. The drill that bores the holes is the ordinary flat pointed drill, and has a shoulder on its stem that stops the progress of the drill when it has gone through the first part of the pinion head, and nearly through the other.

The action of the machine is simple. The pinion, after it has been turned and pivoted, is placed in its position in the machine, and by pulling a lever, the drill, which is running at a speed of about ten thousand revolutions in a minute, comes in contact with the brass heads of the pinion and bores the one through and the other nearly through. The lever is then let go, and a spring pulls the drill back; the index is turned round a hole, and another hole bored in the pinion, and so on till all the holes are bored. An ordinary expert workman, with a good machine, will bore about fourteen hundred of medium-sized pinions in a day. The wires are put into the holes by hand. We have already stated that the holes are only bored partly through one of the pieces of the brass, and after the wire has been put in, the holes are riveted over, and in this manner the wires are fastened so that they cannot come out. The wheels are then riveted on to the pinions by catching the pinions in a clamp constructed for the purpose, and the truth of every wheel, and the equality of every pinion, is practically tested before they are put into clocks.

The solid brass pinions of the motion work and the ratchets of the barrels are all cut in precisely the same manner as wheels are cut, only they are cut one at a time, and they are fastened to the engine in a different manner from the wheels. On the end of the arbor of the index plate are two deep cuts across its centre, and at right angles to each other. These cuts are of the same shape that would be made by a knife-edged file. The effect of these cuts is to produce a taper hole in the end of the arbor, with four sharp corners. Into this hole the end of the arbor of the pinion or ratchet that is to be cut is placed, and a spring centre presses on the other end, and the sharp corners in the hole hold the work firm enough to prevent it from turning round when the teeth are being cut. The marks that are to be seen on the shoulder of the back pivot of the arbor that carries the minute hand of a Yankee clock is an illustration of this method of holding the pinion when the leaves are being cut, and no injurious effects arise from it. The convenience the plan affords for fastening work in the engine, enables twenty-five hundred of these pinions to be cut in a day, one at a time.

The pivot holes, and all the other holes in the frames, are punched out at one operation after the frames have been flattened. They are placed in the press, and a large die having punches in it of the proper size and in the right position for the holes, comes down on the frame and makes the holes with great rapidity and accuracy, which are finished afterwards by a broach. In some kinds of clocks, where some of the pivot holes are very small, the small holes are simply marked with a sharp point, and afterwards drilled in a small vertical boring machine. These machines are very convenient for boring a number of holes rapidly. The drill is rotated with great speed, and the stand or plate on which the work rests is moved upwards towards the drill by a movement of the operator's foot. All the boring, countersinking, etc., in American clocks, is done through the agency of these boring verticals.

Milling the winding squares on barrel arbors, is an ingenious operation. We have already noticed that, with a trifling exception, files are not used in any part of the manufacture of an American clock. The machine for milling squares and similar work, is made on the principle of a wheel-cutting engine. The work is held in a frame, attached to which is a small index plate, like that of a cutting engine. In the machine two large mills or cutters, with teeth in them like a file, are running, and the part to be squared is moved in between the revolving cutters, which operation immediately forms two sides of the square. The work is then drawn back, and the index turned round, and in a like manner the other two sides of the square are formed.

The cutting sides of the mills are a little bevelled, so that they will produce a slight taper on the squares.

Winding keys have shown great improvements of late. Some manufacturers originally used cast iron ones, but the squares were never good in them, and brass ones came to be adopted. At first the squares were made by first drilling a hole and driving a square punch in with a hammer; and to make the squares in eighteen hundred keys by this method, was considered a good day's work. Restless Yankee ingenuity, however, has contrived a device by which twenty or twenty-five thousand squares can be made in a day, while at the same time they are better and straighter squares than those done by the old method ; but we are not at liberty to describe the process at present, but only to state the fact.

Pendulum rods are made from soft iron wire, and the springs on the end rolled out by rollers. Two operations are necessary. The first roughs the spring out on rollers of a kind of eccentric shape, and the spring is afterwards finished on plain smooth rollers. The pendelum balls in the best clocks are made of lead, and cast in an iron mould in the same manner as lead bullets, at the rate of about eighteen hundred a day. A movable mandrel is placed in the mould to produce the hole that is in the centre of the ball. The balls are afterwards covered with a shell of brass, polished with a blood-stone burnisher. The various cocks used in these clocks are all struck up from sheet brass, and the pins in the wheels in the striking part are all swedged into their shape from plain wire. The hands are struck out of sheet steel, and afterwards polished on emery belts, and blued in a furnace.

Dipping the brass work in acid is an operation to clean the brass and prepare it for lacquering. Different manufacturers use different mixtures of acids, which accounts for the difference in the brightness of the color of their work. After the brass is dipped in the acid it is rinsed in water and dried in sawdust, and gently heated to a blood heat, and brushed over with a thin solution of shellac dissolved in alcohol to prevent it from tarnish.

All the little pieces of these clocks are riveted together by hand, and the different parts of the movement, when complete, are put together by workmen continually employed in that department. Although the greatest vigilance is used in constructing the different parts to see that they are perfect, when they come to be put together they are subjected to another examination, and after the movements are put in the case, the clocks are put to the test by actual trial before they are packed up to be ready for a market. As a general rule, all the different operations are done by workmen employed only at one particular branch; and in the largest factories, from thirty to fifty thousand clocks of all classes may be seen in the various stages of construction.

Such is a description of the main points in which the manufacture of American clock movements differs from those manufactured by other systems. All admit that these clocks perform the duties for which they are designed in an admirable manner, while they require but little care to manage, and when out of order, but little skill is necessary to repair them. Of late years there has been a growing demand for ornamental mantel-piece clocks in metallic cases of superior quality, and large numbers of these cases of both bronze and gold finish are being manufactured, which, for beauty of design and fine execution, in many instances rival those of French production. The shape of the ordinary American movements were, however, found to be unsuitable for some patterns of the highest class of cases, and movements of the same size as the French, but with improvements in them that in some respects render them more simple than the French, are now manufactured by Seth Thomas, Sons & Co., at the rate of about seven hundred a month. Exactly the same system is employed in the manufacture of the different parts of these clocks that is practised in making the ordinary American movements, only the pinions, being solid, are cut with cutters, while the brass and steel work is polished all over.

In our next number we will describe the American system of making main-springs and the improved processes which have lately been adopted in their manufacture.

The Lathe.

No machine is so often called into requisition by the watchmaker as the lathe in some of its various forms; and if it were better understood, and its uses more developed by the mass of workmen, it would be oftener used, much time and labor be saved, and work done to greater satisfaction. The improvements upon previous forms which have been made, and which are still to be made, make its study and practice indispensable to every good workman.

In Vol. I. of the Journal, somewhat of its history, uses, and capabilities, were treated of; and, to answer many inquiries, some further practical hints will be given as to its use. No amount of written or verbal instruction can supply the place of practice. Reading over and over again the directions for so simple a thing as centring a piece of brass running in the lathe, will not enable a novice to do it; practice is the only thorough instructor; even failures to succeed are sometimes excellent teachers.

It is supposed you have an American or Swiss lathe, and wish to replace a broken pivot on a staff or pinion. First screw into the nose of the mandrel a piece of brass wire, allowing it to project about $\frac{1}{3}$ of an inch; see that the mandrel of the lathe has no end or side shake; turn the brass true and the end square; next make a slight countersink in the end of the brass to receive the perfect pivot, which remains on the staff or pinion. To make this countersink exactly in the centre requires a little practice, but the requisite dexterity can soon be acquired.

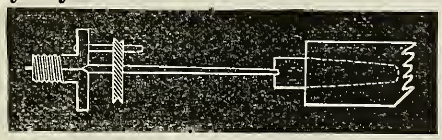
Turn the T rest of the lathe around at right angles to the lathe bed, and facing the front of the brass chuck which has been turned, and at a height which is a little below the centre; set the point of a sharp graver as near the centre as possible; if placed at the exact centre it will remain motionless while the lathe revolves, but if off the centre the point will describe a small circle; pressure must be applied only sufficient to keep the graver in place. At each revolution the graver will be brought near to and recedes from the top of the rest, but by revolving it on its point the thick part of it can be made to touch the rest at each revolution of the chuck, each time pushing the point of the graver a little nearer the centre, till finally it is found to remain motionless; a little pressure then produces a sufficient countersink to receive the pivot.

It then remains to secure the broken staff to the chuck thus formed, which is done by means of shellac. In the American lathe the most convenient way is to place the perfect pivot in the countersink, bringing a female centre in the tail stock up against the shoulder of the broken staff; this will hold it in place while the shellac is melted and dropped blazing on the slowly revolving chuck; the heat will communicate sufficiently to the chuck and staff to cause the shellac to adhere. Enough must be applied to form a mass as large as a good-sized pea, and enveloping the whole except the shoulder to be drilled.

Before the wax has entirely hardened, remove the tail stock and observe whether the projecting shoulder is entirely true; if not, force it into truth by a point, bearing on the rest and pressing against the shoulder as it runs.

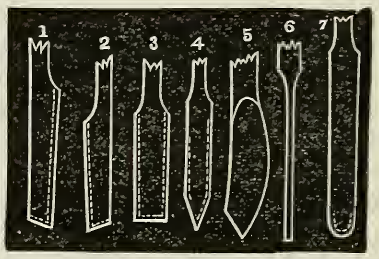
So large a mass of shellac is not necessary to hold the pinion for drilling, but it gives great solidity and firmness for all the subsequent operations of turning and polishing. The stump of the old pivot must then be centred in the same manner as was the chuck; the drilling being performed by a stationary drill, the point of which is set in the countersink, and the opposite end held in place by resting in the female centre of the tail stock, by means of which the necessary pressure is applied. To prevent the drill from revolving, it may be held by plyers, tweezers, or any convenient method. The form and construction of pivot drills will be treated of in connection with the subject of drills in general. Sometimes it is necessary or convenient to give the drill action by placing it in the lathe, the object operated upon remaining stationary; in this case parallelism of the drill and staff is maintained by placing the perfect pivot against the female centre of the tail stock.

All the usual methods for turning, stoning, and polishing the pivots, are applied while the staff remains in the wax. To remove it, place the rest in such a position as to shield the pivot from the flame of a lamp applied behind the mass of wax till so softened that the object may be drawn out with tweezers, placing it in alcohol until the shellac is removed. All the operations upon the lathe where chucking with wax is resorted to, must be performed upon the principle of placing the inner end of the object truly in the centre of motion of the lathe. If by any means the end of an object which ought to be in the centre is not so, it will be impossible to bring it there from the outer end. Many have found it difficult to use the ordinary drill bow arbors in the lathe, and whenever finding it necessary to use them, resort to the dead centre lathe and drill bow. The difficulty is easily overcome by this means. Take the *smallest* of a set of arbors, and through the collet drill a good-sized hole as near its periphery as possible, without cutting into the groove for the cord; through every collet of the set drill a similar hole at exactly the same distance from the centre of each arbor as that through the smallest collet; then make a brass chuck for the lathe, the face of which shall be large enough to permit a stout steel pin to be put through it, projecting far enough, and at such a distance from the centre as to reach into the hole in the collet of the largest arbor of the set. In the centre of this chuck produce a deep sharp countersink to carry one end of the arbor, and run the other in a countersink in the centre of the tail piece. This steel pin will form a " dog " which will carry any arbor of the set.



The subject of cutters and cutting tools as used in connection with the lathe, may with propriety be introduced in this article. Although much has been said on this subject there is no danger of saying too much, for every manipulation upon the lathe depends upon them. It may be enunciated as an established fact that the angles for the edges of cutting tools for brass must be more obtuse than those for iron or steel, for the reason that in the softer metal the acute cutters have a tendency to run in. The diversity of opinions with regard to the proper angle among practical workmen, undoubtedly arises from the fact that the peculiar action of a cutting edge upon a metal, is peculiar to *that* tool and *that* metal. Apply the same tool to another specimen of the same metal, and its action may not be so satisfactory, one workman saying that an angle of 45° cuts beautifully, and another, equally skilful, asserting that he succeeds best with his cutters at 75°, both being right for the particular tool and material spoken of. Experience seems to be the best teacher. Holtzappfel names 60° and 90° as the representative angles for iron and brass.

The principal turning tools, except for some peculiar and especial work, are point flat, round, right and left side, parting and screw tools.



Figures 1 and 2 represent right and left hand tools.

Fig. 3, flat tool.

Fig. 4, point tool, of which the common graver is a representative.

Fig. 5, parting tool showing breadth and thickness.

Fig. 6, round tool.

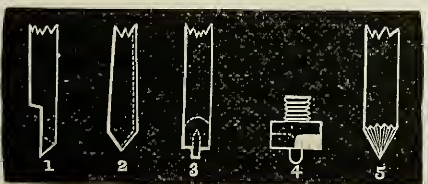
These tools, with angles adapted to the purpose for which they are designed to be used, are a necessary accompaniment to every lathe. The angles for drills follow the same general laws, being only cutting edges in another form.

Grinding the minute tools used by the watchmaker cannot practically be done at a given angle; the most that can be expected is to impress clearly upon the mind of the artisan the fact that small angle tools will not work well on brass and kindred metals. Practical experience, based upon this law, will give the best results. More acute angled tools are best suited to steel and iron, and in forming such tools, the type of the class should be the guide in practice.

For the watchmaker's use the graver, a square bar of steel ground off at the end diagonally and obliquely, at an angle of about 45°, furnishes in itself most of the cutting angles required. By a judicious assortment of obtuse and acute angled gravers, almost every thing can be done except cutting off.

Another tool which may be called a centring graver, is excellent in the hands of an expert. A flat piece of steel is fixed in a handle, the end filed off from the right hand side to the left at an angle of 30°, and undercut on the end and left hand edge, which is straight; then harden and temper. It is laid flat on the rest; the point, at the same level as the centre, is brought in contact with the work a little in front, and the cutting corner forced toward the centre, when it will rest; for the back part of the cavity thus formed is moving in a direction which compels the cutting edge to become a stop, and no amount of force will push it past the centre. Any one accustomed to this tool will be surprised to find how easily he can centre the end of a staff for entering a drill.

It will be needless to mention the ordinary drill so commonly used and propelled by the reciprocating motion of the drill bow; whether the angle is to be acute or obtuse, or the end be slightly rounded, must be determined by the circumstances of the case, the material upon which it is to operate, and the position in which it is to be used. The action is scraping rather than cutting in all such as cut in both directions. The more rare forms for drills will be described, as they are often of great service in extraordinary cases, and a knowledge of some peculiar form often proves of great service. Figure 1 is a double cutting



drill, made of wire filed down to the diametrical line, and as far back as it is intended to penetrate ; the end is formed with two faces; it has the advantage of not having the diameter changed by being sharpened ; it may be pointed circular or flat, and will remain central · it is sometimes called the *Swiss* drill.

Figure 2 is suitable for horn ivory, shell, or such materials as are liable to agglutinate and clog up a drill ; it is chamfered somewhat more acute than for metal, and the chamfers are continued around the edge behind its largest diameter.

Figure 3 is a square countersink, and may be used with the drill bow. The centre pin is taken out when it is necessary to sharpen the drill ; the same centre pin may be used for holes larger than those for which it was intended, by slipping over it collars of such size as the hole requires.

Figure 4 is an excellent counterbore, as described p. 202, Vol. I., in the article on Watch Jewelling: "To make the tool for letting in the screw-heads it is necessary to put up in the lathe a piece of steel wire, and turn down with a 'tit' of just the size of the hole in which it is intended to be entered. The shoulder, as matter of course, should be perfectly true and square, and the outside turned off to the accurate size of the head of the screw that is to be put in ; the workmen in every case endeavoring to get the sizes of the heads the same.

"The really best form for a counterbore for gilded work, to be used with high speed, is illustrated in the drawing. The spiral form given to the clearing portion of the tool will enable the chip to roll out of the hole without marring the edges."

The twist drills, now to be found everywhere in market, are an invaluable adjunct of the lathe, and can be had in sizes ranging from the machinist's work to the watchmaker's. To sharpen the small sizes requires some practice. No better directions can be given, aside from experience, than the general rule regarding the cutting angle, which must be produced as nearly as possible by the aid of a glass. They have an additional advantage over other forms of drill in that they are self-centring, and maintain their direction without any tendency to "run," and also the size remains constant until the drill is used up.

Figure 5 is a cone countersink, and sufficiently indicates the mode of construction. Sometimes the radial grooves are intersected by parallel furrows, sweeping at an angle around the cone ; spherical cutters, such as are used for bullet moulds, are made in this manner, and called *cherries.*

Of all the plagues which afflict the watchmaker pivot drills seem the chief, and the person who could give such a method of producing them as would insure their cutting the hardest steel, and not breaking at the most inauspicious moment, would be entitled to a monument bristling with them. Each workman has his own way of hardening and tempering them, each one giving preference to his method over every other. The primitive and generally adopted way of hardening is to suddenly swing the heated drill through the air ; in fact, it is difficult to withdraw a piece of thin steel from the flame of a lamp without hardening it. Another way is to heat in the flame of a candle, and harden by thrusting it in the tallow ; others again preferring beeswax, sealing-wax, etc.

The probable fact is that all these ways are without difference ; the drill being hardened on its passage from the flame to the tallow, wax, or whatever else, the air in each case being the medium of conduction. A ready and convenient way of making a really good pivot drill is described on page 79, Vol. I. of the Journal:

"To effect this the workman may use the round Swiss pivot broach ; as they are sold the temper is always of the proper degree. The operator having determined the size of the hole he wishes to make, puts the broach in his split gauge and takes the measure of that part of the broach that is of just the size desired, breaking the broach off at that point ; he will now have a taper piece of steel which will be too long for use, but he can reduce the length by breaking off a portion from the small end. This being done, the next operation is to fasten the small end in the end of a brass wire of proper size, which is done by drilling a hole deep enough to allow the broach to be soft-soldered in, leaving only a short piece projecting from the end of the wire ; the soldering can be effected without drawing the temper of the steel if the flame is applied to the brass at a distance from the steel, thus allowing the heat to be conducted to the solder. The blank is now to be formed into a drill by grinding the two sides of the steel flat, using two pieces of oil-stone—one a slip, the other the ordinary stone. By placing the steel between the two it will be found on moving the slip that the friction between the two stones has changed the form from the circular to one having two flat sides. The end is now formed by means of the stone, with but one angle for cutting, and can be used in the lathe either as running or stationary drill."

The want of success in making fine pivot drills in any or all these various ways, is attributable to several causes. The first, and one for which no one is blamable, is bad steel; the steel from which such drills are made is selected without reason, the workmen usually "trust Providence," and take for the purpose such as their judgment, experience, or necessities provide. Some prefer for the purpose the best needles, others pivot broaches, or strips of metal cut from mainsprings, or the pivot drills sold by the material dealers. With any or all of this diversified material, everybody meets from time to time with various success; some accidental arrangement of conditions occasionally furnishes a drill that will last for months and seems perfect in its action, and almost imperishable, becoming in the estimation of the workman more precious than its weight in diamonds. Why it is so excellent is impossible to say; but when at last it does fail, creation is ransacked to find a piece of the same steel from which to fabricate another, and the chances are even whether the new one succeeds or fails.

Secondly, the flame of an alcohol lamp, which is commonly used for the purpose of hardening, is very liable, by its constitution, to alter the quality of the steel in minute drills. This flame being a hollow cone, the interior, from the wick to near the apex, is comparatively without heat ; by introducing a bit of paper into the centre of this cone, it will not be even scorched ; the outer surface, where the flame and the external air come in contact, being the seat of most intense combustion, if the fine steel wire be held for a moment in this intensely hot portion of the flame it becomes white hot, and the life of the steel, as steel workers call it, is burned out, very much impairing its toughness and hardness.

The flame of a candle is not so dangerous, for although hollow, like the alcohol flame, the incandescent shell of flame is much thicker, enclosing a smaller space filled with the combustible vapor arising from the hot wick; the candle flame, being abundantly supplied with carbon from the tallow, is rendered nearly opaque and luminous, and seems not to have the same tendency to reduce the steel to iron by abstracting its carbon; neither is it so intensely hot as the alcohol flame. For these reasons, and for the facility it affords for quenching the drill in the tallow, it is a convenient method of hardening.

An excellent way of using the alcohol flame is to hold the drill between the thumb and finger, and approach it to the flame *nearly parallel* to its surface, being particularly careful to observe the instant the point becomes *bright cherry red*, then draw it suddenly through the fingers; the passage being so rapid and the amount of metal so small, there is no danger of the fingers being burned. If the steel is good, a good drill is almost invariably produced.

Hollow drills save much time, on many occasions, and three or four of different sizes should accompany the lathe. A convenient way to make them is to chuck in the lathe a piece of steel wire of sufficient size to afford the necessary face; drill a hole in the centre as deep as will be required, and at the bottom of it file away the steel to the diametrical line, after the manner of the notch in a drill stock; the object of this is, that in case a "tit" of metal is accidentally broken off in the drill, it can be pushed out from the rear. The cutting surface is formed by placing the drill firmly in the vise, face uppermost, and with a sharp cold chisel file cut the surface radially; after removing the burr which will be formed around the centre hole by the cutting, harden and temper. One of the difficult things to do well, is to form the shoulder on the hook to an English main-spring; but with a hollow drill it is easily and rapidly done.

Small circular burr wheels, or rotary files, are very useful at times, and the ease with which they are made leaves no excuse for not having them of various sizes and forms. Mount a piece of steel in the lathe of sufficient diameter to form the proposed tool; turn away the steel at the back until a neck is formed, leaving a circular disk of such thickness as may be desired; the edge which is to do the cutting can be *milled* by placing a coarse sharp file upon the periphery, bearing upon it firmly and steadily, draw it slowly back and forward, allowing the file to turn the mandrel at will; the file will transfer the form of its own teeth to the soft steel, which must then be hardened. Thin circular saws of some considerable diameter may be made for the lathe, from good sheet iron, the teeth cut in the edge by a file, and then *case hardened.* The thin iron is almost wholly converted by this process into steel, and without the inconvenience of warping. They give very satisfactory results where only occasional use is required of them; even cutters for a wheel-cutting engine, can be thus formed in an emergency. Small emery wheels for ready attachment are a great convenience, readily applicable to the sharpening of small drills and other tools.

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Reminiscences of an Apprentice.

MY FIRST CLOCK.

I had learned to handle the tools, and could use the lathes and the turning tools tolerably well, and at last "our maister" decided that I should make something; so he gave me some castings and other materials to make a plain eight-day clock, when my time was not occupied with the other duties that usually and very properly fall to be done by the youngest apprentice.

I had to clean the shop and the shop windows, and run the errands; and I also cleaned all the clocks, although I was not allowed to put them together, and every morning it was my duty to clean all cases of the watches that had been repaired the day previous. But the worst thing of all, I had to go to the well to bring water not only for the use of the shop, but also for the use of "our maister's" wife. I did not mind doing dirty work inside the shop, where but few saw me, but I was of the decided opinion that carrying water on the public street was altogether below the dignity of a watchmaker's apprentice. Still I did not grumble openly, except when at home I sometimes relieved myself, but consoled myself with the hope that the day would come when I would get square with " our maister's " wife for the imposition I then imagined was being practised on me by making me carry water for household purposes.

Although the position of a young apprentice had menial duties connected with it, there were also times of pleasant relaxation. When "our maister" went to the houses of the neighboring gentry or farmers to clean or correct their clocks, I had always to go with him, and generally these were days of enjoyment; but I liked the farmers' houses best, for to me all restraint was thrown off, and unaffected joy everywhere abounded. The farmer or some of his family attended on us all the time, and told us stories while our work was being done; and after the clocks were set going we would wait a little while, on the pretext that some of them might stop. The farmer and "our maister" usually went into a private room containing nothing peculiar except an old cupboard in which stood some fine cut crystal ware. I was sent outside to enjoy myself with the members of the family of my own age, with full liberty of access to the milk-houses, barns, and stables, and sometimes equestrian feats were executed by us on patriarchal horses, who appeared to enjoy the fun as much as we did ourselves. I do not know what kind of business " our maister " and the farmer transacted in private, but sometimes their deliberations were somewhat protracted, and I noticed that usually when the interviews were over they were perfectly pleased and satisfied with themselves in particular, and felt well disposed towards mankind generally.

At one time, if a marriage was projected in our town, a bran new eight-day clock was considered to be indispensable to the respectable appearance of the home of the young couple, and when the house was being prepared for their reception, an eight-day clock that would reach from the floor to the ceiling was sometimes given as a present from the bride's father. On these occasions universal joy abounded, and the joy was often temporarily increased by the cermony of drinking the health of the young people. The "old folks" were happy over the projected marriage of the "young folks," which reminded them of their own earlier years, and which promised to enlarge their own happiness in the future. " Our maister " was happy because he had sold a clock and a wedding ring, and perhaps a watch or a piece of jewelry besides, while I was happiest of all, for I generally got my pockets stuffed full of cakes or confectionery, or one of the old people would "play a trick upon me" by slipping several coins into one of my pockets while I was putting up the clock.

It was a long time before I got my new clock completed, because there were many interruptions, but at last I got it finished, and I did not experience much difficulty in doing it, because I had at first been taught the use of the tools, and " our maister " gave me careful directions at every stage in its construction. The rules he insisted on me following were exactly the same as those laid down in Ried's Treatise, which need not be mentioned here, because many of the readers of the JOURNAL must either own a copy of the work or are familiar with its contents. But those not in possession of a copy, or who are unacquainted with the contents of the book, will find considerable extracts from it in such of our trade papers as in their judgment of Ried consider imitation to be the most sincere flattery.

Although I was a boy, my imagination led me to think that I had learned all that was to be learned, and at the very least I was as good a man as " our maister " was, although he had taught me everything. I showed the clock to all my friends as being the very best that ever was made, and nothing could exceed the care I exercised over that clock to keep it from harm; but one day it was sold to go to a distant part of the country. I would much rather it had remained at home, but I dared not interfere; and when the clock was being packed up and the head slided on for the last time, I felt as if I saw a dear friend put in his coffin.

Since that time I have designed and constructed many pieces of complex mechanism both for horological, astronomical, and philosophical purposes, and although I now look upon making my first clock as but learning the first letters of the alphabet, the successful completion of no undertaking ever gave me such genuine pleasure as the finishing of my first clock.

Young men are too apt to jump at conclusions, and to imagine that when they have been taught the preliminary elements of their business they know everything, and in their blindness consider every little thing that they accomplish to be a great achievement. A little experience in the world will show them their mistake, if friendly advice prove impotent, and instead of their having accomplished all that can be done, they will, like the sage philosopher, discover that they have only found a grain of sand on the sea-shore, while all beneath the ocean is hid from their view

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The Blow-Pipe.

The fatigue of the lips and cheeks which so many complain of when compelled to use the blow-pipe for considerable time, may be remedied by adapting to the large end of it a bell-shaped mouthpiece of horn, ivory, or silver, similar in form to the large end of a French horn. If during the act of blowing, this mouthpiece be pressed against the lips partially open, a much greater blast can be obtained than without its aid, and when once accustomed to its management, will be found to prevent the fatigue of the lips.

The form of lamp to use with the blow-pipe is of not much consequence; but there is an arrangement of the wick tube, and wick, which have several advantages. The wick tube should be rectangular, shaped like the tube of a coal oil lamp, a little thicker and not so wide as the smallest size wick tube in a coal oil hand lamp, and should be cut off at the top diagonally, the left hand corner being a little the lowest. This form admits the flame being directed *downward* upon such large work as requires great heat. Good sperm or lard oil answers every purpose for fuel; the wick must be cut square across, parallel to the top of the wick tube, no filaments being allowed to protrude beyond the general surface of it, otherwise the flame will be streaked and uneven, and will not present the solid uniform mass so necessary to a constant blast.

To become expert in the use of the blow-pipe, a thorough knowledge of the constitution and peculiarities of the flame, and the capabilities of the different parts of it for producing various effects, is necessary. All flame has four distinct parts, as may be distinctly seen by carefully examining the flame of a candle, which assumes a pear-shaped form; the base, a fine blue color, becoming indistinct as it ascends, and in the centre a dark conical portion, encircled by the luminous part of the flame.

This luminous portion of the flame is itself encircled by a thin layer of flame, which gives out most heat, but not much light; the heat of the whole mass diminishing toward the top.

The cause of these phenomena in the flame are explained by knowing that the wick absorbs, by its fibrous nature, and conducts the melted tallow or oil by capillary attraction up into the flame, where the heat decomposes it into carbon, hydrogen and oxygen, the mass being rendered luminous by the incandescent carbon. The interior dark cone being filled with particles of carbon, the blue flame at the base being carburetted hydrogen and carbonic oxide, the exterior, thin, non-luminous shell, enclosing the whole, rendered intensely hot by union with the oxygen of the atmosphere.

By blowing lengthwise of the flame, the air from the blow-pipe passing over and near to the wick, a long narrow blue *oxidation* flame will be produced, very slim and pointed, the most intense heat being produced at its extremity, where the oxygen of the air from the blow-pipe is consumed, and any substance placed in the flame at that point is rapidly oxidized and evaporated. If placed a little beyond the point, oxidation is more rapid, because the air supplies to it more oxygen. In producing this oxidizing flame, the wick must be evenly cut and free from fibres, which will produce streaks of yellow reduction flame.

Allowing the air to pass over the wick at a greater distance from it, and the orifice of the blow-pipe farther from the flame, the whole ignited mass is blown in the same direction as a long luminous cylinder surrounded with that part of the flame, which emits only a small degree of light. By forcing the air, as described, the particles arising from the wick are consumed. Such a flame directed upon a metallic oxide, so that the point entirely envelops it, the oxygen will be eliminated. The wick for the reduction flame must not be so high as to give a smoky flame, nor so low as to give insufficient heat.

The diverse character of these two flames readily accounts for the want of success that attends the first efforts at soldering with the blow-pipe, and the success that results from experience is often only practical experience, without knowing wherefore. By knowing that an *oxidizing flame* will "burn up," that is oxidize, and evaporate a piece of metal, and that a *reducing flame* will take up any film oxide upon metal enveloped in it, the artisan is at once armed with such knowledge as will enable him to handle the blow-pipe intelligently, and to produce the exact results desired.

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What is Steel?

There is no end of experiments, speculations, and theories regarding the structure and constitution of steel. The more the subject is studied the more do previously received theories fail to account satisfactorily for all the new phases this question assumes. Not only is the question important in a purely scientific point of view, but no more important practical question can be asked, because no material is of so universal use in every department of the mechanical art. A positive decision upon any matter or subject cannot be given unless it is thoroughly understood, and were an answer given to-day, to-morrow's investigation would prove it incorrect. The chemist would answer the question readily enough, that "steel was a carburet of iron, composed of twenty equivalents of iron to one of carbon; and as the combining equivalent of carbon is six, and that of iron twenty-eight, there are in steel six atoms of carbon to five hundred and sixty of iron; that is, steel is iron carbonized to the extent of a little more than one per cent."

This theory does not stand the test of practical experience, even chemical analysis showing results constantly variable, showing combining proportions ranging from 0.25 to 1.25 per cent. Such discrepancies of analysis have led to the suspicion that the chemical action was more an impregnation of the iron by carbon than an actual combination in definite proportions, an impregnation, as it were, of iron in a carbon bath as in cementation.

Then, again, steel can be made without the presence of carbon; it can be impregnated with silicon, titanium, tungsten, chromium, etc., even with sulphur and phosphorus, whose presence is considered deleterious. These substances give to iron all the distinctive properties of steel with only characteristic variations; therefore, the nearest answer to be ventured upon is, that iron is the general and steel the specific form of the metal, steel being merely iron hardened, or steeled by being chemically impregnated with carbon, silicon, titanium, etc., or any of those elements which possess more or less the hardening property. There is a proportion of the hardening element which gives to the iron the greatest amount of the hardening property; accordingly, cast-iron may be regarded as impregnated with too much, and wrought iron with too little carbon, in both cases falling short of the strongest form—steel. Pure soft iron, chemically toned by any of these hardening elements, is steel. This toning may be under or over done, or the different tonics may be so mixed and combined as to neutralize each other; the Bessemer process shows that there is no definite boundary established between the three forms.

Crystallization also seems to exert a powerful influence in imparting the hardening property. This is indicated by the usual practice of hardening steel by plunging it in cold water; so also, on the other hand, any degree of hardness may be let down to any degree of softness, by heating the steel. It is evident that relaxing the temper of the steel is associated with the chemical action of heat on the crystalline molecules.

This action is not yet fully understood, and consequently renders an answer to the question started with, impossible.

Only fine iron is used in making good steel; the purer the iron the larger the crystals, the admixture of foreign matter diminishing their size. The finer the steel the closer will be the grain of the steel; then, "how can steel be identified, how can its varying qualities be distinguished?" This is a practical question, and all-important to those whose occupation renders it necessary to determine this question by simple inspection. Analysis certainly would be the correct mode, but impossible to resort to in the haste of every-day business; an approximate analysis might occasionally be resorted to, by dissolving a bit of steel in an acid; the varying shades of brown will indicate the proportions of carbon. The readiest test is by examination of the fracture by the microscope; this method will depend upon experience and the skilful use of the microscope; the unassisted eye may make a very tolerable guess, but the result cannot be depended on. With a powerful lens the crystals are found to be octahedral, presenting the form of a double pyramid joined base to base. As the amount of carbon decreases, the pyramids become flattened, from the cubical form in cast iron to the entire flattened form in wrought iron. Between these extremes may be found a graduated series of pyramidal forms, more or less elevated according to the quality of the metal. If the microscope reveals regular and parallel crystallization reflecting an uniform lustre, the steel is of good quality; in proportion as it departs from this standard and shows groups of crystals not parallel, and the needle-like points reflecting a lustre shaded here and there with dark patches, one portion presenting a bright silvery lustre, and another a dark gray one, the quality of such metal may be assumed inferior.

Although the microscope affords valuable aid towards determining the relative qualities of steel, a positive decision cannot be reached, so long as the laws which assign to each crystal in nature its specific and generic form, are veiled in profound obscurity. While this alcove in nature's great laboratory has conspicuously posted over its portal, "Crystallography—no admittance here," we shall seek in vain for a full and complete solution of the doubts and uncertainties which, at present, cluster around this subject.

We must patiently wait the future development of scientific investigation, for a final answer to the query, "What is Steel?"

Lifting Springs.

Having seen a statement that some one seriously proposes to make lifting springs from brass, it seems an opportune moment to say a few words more on that subject.

Everybody's mode of hardening and tempering has been thoroughly ventilated, and it is to be hoped that some, if not all the readers of the Journal have been benefited by this generous disclosure of private methods. In none of the various communications has the real difficulty which attaches to the subject been treated of, and it is proposed to attempt to show where it lies.

Brass, as a substitute for steel for the purpose, will receive the little attention it deserves, having never proved permanently useful in any case where constant elasticity was required. For clock springs it proved a failure; in the early history of hoop-skirts it proved unserviceable, for if rolled hard enough to be elastic, it was easily broken; in fact, hard hammered brass will break *easier* than steel, and if not hammer hardened is worthless as a spring. In view of these facts there is no hope for improvement in this direction; on steel, then, as the only metal now known adapted to the purpose, must dependence be placed.

There can be no doubt but the form of the spring has much to do with its durability; if the double flexion of the spring when in action be for a moment considered, this idea may not seem undeserving attention. The lifting spring, as the case is shut, has both a downward and inward motion. The restricted space afforded for the spring necessitates the usual rectangular form or some analogous one, to give sufficient strength to a comparatively thin spring, for lifting a heavy case. By modifying the rectangle, which a section of the spring shows, into an ellipse, will not diminish its power, but will remove some of the defects which will be mentioned hereafter.

A law, well understood and holding good for all springs, is that that all abrupt angles offer facilities for breakage. A notch or angle of any description will cause a spring to break at that point in preference to any other. When the lip of the lifting spring breaks, it is invariably at the right-angled corner where it rises from the body of the spring. If the shoulder at the base is a sharp angle, such a spring will be sure to break there, in preference to any other point.

These facts point significantly in the direction where danger lies. Another fact is well established, that if the continuity of a metallic surface be slightly broken, even by a fine line, a tendency is induced to part at that point in preference to any other. To break a cast-iron bar, it is only necessary to mark its circumference with a chisel, and a moderate amount of force will cause a fracture at that point. A fine line, almost invisible, drawn on the surface of glass by a diamond induces it to fracture in that line.

From these and similar facts, the form and finish of lifting springs, as much as their temper, determines their durability and elasticity. In forming the spring, the fine lines which seem to induce it to break are produced by the file, and although sharp angles are avoided in shaping it, unless these file-marks are obliterated before or after the spring is hardened, there can be no certainty of its remaining intact.

Long experience with rounded and oval springs, finished by draw-filing and stoning, confirms this theory. American watchmakers cannot fail to have noticed the manner of finishing case-springs in the high class foreign watches, and their observation will bear out the assertion that they seldom break. Here the springing of cases is done in a totally different manner, and the results are indicated by the constant complaint of breakage.

The two inner, upper, and lower corners of the case-spring are sharp right angles (or less), and the back and rounded part throughout its whole length is crossed by sharp file-marks which break the continuity of the surface of the steel, any one of which jeopardizes its durability. If a broken spring were inspected by a good microscope it would be found broken at a point where some one of these file-marks was deepest.

If spring-makers would be at the trouble to round all the angles, both interior and exterior, rough-finish them by draw-filing so that no transverse file-marks remain, then eliminate the longitudinal file-marks by stoning, they could safely *warrant* then. There is, however, a serious obstacle in the way of this desirable improvement, namely, an unwillingness on the part of community to pay for all this labor. Indirect taxation has irresistible charms for the American people ; they are always ready to slaughter the prospective good for the present dollar, and will tell the watchmaker frankly that " they guess this spring (rough, uncouth and unsafe as it is) will do for the present, and if it does break, why, they'll have to get another." Such short-sighted policy, pandered to by mercenary tradesmen, who value money far above professional reputation, stands in the way of many an improvement in the trade, and will continue to be a stumbling-block so long as reckless craftsmen hold the balance of power, and so long as the mass of buyers prefer low prices to excellence in quality.

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The Baroness Burdett Coutts' Prize.

For the first time in the history of Horology, a woman of wealth and title has publicly manifested an interest in it as creditable to her well-known liberality as it is gratifying to those members of the trade who fully appreciate its importance as a scientific art, and feel a personal pride in elevating it to a point as near perfection as its intimate relation to the science of Astronomy and commercial enterprise demands.

It is remarkable that the Baroness should have selected for discussion the *balance spring*, than which there is no department of horological science, the laws of which are less thoroughly understood. The important office this spring subserves in all portable time-keepers, the irresistible influence it exerts upon the performance of such instruments, renders it imperatively necessary that all the laws which govern its action should be fully established and widely known. The mysteries which lie concealed in the little spiral are only the result of ignorance of those laws, and we earnestly hope the stimulus offered by her Ladyship, not alone in guineas but in honors, will develop a knowledge of these laws to the fullest extent.

The selection of jurors seems particularly felicitous. No better choice could possibly have been made than the eminent representative of theoretical science, the Astronomer Royal, G. B. Airy, C. B. Mr. James F. Cole, another member of the jury, is a mechanician whose practical execution of horological theories has given to very many of the London watchmakers the world-wide celebrity of their productions, and is pre-eminently qualified as judge of whatever is excellent in practice ; and Sir Charles Wheatstone, whose energetic and comprehensive views of the requirements of the commercial world eminently qualify him to judge of the immense benefits *perfect time-keepers* will confer upon science and the mechanic arts, complete a jury which, as a whole, happily embody the theory, practice, and utility of our noble art.

We copy from the *British Horological Journal*, the conditions on which Miss Coutts has offered a prize of Fifty pounds sterling (about $300 currency), for the best essay on the Balance Spring, and trust that some of our own countrymen may become competitors for that honor :

"The Balance Spring and its Isochronal Adjustments must be treated theoretically and practically. The judges, in deciding the merits of the respective essays, will be guided by the treatment of the following points :

"*First.*—A description of the various springs applied to time-keepers, and their results.

"*Second.*—The practical details for making the same, with an account of the necessary tools.

"*Third.*—Modes of obtaining the isochronism of the spring, and its application to various Escapements.

"*Fourth.*—The essay should further contain the method of adjustments for diferent temperatures and positions, and it is desirable that a short history of the spring should be appended. The text will be more easily understood if illustrated by drawings.

"The competing essays must be delivered in, on or before the first of March, 1872, under cover to the secretary at the Institute.

"Each treatise must be marked with some device or motto, and should be accompanied by an envelope similarly marked, containing the name and address of the writer, only to be opened if the essay is successful.

"The judges will have the power of awarding a less amount should none of the essays be considered worthy of the prize offered.

"The judges will be requested to give their decision in not more than one month from the time of receiving the essays for award.

"The writer of the essay to whom the prize shall be awarded, shall be entitled to the copyright. The council reserving the right of publishing it in the *Journal* in whole or part as they think fit, but not till six months have expired after the adjudication and payment of the award."

Cameos.

Figures engraved in low relief on different kinds of silicious stones, shells, etc., having layers of divers colors, are called cameos. The art dates back to a very remote antiquity, some of these ancient engravings upon stone forming valuable and interesting departments in both public and private collections of antiquities. To the general reader, a descriptive and historical account of these exquisite antique gems of art would be of interest. But the interest of the jeweller, lover of art though he may be, centres in merchantable cameos. The seat of their principal production having until late years been in France and the south of Europe. Modern art has made many attempts to discover some suitable material for the purpose more easily wrought; the hardness of the silicious stones precluding the possibility of their coming into general use. The best and most usual substitutes are the shells of molluscous animals; several kinds of these afford the necessary variety of color, and are at the same time soft enough to be worked with ease, and yet sufficiently hard to resist any amount of wear. Early cameos were made from the wreath shells (*turbines*), which have an opaque external coat overlaying an internal pearly one. Seba and Rumphius figure many specimens of these which their collections contained; they are now only to be met with in the cabinets of the curious.

The flesh-eating univalve (*Gasteropoda*) are peculiar for having their shells formed of three layers of calcareous matter, each layer being composed of three perpendicular laminæ placed side by side, the central being placed at right angles to the inner and outer ones. This structure gives great strength to the shell, and furnishes the cameo cutter with the means of giving a peculiar surface to his work, carefully designing his sketch, so that the direction of the laminæ of the central layer is longitudinal to the axis of the figure.

The shells mostly used by modern artists are "Bullsmouth," which has the inner lining of the shell red; from this cameos are formed having a sardonyx ground. The "Black Helmet," with a blackish interior layer, is used for onyx ground. The "horned helmet" has a yellow ground, the Queen's conch (*Strombus gigas*) a pink ground. Most of the pink cameos of any considerable size, have the pink ground variable in color, from the fact that the color of the lining becomes paler, or fades out, as it proceeds back in the interior of the shell.

From Rome, which for many years was the centre of the shell cameo trade, the art has spread over the civilized world. For several years past it has been a regular branch of the fine arts in the United States. Most of the larger cities support one or more of these artists, whose business is mostly confined to the cutting of portraits. The whole expense of cameos being the value of the artistic labor bestowed upon them, their production here as merchandise is impossible, owing to the high cost of such labor.

Those who desire a likeness less perishable than a photograph, painting, or pencilling, and are willing to pay for the skilled labor necessary to produce it, are the persons from whom our artists derive their support.

Such portraits can be executed in great beauty and perfection either in stone or shell; the latter being less expensive, from the fact of its being easily wrought by such steel tools as gravers, chisels, files, etc.

Stone cameos are almost wholly produced upon silicious stones, which, as a family, contain nearly all the semi-valuable gems, such as amethyst, agate, onyx, opal, jasper, moss agate, cat's eye, sardonyx, etc., etc. Musically speaking, these are all beautiful variations upon *quartz*, as the theme. Calcedony is a mixture of crystallized and amorphous quartz, agates being composed of irregular layers of calcedony of various colors. Ribbon agate is formed of alternate and nearly parallel layers of calcedony with jasper or quartz or amethyst; the most beautiful are obtained in Saxony and Liberia.

Fortification agate is found in Scotland and on the Rhine; on cutting it across and polishing it, the interior shows zigzag lines, bearing a slight resemblance to the plan of a modern fortification. Calcedony variously colored, traversed with red veins of jasper, sometimes taking foliform ramifications, is called moss agate. These silicious stones are adapted to the purposes of the lapidary from their diversity of structure and color. For the cameo cutter the onyx, in two or more colors superposed, is the favorite.

Steel tools in themselves are valueless in cutting these stones; corundum and diamond dust alone have sufficient hardness to abrade them, and are always used for this purpose; the whole process from beginning to end is grinding; all the tools used are adjuncts to the simplest form of lathe, namely, a foot wheel, lathe head, with a simple mandrel through it, with a small pulley on its centre. The whole lathe head is protected by a sheet-iron cover through which the nose of the mandrel projects; the purpose of this covering is to shield it from contact with the arm of the operator, which constantly rests upon it when in use. The mandrel is pierced with a female screw into which all the grinding tools are fitted.

These tools by which all the operations are performed are nothing more than steel chucks about three inches long, screwed firmly into the nose of the mandrel, and the end turned into such shape as the particular service required of it demands. This turning up of the chucks is done by an ordinary graver; the rest, a separate and independent affair, being a short cast-iron column rising from a broad base or sole, which is merely set on the bench in such a position as the work in hand requires. The thousands of angles, curves, convex, concave, and plain surfaces, which, combined in millions of ways, go to make up the "human face divine," require hundreds of these little grinding tools. The profile of the face intended to be transferred to stone is photographed, and from that the artist makes his drawing on the surface of an onyx or agate in two colors, one superposed upon the other, the upper layer of stone being rough-ground away down to the under one, so as to leave a mass in the centre projecting or raised sufficiently to afford material for the head and face which it is to be formed into; the outline is then traced, and all the superfluous portion ground away. The parts of the figure most in relief or most prominent are then traced and worked into approximate forms.

These preliminary operations can be very well performed by subordinates, as no particular artistic skill is required; but from this point onward, the artist must be a sculptor, and the tedious work progresses by grinding a little concave here, a little line there, a dot in this place, and a projection in that, by means of the various shaped cutters revolving in the lathe, a little diamond dust and oil being applied to their periphery with a bit of goose-quill. Constant consultation of the model photograph is necessary, for if any prominent feature is erroneously ground away it cannot, as in a painting, be reproduced; once gone, it's gone forever. These delicate operations are constantly under inspection through a lens; and when the whole, in its most minute particulars, is completed, it becomes a fit subject for even microscopic examination.

In watching from day to day and week to week the slow growth of the stone into likeness, the hesitancy is, which most to admire, the skill or the patience of the artist. It seems incredible to what perfection of resemblance some minute specimens of this art arrive at. Why should colossal statues of Minerva, Hercules, or Cupid, receive more applause than exquisite miniatures of the same? If the world pours out its wealth, and shouts its loudest praises, to those who produce such works in marble, and with such gross tools as chisel and mallet, why is he not equally, or more deserving of fame, who does the same thing upon amethyst, and within the space of a ladies' ring?

Antiquity of the Watch.

Editor Horological Journal:

Good authorities on Horology agree that clocks must have been made many years previous to the written records of the oldest. For it was deemed impossible that such an intricate machine as a clock could have been made without many experiments and continual improvements on the first one, before it reached the state in which it appears in its earliest history. It is taken for granted that a clock, and not a watch (using the terms as now understood), was the first invented. And, although it is reasonable to suppose such to be the case, still it is not impossible that the watch was known at nearly as early a period. Vick's clock, of about 1370, is the earliest of which there is a full description; it has the verge escapement and balance, but no balance spring; and, therefore, would be nearly as suitable to carry on the person as to use in a fixed position.

Chaucer, the father of English poetry, was contemporary with Vick, and a man of great importance. He was sent ambassador to Italy and to Flanders, by Edward III. and Richard II., and was closely related to John of Gaunt, son to the former and uncle to the latter king, who governed England during the long minority of his nephew. Chaucer was, also, for many years prominent in the custom-house at London. His various poems, especially "The Canterbury Tales," are accepted as a faithful delineation of the manners and customs of his age, and no better authority can be required. If there was such a thing in use as a watch, Chaucer, above any other man, may be supposed to have known of it. In his "Shipman's Tale," written about 1393, occur the following curious lines:

> "And let us dine, as soon as that we may,
> For by my kalender 'tis prime of day."

They are spoken by Dan John, a monk, in his friend's garden at St. Denis, ten miles from his monastery. These lines serve to indicate, at that early date, the existence of a portable instrument capable of showing the time of noon. The monk does not refer to a stationary dial, for he says, "by *my* kalender," and at the time of speaking he was ten miles from his home, in another man's garden.

There are but two articles to which his words can be applied; the one a watch, the other a portable sun-dial. A watchmaker would naturally take pleasure in supposing it to be a watch; and, unless rather direct evidence points to a different conclusion, it may be fairly presumed to have been one.

The mariner's compass had been introduced into Europe thirty years before the story was written, so that it is possible (although there seems to be nothing known in regard to it) that it might have been used in connection with a sun-dial to be carried in the pocket, as at the present day. It is more than doubtful, however, that the compass had been used for such a purpose. It is certain that it was not used for placing fixed dials in the meridian, as a much simpler and more accurate process has ever been and is still in use. Such a dial would have been of little use to anyone at that time or the present. A watch, of even the rudest construction, would have been invaluable to a monk especially. The prayers and other services in the churches were at all hours of the day and night, and quite as frequent by night as by day. The clocks made before Vick's time, of which there are no descriptions, were made by monks. The most famous of them was afterwards Pope Sylvester II.

It is, therefore, likely that watches were in use five hundred years ago, and not considered so uncommon as to require explanation in referring to them in the manner set forth; a circumstance not to be wondered at, considering that the great mass of every country could not read, so that all writings were intended for a very select few, composed almost entirely of the learned professions. The art, if it ever existed, was undoubtedly lost for many generations; but neither is that surprising to a student of the history of the mechanic arts during the middle ages.

Sag Harbor, L. I. B. F. H.

Fraudulent Dealers.

Ed. Horological Journal:

Can you give the name of a reliable material dealer? I make watch and jewelry repairing a specialty, and it is very desirable when one is in the interior as I am, to have orders faithfully filled. Is ——— a bogus concern? Some time since, I sent them an order, which they put up without any regard to items or quality, though I was particular to specify the quality I wished. For instance, I ordered Gravier's best main-springs, instead of which I got a miserable lot, which I break three or four of on the winder in succession (first-class prices though). The same of English cock and foot jewels; out of one dozen, perhaps two or three would do; watch oil counterfeit, hardly fit to oil a clock; in fact, the whole bill can be beat at half the price. I did think of giving them a *puff* through the Journal or some other paper, just to let them know I have not forgotten them, though they have me, having taken no notice of my letters since.

M. M. Ferguson.

Marion C. H., S. C.

We publish in full the letter of our correspondent. Similar complaints come to us frequently, and we take the occasion to speak upon these pernicious practices. We have known for some time that counterfeit watch oil was bought and sold by parties in this city, and the trade have been warned of it through our columns. There is nothing which so tries the "temper" of the Christian watchmaker as bad materials; if it stand that test, he can safely be "warranted for a year." It is not the value of the material itself, but the time lost in fitting it. A bad jewel, either faulty in the finish of the hole, or not being properly centred, involves an amount of labor in refinishing which yields no profit to the artisan. Bad glasses, out of flat and out of round, will, many of them, break under the pressure necessary to insert them, or will break so soon after they come in possession of the owner, that he very justly expects it replaced for nothing. Bad main-springs give endless trouble; not only is the loss by breakage in the shop of some consequence, but the damage liable to accrue to the fair fame of the watchmaker, by the imperfect performance of the watch, is a more serious affair, and not to be measured by dollars and cents. Buying "American screws" and finding them made in Switzerland, with a thread entirely different from the genuine, is provocative of profanity. Bad oil, of all the bad things, is the worst. Its action is insidious, slowly but surely working detriment to the watch, and equally surely damaging the reputation of the watchmaker. There is no avenue of access to the conscience of these reckless dealers except through their pockets ; there, like Achilles' heel, they are vulnerable. Their conversion can only be effected by the combined efforts of the trade. Let them know for a truth that they can hope for no extensive patronage until they have fully established a character for honest dealing, a point in mercantile life not to be reached in a moment. Young houses, the members of which are strangers, should be dealt with as strangers. We are far from saying young mercantile firms are unreliable and not to be confided in ; such an assertion would not only be unjust, but untrue. Many, and perhaps most of them, are off-shoots from old-established concerns, junior members of old houses ; in that sense they are not new men, simply well-known men in new places ; consequently, having the same, and perhaps greater claims to the consideration of buyers, than their seniors in business.

We fully believe that the truth of the social maxim, " Never desert old friends for new ones," will hold equally good in a commercial point of view, and if vigorously acted upon, will compel the class of tradesmen complained of either to go to the wall, or to so conduct their business as to lay an *honest* foundation for future prosperity. Our aim has been to admit none to our advertising columns except those whose commercial integrity was well established ; had our subscriber given his order to any one of the numerous dealers whose advertisement can be found in the Journal, we will venture that he would never have made the above complaint. We can give our friend only negative comfort under his manifold afflictions, which is, to be careful in the future to whom he sends his orders.

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Isochronous Pivots.

Editor Horological Journal :

In a communication from B. F. H., Sag Harbor, L. I., in your August number, among a selection of practical and useful hints, I notice one on the subject of " Isochronous Pivots," in which the writer proposes in certain instances to reduce the diameter of the balance pivots at the part nearest to the shoulder, with the idea that the friction on the pivots will thereby be reduced, when the watch is in a perpendicular position, to an equality with the friction that is on the ends of the pivots when the watch is in a horizontal position.

In mechanical philosophy it is asserted that it is not the amount of surface that causes friction, but the amount of weight or pressure that bears upon the surface; consequently, within moderate limits, there is the same amount of friction in short pivots as in long ones, if the weight or pressure on the pivots be the same in all cases. For the same reason there will be the same amount of friction on the balance pivots of a watch, in whatever position the watch may be placed; only when it is in a horizontal position the friction is mostly concentrated at one point; but when the watch is in a perpendicular position the friction, which was all at one point in the previous instance, is distributed all over the bearing surface of the pivots.

In seeking for information, I would inquire, by what series of experiments B. F. H. practically tested his suggestion.

Dynamics.

New York City.

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Cleaning Show Cases.

Editor Horological Journal :

I see in your " Answers to Correspondents " in September number of the Journal, that you tell " J. H." of Ill., to use " jewellers' rouge " to clean his show-cases. I presume it is the *metal* part that gives him trouble, and rouge is *not* the best thing for the purpose. If he will use tripoli, the kind that comes in *lumps—not* the prepared article that comes in papers—sold by Frasse, who, by the way, ought to let the trade know where he is, and what he keeps, through the medium of your Journal, as he has many things of use to watchmakers and jewellers that *I* cannot find elsewhere. Let " J. H." get a pound of this tripoli, which will last him for a year or so, to clean his show-cases, and in polishing jewellery, etc. It must be pounded up fine in a mortar and mixed with water for show-cases, applied with a piece of chamois-skin, using a proper amount of "elbow grease," then with a dry chamois rub off the powder after the same has become dry. I tried whiting, rouge, rotten-stone, and the tripoli that is usually sold by druggists, put up in papers, but nothing that I ever saw tried will compare with the genuine tripoli; besides, it does not cost much.

James Fricker.

Americus, Ga.

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Answers to Correspondents.

D. H., *Charleston, S. C.*—The receipt, or secret, for which you are asked to pay five dollars, is a humbug, and if the person who wishes to impose on you calls again you ought, politely or otherwise, to inform him of that fact. It is absurd to suppose that a bruise or depression in the outer wall of an ice-pitcher can be raised up to its former position by filling the air-space between the two walls with water, so that when the pitcher is placed in such position as to bring the depression uppermost, there shall be a small air-space or bubble (like a spirit-level) just at that point, and that by closing the hole in the bottom and heating the water to the boiling point, a pressure of steam is brought to bear upon the depressed part, sufficient to raise it up. It will be seen on a moment's reflection that, though it is possible thus to produce a pressure of steam within the air-space, the metal *around the bruise* would be raised soonest, because offering the least curve of resistance, thus aggravating the difficulty; for, the bruise presenting to the steam an inverted arch, a form which is capable of resisting the greatest amount of force, the sharper the indentation the smaller does the arch become, and its power of resistance proportionally increased. Whenever these "wise men from the east" offer for sale trade secrets, at an exorbitant price, just drop a line to the Horological Journal and you will receive, "free as the air you breathe," all that is known on that particular subject.

A. G. C., *Iowa.*—You can easily have constantly on hand pure alcohol—that is, alcohol free from water. Sömmering found that common alcohol kept in bladders, which it is known have the property of passing water through their texture, but do not permit the passage of alcohol, was rendered nearly anhydrous.

For this purpose an ox bladder should be taken ; soak it for some time in water, inflate it and free it from any attached vessels, turn it and serve in the same manner. After again inflating and drying it, the outer and inner surface must be smeared over two or three times with a solution of isinglass, which renders the texture more firm, and better promotes the concentration of the alcohol. It must be filled with the spirit to be concentrated, leaving a small space vacant, and closely tied up at the mouth, and suspended in a warm temperature, over a sand bath, near an oven, or in the direct sunshine. In from 6 to 12 hours at a proper temperature (about 122°) weak spirit may be concentrated to 0.952. A bladder so prepared may serve for a long time. Strong alcohol is not easily obtained commercially, and this method affords watchmakers a convenient way of always having on hand for use an alcohol which will absorb water with great avidity, and readily dissolve such gums as it is a solvent for.

"Ontario," *Canada*, may find in the following description of a fusible cement, a substitute for soft enamel. Analysis of the Vienna white cement for repairing broken dials shows its composition to be oxide of zinc and some colorless resins, very soluble in alcohol. It may be prepared in this way: Take equal parts of demmara and copal resin, as near colorless as can be obtained, reduce them to fine powder; to five parts of this mixture add two parts of venice turpentine, and rub the whole into a thick paste, by adding as much spirit of wine (alcohol) as is necessary; add now three parts of the finest white zinc, and continue grinding it until of the consistency of oil-ground paint; the extreme whiteness may be modified by adding a very little Prussian blue to the alcohol in which it is rubbed up;

the mass must then be gently heated to drive off the alcohol.

It may also be prepared by melting the resins together, extreme care being taken not to discolor them by burning, adding the zinc while they are in the melted state. Probably various colored cements might be prepared from this basis by the addition of the proper pigments.

C. M., *Ala.*—If you do not feel the inclination to purchase any one of the numerous screw-stands in market, you can make a very cheap and useful substitute by taking a small paper box, or what is better if at hand, one of the tin boxes which American movements come in; turn it bottom up, and sketch on it, either in ink or with a point, the outline of the watch movements whose screws it is designed to hold. At such points in the sketch as the screws come, make holes of suitable size to receive them. The confusion and lost time saved in taking down and putting up watches where the screws are various, and allowed to become mixed up on the bench, will amply repay for the construction of three or four of these holders, adapted to as many kinds of watches.

M. Z., *Milwaukie.*—No; the wonderful Strasburg clock was not injured by the bombardment; a huge pointed cartridge, a horrid "obus," came crashing through the Cathedral one night and lodged in the organ, but did not explode. Had it done so, the beautiful organ, the great clock, and perhaps the grand old Cathedral itself would have "gone up."

C. A. G., *Wis.*—A very good poising tool can be made by adapting to one end of the ordinary depthing tool two new centres of steel wire, about a half inch of the inner end of each of which is filed away somewhat beyond the diametrical line. Harden and polish these ends, and they will present when properly fastened in the tool by the set screws, a very nice sharp angle on which to poise the balance, the adjustment for the length of staff is of course made by the screw which opens the tool.

F. A., *Tenn.*—Removing the roller from the main-wheel arbor in cases where it is screwed on, is sometimes troublesome, unless some convenient tool is at hand to do it with. Such a tool may be made in a few moments by taking a pair of old (or new) round-nose plyers, and grinding or filing the points to a size and shape that will take into the holes usually made in the roller for the convenience of unscrewing it; the plyers can be opened to any distance, and consequently will fit all sizes. Place the winding square firmly in a bench key held in the left hand, then apply the points of the round plyers in the holes in the roller, and by firm, steady pressure it will be easily unscrewed, with no danger of damage to any part.

D. C. W., *Ga.*—You will find your marble top bench not as desirable on some accounts as you seem to imagine. Firstly, it is very trying to the eyes; a good light is always required for watch work, and the constant reflection from the pure white surface directly into the eyes of the workman, you will find annoying, unless your eyes are stronger than the average. It is always desirable where the eyes are severely taxed (as they are at our work) that no light enter them, except that reflected from the object under inspection. Again, the surface of the marble in winter weather is unpleasantly cold for all the early part of the day, and communicates its coldness, or, more properly speaking, abstracts the heat from all the metal tools lying upon it, which in cold frosty mornings is no small consideration The noise produced by the constant laying down of metal tools is, to some nervous persons, an objection; and in case of such an accident as dropping a glass or dial, the liability to breakage is much greater than a wood surface. Undoubtedly the *best* bench-top is an oil-polished dark wood surface, with light-colored tinted paper upon which to place the work.

D. A. M., *Ga.*—Professor Bottger prepares cement of divers colors and great hardness by mixing various bases with soluble glass. Soluble soda glass, thoroughly stirred and mixed with chalk, and the coloring matter well incorporated, sets in the course of six or eight hours as a hard cement; it is capable of a great variety of uses. Well-sifted sulphide of antimony gives a black mass, which, after solidifying, can be polished with agate, and then possesses a fine metallic lustre. Fine iron dust gives a gray black cement; zinc dust makes a gray mass exceedingly hard, which, on being polished, has a bright metallic lustre, so that broken or defaced zinc castings can be mended or restored. Carbonate of copper gives a bright green cement; sesquioxide of chromium gives a dark green; Thenard's blue, a blue; litharge, a yellow; cinnabar, bright red; carmine, a violet red cement. The soluble glass with chalk alone gives a white cement of great beauty and hardness. Sulphide of antimony and iron dust in equal proportions, stirred in with soluble glass, afford an exceedingly fine black cement; all adhere firmly to metal, stone, or wood. As soluble glass can be kept in a liquid form, and the chalk and coloring matter are cheap, the cements can be readily prepared when wanted, and the material kept in stock ready for use, at little expense. Soluble glass is fast becoming an important article of chemical production.

A. F., *Kansas.*—A new brass has been made, having its expansion and contraction by changes of temperature, the same or nearly the same as those of iron and steel, that it may be used to solder those metals to brass. Its composition is: 3 parts tin, 39½ parts copper, 7½ parts zinc.

W. P. F., *Cal.*—The small files you inquire for are called equalling files, and can be sent you by mail; they are numbered from 24, downwards, the thinnest being about as thick as a very thin main-spring, which, if you are driven to an extremity, you can easily convert into a temporary tool by file-cutting the edge, while firmly held in the jaws of the vise; stiffen this thin saw, by binding over the back of it a narrow strip of tin, hammer it down tightly, and you will have an excellent miniature "back saw."

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EQUATION OF TIME TABLE.

GREENWICH MEAN TIME.

For October, 1871.

Day of the Week.	Day of Mon.	Sidereal Time of the Semi-diameter Passing the Meridian.	Equation of Time to be subtracted from Apparent Time.	Diff. for One Hour.	Sidereal Time or Right Ascension of Mean Sun.
		S.	M. S.	S.	H. M. S.
Sunday	1	64.35	10 14 86	0.803	12 39 6.54
Monday	2	64.40	10 33 96	0.790	12 43 3.09
Tuesday	3	64 45	10 52 74	0.776	12 46 59.65
Wednesday	4	64.51	11 11 17	0.760	12 50 56.20
Thursday	5	64.57	11 29 25	0.745	12 54 52 75
Friday	6	64 63	11 46.95	0.729	12 58 49 30
Saturday	7	64.69	12 4.26	0.712	13 2 45.85
Sunday	8	64 75	12 21.15	0.694	13 6 42.41
Monday	9	64.82	12 37.59	0.675	13 10 38.96
Tuesday	10	64.88	11 53.57	0.655	13 14 35.52
Wednesday	11	64.95	13 9.06	0.635	13 18 32.07
Thursday	12	65.02	13 24.06	0.615	13 22 28.62
Friday	13	65.08	13 38 56	0.593	13 26 25.18
Saturday	14	65.16	13 52.54	0.571	13 30 21.73
Sunday	15	65.24	14 5.98	0.549	13 34 18.28
Monday	16	65 32	14 18.87	0.525	13 38 14.84
Tuesday	17	65 41	14 31.20	0.501	13 42 11 39
Wednesday	18	65.50	14 42 95	0.476	13 46 7.95
Thursday	19	65.59	14 54.10	0.451	13 50 4.50
Friday	20	65.68	15 4.64	0.426	13 54 1.05
Saturday	21	65.78	15 14.56	0.400	13 57 57.61
Sunday	22	65 87	15 23.84	0.373	14 1 54 16
Monday	23	65 97	15 32.46	0.345	14 5 50.71
Tuesday	24	66.07	15 40.41	0.316	14 9 47.26
Wednesday	25	66 17	15 47 68	0.287	14 13 43.82
Thursday	26	66 27	15 54 24	0.258	14 17 40.38
Friday	27	66 38	16 0.07	0.227	14 21 36.93
Saturday	28	66 49	16 5 16	0.196	14 25 33.49
Sunday	29	66 60	16 9.51	0.164	14 29 30.04
Monday	30	66 71	16 13 09	0.132	14 33 26.59
Tuesday	31	66.82	16 15.88	0.099	14 37 23 15

Mean time of the Semidiameter passing may be found by subtracting 0.18s. from the sidereal time.

The Semidiameter for mean noon may be assumed the same as that for apparent noon.

PHASES OF THE MOON.

	D. H. M.
☾ Last Quarter	6 5 31.9
● New Moon	13 18 19 2
☽ First Quarter	20 11 54.5
⊙ Full Moon	27 20 14.3

	D. H.
☾ Apogee	4 20.3
☾ Perigee	16 16 2

	° ′ ″
Latitude of Harvard Observatory	42 22 48.1

	H. M. S.
Long. Harvard Observatory	4 44 29.05
New York City Hall	4 56 0.15
Savannah Exchange	5 24 20.572
Hudson, Ohio	5 25 43.20
Cincinnati Observatory	5 37 58.062
Point Conception	8 1 42.64

	D.	APPARENT R. ASCENSION. H. M. S.	APPARENT DECLINATION ° ′ ″	MERID. PASSAGE. H. M.
Venus	1	11 46 54.11	− 7 11 49.5	23 2.3
Jupiter	1	7 54 43 05	+20 59 50.4	19 12.9
Saturn	1	18 16 13.34	− 22 50 23.0	5 36.2

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CONTENTS.

Manufacture of American Clocks.

COMPARATIVE ADVANTAGES OF WEIGHTS AND MAIN-SPRINGS—DIFFERENT METHODS OF HARDENING AND TEMPERING MAIN-SPRINGS—REMARKS ON MAKING CLOCK CASES, ETC.

Probably the greatest progress shown in the manufacture of American clocks of late years has been in developing improved methods of making main-springs. As the demand for portable clocks, and for mantle clocks in small ornamental cases, increased, weights had to be abandoned as a motive power, and the question of producing a spring as a suitable and equally reliable substitute for a weight was one which for a long time puzzled the smartest of our Yankee clockmakers. Finally the difficulty was overcome, and the production of good clocks in small elegant cases was thereby rendered possible.

There is a popular notion that a weight, in all cases, is superior to a spring as a motive power for clocks ; and this opinion is unquestionably a correct one when there is sufficient room in the inside of the case to allow the weight to have a long fall or drop; for then a weight can be applied to advantage, and it may be considered the cheapest as well as the most regular motive power ; but in short, cramped up cases, where there is but little room for a weight, and when either the diameter of the barrels has to be reduced, or the main wheels made very large, or a series of pulleys introduced, and the weights increased in size to compensate for a short drop or fall, it is always preferable in such instances to discard weights altogether and use springs.

It is a fact, probably not very extensively known, that the first marine chronometer made in the New World went by a weight. This chronometer was made by Mr. William Bond, of Boston, during the war of 1812-14, and as at that period no main-springs of any kind were made in the country, and communication with Europe being for the time cut off on account of the war, Mr. Bond was placed under the necessity of using a weight as a motive power for his chronometer. This chronometer performed good service in the United States navy, and is still in existence in its original condition. In place of the movement being encased in the usual brass bowel, it is fastened in the end of a brass tube of the same diameter as the dial, and long enough to allow a sufficient drop for the weight. The movement is hung on gimbals, in the same manner as other marine chronometer movements are suspended, and the weight falls between perpendicular slides to prevent it from oscillating in any direction when the ship is in motion. But although the soundest judgment is displayed in all the details connected with the application of a weight for this special purpose, and the fact of it being a successful instance of applying a weight to a marine chronometer, no one would argue from these facts that weights should be applied to all marine chronometers, for the reason that a weight makes the chronometer much less portable than when a spring is used. In a like manner, occasions may arise when *good* springs may be used as a motive power in preference to weights, even for clocks designed for more than ordinary accurate time-keeping, when the peculiar design of the case will not allow sufficient room for a weight to be applied conveniently and effectively.

At the period just before the advent of American spring clocks, good main-springs could be purchased from importing houses the same as they can be purchased now, or they could be made to order by European watch-spring makers who were beginning to settle in our large cities; but as cheapness has always been a fundamental principle in the production of Yankee clocks, these springs could not be made available owing to their high price; so native clockmakers were thrown entirely on their own resources to make suitable springs, and at such a price that would not materially increase the total cost of the clock. To produce suitable steel springs at a suitable priee was indeed a formidable undertaking at that period, and it is not surprising that, in the early history of American spring clocks, several experiments were made by manufacturers to obviate the necessity of using coiled steel springs by fastening elliptic and double elliptic springs on the inside of the case, and connecting them with the movement in a suitable manner by cords, and also by using coiled springs made of hard rolled brass, in order to obviate the difficulty of hardening and tempering steel ones. After a short trial elliptic springs were found to be unsuitable for the purpose, and brass coiled springs could not be made to retain their elasticity. The rising generation of American housekeepers demanded elegant mantle clocks to make their homes look attractive; so there remained no other course for the Sam Slicks of the period to pursue, but to overcome the difficulties incident to hardening and tempering steel springs at a moderate cost; and, however, great the undertaking seemed, it was but a trifling task in comparison to the one of trying to persuade Miss Young America that the old weight clocks, looking like "ornamental packing cases," were exactly the style for her drawing room, although she readily admitted their usefulness and their adaptability for the kitchen and other parts of the house.

The method of making main-springs for watches, as is practised in New York and other large cities, is first to cut up steel of the necessary thickness into strips of the necessary breadth. These strips are then fastened by the ends in a long horizontal frame, and the edges and sides of the steel are smoothed by polishers fastened between two sticks and worked by hand lengthwise on the steel, from the one end of the frame to the other. After being prepared in this manner the steel is wound *closely* round a wooden centre, in the same manner as a ribbon is wound on a small block, and in the process of winding the end of each strip of steel is fastened to the other by binding wire—a number of lengths being coiled one on the top of the other. The roll of steel is then put into a furnace, the necessary heat is applied, and the hot steel suddenly plunged into oil. In this condition, although the steel is hard, there is a certain amount of flexibility to it, just the same as a very thin and narrow strip of glass is elastic, which prevents the steel from breaking when the surface is being prepared for bluing, and which is done in something the same manner as smoothing the steel in the first instance, only finer polishing materials are used. The bluing is done by drawing the steel in *straight* lengths over an alcohol lamp, or a hot piece of metal, which renders it perfectly elastic, and afterwards it is cut to the proper lengths, and the eyes for the hooks put in, and then coiled into a spiral form on a tool, the same in principle as the tool used by watchmakers in putting main-springs in their barrels or boxes.

The plan first practised by American clockmakers for hardening and tempering springs essentially differs from the above. After the steel has been cut into ribbons of the desired breadth, and the edges rounded, it is cut into proper lengths and the eyes for the hooks punched out in the ends, and then each piece is coiled up into a loose spiral form, similar to the form which a spring takes when taken out of a clock, or when the wire clasp is taken off of it. In this condition each spring is placed in a furnace, and when the steel is brought to the proper redness it is hardened in oil, and after being cleaned, but without any further operation of polishing, they are tempered in molten lead, and in this state sent to the market.

The reader will notice that while a small roll of steel coiled *close* together may be easily heated equally throughout, it is a very difficult matter to heat a loose irregular coil equally; and it is evident that a large number of springs hardened in a loose coil must be unequal in hardness, for the reason that when they are in the furnace the heat cannot be applied to them regularly,because, the coils being much closer together in the centre of the spring than they are at the outer extremity, the outer coils are liable to take the heat first, and the coils near the centre are therefore liable to be soft, or if they are hard, the outside coils are liable to be burnt. In tempering the springs, however, there are no such difficulties ; because it is one of the peculiarities of tempering in molten lead or other hot liquids, that the steel will take a uniform color throughout if its surface be clean, although it may be irregular in shape; and, consequently, the hardness will be regular throughout if the steel has been hardened equally all over in the first instance. To recapitulate, the steel will be deprived of a certain amount of its hardness *equally* all over, and in quantities proportionate to the temperature of the liquid or the length of time the article remains immersed. (See articles on Heat in the second volume of the Journal.)

It is therefore plain that although the steel may have been *tempered* equally, if it has not been *hardened* equally, the spring cannot have the same uniform elasticity throughout its entire length ; and this difficulty with a majority of the springs hardened in a loose coil was a very great drawback to the introduction of spring clocks, for from this cause spring clocks at that period gave very considerable more trouble than weight ones did, and the production of good time-keeping movements at a cheap rate, suitable for small cases, was for a time rendered doubtful. In addition to the want of a uniform elasticity, the surfaces of the springs were sometimes rough, being left in the same state as they came out of the fire. When the springs were not burnt in any part, this roughness of the surface was not great, yet, strange to say, it was asserted that the rough surfaces were better than smooth ones, for it was supposed that the coils worked against each other with less friction when rough than when they were smooth, which is an idea that cannot be admitted, except being remarkable for its originality, as a means of getting over a difficulty that could not be avoided or remedied by calling it an improvement.

As this system of hardening main-springs in a loose coil could not be depended on for making good springs in large quantities, and as the plan adopted by watch main-spring makers for hardening the steel in rolls coiled *close* together could not be used, for the reason that the greater breadth and thickness of the clock springs rendered them less elastic when in the hard state, and therefore could not be put through the operations afterwards necessary, without breaking, the plan of hardening the steel in straight lengths was experimented upon and finally adopted. It is foreign to our present purpose to enter into any discussion as to whom the credit of the invention of tempering straight springs belongs, but it is generally conceded that the system has its foundation in Washburn's patent for tempering piano wire by tension. Like every other great improvement, it was not completed at one time, or by one man; and without entering into any particulars about priority of invention, we will proceed to describe the accumulated improvements which are now combined, and are in operation at the Seth Thomas Clock Factory.

The steel from which the springs are made is imported, and comes to the factory in rolls about three inches wide, each roll containing from forty to one hundred feet. It is first cut up into ribbons of the desired width, which vary according to the breadth the springs require to be—the narrowest usually being about three-tenths of an inch, and the widest about one and a half inches. These ribbons are cut by circular shears, which are simply steel disks or rollers, with square sharp edges, and fastened on arbors so that the edge of the one disk shall slightly overlap the edge of the other; and when the disks are made to revolve, they cut the steel in the same manner as shears, only the cutting motion is a continuous one. If the springs to be made are to be one and a half inches wide, the circular shears are arranged to cut the sheet into two ribbons; but if the springs are to be three-tenths of an inch in breadth, the shears are arranged to cut the steel into five ribbons at the same time, and so on. The end of the sheet of steel is introduced into the machine, and when the circular shears are set in motion the sheet is cut up into ribbons as fast as a boy can walk and carry away the ends. The pieces of the same breadth are then riveted together at the ends into one continuous length and coiled on to a large reel, and taken to another apartment to be hardened, tempered, polished, and colored.

The furnace in which the steel is heated consists of a brick structure, six feet long, about three feet wide, and about four or five feet high. The furnace bars, as is usual in other furnaces, are placed some distance from the ground in order to secure a good draught of air ; and this draught is increased by an iron tube full of holes, which is placed below the furnace bars, and into which a stream of air, generated by a circular blower, is introduced; and by this means an equal draught is produced through the entire length of the furnace, and the fuel made to burn evenly. In the centre of the fire an iron tube, six feet long, six inches wide, and about two inches deep, is fixed, and kept red hot all the time, and through which the steel passes, preventing it from coming in contact with the fuel. The wooden reel or drum on which the long ribbons of steel have been wound, is placed on a stand at the end of the furnace in such a manner that it will revolve with the necessary freedom, but not too free, neither too stiff. The end of the steel is then passed through the hot tube, and, in passing through, is heated to the desired redness; and then it is again cooled by passing through a tank of oil four feet long, two feet broad, and about three feet deep, which is placed in the inside of a larger tank, placed at one end of the furnace, and through which a constant stream of water is kept running to keep the oil cool. The steel then passes through a bath of molten lead, which gives to it the necessary temper ; and afterwards it passes between iron rollers—an arrangement designed to regulate the rate of speed which the steel has to travel through the furnace; and, lastly, the tempered steel is coiled on to a reel the same as the one it came off when it was in its soft state, and which has been placed in a convenient position to receive it, and is made to revolve slowly by machinery. If the broadest strips of steel are being hardened and tempered, only one breadth is done at a time; but of the narrower widths several lengths usually go through the furnace at the same time. About one thousand feet a day is the rate of speed the broad strips are hardened and tempered, and a proportionably greater number of feet for the narrower strips, according to the number of breadths done at the same time.

Some of our readers may probably detect a resemblance in this system of hardening and tempering, to the plan patented in Great Britain and France by Mr. Charles Chesterman, of Sheffield, and which is described and illustrated in the "London Journal of Arts" for July, 1860; and also in Emanuel Schreiber's "Handbook for Watchmakers," a work published, a few years ago, in the German language. Still, although the principle is in some particulars the same, a great many of the details—which contribute largely to the success of a plan or invention—are entirely different, and much more complicated, according to the published description of Mr. Chesterman's method.

The arrangement for equalizing the strain or tension on the ribbon of steel, and thereby keeping it from twisting or bending in the hardening ; and also the plan for regulating the speed which it is desired the steel should travel, according as the heat of the furnace varies, is worthy of special notice, although without drawings it is impossible to give a clear description, further than mention that the iron rollers which the steel passes through after coming out of the molten lead, are placed on a platform; and inside the platform are a pair of reversed smooth cones, with a belt running on them. These cones are connected with the iron rollers that draw the steel through the furnace, and also with the reel that coils up the steel after it has been tempered, and any alteration of the position of the belt on the cones alters their speed; and the man who is attending the furnace is thereby given complete control of the passage of the steel, and can pass it through fast or slow, according to the peculiar nature of the steel, and the quantity of heat in the furnace. These, and other improvements for regulating the draught of air going into the furnace, we believe to be due to Mr. Ira N. Bevans, a gentleman who has given the subject much attention, and who is at present superintendent of the main-spring department at Thomaston.

The rolls of steel, having been hardened and tempered, are taken to a machine to be polished and colored. This machine consists of a long and very strong frame, in which a series of wooden rollers, covered with leather, are running. The rollers are enclosed in boxes full of emery, and the strips of steel are made to run over the one roller, and below the other, in such a manner that both sides are polished at once; while at the same time, the edges are smoothed and rounded by two vulcanite wheels, one working against each edge of the spring. The strips of steel then pass through molten lead the second time, simply to color the steel, and prevent oxidization; the color used usually being a dark straw color. The steel, after being in this manner hardened, tempered, polished, and colored, is cut up into lengths necessary for the particular description of spring that is desired. This is done by an experienced workman, who in passing the steel through his hand, feels the strength of every inch of it, and a soft piece is instantly cut out and thrown aside. The ends are then softened, and the hooks and eyes put on, and the springs are afterwards coiled up on a machine, the same in principle to the one watchmakers use to put main-springs in their boxes. In this operation great precaution is used to detect bad springs; each one being wound up twice before the clasp is put on, and if it does not spring out as it ought to do, it is thrown aside as being too soft. There is ample testimony to prove the great superiority of these springs over those made by other methods; but we will only instance one case, where a number of clocks, with springs ten feet long, could not be got to run longer than seven days. The old springs were removed, and springs nine feet long, made in the manner we have described, put in their place, and the clocks run nine days before stopping; which was two days more time with one foot less of spring. These springs are sold at prices varying from fifteen to forty cents, and we have seen a great many of the size sold at forty cents, which we consider to be but little inferior to springs that were made singly and by hand, that cost three dollars. So the difficulty of making good springs at a cheap rate, which was such a formidable barrier in the way of making small movements, suitable for handsome mantle clocks, may be considered to have now been satisfactorily overcome.

The manner of constructing clock cases, when they are made of wood, vary but little from the processes employed in making household furniture. Much of the same kind of machinery is used, and what attracts the attention of a stranger most on visiting one of these case factories, is the great subdivision of labor, and the immense scale upon which the different operations are conducted. In addition to the production of handsome cases, speedy execution and economy of materials seem to be the great objects aimed at. We will only mention one instance where a great saving has been recently effected, that of cutting veneers. After the economical plan of cutting or slicing thin slices of wood from a round log, placed in a machine made for the purpose, was substituted for the former method of sawing the veneers, it was soon discovered that a considerable waste of material was caused by the necessity of using a square iron mandrel through the centre of the log of wood, by which it was turned round when the veneers were being sliced off. The log could never be cut down to the centre, and sometimes, when it was little more than half cut down, the log would split into pieces, and consequently there was great liability of waste from that cause. At the Seth Thomas Case Factory a plan was originated which obviated these chances of waste. The square mandrel through the centre of the log is dispensed with, and an arrangement adopted which holds the log of wood by the ends. This plan allows nearly the entire log to be sliced down into veneers, leaving only a core of the smallest size possible. The adoption of this plan of holding the wood, produces results which ought to satisfy the most rigid economist, for even the cores can be put to some useful and profitable purpose, and therefore nothing is wasted. But although the principle that nothing should be lost or wasted, is rigidly carried out, and is a ruling idea in the manufacture of cases as well as movements, we do not credit the idea, however, that any of the Connecticut clock companies save up these cores to sell to the wooden nutmeg makers,. although their shape and diameter render them admirably adapted for that purpose.

Our space will not permit us to enter into all the details of case making, and besides, the subject may be only of secondary importance to the great majority of our readers; still we must notice some improvements which have been made in the manufacture of bezels for holding the glasses of the cases, or what are known in the factories as sashes. These sashes have been usually made of a thin strip of sheet brass, bent to a circle, hard-soldered at the ends, and struck into shape by dies in a punching press, and when finished the glass is fastened from the inside with plaster of Paris, or some similar material. Recently, however, sashes have been made with a brass ring inside to hold the glass. This ring also lies close against the dial, its surface being at an angle of about 45 degrees from the surface of the dial, which gives a finished appearance to the clock, nearly equal to a solid cast brass one with a ground glass. Powerful and expensive machinery has been constructed for the manufacture of these improved sashes in large quantities to suit all the ordinary sizes of dials, even those as large as twelve inches. We would also notice a cheap style of case intended for locomotive clocks, which is beginning to appear in the market. They are made from sheet brass, and constructed with a special view to exclude all dust from getting into the works, and much ingenuity is displayed in accomplishing this object, and at the same time allowing the glass to be removed with ease when necessary. We would judge, from the arrangement and accuracy of the fittings, they are better adapted to answer the special purpose for which they are required, than some of the more pretending and much more expensive solid cast brass ones.

The crowning feature, however, in the development of the manufacture of clock cases, is the production of those elegant and artistic designs cast in bronze, and finished in both bronze and gilt, and which closely rival any cases imported from France. All of our American readers, at least those residing in large cities, must have seen these cases, and consequently are in a position to judge for themselves. In conclusion, we would remark, that among those interested in the manufacture of American clocks, there are bands of intelligent, energetic men, and skilful mechanics, who, while claiming to have produced good and reliable time-keepers, consider that a higher stage of perfection may yet be attained ; and in all branches of the manufacture of the various descriptions of movements and cases, and also among those gentlemen conducting the mercantile departments, but one spirit prevails, which may be justly defined *Excelsior.*

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Science in Plain English.

The rapid advancement of the mechanic arts, and their adaptation to the every-day concerns of life—the absolute necessity for every department of modern labor to employ the highest scientific knowledge in order to attain tolerable success in the prosecution of almost any form of business—makes it imperative that the large mass of workers be educated in such departments of science as bear upon the calling they have chosen, or are compelled to follow.

The difficulty of obtaining a thorough understanding of the sciences in schools above the common, and below the collegiate, places this important branch of education beyond the reach of all except those who can lavish both time and money for a "liberal (collegiate) education." Only colleges can afford the necessary appliances and competent instructors for scientific studies. Rarely, indeed, does the collegian make science an occupation. Of course, there are cases where irresistible *instinct* forces men thus educated into such pursuits, and then they are lost to the practical world by being absorbed as instructors in new or similar institutions to those which gave them birth.

The demands of the time are for a rare combination of theoretical with practical knowledge. Chemistry, as a science, has been as thoroughly explored as any other, but the tendency of modern research takes also the direction of practical utility; and to fully accomplish this demands, not only theoretical knowledge, but a mechanical aptitude for so combining the two as to bring out of both some commercial utility. Competition in mechanical industries has so thoroughly drawn upon the most economical modes of construction as to make it imperative for the constructive mechanic to be practical, and at the same time so scientific as to waste neither material nor power. So must the manufacturing chemist be as conversant with the most economical appliances for the laboratory, and expert in their manipulation, as he is learned in abstract chemical theories, or he cannot compete successfully with others of his class.

Once it could be said with truth that

"He who by the plough would thrive,
Himself must either hold or drive."

Now, the case is far different. Simple tools, like the two sticks coupled together by a leathern thong, have given place to the elaborate and complicated threshing machine, driven, perchance, by steam, its proper and economical use involving the whole circle of the sciences.

To be emblematical of the present, that venerable mythological gentleman, with one white lock pendant from his glossy pate, should have slung upon his back the "mower" in place of the ever-present scythe. Even Æsculapius should have his staff and serpent replaced by a binocular microscope and alembic.

This tendency of the age, to put metal in the place of muscle, and steam for vital force, giving the mind only the task of guidance, compels an education far in advance of the necessities of the past; demanding facilities which educators seem to have taken no pains to furnish. The college, in its venerable antiquity and gray old age, is deserving of all respect; for full well has it served its age and generation. The present should accept it as an antique gift, and so value it; but its claim of being adequate to the supply of modern educational needs is preposterous. While the world has been rushing on with impetuous flow, it has stood like a grand old tower breasting the flood. It now stands in the very same sandals it wore years ago, having made no visible effort to keep pace with the advancing needs of the present generation.

How can the old fossil be rejuvenated? Is there any process by which it can be electrified into life, or must it be embalmed, and laid quietly aside to make way for some new and vigorous successor, which shall be up with the times, and fully satisfy the demands of the new order of things? These are questions which must some time be answered; the pleading cry is for something to be done towards supplying the demands of modern education.

Professor Joy speaks truly and forcibly when he asks if anybody knows a school in the United States, "where instruction is given in science on a systematic plan, by teachers especially fitted for the work, and with well selected apparatus and judicious text-books? The custom of studying everything else but the world we live in, which has been handed down to us from our ancestors, has precluded the possibility of anybody being fitted to teach the natural sciences except the few who have had the energy and means to overcome every obstacle. The teacher in a preparatory school knows that the pupil can attend only a certain number of hours to get up his task or admission to college, and nearly all his time must be devoted to classical studies; there is no time left for science, and it is not taught. The controversy which this state of things has produced appears no nearer an end than it was years ago. The advocates of classical training will not yield an inch of ground, and the scientists are equally firm. It is a great pity some compromise could not be effected, as a knowledge of Latin and Greek aids greatly the scientific student.

"It has been said that the most ignorant members of community are the men of education; and after looking over the scheme of studies which the victims of liberal education are obliged to follow, the paradoxical remark would almost appear to be true. What the reform should be is difficult exactly to determine. There is a large class in community who would not banish Latin and Greek from the curriculum; but they would remove that study to a later period of the course, and replace it by scientific subjects. They think that those subjects which strengthen the powers of perception, observation, and judgment, should be taught first.

"They would instruct in the laws of health and physiology. They would have him know something about plants, animals, and minerals, and the commonest laws of chemistry and physics, so that if by chance the pupil is compelled to leave school at an early age, he would know how to take care of mind and body, and be enabled to turn what knowledge he had acquired to some account. The study of Latin and Greek might be commenced at a period when the mind was more mature. There are so many instances of persons who commenced the study of the classics at mature years, who have excelled all others, that the advocates of postponing languages to the latter part of a boy's course, appear to be justified in their claim. If the study of Latin and Greek could be commenced after the student enters college, it is believed that more real progress would be made in the four years college course than is effected under the present arrangement of devoting ten years of a boy's life to this study.

"This is the compromise that many good men advocate. They wish the preparatory schools to be given up to mathematical, scientific, and English studies, and have the colleges assume the charge of the classics, and have them demand a knowledge of the general principles of science as a requisite for admission to college. This would be turning the tables entirely, and would afford scientific men a chance to try the effect of modern education.

"The other side have had it all their own way for a long time, and it is no more than fair for people of different views to have a chance. It would demand immense moral courage on the part of the trustees of a college to propose such a radical change, and would expose them to the cry of lowering the standard of study. They would have the alumni of existing institutions, and the prejudices of the community against the new order of things. The scarcity of competent scientific instructors has been a great obstacle to popularizing the sciences, and until the supply exceeds the collegiate demand for such teachers, the want will continue. The hope is not dead, that science will yet be taught in plain English."

Technical journals, far and near, ought to put a shoulder to this great revolutionary wheel and keep it rolling. The whole army of working men should give a prodigious lift to push it on; for the good to be accomplished is especially theirs, securing as it will to them and their children, advantages which cannot but contribute largely toward ultimately placing them in a position above mere muscular laborers.

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Little Faults in Watches.

None see so plainly, or feel so keenly, the need for reformation of many little errors in the manufacture of watches, as the practical watchmaker—minute errors which do not really vitiate the performance of the watch, but which will ultimately work detriment to their sale, so soon as other goods are put upon the market free from these minor defects. These little details in construction annoy the retailer, and, if corrected, would appeal powerfully to his judgment in selection of stock for sale. The mention of a few of these errors will indicate the direction in which they lie, and if it lead to their correction, would be a valuable service to the trade.

Steady pins, as formed on cocks and bridges, particularly in foreign watches, are exceedingly troublesome, and the occasion of much damage to the appearance of the movement after a few times putting up and taking down. In many instances they are three times the necessary length, going nearly through a thick plate, and fitted so tightly that it requires considerable force to remove the cock, and which must be applied by a screw-driver, or other sharp instrument, at the risk of mutilating the frame. In replacing a cock or bridge, still greater risk is run; the cock will not go down to its seat without violent pressure—the pivots cannot be guided into the jewel holes until it is nearly down, and the force required to do this makes it impossible to tell whether the pivot is entered or not; if not, the jewel is either forced out of its setting or broken, or the pivot bent or broken. These, and other dangers and inconveniences, could all be remedied by making the steady pins short and conical. These pins are not designed to hold the cocks and bridges *down;* their office is simply to prevent lateral shake; and if they perfectly fit their respectives holes when the sole of the cock and the surface of the plate are in contact, or nearly so, it is sufficient. (See Mr. Grossmann, in a communication to the Journal, p. 243, Vol. II.)

There is another error in construction which causes more annoyance to the repairer than any other little one in the long catalogue—namely, screws. The error in form is not so great in American and English screws as in those made on the Continent. These screws, for the most part, are very long and thin, with large heads, which fit into a very deep recess in the cock, bridge, or wherever it is used, and very often the screw-hole in the plate is not concentric with that in the cock. In all such situations, the head fitting closely in its recess, there is a lateral strain upon the screw, which eventually breaks it off (being hardened) at the surface of the plate; and the vexations attending the removal of such a broken screw (quite small, and hard, and extending through a thick plate) are certainly very annoying.

Then, again, the thread of the screw is run up to the shoulder, offering every inducement to the screw to break at that point, particularly when the screw-hole is not perpendicular to the under surface of the screw head, which is often under-cut, compelling the screw head, when the screw is forced home, to touch on *one side* of its extreme diameter, thereby causing it to break.

A correction of this difficulty ought to claim the attention of the manufacturer; to make them properly is no more expensive, and perhaps less so, than as now made. Let the recess for the head be only of sufficient depth to allow the necessary strength of metal below the slit in the head; let the bearing shoulder underneath be as slight as possible, and the body of the screw from that point be a taper down to, or nearly to, the sole of the cock, and from there let the screw thread commence and extend as deep in the plate as is thought desirable, and temper to a degree that will permit them to be drilled, in case of their being broken off in the plate. A watch fitted with such screws, and proper steady pins, will be a source of comfort to the repairer during its whole existence.

The depth to which the wheel teeth are cut is often a source of mischief. In some American watches the leaf of the pinion they drive does not reach more than *half way* to the bottom of the space between the teeth; in fact, the web of the wheel is less in width than the length of the teeth. Such an error can only be accounted for by supposing the machinist who constructed the wheel-cutting engine was proud that it made such a nice, smooth, deep cut. Of course it was no business of his whether the tooth was right or wrong. The girl or boy who run the machine knew nothing of its proper office, and the officers of the Company were too busy advertising their products to attend to minor details. These long, narrow teeth, particularly in the centre wheel, are liable to become bent or broken, either by carelessness in winding, or by recoil when the main-spring breaks.

Why Swiss manufacturers will persist in suspending the going barrel from a bridge, is a profound mystery; the very little gain in space is no adequate offset to the endless catalogue of troubles this method entails upon the repairer. The teeth in the solid ratchet and arbor are as liable to strip, or to break one by one, as in a detached ratchet; and when that accident does occur, the difficulty of repair is vastly greater. The very small and necessarily short screws which secure the suspended barrel in its place are soon worn out by their repeated removal whenever it is necessary to repair or clean the watch, they being obliged to sustain the whole force of keeping the main wheel upright, which is a service they are wholly inadequate to perform safely. The labor and consequent expense necessary to replace a solid arbor and ratchet, when damaged, should be a perpetual bar to their production, even were the arrangement as good and as cheap as some other. Another serious objection to this form is the difficulty, and often utter impossibility, of removing the main wheel when it and the centre wheel run very near each other, without removing the centre wheel, which necessitates the removal of the hands and dial. To constructors these things may seem trifles, but trifles are especially vexatious when there is no necessity for their existence.

The position in which the half-head holding screw is placed by many makers is a fault which would seem easily remedied. It should never be near the balance, lever, or escape wheel, because in getting the movement in or out of the case more or less force is required, and when the slots in these screw heads are shallow the force required to move them requires a good-sized screw-driver, for which there is not sufficient room when this screw is near the escapement, for, even with the greatest care, a slip will sometime be made, to the imminent danger of the fragile parts which lie in that vicinity.

Of all the foolish things which American watch companies have been guilty of, the most absurd is in substituting for the good strong old-fashioned ratchet and click, a small, inefficient, trifling contrivance, sunk into the plate, leaving plenty of unoccupied space between the dial and plate for an honest, substantial click and ratchet. There can be no possible reason for this substitution, except it be the fancied necessity to have something new and different, a change simply for the sake of a change. Instead of studying for and finding some device better than the old, they have found and adopted a plan far worse, forgetting that old things are not necessarily bad, neither are *new* ways always better than the old.

There is very little hope, however, that the mention of defects of construction will correct them, competition being the most effective stimulus to improvement. So long as every American watch looks like every other, and the faults of one are as faithfully copied as if they were points of excellence, and so long as the performance of any one has no marked superiority, so long will the heaviest bank account, and the "loudest" advertising agent win the race for public favor. The establishment of the JOURNAL has brought about an extended interchange of sentiment between practical watchmakers, which unmistakably indicates that whoever puts upon the market a movement free from these obvious defects will as certainly secure the largest share of trade as that practical dealers are painfully aware of present imperfections. It remains to be seen who will reap the golden harvest.

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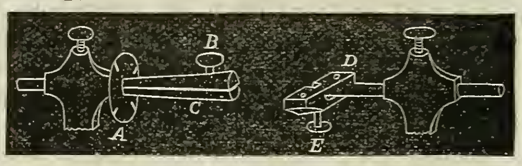
Tool for Squaring Arbors.

The following cut represents a tool for the purpose of perfectly squaring up a winding arbor by the use of a common flat file and burnisher. A split spring arbor, C, fitting into the head of the common bench lathe, the jaws of which close by the set screw, carries upon it an index plate, A, its periphery divided by shallow radial slots into four equal parts. The guide rest D, with a cross head, which the diagram fully represents, fits into the opposite lathe head, and is fastened in



position by the set screw. This guide rest may be made of brass, being easily wrought. In the flat face of the cross head insert three hardened screws, flush, or nearly so, with the surface, to insure perfect flatness in using the file.

To use this tool, place the arbor to be squared in the notch to receive it, elevating it by the screw E so that it barely touches the file; turn the index plate so that one of the cuts touch upon the edge of the lathe rest, then screw the jaws down securely upon the pivot of the winding arbor, and secure the whole in position by the set screws. The arbor is now firmly in position, so that the first side of the square can be filed and burnished. To do the next square, pull out the rest, loosen the dividing arbor revolve the square, and bring the next slit in the index plate to the face of the rest; secure it in position as before, and file and finish the second square, and so proceed with the four sides, thus doing a job in a short time that will excel simple unguided hand work.

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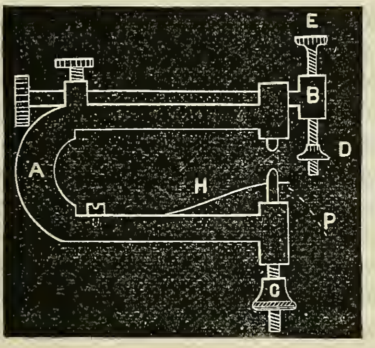
Tool for Measuring Cylinders.

The accompanying cut represents a tool for getting the exact position for every part of a cylinder when it becomes necessary to replace one, made by Mr. E. T. Child, Hamilton, Bermuda. The drawing is full size, A representing the solid frame. Through the two projections on the top runs a round slide bar, the head of which, B, is tapped for the



screw E; this bar is fastened in place, as the drawing shows, by a small set screw On screw E is a small nut, D. Through the end of the lower arm of the tool is a smooth arbor, P, the lower projecting end screw cut, the nut, C, running on it; this centre is kept drawn up against the nut by the spring H, the end of which passes through a hole in the arbor The upper end of this arbor is formed into an obtuse conical point, of such a shape and size as to rest easily in the jewel hole. Exactly vertical to this conical point is a fixed similar cone.

The tool is used by placing the conical points in the cock and foot holes; adjust the spring arbor P by the nut C, so that on removing the tool it will resume again the same position; the distance between the extreme points gives the extreme length of the cylinder and pivots, which measure can be transferred by calipers or otherwise. When the tool is in place, adjust the slide bar B so that the screw E may be run down to barely touch the arm of the escape wheel, which will give the limit to the lower slit in the cylinder. The nut D can then be adjusted to the top of the escape wheel tooth, which will determine the position of the upper cut of the cylinder; which measurements can at once be transferred to the cylinder in the lathe, which will thus determine the position of the pivots and shoulders. In the same way may be got the height of the balance shoulder, entirely doing away with the necessity for continued trial of the "rule of thumb."

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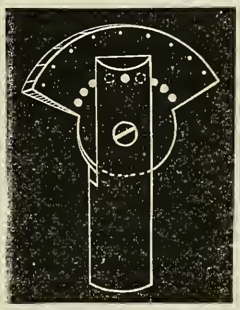
Pivoting Rest.

In the following diagram is represented an adjunct to an American lathe, as a substitute for the "Jacot." It is placed in the stock of the common rest, and adjusted to height and



position by the usual set screws. The circular rest is let into the slot, and turns upon the set screw in its centre, so as to bring any of the pivot holes opposite the lathe centre. It is made of hardened steel, with a series of pivot holes graduated to correspond in size with polished notches on the face of the rest, which is held firmly in position by a steady pin fitting through the stud and corresponding holes in the disk. The holes through the rest are deeply countersunk on the reverse side to receive the shoulder of the pivot when centring or drilling, or in place for rounding up; it is also made thin toward that part for producing small and short pivots. The pinion or staff must be carried by a dog when finishing pivots by this method.

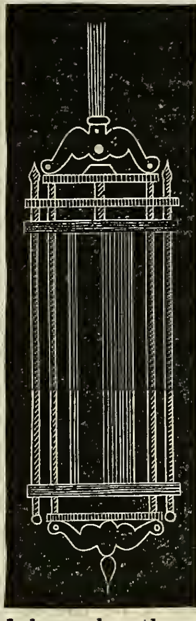
The pivot file and burnish, if used, or the metal polishing bar, can be kept exactly parallel to the axis of the pivot by fixing in the opposite lathe head an arbor with an eccentric nose upon it (hardened), and so fastened in place as to support one edge of the file while the pivot being operated upon supports the other, thus preserving parallelism between the face of the file and the pivot; in effect producing a pivot equalling in every respect that finished upon the Jacot lathe.

A few more Words about Pendulums.

EDITOR HOROLOGICAL JOURNAL:

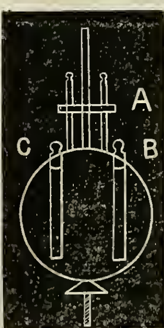
Almost every workman has his own arrangement of apparatus for the fine adjustment of the amount of mercury necessary for each individual pendulum, as the steel will always differ in density, and the jars will ever differ in size. By the way, if any of your readers would be kind enough to inform the craft where these jars can be bought, he would, no doubt, confer as great favor as to tell how much mercury each required when adjusted. I found great difficulty in obtaining a jar this summer, and when I succeeded in getting two from Messrs. Terhune & Edwards, neither of them pleased me. After a great deal of unnecessary twaddle about the difficulty of getting good jars, and a charge of some seven dollars for the two, one of which was totally unfit for anything of a *time-piece*, I received them, and made a pendulum to suit, the design of which I send in this communication. I employed, as you will notice, Reid's method of raising the jar for regulation, with the exception that I think mine a more symmetrical arrangement of rods. You will notice that I have let the ends of the rods project beyond the cross-pieces a short distance, for the sake of ornament. This additional weight affects the adjustment so little as scarcely to be perceptible in several months' running. I have tried three different pendulums before I was satisfied with the performance of the clock. The first was a gridiron of my own construction, consisting of the usual number of steel and brass rods, and having the ball constructed somewhat different from the usual style. I attached the usual lyre to the ball to prevent "wabbling" upon the rods. I suspended the ball from the point A, and, with a plumb-line, drew the line A E; then from the point B, drew, in like manner the line B F, which gave, at the intersection of the line C, the centre of gravity, at which point I fixed, on the inside of the ball, a small piece of brass. From this point, and causing the ball to rest upon it, I placed a well-shellacked wooden tube, which projected below the ball about one-fourth of an inch. Through this the middle rod of the pendulum ran, raising or lowering the pendulum bob by the screw, D. I then compensated for the whole length of the pendulum rod. This was as nearly correct as I could make it.

The irregular expansion of the metals made some little inaccuracy, but this was very slight. The rods were carried through the upper cross-head, and likewise through the lower one; and, although I adjusted the distance from the cross-pieces to the ends of the rods as nearly as I could, so as to preserve the due proportion of their squares along the pendulum rod entire, yet, with all my care and calculation, the expansion and contraction of the rods was continually changing the centres of oscillation and of gravity, so that in the end my experience bore testimony to the truth of the theory, that a gridiron pendulum cannot be constructed so as to be in all circumstances mathematically correct. It would seem that if the theory could be maintained in a gridiron pendulum, that the entire weight could be concentrated in the point of oscillation, so that the centres of gravity and of oscillation be identical, that a metallic solid would be the proper material with which to compensate for the changes of a solid of the same order. All metals in a solid state contract and expand by "jerks." This is illustrated by a very familiar fact. Any one noticing a thin-plated stove in particular will hear very frequently a noise as if the plates were cracking, as the stove is being heated up; and the same phenomenon occurs when the stove is cooling. This arises from the expansion and contraction of the plates changing position suddenly in the joints. According to the known difference in the density of steel, every rod must be compensated individually, and every one has its own peculiar increment of heat necessary for the "jerk" of expansion and contraction. The "jerk" of expansion is not synonymous with the "jerk" of contraction, nor do they both, in all cases, require the same increment of heat. On the application of heat, the ratio of *spasmodic* expansion at one time will differ materially from that of another. Density and quality will affect this peculiarity of steel; but as yet no one that I know of has been able to reduce these "jerks" to a regular law. This peculiarity affects every metal, and I might say every piece of metal differently. Those metals which expand most with the same degree of temperature, do not, in this respect, expand or contract in a regular ratio with those which expand least. In proportion to the molecular attraction in metals will be the ratio of these spasmodic effects of heat. I need not pursue this line of thought, however, as your intelligent readers will at once see that the expansion of brass to compensate steel is open to even graver objections than that of mercury. And as I do not desire to swell this communication beyond due limits, I will simply say that I obtained fine results, but not satisfactory to me. I next tried the West Point plan of the pendulum on the turret clock, which has done so admirably. The arrangement of this, by calculation, in getting the length of the wires for expansion, the proportion of the balls, and the place at which to fasten the compensating ball, I found to be a very neat affair. After spoiling a great deal of foolscap I got it up, and after thorough trial, came to the conclusion that it was a most excellent thing for a *turret clock*, or a *recoil escapement*. Then I came down to the old mercurial plan, and, after making three drafts, I hit on one that I thought neither too ornamental to affect its time-keeping qualities, nor too plain to be in keeping with the case. I first tried a round rod, as I did not have a flat piece of steel on hand, but found that the very slight springing of the rod affected the rate of the clock, and set me to thinking. I thought at first, as this springing would almost be uniform, that this was a strange defect in rate; but, on after thought, I found it according to known laws, and not so very mysterious. The changes of temperature affected the rigidity of the metal, and enlarged or contracted this damaging curve. The very slight effects of temperature on the train, in the pitch, bearings, and oil, had in this thing a remarkably minute indicator; all the more minute by the rod being a very fine piece of steel. I substituted a flat rod of Stubbs' steel, and am now making fine adjustments. I here give you the design of the pendulum. I have made a new arc of ivory,



and am about placing a cup upon the weight in order to add shot or other small weights in order to keep up regularity of pendulum spring, as occasion may require. When, however, the arc of vibration should be lessened one-eighth of a degree, the clock should be carefully cleaned, and the old oil removed, as adding to weight for impulse after that is only injuring the clock. You will see in the diagram that I have the advantage peculiar to the Howard pendulum, of having a rigid rod the whole length of the pendulum, by the way in which I have the mercury attached. Almost all of the pendulums in use might as well have the pendulum stirrup hung on a hook at the base of the rod as to be attached in the way they are. In my former communication I gave the reason for this rigidity, in stating the varied momentum of the upper and lower halves of the ball. The result of these loose points will be to give a damaging angle instead of an even less damaging curve by an elastic pendulum rod. This may be very slight; but slight things affect seconds; and when that slight aberration occurs every second, it becomes a serious thing in the course of a day or a week.

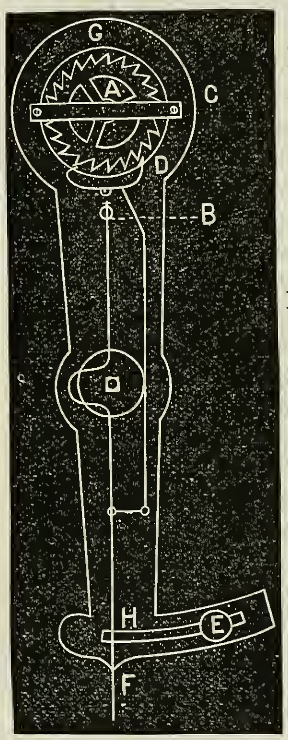
I still believe that a wooden rod, properly compensated, comes most nearly to the mathematical idea of a true pendulum. If a wooden rod were used, and a ball of glass with tubes for mercurial adjustment, something like the accompanying diagram, I think very fine results might be obtained.



Let A be a small cross-piece of wood fastened to the pendulum rod, in which two small wires might slide, in order to prevent the "bob" from swinging out of position.

Let B and C be two holes made in the glass, or, if the "bob" be steel, bored in the steel in which to put the mercury for compensation. When I have opportunity, I mean myself to test this thing. If any of your readers feel like trying the plan, as I don't wish to patent it, they are at liberty to do so.

My attention has lately been directed to the feasibility of so arranging a clock as to make it very easy for any one to put it in beat in a position *approaching* the perpendicular. As very few people have educated ears, very few people have their clocks in proper beat, unless those clocks have been put up by professional workmen. This attachment would only be applicable to such time-pieces as are in use by persons who wish only approximate time. Any plan which has in view the moving of the pendulum stud alone, must be rejected as unscientific and injurious to time. I therefore hit upon the following expedient:



Let A be the escape wheel in a Yankee clock; let B be a piece of brass, which can be cut at one stroke; let C be a piece of brass riveted or screwed on to B, holding the pivot hole for escape wheel; let the verge be fastened to plate B; let pendulum stud be fastened to B, as science and convenience would suggest. (Science says that centre of verge motion should be *point d'attache* of pendulum rod.)

Let the plate B move on a flange in the hole of the top plate through which the escape-wheel plays, so that its centre of motion will be the centre of escape-wheel; then it will be seen that when the clock is put in correct beat with the index point, F, put behind the pendulum wire, at whatever angle the clock may be placed when the index, F, is put behind the pendulum rod again, the clock is in the same beat. This change is only limited by the slot H, or other impediments to motion of the plate B. When adjusted, the plate should be firmly fastened by the thumb-screw E, which should be just below the face of the clock, or perhaps be on the lower edge of the face. One more improvement I think could be made in Yankee clocks, if the manufacturers will persist in making such a distance between the verge pivot and pendulum stud, and in consequence create so much unnecessary friction on the pendulum wire. Let the verge wire be connected with the pendulum rod by a link, as follows:

The diagram explains itself.

I have used this link very successfully on wooden pendulum rods. It makes a more regular beat and arc of vibration, where there is variable friction, and has the advantage of giving a regular impulse from the clock movement. But this communication has assumed enormous proportions. I am now engaged in trying a new transit instrument, very cheap and simple, by the way, and may give you a few words on *getting* true time, shortly. J. C. Hagey.

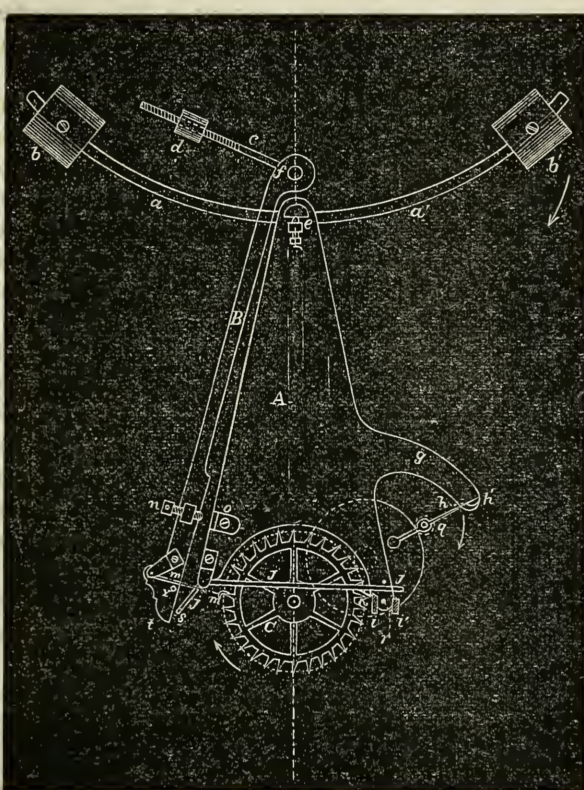
Jarrettsville, Md.

Experiments like these, by our correspondent, are always acceptable. If not in themselves satisfactory to the experimenter (and they usually are not), they may convey useful hints to others, which may possibly result in advancement; at least, they may save some one else a long and tedious jorney over the same road. Hints have in the past led to wonderful conclusions, and who can say that in the future equally great results may not follow the mere mention of a fact? Experiments, whether successful or not, are always instructive, and, if communicated in the proper spirit, through a medium accessible to those who are interested in the particular department to which they pertain, their influence for good reaches those who most need the very facts the experiments go to establish.

A New Gravity Escapement.

EDITOR HOROLOGICAL JOURNAL:

Notwithstanding the great variety of forms which have been given to the gravity escapement since the days of Hardy and Berthaud, the changes seem by no means exhausted. The principle of using a constant weight to drive a pendulum, independently of the train, and thereby eliminating the errors incident to the construction of the wheel-work, is so attractive in itself that it has engaged the attention of many of the first scientific men of our age, for whom an ordinary piece of mechanism would have no charm.



During a recent visit to New Hampshire, I saw running at the Observatory of Dartmouth College, a clock with a gravity escapement, the invention of Prof. Chas. A. Young, whose name is prominently connected with many of the recent spectroscopic discoveries relating to the constitution of the sun.

As the clock has performed remarkably well under severe scrutiny, though the wheel-work is only that of an ordinary old-fashioned eight-day clock, and the workmanship of the escapement itself by no means unexceptionable, moreover, because it is actually in operation and not merely a "design," I thought it would interest the readers of the JOURNAL, and so have prepared a drawing and a description of it.

It must be premised that the impulse is given to the pendulum in only one direction, which Prof. Young, as well as Bond, Airy, and other high authorities, consider of no practical consequence; and also that the clock has an excellent gridiron pendulum. In *principle* the escapement is identical with that of Kater, and is closely analogous to others invented by Bond and by Tiede, but differs from them all in requiring no especial accuracy of construction to secure its perfect performance.

The drawing is about half size. The escape wheel C is the same which belonged with the dead-beat escapement with which the clock was originally constructed. A is the locking arm, having at its upper part two horns *a* and *a'*, on which slide weights *b b'*, admitting of adjustment so as to put the system consisting of the arms A *a a'* in equilibrium around the conical points *e*, on which it turns, with a *slight* preponderance to *b'* in the direction shown by the arrow. This whole system is made somewhat heavy, so as to have considerable inertia, an essential quality in this type of escapement.

The arm A also has on the right side an arm *g*, which carries at its outer end the locking jewel *h'*, and the check *h*. The lower end of the arm A is forked and the right hand end carries a pin *r*, which plays between two stops *i*, *i'*, which are attached to the front plate of the clock and serve to limit the motion of the arm. The left hand end of the arm carries a delicate bent lever *j*, *j*, *j*, about as light as an ordinary sewing needle, and which Prof. Young calls a "trip-guard;" this lever has near its right hand end a tooth *k*, which, when the arm A is in its locking position, drops behind the stop *i* and prevents the arm from being displaced either by an irregular force in the train or by any sudden jar from without. At the lower left hand extremity this lever is bent towards the spectator in such a way that it may be struck by the arm B. This movement raises the other end lever and throws the tooth *k* clear of the stop *i*, leaving the arm A free to move.

A little behind the locking arm lies the impulse arm B, and attached to the same axis *f* is an arm on which is an adjustable weight *d*, for varying the impulse given to the pendulum, and there is also another arm laying behind B and parallel with it, which acts on the pendulum in the manner usual in this class of escapements. The arm B has near its lower end a screw *n*, for acting on the stop *o*, on the arm A, and still lower down it has a lever *m*, *m*, by which the scape-wheel is enabled to lift the arm with little or no friction, as Harrison gave the impulse in his escapement.

To diminish the friction of unlocking, the wheel C is connected to a train of two wheels, the last of which makes one revolution for every tooth of the scape-wheel. The last axis of this train carries the poised pin *q*, the long end of which is bent backwards at a right angle, and engages with the locking jewel *h′*.

So much by way of explanation ; now for the action.

Suppose the parts to be in the position shown in the figure, the pin *q* locked by the arm A, through the instrumentality of the jewel *h′*, the arm itself held in position by its preponderance and protected from disturbance by the "trip-guard" *j*, *j*, and the impulse arm B raised and held in position by the scape-wheel C. The pendulum swinging towards the left, raises the arm B until the forked end of the lever *m* drops off the point of the supporting tooth of the scape-wheel and rests on the pin *v*. Having completed its excursion to the left, the pendulum, in returning, carries the arm with it until the lower end *t*, touching the tail of the "trip-guard" *j*, *j*, lifts it clear from the stop *i*. Immediately after, the screw *n*, striking the stop *o*, meets the resistance due to the inertia of the arm A, and its attached weights. This momentarily checks the motion of the impulse arm and allows the pendulum to leave it, after which the weight of B, acting upon A, moves it towards the left, and unlocking the pin *q*, allows the scape-wheel to turn ; then the tooth, catching the end of the lever *m*, lifts the impulse arm B, and the locking arm A, relieved of the extra weight, resumes its original position, the trip-guard drops into place, and all is ready for another movement. Were it not for the trip-guard, which is really the characteristic feature of the invention, it would be exceedingly difficult to prevent the pin *r* from rebounding from the stop *i*, and thus unlocking a second tooth.

Such is the action of the escapement, which may, at first sight, appear a little complex, but whose certainty of action and ease of construction leave nothing to be desired.

It will, of course, be noticed that in constructing this escapement with new materials, it might be considerably simplified, as by putting the scape-wheel and arms outside of the plate, and by giving three or five teeth to the scape-wheel. Being constructed with the movement of an old clock, the garment had to be "cut according to the cloth."

As will be noticed, the impulse arm is utterly independent of the train while the pendulum is in contact with it, and it is only after the pendulum has left it that the unlocking takes place, consequently no imperfection of the train or variation of the driving power can by any possibility affect the pendulum.

To show that such is the case, the following statement of performance under varying weights is appended:

1869.	Error.	Daily Rate.	Weight.	Remarks.
	s.		lbs.	
Feb. 17.	— 2.86		16	Arc 2° 25′ sensibly unchanged throughout the whole trial.
" 20.	+ 0.72	+ 1.193	16	
" 25.	+ 6.10	1.076	24	
Mar. 2.	11.62	1.104	30	
" 6.	16.32	1.175	30	The outstanding differences of rate are largely due to Barometric changes.
" 11.	21.66	1.068	40	
" 13.	24.13	1.235	54	
" 16.	27.81	1.227	54	
" 20.	32.46	1.162	16	
" 24.	37.53	1.267	24	
" 27.	42.10	1.142	60	
April 3.	50.83	1.247	16	
" 7.	55.80	1.242	30	April 16, cord broke, putting an end to this trial.
" 10.	59.40	1.200	70	
" 15.	65.54	1.228	70	
Mean		1.200		

The error of the clock was determined by observations of stars with the transit instrument, and may be relied on to the nearest tenth of a second.

ALFRED BLAISDELL.

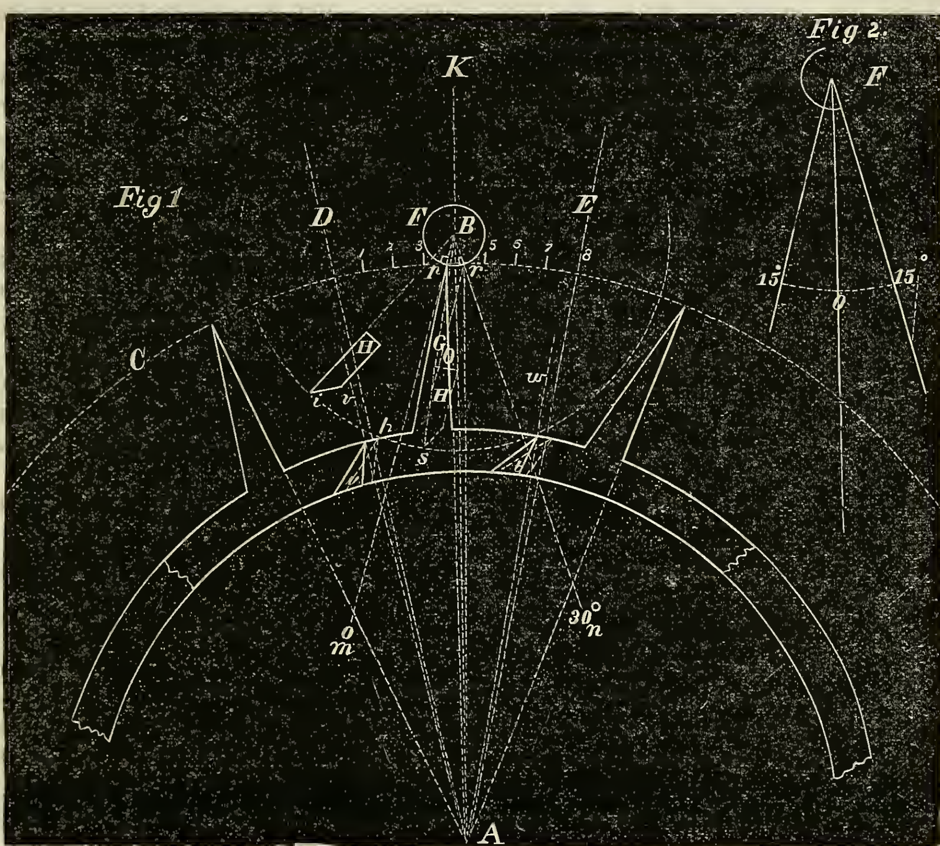
Brooklyn, N. Y.

The English Duplex Escapement.

Editor Horological Journal:

Some time since I saw in the Journal an inquiry made by a correspondent, how to determine the size (diameter) of the roller jewel in a duplex escapement. If you will allow me the space, I will try to show how the diameter of a roller jewel and centre distance are determined, also how the entire escapement is drawn, based upon scientific principles.

First.—It becomes necessary for the workman who desires to do accurate work, both scientific and practical, that he be provided with a set of good measuring instruments, such as have been described in previous numbers of the Journal, based upon the metrical system, for without such he is like a ship at sea without a compass. The correct way to draw an escapement is a very important object, especially for those who would like to give a solid and rational base to their endeavors in this part of watchmaking; and



for most persons the graphic way is the most convenient.

For making a good and accurate drawing of an escapement, and to make the necessary rules very plain, the escapement is drawn much larger than the natural size, because the lines of very small angles, as for instance 1° or 1½°, would nearly coincide if not drawn up to a certain length. Most of the diagrams are made with a radius of the scape wheel = 100 to 300 mill., which is convenient for the drawing, and also for the reduction of sizes.

The diameter of the star-wheel in the drawing = 200 mill., and the proportional diameter of the impulse-wheel to that of the star-wheel is as 5 to 7, therefore = 142.86 mill. The wheel is divided into 15 teeth.

The diameter of the roller jewel is ¼ the distance between two teeth. The roller jewel is so placed that the star-wheel in passing must move it (the roller jewel) 30°. When the tooth drops, the tooth of the impulse-wheel, which then comes into action, will have a fall of 10° upon the impulse pallet, and will move the impulse pallet from 30° to 35°

Draw a circle, C, with a radius of 100 mill., in which the points of the star-wheel teeth are lying, and trace the line of centres, A, K. From the centre A draw the impulse circle, the radius of which = 71.45 mill.; then, by the aid of a good protractor, from the centre of the wheel A draw two lines at a distance of 24° (= to the distance of the points of two teeth), one 12° to the left of the line of centres K, and call it D; the other 12° to the right, and call this E. These 24° divide into 8 equal parts upon the periphery of the star-wheel C, which gives, in the drawing, the proportional diameter of the roller jewel, and which also can be found in the following way:

The diameter of star-wheel in the drawing = 200 mill., and the diameter of any circle is to the circumference as 1 to 3.1416; therefore the circumference of the star-wheel = 628.23 mill.; this circumference divided by the number of teeth in the star-wheel (15) gives us 41.89 mill. as the distance from the point of one tooth to the other; consequently, $\frac{41.89}{4} = 10.47$ mill., which will be the diameter of the roller jewel.

Now, in order to find the centre of motion for the balance so that the star-wheel produces a leverage of 30° upon the roller, draw a circle equal to the diameter of the roller (10.47 mill.), Fig. 2; draw by the aid of the protractor the 30°, and transfer them (where the lines cross the circle F) to the periphery of the star-wheel, exactly at equal distance on each side of line K. From this point denote the radii of the roller jewel on the line of centres K; thus you find the centre of motion of the balance B. Now extend the lines *m* and *n* from the point B, which embrace the 30° of roller action, and draw the circle of the roller F. From that point where the line *m* crosses the circle F (the roller) and the periphery of the star-wheel C, draw a line O to the centre of the wheel A, and you have the front or acting face of the tooth G; then from the centre A at a distance of 24°, 12° on each side of line O, draw lines *v* and *w*, which will give the points of the teeth of the impulse-wheel. These teeth must have an inclination of 17°. The position of the teeth determines the length of the impulse pallet H, as it (the pallet) must pass the point of the tooth *t* freely. According to this measure the impulse pallet must be 37 mill. long.

The proper position of the impulse pallet so as to produce a drop of 10°, is found by turning the wheel until the point *p* of tooth G, reaches *r*, and is about to drop off the roller; at this time the tooth *u* of the impulse-wheel will have reached *h*, and so the impulse pallet H must be 10° in advance of the tooth; therefore it follows that the latter will have its proper position at *s*, and must have its position at *i* when the tooth G begins to act upon the driving plane (or slot) of the roller. Consequently, the driving plane of the impulse pallet H will form an angle of 27° with the driving plane (or slot) of the roller, which we find by the line *m*. The slot in the roller must be sufficiently large to give the point of tooth G perfect freedom when on the line of centres K.

The drawing is not intended as a working model, but only to give the student a general idea of the necessary angles in drawing a Duplex Escapement.

E. B. Nicewaner.
Baltimore, Md.

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A Few Words on Friction.

Editor Horological Journal:

An inquiry in the October Journal, signed "Dynamics," in regard to an item of mine, previously published, on Isochronous Pivots, naturally calls for an answer. One most extraordinary statement of that writer has changed the nature of the answer asked for, from the record of the results of two or three common experiments to a few words in regard to the principles which underlie the whole matter. His statement to which I allude is as follows, viz.:

"In mechanical philosophy it is asserted that it is not the amount of surface that causes friction, but the amount of weight or pressure that bears upon the surface.

"Consequently, within moderate limits there is the same amount of friction in short pivots as in long ones if the weight or pressure on the pivots be the same in all cases."

Now, it is a well-known rule in logic, that if the premises are false the conclusions must be false also.

There is no work on philosophy, within my reach, that makes the assertion quoted, and I would not believe it if there was, for I know better than that from my own knowledge. On the contrary, the reverse is expressly stated, that friction is increased by increasing surfaces in contact as well as by increasing the weight, as will be shown by quoting a few lines from the first work on Natural Philosophy that I took up. As to the conclusion he arrived at, that "there will be the same amount of friction on the balance pivots in whatever position the watch may be placed," etc., the contrary has been repeatedly stated by inference in the Journal, and provision made for lessening the friction in the vertical position by cutting the sides of the jewel holes convex, and *altering* the *bearing surface of the pivots*. The reader will refer to the valuable articles by the Editor, on page 12, Vol. I.; by Mr. Spiro, page 58, Vol. II., and by "Horologist," page 107, Vol. II. It will also be noticed, on reference to my item in the August Number, that I did not claim very much for that simple process. In the few experiments that I made on rather common watches, with deep jewel holes and large pivots, in each case the friction in the vertical was reduced to less than in the horizontal position by cutting away the surface of the pivots at the ends next the shoulders, and by making the ends flat, or nearly so. Their rate was changed from 90″ to 120″ gain in 12 hours in the horizontal, and to from 10″ slow to 10″ fast in the same time. No alterations were made in the springs, nor were the watches tried in more than the two positions. The results were certainly quite satisfactory, and with but little expense to the owners. This process, whether valuable or not, is, I think, not original with me, but am under the impression that I heard of it from a watchmaker while on a visit to London ; and it was considered valuable only as it avoided the expense of changing deep holes for shallower, or the making of new ones with the sides of the holes convex. The very day I received the Journal containing the statement of your correspondent, "that it is not the amount of surface that causes friction," I had occasion to reduce the depths of the balance holes to an unfinished duplex clock, with a balance of 2¼ inches diameter, and was gratified to find an increase in the arc of revolution of 20° ; of course without altering the weight of the balance, although the increase of the arc of motion did not alter the time of the clock.

Parker's Philosophy states that "There are two kinds of friction, namely, the rolling and the sliding friction. The rolling friction is caused by the rolling of a circular body. The sliding friction is produced by the sliding or dragging of one surface over another. Friction increases as the weight or pressure is increased, *as the extent of surface in contact* is increased, and as the roughness of the surface is increased. Friction may be diminished by lessening the weight of the body in motion; by mechanically reducing the asperities of the sliding surfaces; by lessening the amount of surface of homogeneous bodies in contact with each other; by converting sliding into rolling motion; by applying some suitable unguent."

Both kinds of friction are to be found in watches. The rolling friction, which is produced by the motion of properly shaped wheel and pinion teeth, is found less frequently than it should be ; and the want of it, or rather the sliding friction which often takes the place of the rolling, is caused by the working of badly shaped teeth, and occasions great loss of power, and the rapid destruction of the pinions. In the fine verge watch, No. 1455, made by Morris Tobias, London (and sold in London to the father of the present owner, a resident of this town), the teeth are shaped with such perfect accuracy that there is absolutely no wear in their motion, although in constant use through three-quarters of a century. In fact the closest scrutiny failed to find any marks to indicate on which side of the pinion leaves the wheel teeth worked. This is a good example of the rolling friction. Almost every watchmaker has seen pinion leaves cut half way through in watches not over 25 years old. These are bad examples of the sliding friction in places in which it is not necessary to produce it.

The sliding friction is, of course, a necessary adjunct to the motion of pivots and other parts of a watch, excepting wheel teeth, and can neither be dispensed with nor avoided; therefore, it should be the aim of watchmakers to reduce it to as little as possible, which can be done in many ways. It is usually computed that one-third of the power of a machine is lost in friction; so that it can be readily understood how a watch badly executed will have a greater loss, and require altogether too large a share of the power of the spring in overcoming its own friction. Also, the repairer must know that nothing can be expected from a watch, no matter how well made originally, in which the holes or pivots may be worn or rough, the wheels or barrel touch the plates or each other, and the spring dry, and almost rusty. These things produce friction as sure as the day follows night, and must be remedied to make a watch serviceable, as this friction destroys the power of the spring before it reaches the escapement, and leaves nothing for the required impulse; and the adding of more power only makes a bad matter worse, by increasing the friction and hastening the destruction of the watch.

B. F. H.

Sag Harbor.

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Free Hooks for Main Springs.

Editor Horological Journal:

The busy brains of inventors seem to be ceaselessly at work upon new devices, and new applications of old ideas, or old ideas newly applied. Watchmakers are no exception, and almost every week witnesses the granting of patents upon alleged improvements upon some part of the watch.

To do away with the unequal tension of the main-spring, independent of the fusee, is, as all workman know and feel, a desirable thing to accomplish, and all progressive minds have given it more or less thought. Some have been so self-convinced of the good effects of their own arrangement for the purpose, as to venture upon the expenditure necessary to procure patents. Inventors seem often to be self-deceivers, and the intense desire to achieve certain results appears to prejudice their judgments, and almost to deceive their eyesight as successfully as the tricks in legerdemain.

I, too, have been experimenting, not only upon my own conceptions, but upon such inventions of others as chance to come in my way—my latest efforts having been upon main-spring hooks. Having been shown a recent patent (I think) of a swinging hook, which is the best name I can give it, I have been trying it in order to verify, if I could, the assertions of the inventor, which were that it equalized the force of the main-spring upon the going barrel. In the sample which he had, the test, by the adjusting rod, did show remarkable results; and although the philosophy of its action was not clear to me, I could not contradict results which I thought I saw, and so determined to experiment myself on the same plan. Taking a new large-sized going barrel and fitting into it an arbor, I cut through the solid head a slot radially from the inside periphery, toward the centre, a sufficient distance to reach to the mass of the spring when entirely coiled on the hub of the arbor. A right-angled hook was then constructed, the hook end turning down through the slot so as to permit the outer end of the main-spring to be attached to it, the other (or flat) part of the right angle lying on the outside of the barrel head and secured to it by a repose screw, which, of course, allowed the hook to swing the whole length of the slot when the spring was in place in the barrel and the outer end attached to this hook. On winding it fully up, liberty was given the spring to coil entirely upon itself about the arbor, the movable hook allowing the outer end of the spring to draw freely in toward the centre. This spring had $7\frac{1}{2}$ turns to completely wind it up. At $2\frac{1}{2}$ turns the hook commenced to draw toward the centre, and at the fourth turn it was resting against the mass of coiled spring in the centre.

I could discover no difference in tension, as was asserted, of the spring by this arrangement from that when it was attached directly to the barrel by the usual hook; but to be certain that there was no change of conditions, I arranged a bolt by which I could fasten the movable hook back against the inside of the spring box, thus converting it at pleasure into a stationary or movable hook. At the third turn the spring showed slightly more force when the hook was bolted back against the periphery of the barrel; when the rod was adjusted to the fourth turn, the difference between the two conditions of hook was not perceptible; at the fifth turn the force was very sensibly increased when the hook was fixed; the sixth turn was without any marked difference, and the seventh turn showed but trifling difference, if any. The spring experimented upon in this instance was a thin one and of a medium width (No. 16). The marked effect at the fifth turn may have been owing to some peculiarity of the spring instead of any *principle* of action; the spasmodic effect seeming to indicate some peculiar quality of the individual spring under experiment.

I next tried a very stiff spring of the same width. The free hook commenced to move toward the centre at $2\frac{1}{2}$ turns; at 3 turns there was no perceptible difference in the action of the spring, whether the hook were fixed or free; the fourth turn showed no perceptible difference; but the fifth turn again showed very perceptible increase of strength when the hook was fixed. This spring had only $5\frac{1}{2}$ turns, owing to its thickness. At the full $5\frac{1}{2}$ turns with the fixed hook, it showed considerably increased tension over the free hook. The first $2\frac{1}{2}$ turns seem not to draw very perceptibly upon the hook, the friction of the outer coils keeping the spring in place; from that to 4 turns the force comes upon the hook and the tension is inward; from there to the last turn the arrangement seems materially to modify the force of the spring. I ought to have said that the screw about which the hook swung was placed about midway between the centre and circumference of the barrel. The position in which it is placed may have some effect upon the results, and I shall make some experiments upon that point hereafter.

My next experiment was to secure to the outer end of the main-spring two round smooth pivots, similar to those used on some of the American watches. A slot was then cut from the circumference of the barrel-head toward the centre, not in a radial line to it, but at such an angle as to form an inclined plane, down which the pivots before-mentioned could slide (a corresponding slot having been made in the opposite head) toward the centre of the barrel. Upon trial I found this incline too steep; the pivots did not move till near the last turns of the spring, and then the slip down the incline was all at once. In consequence, two other inclined planes were cut at a less angle. On experimenting with this I found the outer end of the spring to commence drawing towards the centre at two and a half turns, the same point as it did with the swing hook, and from there till it rested on the mass of coiled spring the movement was quite gradual; the amount of force upon the barrel was, however, very little modified, in fact not so much so (apparently) as by the swinging hook. Undoubtedly the friction upon the inclined plane somewhat modified the effect, and the want of delicate indication by the adjusting rod failed to show minute differences of tension.

On the whole, the experiments did not develop any principle of equalization which would lead to the hope of any great results for good in that direction.

I feel safe in saying that dependence upon any adjustment of the main-spring for equal tension, with a view to equalizing the excursions of the balance, will be going a long way around to arrive at a near point. Isochronism of the hair-spring will more surely correct the errors consequent upon unequal impulse, as well as those occasioned by bad oil, the accumulation of dirt, change of position, or any other cause affecting the excursions of the balance.

Some more delicate indicator than the ordinary adjusting rod should be used, its inertia rendering small increments of force hardly perceptible; still, enough was developed, by even these crude tests, to show an advantage by this or some analogous arrangement in the last turns of a spring in the going barrel. All experiments with the view of equalizing the force of the main-spring will probably never give a result entirely satisfactory. The defects arising from unequal tension of the main-spring, as well as irregularities arising from bad oil, the accumulation of dirt, change of position, or any cause affecting the excursions of the balance, can be diminished, if not entirely remedied, by the proper adjustment for isochronism; whereas, by the adjustment of the tension of the mainspring, only a part of these errors can be eliminated.

I hope to live to see the day when the thick cloud which veils isochronism from the perception and practice of the ordinary workman shall be rent asunder, and thus a ready means be afforded for the better performance of watches of common quality.

J. G.

New Orleans, La.

Mr. Charles E. Rice, of the United States Watch Factory, has recently patented a method of attaching the outer end of the main-spring to the going barrel, which is simple and easy of construction, and seems effective and sure in its action. It is done by bending back upon itself about one-third of an inch of the outer end of the spring, which is easily done by heating it at the place where the bend is to be made. The end of the short piece thus folded back sits firmly against the hook in the box, or into a notch or recess cut in the barrel to receive it. As the spring is coiled around the hub on the arbor, the short piece binds sufficiently to allow the whole spring to coil upon itself. When the watch is fully wound up, the draw upon the end is not so sudden and severe as upon a rigid hook, and the liability of damage to the train by careless winding is said to be much lessened by this method of attachment.

—o—

Answers to Correspondents.

J. F., *Ga.*—Can recover the gold from his cyanide solution by using a piece of copper attached to each pole of his battery. After being in action for some time, the greater part of the gold will be deposited upon the negative pole, from which it may be removed mechanically, or by means of aqua regia (1 pt. nitric acid, 2 pts. muriatic). The metallic gold so procured may be fused into a button by melting in a crucible, with potash as a flux, or it may be recovered by placing the cyanide solution in a large vessel in the open air (as the fumes arising during the process are pernicious), adding sulphuric acid so long as any effervescence occurs. The precipitate must then be allowed to subside; pour off the clear liquid; the remaining precipitate must then be thoroughly washed in hot water, dried, and mixed with dry pulverized potash; then melt to a button in a crucible. Persons are often disappointed in the amount of gold to be obtained from old solutions; they frequently yield but very little. The usual method of working cyanide solutions is very exhaustive, much being taken from them, and but little supplied.

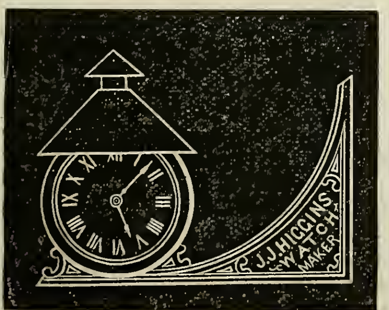
You can refine your old rubbish by mixing with it dry carbonate of potassa, and melt in a strong fire; remelt the button of alloy, and granulate by pouring it into a deep vessel of cold water while agitated by stirring. Still greater subdivision of the liquid metal will occur if the surface of the water be strewn with straws or small sticks. The alloy by this means is obtained in small grains. A better way is, if you have rolls, and the metal is sufficiently ductile, to cast it into an ingot or bar, and roll it into a thin ribbon—as thin as possible. Take this thin gold alloy, roll it up loosely—or the granulated alloy, if you prefer that form—place it in a porcelain or stone dish, and dissolve it in 2 parts nitric acid to 1 of water. The acid will take up the silver and alloy, leaving the gold as a gray powder. Pour off the solution, thoroughly wash the powder in hot water, and melt with potash or borax as a flux. The silver may be recovered by precipitating with copper; wash, and melt in the same manner as for the gold. The copper you can also precipitate by iron.

N. B., *Ind.*—1*st.* If you simply wish to select a ready made wheel to fit the pallets you have, you should place one tooth of the wheel against the locking angle of the outer pallet, and if the front of the third tooth goes in freely past the angle formed by the inner locking and the impulse planes, the wheel is the proper size. If you wish to *construct* an escape wheel for any determined pallets, you will find all needed instruction in an article on page 83, Vol. II. of the Horological Journal.

2*d.* Hair springs are made from flat steel wire especially prepared for the purpose, and are coiled into shape by being wound on an arbor between two face plates. A plate of a diameter larger than the coiled spring, is fixed upon an arbor, which projects through it sufficiently to allow another similar loose disk to be slipped on in front of it; this end of the arbor is slotted diametricaly at right angles down to the fixed disk. Four pieces of the spring wire are taken of sufficient length to each form a spring, the end of each being inserted in the slits in the arbor. The loose disk is then slipped on, which permits the wire to be wound upon itself, on revolving the arbor, without being displaced. This arrangement of winding makes four springs at one operation. If they are blued before the loose disk is removed, the form is preserved; that is, they do not spring open. By coiling four at once a rather open spring is produced; when three only are coiled together, a closer coil results if two, the interval between the coils is only equal to the thickness of the wire.

3*d*. There is no way to preserve the color of gold when heated sufficiently to hard-solder. Many applications are used for the purpose, with but indifferent results. Probably yellow ochre mixed with water to the consistency of a paste, and smeared over the surface, is as good as anything you can use.

J. J. H.—*Ill.*—In your inquiries about placing and illuminating the clock in front of your building, you did not mention the position, nor the number of dials you intended to put up. If you propose to place it at right



angles to the wall of your building, one dial facing up and the other down the street, your best plan would be to make metal dials (zinc); paint them white, with black hands and figures. The dials you can illuminate by a good sized coal oil lamp, placed above the clock and concealed by two reflectors, placed at such angles as to direct the light on each dial. Perhaps you could make the reservoir for oil *within* the upper part of the clock. Direct illumination shows much farther and more distinctly than any transparency. Glass dials are quite expensive, very liable to fracture by the heat when illuminated from the inside, and would be impracticable in your case, having no gas. The accompanying sketch will give you an idea of the arrangement, the details of the design of course being a matter of taste.

If you place the clock near the wall, you can get an excellent light on the dials by using a lamp on each side, placed in a niche in the wall, with the light directed upon them by concave reflectors, six or eight inches in diameter which are now in very common use for illuminating.

A. P., *Portsmouth, N. H.*—The error you detect in the compensation balance is inherent to all expansion balances, and its correction is called secondary compensation. It has long been known that when a compound balance is adjusted to a temperature of moderate limit, if the temperature be increased or diminished beyond those limits, the chronometer or watch will *lose* upon its rate; and if adjusted to extremes it will *gain* in the mean temperatures.

In the *Nautical Magazine* of 1833, M. Dent gave the following illustration of this peculiarity of the balance: "The diminution of the force of the hair-spring proceeds uniformly in proportion to the increase of heat, and may be represented by a straight line inclined at some angle to a straight line which is divided into degrees of temperature. But the inertia of the compound balance cannot be made to decrease quite so fast as the heat increases; therefore its rate can only be represented by a curve, and can therefore coincide with the straight line representing the variation of force of the spring in two points cutting the two extremes or the two means, or one mean and one extreme; in other words, adjustment can only be exact for some two temperatures for which you may choose to adjust it."

The correction of this error is auxiliary compensation, and a great amount of ingenuity has been displayed in the last few years in contrivances for correcting this error. The almost unnecessary extremes of temperature to which the Greenwich trials subject competing chronometers, have compelled the makers to give great attention to this point, and yet the recorded rates do not show any great progress to have been made towards perfection in this respect. The compound balance designed by Mr. Munger, and described in the Sept. No. of the JOURNAL, is worthy of trial for this correction, and should it prove successful, will be far more simple to construct than most of the plans now in use.

A. F., *S. C.*—There is no necessity for you to construct any particular tool for producing the square polished end on pinion leaves. There is no arrangement so well adapted to the wants of the repairer as simple metal disks, with which results quite satisfactory can be produced. All the appliance necessary is to prepare several metal disks for grinding and polishing, with holes through their centres a little more than large enough to pass the pinion arbor through ; apply to the face of the grinding disk a little stone dust and oil, and hold it against the face of the pinion with the tip of the finger, running the pinion by a bow and collet, the opposite pivot resting in the countersink of a lathe arbor. It is almost impossible to grind the face out of flat by this method. After being perfectly faced, polish with other disks, to which is applied polishing material in the same manner.

This plan of operating is so cheap and easy of application, that any one can successfully adopt it with but trifling practice.

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EQUATION OF TIME TABLE.

GREENWICH MEAN TIME.

For November, 1871.

Day of the Week.	Day of Mon.	Sidereal Time of the Semi-diameter Passing the Meridian.	Equation of Time to be subtracted from Apparent Time.	Diff. for One Hour.	Sidereal Time or Right Ascension of Mean Sun.
		S.	M. S.	S.	H. M. S.
Wednesday...	1	66.93	16 17 88	0.065	14 41 19.71
Thursday......	2	67.05	16 19.06	0.031	14 45 16.26
Friday.	3	67.16	16 19.42	0.003	14 49 12.81
Saturday......	4	67.27	16 18.97	0.038	14 53 9.37
Sunday.......	5	67.38	16 17.66	0.073	14 57 5.93
Monday.......	6	67.50	16 15.50	0.109	15 1 2.48
Tuesday	7	67.62	16 12.49	0.144	15 4 59.04
Wednesday. ..	8	67 74	16 8.63	0.179	15 8 55.59
Thursday.....	9	67.85	16 3.91	0.215	15 12 52.15
Friday........	10	67 97	15 58.33	0.251	15 16 48.70
Saturday......	11	68.09	15 51.89	0.287	15 20 45.26
Sunday.......	12	68.21	15 44.58	0.323	15.24 41.81
Monday.......	13	68.33	15 36.43	0.358	15 28 38.37
Tuesday	14	68.44	15 27.45	0.393	15 32 34.93
Wednesday...	15	68.56	15 17 63	0.428	15 36 31.48
Thursday......	16	68.68	15 6.97	0.462	15 40 28.04
Friday	17	68 80	14 55.47	0.496	15 44 24 59
Saturday......	18	68.91	14 43 15	0.530	15 48 21.15
Sunday	19	69.03	14 30.03	0.564	15 52 17.71
Monday.......	20	69.15	14 16.11	0.597	15 56 14.26
Tuesday	21	69.27	14 1.39	0.630	16 0 10.82
Wednesday ...	22	69.39	13 45.89	0.663	16 4 7.38
Thursday.	23	69.50	13 29.61	0.695	16 8 3 94
Friday........	24	69.61	13 12 56	0.727	16 12 0.49
Saturday	25	69 72	12 54 75	0.759	16 15 57.05
Sunday..... .	26	69.82	12 36.19	0.790	16 19 53.61
Monday.......	27	69.92	12 16 90	0.820	16 23 50.17
Tuesday	28	70.01	11 56.89	0.850	16 27 46.72
Wednesdey ...	29	70.10	11 36.17	0 879	16 31 43.28
Thursday	30	70 19	11 14 76	0.907	16 35 39.84

Mean time of the Semidiameter passing may be found by subtracting 0.18s. from the sidereal time.

The Semidiameter for mean ncon may be assumed the same as that for apparent noon.

PHASES OF THE MOON.

	D. H. M.
☾ Last Quarter	5 0 55.1
● New Moon	12 5 8 9
☽ First Quarter	18 20 47.2
☺ Full Moon	26 13 53.3

	D. H.
☾ Apogee	1 15.8
☾ Perigee	13 16 4
☾ Apogee	29 6.4

	° ′ ″
Latitude of Harvard Observatory	42 22 48.1

	H. M. S.
Long. Harvard Observatory	4 44 29.05
New York City Hall	4 56 0.15
Savannah Exchange	5 24 20.572
Hudson, Ohio	5 25 43.20
Cincinnati Observatory	5 37 58.062
Point Conception	8 1 42.64

	D.	APPARENT R. ASCENSION. H. M. S.	APPARENT DECLINATION. ° ′ ″	MERID. PASSAGE. H. M.
Venus	1	11 53 13.33	− 0 54 38.1	21 10.3
Jupiter	1	8 6 57.54	+20 29 23.9	17 22.9
Saturn	1	18 24 23.76	−22 50 12.5	3 42.5

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CONTENTS.

Gravity Escapements and the Improvement of Astronomical Clocks.

In the last number was presented a communication from Mr. Albert Blaisdell, of Brooklyn, N. Y., giving an illustrated description of a new gravity escapement invented by Professor Charles A. Young, of Dartmouth College, N. H.; or, speaking more correctly, his improvement on the escapement invented by Capt. Kater, whose name is rendered famous by his experiments with the pendulum for the purpose of determining the force of gravity at various points on the earth's surface. His escapement, however, was a failure, on account of its liability to trip, as shown by the performance of a clock with this escapement erected under Capt. Kater's superintendence at Ramsgate Harbor, and which, after a protracted trial, was removed, and another escapement substituted. Prof. Young's improvement obviates any liability of tripping, yet another fault remains, which we shall endeavor to point out. A defect in the drawing of certain parts of the diagram rendered it somewhat indistinct and difficult to comprehend by those unacquainted with the general construction of gravity escapements, and we now reproduce a corrected diagram, with a criticism on the construction of the escapement itself, and also on the rate of the clock, as shown by the table appended to the communication of Mr. Blaisdell, together with a few observations on improving the performance of high-class clocks.

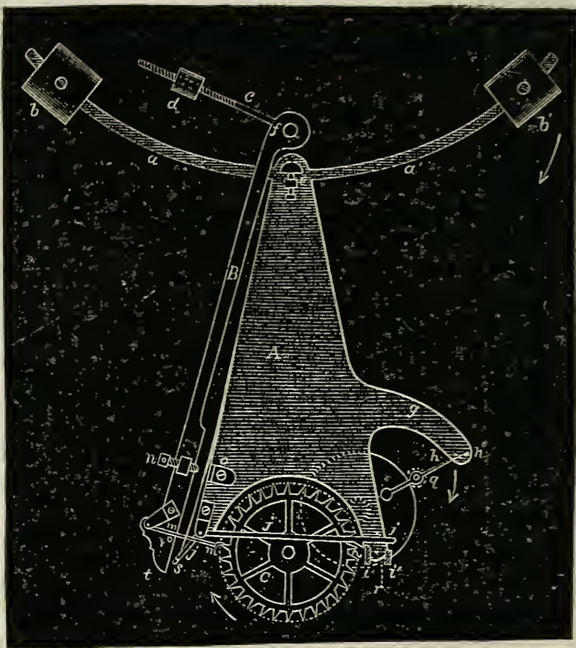
Mr. Blaisdell truly remarks that "the principle of using a constant weight to drive a pendulum independent of the train, and thereby eliminating the errors incident to the construction of the wheel-work is so attractive in itself that it has engaged the attention of many of the first scientific men of our age, for whom an ordinary piece of mechanism would have no charms;" to which we would add that the great point aimed at by those seeking to improve the performance of high-class clocks, has not only been to remove the errors incident to the wheels and pinions, and pivots and pivot holes, and the varying effects of oil upon them, but also that the resistance the pendulum meets with in its ascent from the perpendicular line to the extremity of its arc, should be as little and as constant as possible; and that the impulse given to the pendulum at each alternate vibration should invariably be the same. We must, however, candidly confess that, so far as we have studied the subject, or have had opportunities for observation, with but one or two exceptions the result of the labors of the present generation in this particular, either in the Old World or the New, has been, either experiments yet unproductive of satisfactory results, or a reproduction of old ideas, or some improvement of escapements the same in principle as those constructed and published to the world during the past century; and that the regularity of the performance of fine clocks at the present day is but little, if any, better than the old records of private observatories show they were one hundred years ago.

There have been many plans proposed

for the improvement of fine clocks ; in fact, they are about as numerous as there are phases to the human character or intelligence, but the whole number may be classified as belonging to two distinct orders : 1st, those that have a small weight or spring attached to the axis of the scape-wheel, and from which the wheel derives its motion, this small weight or spring being wound up at stated intervals through the agency of the large weight that drives the clock. This class of escapement is known as the remontoir, or re-winder, and is intended to obviate every irregularity that may exist in the clock between the weight and the scape-wheel. 2d, those escapements that are constructed so that the scape-wheel will raise weighted arms, and these arms, falling upon the pendulum, maintains its vibrations. This class is known as gravity escapements, because the pendulum is impelled by the force of the arms falling against it at a given instant. Gravity escapements are intended not only to obviate the errors in the wheel-work, etc., but also the errors and the irregularities incident to the wheels and pinions, but also those of the Graham escapement, and others of that class, without introducing other errors equal or greater than those sought to be removed. Professor Young's escapement belongs to the class last mentioned, and will be readily comprehended by the following description :

"The drawing is about half-size. The escape-wheel C is the same which belonged with the dead-beat escapement with which the clock was originally constructed. A is the locking arm, having at its upper part two horns *a* and *a'*, on which slide weights *b b'*, admitting of adjustment so as to put the system consisting of the arms A *a a'* in equilibrium around the conical points *e*, on which it turns, with a *slight* preponderance to *b'* in the direction shown by the arrow. This whole system is made somewhat heavy, so as to have considerable inertia, an essential quality in this type of escapement.

"The arm A also has on the right side an arm *g*, which carries at its outer end the locking jewel *h'*, and the check *h*. The lower end of the arm A is forked and the right hand end carries a pin *r*, which plays between two stops *i i'*, which are attached to the front plate of the clock and serve to limit the motion of the arm. The left hand end of the arm carries a delicate bent lever, *j, j, j*, about as light as an ordinary sewing-needle, and which Prof. Young calls a "trip-guard ;" this lever has near its right hand end a tooth *k*, which, when the arm A is in its locking position, drops behind the stop *i* and prevents the arm from being displaced either by an irregular force in the train or by any sudden jar from without. At the lower left hand extremity this lever is bent towards the spectator in such a way that it may be struck by



the arm B. This movement raises the other end lever and throws the tooth *k* clear of the stop *i*, leaving the arm A free to move.

"A little behind the locking arm lies the impulse arm B, and attached to the same axis *f* is an arm on which is an adjustable weight *d*, for varying the impulse given to the pendulum, and there is also an other arm laying behind B and parallel with it, which acts on the pendulum in the manner usual in this class of escapements. The arm B has near its lower end a screw *n*, for acting on the stop *o*, on the arm A, and still lower down it has a lever *m*, *m*, by which the scape-wheel is enabled to lift the arm with little or no friction, as Harrison gave the impulse in his escapement.

"To diminish the friction of unlocking, the wheel C is connected to a train of two wheels, the last of which makes one revolution for every tooth of the scape-wheel. The last axis of this train carries the poised pin *q*, the long end of which is bent backwards at a right angle, and engages with the locking jewel *h'*.

"So much by way of explanation; now for the action.

"Suppose the parts to be in the position shown in the figure, the pin *q* locked by the arm A, through the instrumentallty of the jewel *h'*, the arm itself held in position by its preponderance and protected from disturbance by the 'trip-guard' *j*, *j*, and the impulse arm B raised and held in position by the scape-wheel C. The pendulum swinging towards the left, raises the arm B until the forked end of the lever *m* drops off the point of the supporting tooth of the scape-wheel and rests on the pin *v*. Having completed its excursion to the left, the pendulum, in returning, carries the arm with it until the lower end *t*, touching the tail of the 'trip-guard' *j*, *j*, lifts it clear from the stop *i*. Immediately after, the screw *n*, striking the stop *o*, meets the resistance due to the inertia of the arm A, and its attached weights. This momentarily checks the motion of the impulse arm and allows the pendulum to leave it, after which the weight of B, acting upon A, moves it towards the left, and unlocking the pin *q*, allows the scape-wheel to turn; then the tooth, catching the end of the lever *m*, lifts the impulse arm B, and the locking arm A, relieved of the extra weight, resumes its original position, the trip-guard drops into place, and all is ready for another movement. Were it not for the trip-guard, which is really the characteristic feature of the invention, it would be exceedingly difficult to prevent the pin *r* from rebounding from the stop *i*, and thus unlocking a second tooth."

In this escapement, it is claimed that the pendulum is beyond the influence of, and consequently its vibrations will be undisturbed by, any of the irregularities that may exist in any part of the mechanism of the clock. This claim is proved by the results obtained in running the clock for three months in the early part of the year 1869, with weights varying from 16 to 70 pounds, as is shown in the table appended to Mr. Blaisdell's communication. Comparing the escapement, however, with other gravity escapements, it seems to us that the objectionable feature in its construction is the great weight the gravity arm B must necessarily have in order to exert sufficient force to lift the trip-guard J J, and then move the large arm A, and the jewel *h'*, from the point of the arm *q*, after the pendulum has left the gravity arm B, when the screw *n* has touched the stop *o*.

The gravity arm being so heavy, it is evident that the resistance the pendulum will meet with must be considerable in raising it a sufficient distance to allow the forked end of the lever *m* to drop off the point of the scape-wheel tooth. Should the extent of the arc of vibration of the pendulum be altered by the varying density of the atmosphere, the effects of heat or cold on the elasticity of the pendulum spring, or from any other cause, the gravity arm will be in connection with the pendulum for a longer or shorter period, and consequently the pendulum will meet with a greater or a less resistance from it, as the length of the vibrations vary. This resistance being greater the greater the weight of the arm, it is our opinion that a heavy gravity arm, although it may be arranged in the most favorable position, disturbs the isochronal properties of a pendulum as much as all the mechanical errors in a fine clock with a Graham escapement having the power transmitted directly from the weight through a train of wheels. In support of this opinion, we refer to the rate of the clock at Dartmouth College, which, for the three months that we have account of, the table shows that, although changing the amount of weight had no effect on the regularity of the running of the clock, the rate itself is no better than the rates of many clocks where the weight acts directly on the pendulum. The pendulum, which is a gridiron one, is assumed by Mr. Blaisdell to be correct; but it would be instructive to see a rate of the clock for a year, or for three months summer and three months winter, together with the changes in the thermometer and barometer during that time.

The reader must not infer from these remarks that we are unfavorable to gravity escapements, but only to heavy gravity arms; and although the labors of the past hundred years have been unproductive of any substantial results in improving the rate of fine clocks, still some of the experiments have been the cause of much deep investigation, and an incentive to many fruitful discussions; and it is now generally acceded that the compensation of the pendulum stands much in need of improvement, and that the effects of the errors of the escapement, in many instances, is to supply, in an irregular manner, a want of correct compensation, which undoubtedly does exist in all pendulums. It has been observed that errors in the pendulum have made themselves visible in about the same proportion as the errors of the escapement have been removed; and the question of constructing a compensating pendulum without violating the laws that govern its motion, is the one now foremost in the minds of those who give the improvement of fine clocks much of their attention.

Take the ordinary mercurial pendulum as an instance, which is the one mostly in use in countries where the English language prevails; when this pendulum is in connection with a clock having a Graham escapement driven by force transmitted through the wheels, for many purposes it performs very well; yet there is a vexatious uncertainty about the regularity of its rate when used for any purpose requiring great accuracy. Detach the pendulum in question from the Graham clock, and attach it to a clock having a good gravity escapement, and it will be found on trial that the pendulum is not sufficiently compensated, and that the length of the column of mercury must be considerably increased to get the gravity clock to keep as regular a rate as the Graham one did. This has been the experience of all who have had opportunities for observation. Mr. Dennison, of London, in the appendix to the last edition of his book, states that he found, on trial, that a column of mercury nine inches long was not too much for a clock having one of his gravity escapements; while for ordinary clocks a column six-and-a-half or seven inches is the length generally in use.

The clock erected by Wm. Bond & Son, of Boston, in the Observatory of Harvard College, about fifteen years ago, and which has the *first* detached escapement invented by Mr. R. F. Bond, was found, after a number of years of trial, to be not enough compensated. An assistant in the Observatory at that time, and who is now Director of the Dearborn Observatory, at Chicago, constructed a diagram which showed that the variation of the clock always agreed with the change of the thermometer with the greatest regularity, while a pendulum having the same amount of mercury and height of column attached to a clock having a Graham escapement and driven by power transmitted from the weight through the wheels, did not show the same regularity in the variations of its rate. We might mention other instances of a like nature, but perhaps we have said enough to show that the improvement of escapements and pendulums must go together, and that the improvement of the one is useless for any practical purpose, without the improvement of the other.

The laws that govern the vibrations of a simple pendulum, and the laws that govern the revolution of a body round a fixed axis, have been known and demonstrated for many years; yet the majority of those who have been engaged in the invention of compensation pendulums, from the days of Graham downward, have constructed their compensation medium as if no such laws existed in nature. The deficiencies of the gridiron and other pendulums in this respect, are pointed out in a masterly manner in a communication from the Rev. J. C. Hagey, of Jarretsville, Md., which appeared in the May number of the second volume of the JOURNAL; and also in the last number of the present volume, the same correspondent communicates many valuable ideas on the subject of compensating pendulums. On page 311 of Vol I. there is a short communication, signed "Clyde," which contains a number of statements we would be happy to hear discussed by some of our correspondents, because, if the statements there advanced can be substantiated, it will show the errors of compensation in mercurial pendulums in an entirely new light.

We claim the JOURNAL to be an educational medium, and it is its province to elevate the ideas of those engaged in horological pursuits, in matters pertaining to their business. For the benefit of the unexperienced, we present to our readers a few conditions that must be adhered to in constructing improved clock escapements and compensating pendulums.

In the escapement, it is desirable that it be constructed so that the pendulum will be the least possible time in contact with any part of the mechanism. That the resistance the pendulum meets with in unlocking, be of the least possible quantity, and that that resistance be uniform ; also, the impulse given to the pendulum to be no more than is necessary to maintain a certain vibration, and to be imparted to the pendulum when it is passing near to the perpendicular line. A greater impulse than what is necessary, is as destructive to the isochronal properties of a pendulum, as a heavy hammer would be for executing some of the delicate manipulations required by a watchmaker. In constructing compensating pendulums, the one will be best, other things being equal, that has the centres of oscillation and gravity nearest the same point. [See article on "Centre of Oscillation."] The materials that compose the pendulum, should be of such a nature as not to be affected by terrestrial magnetism, and the suspension spring to be of some suitable material, the elasticity of which is the least affected by heat or cold, and that any change of temperature should act equally over the entire surface of the pendulum.

It is to be regretted that this complex question is one that does not usually attract the attention of competent persons, who have the means of carrying on the necessary experiments ; but although there is a proverb to the effect "that the stupidest peasant always gets the largest potato," we hope that the labors of those enlightened men who have spent so much time and money in investigating the questions incident to the improvement of the running of fine clocks, will finally be crowned with a success commensurate with the importance of the subject, and that those substantial benefits, which sweeten all toil, will speedily follow.

Centre of Oscillation.

The facility with which compensation pendulums are invented seems to indicate that many young persons, and perhaps some not so young, have not a clear comprehension of what is exactly meant by centre of oscillation in a pendulum. The centre of gravity they easily understand, because it is easily found by experiment, and is easily explained without experiment, as being the point upon which the pendulum, as a whole, would be poised; but fail to comprehend why the centre of oscillation should not be at the same point. Perhaps, the following explanations may help to elucidate the "mystery."

All know that a simple theoretical pendulum is one where the whole weight is centred in one point, suspended from, and oscillating about, a fixed point, or centre of suspension. A sphere of platinum, suspended by a fibre of silk, would probably be the nearest approximation to a perfectly simple pendulum. A compound pendulum is one where the weight is not centred in or about one point, but is extended for some distance up and down the rod. Suppose there are fixed upon the fibre, at equal distances, three platinum balls. From the well-known fact that a short pendulum vibrates quicker than a long one, the upper or short pendulum will *endeavor* to make its vibrations in the short time due to its length as a pendulum. The middle ball will *endeavor* to make its oscillations in the time its length of support demands, and the lower and longest will attempt the slow and regular vibrations of the long pendulum. Suppose that these three balls, representing three pendulums of three different lengths, be drawn aside from the perpendicular 5°, and suddenly released, the consequence will be that the upper one will have made its full excursion by the time the middle one has descended to the perpendicular, and before the lower one has arrived there ; the momentum of the three balls bending the fibre of silk into such a curve as will accommodate the *tendencies* of the three balls.

If the silk fibre be replaced by an inflexible rod, and the now rigid compound pendulum be drawn aside as before, the upper ball will *endeavor* to hasten forward the middle one to its own speed, and the middle and upper one will both combine to hasten the lower one. So also, the middle one will retard somewhat the rapidity of the upper one, and the slow-moving lower one will do its best to restrain the haste of both those above it, and the consequence of all these tendencies will be that the lower one will be somewhat accelerated, and the upper one proportionally retarded; the whole assuming a vibration which is the mean (middle ball) of the two extremes, provided the three masses are equal, thus compelling the whole to oscillate as a pendulum whose length is that of the middle ball. But if the lower ball be the largest, its control over those parts above it will be in proportion to its mass and the time of its vibrations will nearly coincide with those made by its centre of gravity.

Suppose, again, the largest amount of matter to be in the upper ball. Then will its influence be more potent toward forcing the lower and longer pendulums to accommodate their rate to that of the upper one, and their vibrations will be thereby increased to a degree which will approximate the normal vibrations of that short pendulum. Thus you see the difficulty of exactly fixing upon the exact length of any compound pendulum by simple computation. Every particle of matter from the top of the rod to the lower extremity, which differs in its distance from the point of suspension, has its own time for making an oscillation about that point; and the greater the number of particles that have an equal distance from that point, the greater influence they possess in determining the time of vibration; in this case, as in republics, the mass rules. To obviate these counteracting influences that are constantly at work in the oscillations of the compound pendulum, it becomes necessary to concentrate, as far as possible, all the matter of the pendulum at such a distance from the point of suspension as will produce the number of vibrations desired, and this centre of oscillation will always fall in a line produced through the centre of gravity and the point of suspension, and will always be below the centre of gravity.

The centre of oscillation and suspension are convertible points; that is, a pendulum inverted and suspended from the centre of oscillation will vibrate in the same time. Huygens, the Dutch scientist, discovered this remarkable fact, and it affords a ready means of determining experimentally the length of a compound pendulum, which may be measured by means of a platinum or lead ball, suspended by a fibre of silk from the same point, and in front of the pendulum to be measured, and of such a length that the vibrations will perfectly coincide in time. The distance from the point of suspension to the centre of the ball (which is also the centre of oscillation) is very nearly the length of that compound pendulum.

It should be remembered that the *centre of oscillation* is the point to be affected in all compensations for temperature. The difficulty in producing a perfect compensation pendulum is, to harmonize and bring into coincidence the antagonistic tendencies of the centre of gravity, centre of oscillation, and moment of inertia, all of which are properties and peculiarities of compound pendulums, and must be taken into consideration by those who are experimenting upon them with the expectation of producing any arrangement in advance of those in use at present.

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Comparative Weights of Stones.

Mineralogy, although not directly a part of the horological art, yet is somewhat related to it practically, from the fact that a large proportion of the watchmakers are also jewellers, or at least deal in jewelry, and consequently are expected to be more or less familiar with the various stones in common use. Considered in its broadest scope, mineralogy is a comprehensive department of natural science, embracing, as it does, all substances found in nature which are homogeneous, or of the same composition throughout their structure, and do not owe their origin to animal or vegetable life. Its full understanding requires more study than the watchmaker can give, and more space than the Journal can devote to it; still it is by no means improper, and in fact it is eminently desirable, that every dealer in jewelry should understand something of it, and more particularly such facts and characteristics as pertain to those minerals especially brought to his notice in the course of business.

It is a singular fact, and perhaps rather creditable than otherwise, that rustic simplicity almost always places the jeweller on a pinnacle of the temple of natural science. Whatever no one else understands he is supposed and expected to know all about; whatever no one else can do in the mechanical way is taken to the watchmaker; consequently when both jeweller and watchmaker are embodied in one person, it is necessary that he have at least a smattering of all knowledge. It is a little awkward, and occasionally humiliating, when he is appealed to, not to be able to decide whether a specimen submitted to his judgment is a white sapphire, quartz crystal, or a white zircon. The amount of knowledge necessary to decide with tolerable accuracy as to the character of the stones ordinarily met with is easily acquired, and the reason why it is not more generally attained is because a full and complete mineralogical education is supposed to be necessary. A few pages of the Journal will be devoted to such instruction as will disabuse the trade of this idea.

The characteristics of minerals, by which they are known and determined, are form, hardness, specific gravity, fracture, lustre, color, brittleness, flexibility, malleability, taste, and smell. The three most useful characteristics in determining them are color, hardness, and specific gravity. Whether a mineral is transparent or colored is seen at a glance. Hardness is referred to the following scale, introduced by Mohs:—

1. Talc.	6. Felspar
2. Rock Salt.	7. Quartz.
3. Calcite.	8. Topaz.
4. Fluor.	9. Corundum.
5. Apatite.	10. Diamond.

A mineral which neither scratches nor is scratched by any member of the series, is said to be of the same hardness.

Specific gravity is the weight of any body as compared with an equal bulk of distilled water at a temperature of 60° F. When bodies, having the same specific gravity, are compared together, any volume of one must of course have the same weight as an equal volume of each of the others. The volume of any irregular body may be ascertained by the bulk of water it displaces by being immersed in it. Equal volumes of different substances are frequently found to differ in weight, and to determine this weight it is only necessary to weigh the substance first in air and then in water. An ordinary balance, such as used by jewellers, is easily converted into such use, it being only necessary to remove the scale pan from one side, and attach in its place a counterpoise, from which depends a fibre of silk to attach to the substance whose specific gravity is to be ascertained. The more delicate the balance, the more accurate will be the result.

To determine the specific gravity of a solid, it is weighed first in the air, and then in water. In the latter case it loses of its weight a quantity precisely equal to the weight of its own bulk of water; and hence by comparing this weight with its total weight its specific gravity is found. The rule, therefore, is: divide the total weight by the loss of weight in water, the quotient being the specific gravity.

By this same method can the quantity of alloy in gold be determined. If a mass of gold immersed in a cylinder containing water causes the water to rise a inches, a mass of silver of the same weight causes it to rise b inches, and a mass still of the same weight, but composed of gold *and* silver, causes it to rise c inches; the quantity of gold and silver respectively in the mass can be deduced by instituting proportions between the quantities of water displaced.

It is more especially with the view to its application to the determination of stones that attention is called to specific gravity, as by its aid and the color of the stone their identification is arrived at. By the use of tables of comparative weights, prepared by Mr. Brard, nearly fifty precious and semi-precious stones may be identified. These tables being arranged with reference to the color of stones, there can be no difficulty in application. The first is a table of the colorless stones; then yellow, red, and rose color; blue, violet, green, brownish, and flame color; chatoyant, or those possessing a play of colors.

Comparative Table of the Weights of

COLORLESS STONES.

Weight in air, Grains.	Weight in Water.				
	White Zircon.	White Sapphire.	White Topaz.	Diamond.	White Quartz.
1	0.77	0.76	0.71	0.71	0.61
4	3 10	3.06	2.86	2.86	2.42
8	6.20	6.12	5.72	5.72	4.86
12	9.30	9.18	8.58	8.58	7 31
16	12.40	12.25	11 55	11.45	9.75
20	15.50	15.31	14.42	14.31	12.19
24	18.60	18 37	17 28	17.17	14 64
28	21.70	21.44	20 15	20.13	17.08
32	24.80	24.51	23.01	22.90	19.53
36	27.90	27.57	25.88	25.76	21.98
40	31.00	30.46	28.75	28.63	24.43
44	34.10	33.71	31.61	31.49	26.88
48	37 20	36.76	34 49	34.35	29.32
52	40 30	39.82	37.34	37 21	31.77
56	43.40	42.89	40 20	40.17	34 21
60	46.50	45 95	43 06	42 94	36.66
64	49.60	49 01	45.93	45.80	39.11
68	52.70	52.07	48.90	48.66	41.56
72	55.80	55.14	51.77	51.52	44.00
76	58 90	58.21	54.63	54.38	46.44
80	62 00	61 28	57.49	57 24	48.88
84	65.10	64.34	60.35	60.12	51 32
88	68.20	67.41	63.22	62 97	53 76
92	71 30	70.47	66.08	65.33	56.21
96	74.40	73.54	68.94	68.69	58.65
100	77 50	76.60	71.80	71.55	61.09
Sp. Gr.	4.44	4 27	3.54	3 52	2.55
Hard's.	7.5	9.	9.	10.	7.

Comparative Table of the Weights of

RED OR ROSE COLORED STONES.

Weight in air, Grains.	Weight in Water.				
	Red Sapphire.	Deep Garnets.	Ruby.	Red Topaz.	Red Tour'e.
1	0.76	0.75	0 72	0.71	0 69
4	3.06	3.00	2.88	2 86	2.76
8	6.12	6.00	5.57	5.72	5.52
12	9 18	9.00	8.66	8 58	8.28
16	12.25	12.00	11.55	11.55	11.04
20	15.31	15.00	14.44	14.42	13.80
24	18.37	18.00	17 33	17.28	16.56
28	21.44	21 00	20.22	20.15	19.32
32	24.51	24.00	23.11	23 01	22.08
36	27 57	27.00	26.00	25.88	24.84
40	30 64	30.00	28.88	28.75	27.60
44	33.71	33 00	31 77	31 61	30.36
48	36.76	36.00	34.66	34.47	33.12
52	39.82	39.00	37.55	37.34	35 88
56	42.89	42.00	40 44	40.20	38.64
60	44.95	45.00	43.30	43.06	41.40
64	49.01	48.00	46.22	45.93	44.16
68	52 08	51.00	49.11	48.90	46.92
72	55 14	54.00	51.99	51.77	49.68
76	58.21	57 00	54.88	54.63	52.44
80	61 28	60.00	57.77	57.49	55.20
84	64.34	63 00	60.66	60 35	57.96
88	67 41	66.00	63.55	63.22	60 72
92	70.47	69.00	66.44	66.08	63 48
96	73.54	72.00	69.33	68.94	66.24
100	76 60	75.00	72 22	71.80	69.00
Sp. Gr.	4.270	4.000	3.600	3.530	3.22
Hard's.	9.	7.5	8.	9.	7.50

YELLOW STONES.

Weight in air, Grains.	Weight in Water.						
	Yellow Zircon.	Yellow Sap're.	Yellow Cymo.	Yellow Topaz.	Yellow Tour'e.	Yellow Emer'd	Yel'w Qu'z.
1	0.77	0.76	0.73	0.71	0 69	0 63	0.61
4	3 10	3.06	2 95	2 86	2 76	2 53	2.42
8	6.20	6.12	5 90	5.72	5.52	5.06	4.86
12	9.30	9.18	8.85	8 58	8.28	7.59	7.31
16	12.40	12.25	11 80	11.55	11 04	10.12	9.75
20	15.50	15.31	14.75	14.42	13 80	12.65	12.19
24	18 60	18.07	17.70	17 28	16 56	15 19	14.64
28	21.70	21 44	20 65	20.15	19.32	17.72	19.08
32	24.80	24.51	23.60	23.01	20.08	20.25	19.53
36	27 90	27 57	26.55	25.88	24.84	22 77	21.98
40	31.00	30.64	29 50	29.75	27.60	25.30	24.43
44	34.10	33.71	32.45	31.61	30.36	27.83	26.88
48	37 20	36.76	35.40	34.47	33 12	30.36	29.32
52	40.30	39 82	38.35	37.34	35.88	32.89	31.77
56	43.40	42.89	41.30	40 20	38.64	35 43	34.21
60	46 50	45.95	44.25	43.06	41.40	37 94	36.66
64	49.60	49.01	47 20	45.93	44.16	40 47	39.11
68	52 70	52.08	50.15	48.90	46 92	43.00	41.56
72	55.80	55.14	53.10	51.77	49.68	45.53	44.00
76	58.90	58 21	56.05	54 63	52.44	48 07	46.44
80	62.00	61.28	59.00	57.49	52 20	50.60	48.88
84	65.10	64.34	61 95	60 35	57.96	53 13	51.32
88	68.20	67.41	64.90	63 22	60.72	55.66	53.76
92	71.30	70.47	67 85	66.08	63.48	58.19	56.21
96	74.40	73.54	70.80	68 94	66 24	60 72	58.65
100	77.50	76.60	73.75	71.80	69.00	63.25	61.09
S Gr.	4.44	4.27	3 89	3.53	3 22	2.75	2 55
Hd's.	7.5	9.	8 5	9.	7.5	8.	7.

GREEN STONES.

Weight in air, Grains.	Weight in Water.					
	Green Sapphire	Crysolite Peridot.	Green Tour'e.	Emerald.	Aqua Marine.	Crysophrats
1	0.76	0.70	0.69	0.63	0.63	0.61
4	0.63	2 83	2.76	2.53	2.53	2.42
8	6.12	5 66	5.52	5 06	5.06	4.86
12	9.18	8 49	8.28	7 59	7.59	7.31
16	12.25	11.32	11.04	10 12	10.12	9 75
20	15.31	14.16	13 80	12.65	12.65	12.19
24	18 37	16 99	16.56	15.19	15.19	14.64
28	21 44	19.82	19.32	17.72	17 72	17.08
32	24 51	22.65	22.08	20.25	20.25	19.53
36	27.57	25.48	24 84	22.77	22.77	21.98
40	30 64	28.32	27.60	25 30	25 30	24.43
44	33.71	31 15	30.36	27.83	27.83	26 88
48	36.76	33.98	33 12	30.36	30.36	29.32
52	39 82	36.81	35 88	32 89	32.89	31 77
56	42 89	39.64	38 64	35.43	35.43	34 21
60	45.95	42.48	41.40	37.94	37.94	36 66
64	49.01	45.31	44.16	40.47	40.47	39.11
68	52.08	48.14	46.92	43.00	43.00	41 56
72	55 14	50.97	49.68	45 53	45.53	44 00
76	58.21	53.80	52 44	48.07	48.07	46.44
80	61 28	56.64	55.20	50.60	50 60	48 88
84	64.34	59.47	57.96	53.13	53.13	51.32
86	67.41	62 30	60.72	55 66	55.66	53.76
90	70 47	65 13	63.48	58.19	58.19	56 21
94	73.54	67.96	66 24	60.72	60.72	58.65
100	76.60	70.80	69.00	63.25	63.25	61 09
S Gr.	4.27	3.42	3.22	2.72	2.72	2 56
Hard's	8.	7.	7.5	8.	8.	7.

Comparative Table of the Weights of

BLUE STONES.

Weight in air, Grains.	Weight in Water.					
	Blue Sapphire	Disthene Cyanite.	Blue Topaz.	Tour-maline.	Blue Beryl.	Water Sap're
1	0.76	0.71	0 71	0.69	0.63	0.62
4	3.06	2.87	2.86	2.16	2.53	2.49
8	6 12	5.74	5 72	5.52	5.06	4.98
12	9.18	8.61	8.58	8.28	7.59	7.47
16	12.25	11.48	11.45	11.04	10.12	9.96
20	15.31	14.35	14.42	13.80	12.65	12 45
24	18.37	17.22	17.18	16.56	15.19	14 94
28	21.44	20.09	20.05	19 32	17.72	17 43
32	24.51	22.96	22.91	20.08	20.25	19.92
36	27.57	25.83	25.78	24 84	22.77	22.41
40	30.64	28.70	28.65	26.70	25.30	24.90
44	33.71	31.57	31.51	30.36	27 83	27.39
48	36.78	34.44	34.37	33.12	30.36	29.88
52	39.82	37.31	37.24	35.88	32.89	32.37
56	42 89	40 18	40.10	38 64	35 43	34 86
60	45.95	43 05	42 96	41.40	37.94	37.35
64	49.01	45 92	45 83	44.16	40.47	39 84
68	52.08	48.79	40.80	46.92	43.00	42.33
72	55 14	51.66	51.67	49.68	45.53	44.82
76	28.21	54 53	54 53	52.44	48.07	47.31
80	61.28	57.40	57.49	55.20	50.60	49.80
84	64.34	60.27	60.25	57.90	53 13	52.29
88	67.41	63.14	63.12	60.72	55.66	54.78
92	70 47	66.01	65.98	63.48	58.19	57.27
96	73.54	68.88	68.84	66.24	60.72	59 76
100	76.60	71.75	71.70	69.00	63,25	62.25
Sp. Gr.	4.27	3.54	3.53	3.22	2.72	2.65
Hard's.	9.00	3.7	9.00	7.5	8.	7.5

The white zircon is sometimes employed in jewelry under the name of "rough diamond." It can readily be distinguished from the diamond and quartz by its hardness and specific gravity; it may also be distinguished by placing a drop of strong hydrochloric acid on the stone ; if allowed to remain a little time it produces a dull spot, but on the diamond no effect is produced. White topaz, when finely polished, has nearly the same lustre as the diamond, but can be distinguished from it by being electric, which the diamond is not.

Violet sapphire has the same characteristics as the red, also violet tourmaline the same as the red.

Amethyst is only violet-colored quartz.

The ruby may be distinguished from the red sapphire and the garnet, by hardness and specific gravity, and from reddish topaz, which possesses nearly the same specific gravity, by its electrical properties.

Water sapphire has a fine blue or a normal yellow, as it is viewed in different directions; it is the lightest of the blue stones.

Blue topaz can be certainly distinguished from disthene, which has the same specific gravity, by its being electrical.

Blue beryl has the color of blue topaz; their specific gravities are so different as to easily distinguish them.

The use of the tables is easiest explained by an example. A stone weighing 40 grains in the air, when weighed in water is reduced to 24.43. Look in the first column for 40, trace along its horizontal line until a number very nearly approaching 24.43 is found; at the head of this column will be found the name of the stone. Suppose, however, that the stone be 41 grains, the aliquot part (611) between 40 and 44 must be added, or the specific gravity can be computed and the mineral identified by reference to the specific gravities at the foot of the table.

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The Fusee.

In these days of "going barrels," the fusee, that arrangement so dear to the heart of the English watchmaker, and the cause of many a long controversy, is but little understood in its principles of construction by the present generation of American watchmakers; and it may be interesting to many to know somewhat of the theory of its construction, as being pertinent to a thorough knowledge of the business, although not called upon to make a fusee. There may be peculiarities of action in a fusee watch that would baffle the scrutiny of a modern watchmaker to detect the cause of, were he ignorant of what the fusee would, and would not do, under certain circumstances; consequently, it is well to know all things as well as to "prove all things."

The English fusee is known to all as a mechanical contrivance for equalizing the power of the main-spring as it is delivered to the train of the watch.

The Germans, before the invention of the fusee, used two springs, opposing each other in their force, and called "stack freed," the available force for propulsion being the difference between the tension of the two. The theory of the construction is based upon knowing the force of tension at both extremes, highest and lowest, from which data the diameter of the two extremes of the fusee are determined. The increasing tension, as the spring is wound, must be counteracted by diminished leverage upon the fusee. This diminution must proceed according to some certain law, either in straight lines, forming the frustum of a cone, or by curves of some order bounding the sides of the figure. This curve can be demonstrated mathematically to be a parabolic curve, and can be drawn absolutely correct, knowing the extremes of tension of the spring, the desired diameter of the fusee at its base, and the required height. This cone, when laid out, can be transferred to brass and used as a pattern to which the fusee must be fitted previous to turning the groove for the chain. The grooves are then produced by the "fusee engine," a mechanical arrangement by which the cutting-tooth is given a motion, both in a direction parallel to the axis of the fusee, and also toward the centre.

The theory of the fusee is certainly beautifully correct, and were the action of springs equally so, there would be nothing left to desire in the arrangement ; but, unfortunately, a spring has a will peculiarly its own—an individuality of action, which necessitates the construction of a fusee adapted to the peculiar action of each spring ; and this action is governed by no known law — probably has none — but depends upon the peculiarities of construction. To adapt the fusee and spring to each other, no possible rule can be arranged ; patient trial, turn by turn, with the fusee spring-box and chain all in place, and the tension ascertained for each turn by the use of the adjusting-rod,— the grooves deepened, wherever the action of the spring demands it,— is the only mode of perfect adjustment. Of course, this process is only resorted to in those watches where perfection is expected ; ordinarily, the theoretical curve will give a fair approximation to the desired end. In case the spring is broken, or needs another substituted, perfection will demand the recutting of the fusee for the new spring, or an entirely new one, in order to adjust it to these new idiosyncrasies.

Simplicity, and, consequently, cheapness of construction, is another element which largely contributes to the adoption of the going barrel. With the fusee must be coupled the maintaining spring, or, as the old English horologists called it, the "forcing spring," which somewhat complicates its construction, and contributes to it many elements of derangement and the necessary trouble and expense of repairs. These practical difficulties have gradually driven watchmakers to the use of going barrels, which permit larger diameters for the spring-box, and consequently, longer springs, with more turns. The general adoption of jewels in all the modern watches greatly diminishes friction, and thinner springs can be used, thus affording additional turns to the barrel. By the judicious use of stop work, only the middle coils need to be used, which give, with tolerable accuracy, the mean tension of the main-spring, dispensing with the use of either extreme ; the trifling errors arising from unequal impulse to the train by the modern method, being less than the average errors arising from construction when the spring-box, chain, and fusee were generally used, has given the going barrel a hold upon public esteem which the perfect theory, but imperfect execution of the fusee, can never attain to.

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Repairer vs. Customer.

Ordinary afflictions are the common lot of all men, and can be borne philosophically, because they "come as the wind cometh ;" but in addition to these universal ills, the poor watchmaker has especial sources of vexation. Those pertaining to his mechanical operations are peculiarly trying to the temper, but being incident to the occupation, and not hinging upon the perversity of human nature, they can be, and usually are, borne with Christian fortitude. There is a class of vexations, however, which admit of no such palliation ; they are directly chargeable to the "pure cussedness" of depraved human nature, and consequently admit of no palliation ; they are the fruits of direct collision between opposite currents of individual selfishness. This inevitable condition of things has a practical side, which comes home to the experience of every tradesman and mechanic ; his daily intercourse with customers brings all the worst traits of humanity to the surface; self-interest stands boldly up to combat self-interest, and the practical question is, how shall each party so place his case as to avoid a disagreeable conflict. A case in point, by no means fanciful, but such as occur hourly to the watchmaker in active business, will best illustrate the situation.

A customer enters and remarks: "Some little thing has got the matter with my watch; it stopped on me this morning; never did such a thing before, except once when it fell out of bed; just look into it and start it up." This preface, by which the man thinks he has skilfully concealed his real thoughts, means simply this, when analyzed:—"I know my watch needs a thorough repairing; it has not run well since I let it fall out of bed; but I don't wish to go to the necessary expense, and if I can get the watchmaker to start it going it may go on as well as ever; perhaps by a little bend with his tweezers he can straighten something that has got bent, and it will be all right, and if I can get him to do it while I stand here he won't have the conscience to charge much, but if I leave it he very likely will not actually do any more to it, but will have a bill of two or three dollars."

While the customer is making his troubles known, the self-interest of the watchmaker shapes itself in his mind thus: "It is at least three years since this man's watch has been cleaned, and I remember once starting it going, after a fall, and didn't charge him anything for it, and now he wants me to do the same thing again. I am not going to allow him to come it over me that way again. Besides, I very well know that the watch is actually becoming damaged by running so long without cleaning, and I shall not only do myself a good turn but also him by compelling him to have it done."

All these thoughts have taken shape while he has been earnestly peeping through the watch with the eye-glass. The point of difference between these two selfish men is now plainly visible, and the question to be decided is, how shall each side treat the other so as to avoid any unpleasantness, and to bring about the mutual benefit which certainly lies between them. Shall the watchmaker come out fair and square, and say: "Your watch is dirty; and needs cleaning;" or shall he beat about the bush and make up some untruthful story, to the effect that "the locking jewel has got loose and rubs on the dial pin?" This is a question which each one will be obliged to answer for himself, and will depend much upon the character of both parties to the transaction. If the customer be a man of good sound sense, and who is not so blinded by his inordinate self-interest as to be impervious to reason,—and the watchmaker be an honest, conscientious, truthful man, a correct and truthful statement by him that the watch had actually stopped because it could run no longer for want of cleaning, and that it was actually being damaged by being kept going in its present condition, and that it was for the interest of the owner that it should be attended to, the question would be solved to the mutual satisfaction of both parties. If, on the contrary, the owner is known to be obstinate and unreasonable, as well as selfish, and the watchmaker be unscrupulous as to the means he takes to get a job, the probabilities are that he will attempt to secure the job by some imaginary complaint quite impossible to pertain to a watch.

Then again another vexatious dilemma often arises, opening up the chance for a disagreeable if not serious conflict. The repairs that are obviously necessary to be done to a customer's watch involve an expense which it is hardly probable he can be induced to submit to, and after fully and honestly stating the case to him, and offering to do the whole for a price which will barely pay for the time consumed, he coolly says that he can get it done over the way for half the price. Professional pride here enters into the controversy; the man over the way is known as a "botch;" does work for any price, and in a discreditable manner, and it is desirable to prevent him, by any allowable means, from getting the job. Here arises a case when the "carnal man" is apt to be aroused, and the patience of a greater than Job is required to suppress an exclamation of disgust and anger that the work of such a competitor should be thrust so disagreeably under the nose of an artisan who faithfully and honestly endeavors to do good work at a fair price. Here again arises the practical question, how shall "the man over the way" be circumvented, the customer secured, and the job obtained at a price that will pay for the necessary labor it requires?

Of course, rarely will two persons pursue the same method to attain the end desired; and the best plan of proceeding is always dependent on the circumstances, and here comes into active play whatever of skill is possessed in judging of character, as with the merchant a decision must almost instantly be arrived at as to the line of argument to be pursued. Some workmen will allow their momentary irritation to get the better of their self-interest, as well as their good manners, and exclaim "Well, take your watch over there if you wish it spoiled, and be hanged to you." Another will smother his vexation and argue, explain the impossibility of any one repairing the watch as it should be for a price less than that mentioned; and that whoever does it for less will be obliged to slight it in some essential particular. Usually a calm and dispassionate statement of the facts, independent of any appearance of professional jealousy, or anger toward "the man over the way," will secure a customer.

Very few men are without more or less pride in *their* watch; it is a little better than any other one; of course there are others that cost more, but theirs was purchased under some peculiar circumstances, or came to them through an unusual channel, or was owned by some eminent person, or was manufactured or imported to order, or was the only one of that particular make that could be had anywhere; these things they believe, or pretend to, and by humoring their peculiarities their selfish interest in their own watch may be made the avenue of access to their confidence in the watchmaker. But there is no hold upon the mass of the community so good as to establish a firm reputation for candor and honesty.

Every owner is aware of his entire dependence upon the integrity of the repairer for whatever he may do, and this helpless dependence upon his honesty is the foundation of the thousands of stories about watchmakers stealing valuable wheels, jewels, pieces of chains, etc., etc., which every workman has listened to so often. For a lifetime policy there can be no doubt but that a dignified, straightforward, honest course, under *whatever* circumstances, is the high road which will lead to success. There is no excuse for mistaking the path, for the finger-board always bears this laconic inscription, "Do as you would be done by."

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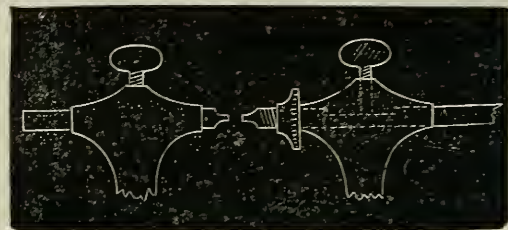
Tool for Removing Broken Screws.

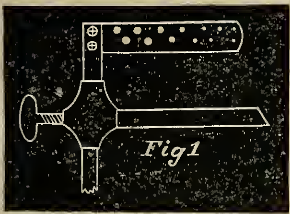
An appliance can be arranged on the common steel bench lathe for removing broken screws from a plate. Make a lathe centre,



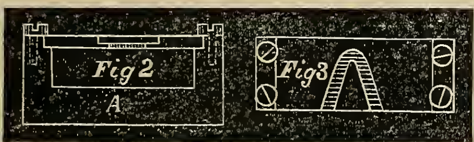
with a slim nose upon the end, as long as half the diameter of a watch plate, and small enough to go through any screw-hole from which you may wish to remove a screw; stipple or roughen the end of this nose by hammering it upon the surface of a sharp file, and then harden; construct a centre for the other head of the lathe, by making a similar arbor, but in addition, cut upon it a thread for half an inch or so back from the shoulder of the nose; upon this screw fit a milled nut, and, in addition, from the middle part of the arbor file away the upper part of it, so that when put in its place in the lathe head the set screw will come down upon the filed away part of it, thus keeping it from revolving, and yet permitting it a motion in the direction of its axis. To use the tool, place the plate containing the broken screw between the roughened points, setting them as firmly as possible against the ends of the screw, then turn down the set screw sufficiently to prevent the arbor from revolving when the nut is so turned as to increase the pressure of the two points upon the ends of the broken screw. Now revolve the plate in such direction as will turn the screw through the plate, or withdraw it, as may seem most desirable.

Centring and Staking Tool.

This diagram represents a convenient tool that any workman may construct for himself. It is for centring and drilling, and is applicable to the common bench lathe. Height and centre distance are easily obtained by movements up or down, and in and out. A steel arbor, fitting the tool rest holder has to its upper end, riveted securely, a steel plate of a size to permit the drilling of as many holes of various sizes as will be required; countersink the holes deeply on the other side to receive and guide the shoulder to be drilled. By this arrangement you can use the drill either active or passive, one end resting in the back centre of the lathe.



Figs. 2 and 3 are cuts of an excellent stake for removing rollers. Fig. 2, a vertical sectional view, consists of a solid base A, of brass or any other metal, with a tempered steel plate resting upon a shoulder in the turned up ends, and secured in position by four hold down screws, as shown in the vertical view of the same, Fig. 3. This steel plate is cut away by an angular notch which permits any staff and shoulder to pass in; around this notch the steel is cut away for a short distance from the notch, but not quite through the plate, thus forming a bearing or shoulder, thin but firm, for supporting the roller, leaving the balance and its appurtenances suspended from this bridge. A hollow punch set over the lower pivot, resting on the shoulder, affords a ready and safe means of driving out the staff.



The stake may be readily adapted to Bissell's upright staking tool by fixing upon the bottom of it two short steady pieces, fitting the holes in the plate, and in such positions as to bring it under the upright punch.

Origin of the Diamond.

Professor Joremejen, of St. Petersburg, has proved, with reasonable certainty, the existence of minute crystallized diamonds in a rock of foliated structure, found only in the Ural Mountains; these small crystals of carbon, having the convex faces and edges peculiar to the diamond. They are enclosed symmetrically in the rock, their trigonal axis being parallel and at the same time perpendicular to the foliation of the matrix. The same arrangement of the crystals has been observed in a reddish brown diamond from Brazil, in which a great number of small diamond crystals are imbedded.

As long as diamonds were found in alluvial deposits, and associated with metals and minerals of various kinds, the most varied theories have been held with regard to their formation. Since it has been found in Brazilian tacolumite, the views in regard to its origin have been much narrowed in their limits; probably the theory most in vogue is that ascribing its production to the Neptunian process, by the slow decomposition of hydro-carbons. Finding the diamond in the zanthophyllite, lying in beds of steatite and talcose slate, seems to support the earlier opinion that the gem was of aqueous origin. Of course it is not yet known by what means free carbon has been converted into crystallized diamond, but enough is known to lead to the suspicion that water and carbonic acid have much to do with the final process to which this beautiful gem owes it origin.

The *Chemical News*, of London, has received a photograph of a rare geological specimen from the diamond fields of South Africa, consisting of hundreds of diamonds cemented to a core of some foreign substance, mixed with garnets and other bodies. The specimen is shortly expected in London, when a careful examination and analysis will be made, and which may throw new light on the origin of the diamond.

It is highly probable that the extended ore over which the pick and pan of the miner are constantly busy, will develop facts, from which the skilful mineralogist will ere long evolve the true theory of its production.

Adjustments to Position.

Editor Horological Journal:

The importance of this adjustment in a watch, the inquiry of "Dynamics," and the reply of "B. F. H. of Sag Harbor, are worthy of a further investigation. That this adjustment can be accomplished by producing equal friction at the balance pivots, in all positions, is hardly subject to a doubt; yet it may appear, from known principles of friction, that some of those who have expressed their ideas on the subject, as to the mode of explaining it, are in error; and for this reason it may, perhaps, be well to consider some questions of friction in general.

The principle of friction in machinery has been declared by all writers on mechanical philosophy as one of the most difficult problems to be solved, and a few quotations may suffice to show this:

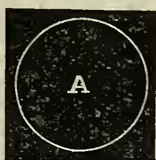
"The laws which regulate friction are derived exclusively from experiments independent of theory. There are no simple or general principles from which they can be deduced by mathematical reasoning. It is a matter of regret, that even amongst the best conducted experiments that have been made, considerable discrepancies are observable, and that differences of opinion prevail between the most respectable authorities, respecting many particulars connected with the properties and laws of these resisting forces." (Lardner's Natural Philosophy, first course, page 252.)

"The principle of friction in machinery is a subject about which little is known, or ever can be known. Some of its general laws have been successfully investigated and a few general principles have been carried into practice; but its effects vary so much with every change of material, of speed, pressure, workmanship, and even temperature and other circumstances, that after all, experience is the only guide in all matters where it is to be considered." (Circle of the Sciences, Vol. I., page 782.)

The number of such testimonies might be indefinitely increased from all sources; and although they have, by numerous experiments, pretty generally established the law that "the force of friction is proportional to the pressure acting on the surfaces in contact," and that for the same pressure the friction is the same, whatever may be the magnitude of the surfaces in contact, yet they confess that these laws are not strictly true, but are subject to considerable variation in certain extreme cases as when the surfaces are very great and the pressure very small, or *vice versa.*

These laws are deduced chiefly from experiments made on sliding friction, and when the pressure of the weight is perpendicular to the plane of motion, as illustrated on page 253 in Lardner's first course; but when applied to the journals of machinery they are said to suffer considerable modification, varying with the speed and the surfaces in contact. From these and numerous other statements, which might be quoted, it would appear that the laws of friction are not always applicable in their strictest sense, and least of all in the case of the balance of a watch, where the disparity between the proportions of the size of the pivots, the weight of the balance, and the velocity with which it moves, is so great. If, however, it be insisted upon that the law of the proportionality of friction to the pressure be strictly true and applicable, we can show that the principle of adjusting a watch to position by equalizing the friction at the balance pivots—and that by increasing or decreasing the surface—does not suffer from it, and is independent of it, or nearly so.

If we place the same balance alternately on pivots of different diameters, then the friction will vary as the diameters. This can easily be proved; for let the diagram



be a revolving disc, and A its centre, then from what we are taught of the motion of bodies revolving around their own centres, we know that a point on the circumference will move faster than any point within the circumference; and that the motion uniformly decreases as we approach the centre.

Proceeding in this way, we may imagine that we reach a point infinitely near the centre, where the motion will be zero; any power of resistance applied at this point will not impede the motion. Let us now consider this point as the fulcrum of a lever, whose arms shal be respectively the radii of the disc, and let us apply a constant power successively at different lengths of these arms; then, from what we know of the nature of levers, the longer the arms the greater will be the power; and, since friction is a power of resistance to motion, the effect of it will be greatest at the circumference; and thus it is proved that it varies as the diameters.

If, then, we make the end of a balance pivot perfectly flat, and apply this same reasoning to it, it will be seen that we obtain, on the end of it, very nearly the same resistance of friction as on the circumference; and if the law of the proportionality of friction to the pressure holds good, we may undercut the centre of the disc at the end of the pivot, and the result will be just the same.

Personally, I believe in this general law; and that I do in deference to the opinions of scientific men who have attained the results by many tedious investigations; and in my own experience I must say that it seems to have proved itself. I have adjusted many watches to position by the above method, and rarely ever failed to effect the desired result, more or less accurately, and in some instances nearer than I expected.

I had one chronometer whose vibrations were much greater in the horizontal position than in a vertical one, and not wishing to diminish its vibrations in a horizontal position, I sought to increase it in the vertical. The balance had rather large pivots, and the bearings in the jewels were thick. I ground the jewels thinner, until the bearings were but a knife edge, without producing the slightest increase in the arcs of vibration; I then changed the jewels for smaller holes, reduced the pivots, and, of course, immediately obtained the desired result.

This may contradict the statement of B. F. H., but I would remind him that he draws a false inference when he supposes that the jewels are made thin and the bearings convex for the purpose of diminishing friction only; thin jewels are much rather intended to permit of shorter pivots, which are stronger, and the convex bearings give the pivots greater freedom. In the experiment he mentions, the jewels being thick, the pivots may have been binding a little in the holes; which, upon a portion of the sides of the pivots being cut down, may have been remedied, and thus the change in the rate produced. On the whole, the statement of the result as to the experiments on the few watches he made, does not convey a clear idea to the reader; I would respectfully refer him to the article by "Horologist," page 129 Vol. II. of the Journal, and advise him to observe the difference in the arcs of vibrations rather than the difference of rate, in order to judge of the increase or decrease of friction, for the faster or slower running of a watch proves nothing. In all mathematical reasoning, and in physics as well as in pure mathematics, the starting-point must be a self-evident truth; a truth so well known as not to need any demonstration. Now we know that greater friction decreases motion, and with less friction motion is increased; from this we know, as a self-evident truth, that in the case of the vibrations of a balance, equal friction will produce equal arcs of vibration.

It is to be hoped that this subject will be thoroughly investigated, and that those who have given it their time and attention will favor us with their opinions and experiences. It is a laudable desire in every thinking workman to increase his knowledge, and acquaint himself better with the sciences he is engaged in, for the purpose of establishing new principles, or searching deeper those already established; but it is not well to jump at conclusions too rashly, or express opinions too positively. In our eagerness to accomplish certain desired results, we sometimes cry "Eureka" before we have the truth. I have myself fallen into the same error, and been obliged to ignominiously retreat.

Theo. Gribi.

Wilmington, Del.

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Psychic Force

Editor Horological Journal:

The buzzing about the ears of Prof. William Crookes would seem to indicate that he has thrust a sharp stick into a nest of scientific hornets. The spiteful stings and thrusts at him from all sides, by both scientific and silly writers, show that prejudice is wounded even worse than science. The whole head and front of his offending is the fact of his announcing to the scientific world, that recent experiments made by him prove "the existence of a force associated, in some manner not yet explained, in the human organism, capable of imparting increased weight to solid bodies without contact." The experiments, devised with all the care and skill of a careful experimenter, by which he arrived at this deduction, you are probably familiar with ; and his farther announcement that this "force" is undoubtedly possessed, in a greater or less degree, by all human beings, may lead to the explanation of facts hitherto unexplained.

I fancy you exclaim, "what has all this to do with horology?" It may have much to do with it. If it is possible for persons to exert a force that can be measured by pounds, and at a distance of several feet beyond possible contact, who knows what amount, or in what direction, or at what times, this invisible force may be in active operation. May there not be found in it a more reasonable explanation than any yet offered for certain whims and caprices of time-keepers, suspected, if not positively established? These eccentricities of performance have been deemed mysterious for the reason that no theory has satisfactorily explained them. The question has been asked again and again, "why do main-springs break?" and the answer has invariably been "why?" Can it be possible that psychic force is at the bottom of it? If it is possessed, as Mr. Crookes asserts, by all human organisms —in degrees differing as those organisms differ—and by persons wholly ignorant of being in possession of this force, may they not unconsciously exercise it in a manner to produce results for which no satisfactory explanation can be given? For all that is now known of its mode of action, it is possible, perhaps, for the owner of a watch to exert upon it, unconsciously, a force that shall break the main-spring.

It is well known that for years a fancy or superstition has obtained, founded upon well-known facts, that there was a personal influence exerted upon the mechanism of a watch in the pocket of one person, which was not so exerted by another. It has repeatedly been proved that a watch in the possession of one, and going at a given rate, on being transferred to the hands of another the rate was changed. From such facts the opinion has grown that there was some magnetic, mesmeric, psychic, or other intangible power, or influence, emanating from, or pervading, each individual ; do not these experiments with psychic force, point to the possibility that the prevailing idea is not without foundation?

If this force can exert a power equal to pounds, is it not possible for it to affect the oscillations of the balance? It is to be regretted that Mr. Crookes did not try its effect upon so sensitive a thing as a pendulum, to give it additional impulse, or to produce total stoppage; or to the balance of a watch, observing if it be sensibly accelerated or retarded I shall watch with great interest for the experiments of scientists to elucidate the manner of its action.

The interest excited by the papers already published on the subject, can scarcely fail to stimulate a desire for further knowledge of the laws which govern the action of this strange power. I hope it will prove the entering wedge which shall open this dark subject fully to the light of day.

J. E. F.

Boston, Mass.

Our correspondent seems to have made a very circuitous journey in going a short distance ; and in his zeal to pursue knowledge, has outstripped the slight facts with which he started in the race. There is no shadow of evidence thus far adduced, to show that this psychic force could be brought to bear upon the motive power of the watch, and if "mahogany levers," "copper vessels of water," or "parchment drum heads," peculiarly arranged upon "very firm tripods," were necessary in order to pull a spring balance a few pounds, instead of taking a good honest pull at it "without contact," what complicated "arrangement" would it require to so pull at a main-spring as to break it?

There is, no doubt, a change of rate in watches *sometimes*, when they change proprietors ; but what is the use of going so far into an unknown "science" for an explanation, when a reasonable one is at hand. A rational view of this peculiarity would seem to be, that the *habits* of persons differ sufficiently to account for this trifling error. All portable time-keepers are more or less sensitive to external motion. In the pocket, a watch is subject every day to about the same routine of motions. Ordinarily a man of business, a professional man, or a man of leisure, goes through a series of motions, which in a week will produce an average; and this average agitation, consequent upon a man's business is, for each individual, different; consequently, a watch regulated to the average habits of one owner, will not be regulated to the average habits of another, particularly if their occupations be of a different nature. Such unequal treatment of a watch would almost inevitably produce quite as unequal a performance. It *may* be "psychic force," but it is more probably *muscular* force.

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Hardening Drills.

Editor Horological Journal:

From some hints with regard to tempering small drills which the Journal contained, and a want of uniformity of results in my own practice, some drills proving marvellously good, and others from the same wire not the 16th of an inch away, proving horribly bad, I was convinced that the difference was simply that of manipulation, and I made up my mind that it must be in the heating and hardening. The difficulty of getting a *very small* piece of steel at anything like an exact degree of temperature, and consequently an exact degree of hardness, set me to thinking of some correction for the difficulty; at last I think I have hit upon a plan which approximates to the desired point. The difficulty does not attach to pieces of steel of a size sufficient to show by their color in the flame how hot they are; it is the very thin pieces that are almost instantly white hot, or not hot at all. To remedy this, I folded together a small bit of sheet-iron, an eighth of an inch square, and hammered close together; into that I slip the point of the drill, as far as I wish to harden it; this little piece of iron, with the enclosed point of the drill, I heat till its redness corresponds with my judgment of the proper temperature for hardening, then quench it in cold water. Obviously the thin pointed drill cannot be a higher temperature than the iron around it, and thus the danger of "burning" is avoided. If your readers will try this plan they will find an advantage in it.

B. D.

Cleveland, O.

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Antiquity of the Watch.

Editor of the Horological Journal:

It draws rather too much upon the imagination to believe the ingenious theory of B. F. H., as advanced in the October number of the Journal, regarding the antiquity of the watch. The accounts given of all the ancient "horologium" are about as accurate in their details as the machines themselves were like "clocks" in their construction. The idea that the art of watchmaking was known at some remote period and subsequently "lost," is hardly possible. B. F. H. admits that the clock was the result of slow growth, commencing in the rude elementary machine and arriving at last, step by step, to its present perfection. The same causes which would have destroyed the art of watchmaking would as well have caused the loss of the art of clockmaking, instead of which, both arts have steadily progressed to the present moment.

Vick's clock, of 1370, had a balance spring, or more properly an equivalent for one; the balance, being quite heavy, was *suspended* by a cord of "catgut" or raw hide, which, by its torsion as the balance vibrated, had an effect similar to a spiral spring, and also served the purpose partially of removing the friction incident to the heavy balance; it would therefore be inexpedient to use such a machine in any other than a fixed vertical position, so also all the clocks at this early period were moved by weights, and by no possibility could a portable time-piece be constructed and used without the use of a spring, either spiral or of some kindred form for propulsion. There is no authentic record of such springs prior to about 1450, and the use of the *spiral* spring cannot be proved as early as that date. The first forms seem to have been straight springs, connected by a cord to the wheel work, a method hardly applicable to any machine small enough to fit the pocket of even a monk's gown.

The indiscriminate application of the term "horologium" in those early times to clepsydra, dials, sand-glasses, and all then prevailing forms of time measures, makes it impossible to determine what specific form of instrument was spoken of. The "clock" attributed to Gerbert, of Auvergne, afterwards Pope Sylvester II., who died 1003, was constructed for the Emperor Otho "after observing through a tube the star which guides the mariner." A reasonable inference from this obscure description is, that it was some form of dial fixed in place by an "observation" of the polar star, "the mariners' guide." From all accounts accessible, it seems scarcely safe to assign the invention and use of what is now called a "watch," at so early a date as 1393.

In Chaucer's work, Dan John, there was undoubtedly a jolly good monk, and socially inclined, as his visit to his friend at St. Dennis proves. After his long walk no doubt but he yearned to have his doublet "with good capon lined," and it is quite probable that he placed his hand upon his rotund figure and pathetically exclaimed to his friend—

"By my kalender 'tis prime of day."

The journey of ten miles from his monastery would more likely have suggested that feeling remark which followed,

"Let us dine as soon that we may,"

than any hint by a "watch" or dial.

Prior says:

"So if unprejudiced you scan,
The goings of this clock-work man,
You find a hundred movements made
By fine devices in his head;
But 'tis the *stomach's* solid stroke
That tells this being what's o'clock."

As well might an argument be deduced for the early existence of the watch from Shakspeare's play "As you like it," when the "fool i' the forest drew from his poke a dial (watch) and looked on it with lack lustre eyes."

The precise date when the watch, as such, was invented, can no more be fixed at any certain period of history, than can the time when the elegant modern fire-place was first in use; the one being a gradual growth from the first revolving of a wheel by drops of water, and the other by successive improvements upon the three contiguous stones upon which the original pot was kept boiling.

Nashville, Tenn. J. B.

——o——

Lathe Attachment.

EDITOR HOROLOGICAL JOURNAL:

Seeing an article in the October number of the JOURNAL, on the Lathe, I thought a description of a dead-centre lathe, as I have one arranged, might be acceptable to a few of your readers I have upon my bench, for general use, a No. 2 Am. Combination Lathe; for fine work I use a common steel lathe, arranged in this way: Under the Am. lathe, which is fastened to the bench by a bolt and thumb-screw, I have a narrow strip of hard wood, about 2½ inches wide, which projects from the edge of the bench about 5 or 6 inches; on this I have a small bench vise, on which I screw the steel lathe for use. The back centre of the steel lathe is turned down the shape of a conical pivot, in the end of which is a slight countersink. The other centre has a flat head, which is turned down slightly for a pulley or collet to run on. I used an arbor collet, in which I drove a bell-metal hub. I run the lathe by a small band running from my Am. lathe, thus giving it a continuous motion, which I found to be a great improvement on the bow. A small pin projecting from the collet turns the work, to which is attached a small screw clasp or dog.

F. A. N.

Bradford, Pa.

——o——

Fitting Barrel Hooks.

EDITOR HOROLOGICAL JOURNAL:

In reply to X., Toronto, I would suggest in regard to the fitting of main-spring barrel hook in English Lever watches: Fit your hook from the outside of barrel reversed, and you can see from the inside when it is the required depth. Y. Z.

Hints from an Employer.

Editor Horological Journal:

Since reading an article, a few months since, on the subject of "Deportment," it has been running in my mind that you were neglecting a class of your readers who are *in* the trade, if not of it. You must know that a large proportion of shopkeepers through the country were originally practical watchmakers, and who have, like myself, been compelled, by the exigencies of business, to assume the role of merchant, whose whole occupation is to "buy and sell (if possible), and get again." Your primary aim in the Journal appears to be, devotion to the interests of the workman; this is all very well, but do not the interests of the workman also somewhat hinge upon the success of the merchant who employs him? Probably, where one workman is his own employer, there are twenty in the employ of others. Now, does not the commercial failure or success of these employers bear directly upon the worldly prospects of these same workingmen? What I wish to come at, is this: there seems to me, a propriety in your now and then devoting a little time, space, and ink to the welfare of the "boss." They, as a class, do not seem to be above improvement, and I am inclined to think that they do not, on the whole, so regard themselves; and, plainly speaking, they are not a whit more conceited than the mechanics whom they employ. Also, there are many young men, clerks in watch and jewelry stores, who might be benefited by occasional friendly hints upon "deportment;" and these same clerks invariably look over the Journal whenever it lies in their way. An occasional article, or the narration of a little mercantile experience, might do them good. Certainly, no article which you would publish could harm them, nor, by any possibility, make them worse merchants or worse men. Therefore, I respectfully suggest, that you sometimes give us tradesmen a little lift. I ask it, not only as a favor, but as an act of justice towards those many subscribers which I know you have on your list that are mercantile watchmakers.

If you could induce them to intercommunicate through your Journal, their experiences of the best "ways and means" to circumvent tough customers,—the best methods to penetrate the thick hides and tight purses of chronic shoppers — the neatest, surest and quickest way to detect shop-lifting — it would have a new interest to mercantile subscribers.

Understand me, not as urging you to deviate one jot from the high position you have taken as a special trade Journal, but urging you to let us old *rusty pivots* have a seat alongside of you new men

J. B. M.

Philadelphia, Pa.

Our correspondent's memory is somewhat treacherous, or he would not so soon have forgotten the language of the Journal upon making its first bow to the public. It then proposed to "afford a medium for the free interchange of thought and fact, stated in the language of those whose pursuits bring them directly in contact with the art of measuring time, embracing, as it does, a number of varied interests, all, more or less, intimately connected with Horology. * * * The aim of the Horological Journal will be to furnish a common ground, on which each particular art, science, or trade may meet and contribute their quota to the advancement of the science of Horology. * * * Endeavoring to meet the wants of the *mercantile interests*, it will be the especial aim of this Journal to become the welcome guest to the intelligent practical workman."

The invitation was cordially given in the outset, to all connected, in any legitimate manner, with the trade, to make it the means of mutual exchange of thought, and, at all times, its columns have been as free to the trade merchant as to the practical workman. The earnest call, day after day, by workmen, for facts and methods, shows unmistakably, either an intense longing for technical knowledge, or a wonderful lack of such knowledge on their part; consequently, the Journal has done its best to furnish the class of information most called for, and yet avoid, as far as possible, making it so exceedingly practical as to be wholly uninteresting to the mechanical merchant. There would have appeared in its pages many more articles descriptive of merchandise of the trade, and methods of its production, but for the persistent call for the practices of the trade by active workmen.

Answers to Correspondents.

L. G. G., Halifax, N. C.—There are many ways by which perfect security to customer and workman, in the receipt and delivery of work, may be secured. There is, however, always a practical difficulty in carrying out the best laid plans, which is, that it is looked upon by both parties, as "much ado about nothing."

The system of duplicate checks is theoretically the most convenient, and the material dealers have them for sale, numbered as desired. One of these little brass checks has attached to it a snap hook, for the purpose of readily attaching it to a watch, when its fellow-check is given out to a customer; and also to couple the two corresponding ones together when not in use. The difficulty in operating this system is, that the customer either loses the check before coming for the job, or when he does call for his work, his check is "in his other pants pocket," and he promises to bring it to you next time he is in. You are conscious he intends faithfully to do so, but you fear he will again forget it; in fact, he is far more liable *not* to think of it again until you ask him for it, because he has his watch, and the check is to him of no consequence. If you, knowing these tendencies, refuse to deliver to him his work, on his promise to return the check, he flares up at once, and asks whether you are afraid to trust his word, whether you mean to accuse him of an intention to "do" you out of a watch, etc., etc. To pacify him, you must go into a long explanation of the check system; that you do not suspect his integrity, only fear that he may forget, or that he may, or has lost the check, and that it will fall into improper hands; that it is not on his account only, but for your own safety, you require its return. Perhaps, after a tedious discussion, pro and con, you deliver him the watch, and remain in anxiety concerning that missing check, it may be, for weeks; at last, the customer again appears, and you are greeted, the moment he enters the door, by the exclamation: "Well, I declare, I never thought a word about that check till this moment; I'll send my boy right down with it, as soon as I get home;" and you wait and wait, and are probably waiting yet—having learned that, after diligent search, he "couldn't find it." This is about the usual satisfactory results of operating this system, and its annoyance to both parties soon abolishes it. Giving the owner a card, with name, number, etc., and corresponding to your register, usually ends in a similar manner. The autograph system is, of all plans, the most secure, and the easiest of execution. By this the evidences are in your own possession, or in case the customer demands security, you can give him a duplicate of your register number on a card, or worded as you see fit. The expense is but little more, if any, than cards or checks. To successfully and conveniently carry it out, you must have your watch register printed and bound to order. The more pages you have in it, the less, proportionally, it will cost. A form like the following, or any more desirable one, will do for the watch register:

No.	Left by	William Jones, Oct. 30, 1871.		
			$	Cts.
1726	Here a description of watch, clock, or whatever else.	Here the repairs and the charges.		

Received the above, Nov. 30, 1871.
WILLIAM JONES.

The operation is this: A gentleman leaves his watch; you turn your register to him, hand him pen and ink, and ask him to please register his name; it takes but a moment, and requires no explanation. You can ask if he *wishes* a check, but nine times out of ten he will answer that he don't wish to be bothered with one; then all you have to say to him is, that in case he does not come for the watch himself, he must send a written order. If he comes in person, have him sign the receipt on the register, which takes but a moment; if an order is sent, you have on your register his autograph, and, consequently, the means of instantly testing the genuineness of the order. Probably, written orders for the delivery of watches are the most fruitful source of loss to watchmakers. An order comes to you for a watch left for repair. You do not personally know the maker of the order; you do not know his handwriting; you, perhaps, doubt its genuineness, but are not quite willing to accuse the bearer of offering you a forgery; his physique and temper may not be such as to make that accusation exactly prudent, and you do not wish to annoy your customer by refusing to accept his written order, simply because it *may* not be genuine; consequently, you take chances and deliver a valuable watch to somebody on a forgery.

Again, it will sometimes happen that a verbal order is sent; you very well know the owner, and the messenger you also know; in that case, it is optional whether you deliver to him or not. If you do, it is quite proper that you ask him to sign the receipt on your register.

In all the varying circumstances that are constantly transpiring in the shop this method seems to offer least trouble to both parties, and the greatest security to both. The workman is entirely protected, and the customer has all the security he chooses to ask for.

Even in case of collision between him and the workman, if the customer has no card or check, he can *demand* the evidence of the shop register, which will afford him all the proof necessary of his having left his property in your care, and the proof of proper delivery is in your own hands. For these reasons, we think this plan the best.

A. P. W. & S. M. S., *Iowa.*—In answer to your query, we must say that heat will not change the color of a true amethyst, neither will it change the color of the purple quartz crystals into that of a topaz. Some of these stones have their color partially, and sometimes wholly, discharged by heat; these experiments, however, are dangerous to try upon valuable stones, as they are liable to be broken, or, at least, show fissures through the body of the stone after such treatment. Attempts have been made to manipulate diamonds that were not of the first water, by means of heat and other processes, so as to discharge that slight tinge which diminishes their commercial value; but success has not as yet attended any of these experiments. It is not prudent to assert that these changes will never be accomplished, for the progress of chemical science and crystallography may yet reach such a point as to be able to produce results now considered impossible.

Onyx and some of the forms of calcedony are capable of absorbing fluids in the direction of their strata, although the strata are not discernible by the eye. This property differs in different specimens of the same stone; sometimes a single stone may be made to present as many gradations of color as there are layers of strata. This fact explains a statement of Pliny, which for a long time was not understood, where he speaks of Roman artists boiling the onyx stone in honey for seven or eight days. This statement is not incredible, for the dealers in agate, onyx, and calcedony, at Oberstein, have manufactories where analogous processes are carried on at the present day. This coloring was for many years in the hands of one person, but at present the art is practised to a considerable extent.

A red or yellow carnelian, which is to be converted into an onyx for the cameo engraver, is first carefully washed and dried, placed in a clean vessel containing honey and water, and is kept at nearly a boiling heat for two or three weeks—the honey and water being renewed as often as it evaporates—after which it is transferred to a vessel containing strong sulphuric acid, heated to 300° or 400° F. For a soft stone, a few hours will suffice; harder specimens requiring a whole day. The stone is then washed, dried, and polished, then steeped for some days in oil, and carefully cleaned with sawdust. Sulphuric acid is used when a dark onyx ground is desired; if a red or carnelian ground is wished, nitric acid instead of sulphuric; several stones may be operated upon at once.

The rationale of the treatment seems to be this: The honey penetrates between layers of the stone and is carbonized in the pores by the action of the acid. This carbonization deepens the tints of the dark layers in the onyx specimens, and the red layers in the carnelians, while the heat increases the opacity of the white layers, thus making the contrast of color more striking. The black onyx, now in such general use by the manufacturing jewellers under the name of jet (if it is stone), is produced by this or some improved method of coloring; and so obviously are these stones "doctored" that the chemicals are often found oozing out of the pores, adhering to and staining the paper in which they are imported. It is asserted that moss agates, large quantities of which are now in use, are manipulated in such a manner as to introduce into the fissures, cracks, and crevices of the stone, some preparation of nitrate of silver, which, on exposure, becomes blackened by the action of the light, thus showing distinctly each fissure of the stone into which it has penetrated.

The Spanish topaz, which has for several years been in high estimation among jewellers, is supposed to be the production of a single individual in Paris. The color, which is an indescribable yellowish, reddish, brownish hue, is the result of artificial coloring. That the art was localized at Paris is evident from the fact that the supply ceased simultaneously with the environment of the French capital.

Fashionable taste is so capricious that the favorite color of this season may be discarded the next, only the diamond remaining permanent under all the changes of time.

O. B., *Waterloo.*—A very good way to open the hole in a cannon pinion, where you have no broach of the proper taper, and you wish to preserve the present taper of the hole, is to fasten upon it a screw collet, slip the pinion and collet upon a broach small enough to be *free* in the hole, secure the broach by the larger end horizontally in the bench-vise, and run the pinion by a bow, at the same time supporting the free end of the broach with the fingers. This mode cuts away the surface of the hole and keeps it constantly parallel to itself.

A. G. S., Mass.—Take a pair of tweezers, drill through them, near the point, a hole large enough to receive the socket of any second-hand; if the hole is to be opened to fit the hand to the pivot, slip the socket through the hole in the tweezers, grasp it tightly, and it is held sufficiently firm for any manipulation necessary. It is an admirable little arrangement for shortening the socket when necessary to be done.

R. F., Mich.—Standard ring-gauges are not as yet in such general use as to make it safe to order sizes by them. Your surest way is to say, when ordering, what gauge you use, and then your correspondent can fill your order according to the gauge you mention. Just about as convenient a way as any, is to take a piece of annealed binding wire, wrap it about your gauge at the size you wish, twist it together, send it with your order, and no mistake can then occur; it is almost as quickly done as to write the number of a size. As soon as Allen's standard ring gauges come into general use there will be no more trouble in ordering by sizes than is now experienced in ordering main-springs.

G. M., *Ga.*—Certainly you can make yourself a set of test needles, if you can get *pure* gold and silver. The former you can get of a dentist, either granulated gold, or dentist foil; and the fine silver you can easily prepare, if not otherwise obtainable.

Melt 10 grains of pure gold into a lump, which will represent 1,000 fine, or pure gold. Take next 9 grains of fine gold and 1 grain of silver and melt into a second lump, which will be.......................... 900 fine.

Next	8 grs.	of gold and	2 of	silver	800	"
"	7	"	" 3	"	700	"
"	6	"	" 4	"	600	"
"	5	"	" 5	"	500	"
"	4	"	" 6	"	400	"
"	3	"	" 7	"	300	"
"	2	"	" 8	"	200	"
"	1	"	" 9	"	100	"

Hard-solder each of these pieces of gold to a piece of German silver wire, round or square, and file or hammer them to the shape of the wire, whatever it may be, and stamp or engrave on each needle its quality. It is well to make another set alloyed with copper in place of silver. Directions for using you will find on page 251, Vol. II., of the Journal.

G. M. P.—*Cincinnati, O.*—It is doubtful whether you can obtain any very good results from re-sharpening old files by acid. The numerous receipts for that purpose have not proved satisfactory. The following directions are new and may be good. If you try the experiment, please forward to us the result.

Well-worn files are first cleaned with warm water and soda, then placed in connection with the positive pole of a battery in a bath of 40 parts sulphuric acid, 80 parts nitric acid, 1,000 parts water. The negative pole is formed of a copper spiral wire, surrounding the files but not touching them; the coil terminating in a wire which rises toward the surface. This arrangement of the battery is the result of experience as producing the best results. After an action of about ten minutes remove the files and wash thoroughly in lime water and dry rapidly. If not sufficiently cut, repeat the operation. They present the appearance of new files, and are said to be good for sixty hours' constant work.

S. A. B., *Ill.*—The device for keeping clocks in beat, which you send sketch of, was patented several years ago, in a somewhat different form, by a Mr. Kendall; consequently you are anticipated. The same principle was involved, namely, arranging the pallets and pendulum on a pendulous plate, the centre of oscillation being concentric with the escape wheel, and kept vertical by being heavily weighted at the lower extremity. Its action is obvious; in whatever position the clock might be placed, the escapement would still be arranged on a vertical line from the escape wheel pivot, and in consequence would always be in beat.

G. A. M., *Pa.*—To protect polished steel from rust, warm the steel sufficiently to melt the paraffine, which is more conveniently applied in a melted condition; lay it on with a rag or brush, wipe carefully off with a warm rag. The thin coat left on the metal after the process will not be perceptible to the eye; being solid, it does not leave the greasy feeling that oil or tallow does when applied, nor does it affect in the slightest degree, the color of the object. Dr. C. Purscher recommends for the same purpose, one part by weight paraffine with three parts petroleum.

A. C., *Mass.*—The old silver pencil-heads, and points from which you wish to remove the silver, or any other plated article you wish to "strip," may be treated as follows: First put strong sulphuric acid in a stone or porcelain jar, add a few crystals of nitrate of potassa (saltpetre,) and heat the acid until all the crystals are dissolved.

Place the articles to be stripped in this hot acid bath, stir them about till all the silver is dissolved; watch the articles closely, and as soon as any of them are stripped of silver take them out, as the inferior metal is attacked as soon as the silver is gone; those with the thickest coating of silver will of course require more time. If the action of the acid becomes too slow, add more nitrate of potassa, and increase the heat. A quantity of crystals will be found deposited in the bottom of the vessel as it cools; now add cold water, and suspend in the bath strips of zinc, which will throw down the silver held in solution, in the form of grayish powder, which is the silver in minute crystals. Then ascertain whether all the silver has been precipitated, by placing a little of the solution in a glass, and add to it a few drops of hydro-chloric acid, if there is yet silver in it, it will show a little white cloud. After the silver is entirely precipitated, pour off the supernatant liquid, add fresh water, and wash till the precipitate is quite clean, removing the zinc before the final washing. Thoroughly dry the granulated silver, and mix with it some dry powdered potash; place the mixture in a crucible, and melt into a button. During the melting, drop into the crucible a few crystals of potash.

The silver may also be precipitated from the acid solution, by adding common salt; the precipitate then is a chloride of silver, which must be treated in the same manner by washing, drying, and fusing in a crucible.

N. C. A., *Kansas.*—By experiments recently tried in Paris on a somewhat extended scale, with a view to the improvement of bronze artillery, it was demonstrated that the strength of bronze castings was much diminished by the oxidation of the tin in melting. This oxide being entirely without strength, and interspersed among the molecules of cast bronze, reduces its tensile strength in a great degree.

By the use of phosphorus as a reducer in melting, remarkable results were attained; the oxygen of the tin oxide uniting with the phosphorus to produce phosphoric acid, which, in its turn, unites with the copper, forming a phosphate which passes away with the scoriæ; so in remelting ordinary bronze, its character is changed at each melting by a greater or less loss of tin by oxidation, but the new bronze has a remarkable permanency in this respect, appearing to be a fixed phosphate, consisting of one part phosphorus and nine parts tin. The color, when the amount of phosphorus exceeds ½ per cent., is like 18 carat red gold; the grain, as shown by a fracture, approximates that of steel, and its density can be increased to such a degree as to almost resist the file. The peculiarities can be varied by varying the proportion of phosphoric copper. It can be rolled out and hammered, and seems not to lose its tensile strength, appearing to be well adapted to purposes of art, being of good color and not easily oxidized.

The study of alloys seems to be gaining favor among experimenters; the combinations which the hundreds of simple metals are capable of producing having been but imperfectly examined, explorers in this field of metallurgic science are sure of gathering a rich harvest for themselves, and conferring immense benefits upon the mechanic arts.

G. E. M., *N. J.*—The complaint you make of the want of durability in oxidized chains, is a fault not easily remedied. The coating upon the silver surface being only superficial, its durability depends wholly upon the hardness of the coat of oxide.

There are several modes of producing this oxidized surface, and there may possibly be a difference in durability. One method is to make a solution of platinum in aqua regia (nitro-muriatic acid). Dissolve in sulphuric ether or alcohol, a little of the red mass which is left after evaporation, and apply with a camel-hair pencil to such parts as are to be oxidized; as soon as the ether evaporates, the pellicle of platinum remaining upon the surface will give the color required.

Another mode is to dissolve, in acetic acid, 2 dwt. sulphate of copper, 1 dwt. nitrate of potassa, 2 dwt. muriate of ammonia. Heat the article to be oxidized, and apply the solution with a hair pencil. A very beautiful blue steel-like appearance can be given to a silver surface, by subjecting it to the fumes of sulphur in a close box.

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All communications should be addressed,
G. B. MILLER, *P. O. Box* 6715, *New York.*

EQUATION OF TIME TABLE.

GREENWICH MEAN TIME.

For December, 1871.

Day of the Week.	Day of Mon.	Sidereal Time of the Semi-diameter Passing the Meridian.	Equation of Time to be subtracted from / added to Apparent Time.	Diff. for One Hour.	Sidereal Time or Right Ascension of Mean Sun.
		S.	M. S.	S.	H. M. S.
Friday	1	70.27	10 52 66	0.934	16 39 36.39
Saturday	2	70.35	10 29.90	0.961	16 43 32 95
Sunday	3	70.44	10 6.50	0 987	16 47 29.51
Monday	4	70.51	9 42.47	1 014	16 51 26.07
Tuesday	5	70.58	9 17.85	1.039	16 55 22 62
Wednesday	6	70.65	8 52.66	1.062	16 59 19.18
Thursday	7	70.72	8 26.91	1 085	17 3 15.74
Friday	8	70 78	8 0.64	1.106	17 7 12.30
Saturday	9	70.84	7 33.88	1.125	17 11 8.86
Sunday	10	70.90	7 6.68	1.143	17 15 5.41
Monday	11	70.95	6 39.05	1.160	17 19 1.97
Tuesday	12	71.00	6 11 03	1.176	17 22 58.53
Wednesday	13	71.05	5 42.65	1.190	17 26 55.09
Thursday	14	71.09	5 13 94	1.202	17 30 51 64
Friday	15	71.13	4 44 96	1.213	17 34 48.20
Saturday	16	71.16	4 15.76	1.223	17 38 44.76
Sunday	17	71 20	3 46.35	1.230	17 42 41.32
Monday	18	71.22	3 16 76	1.236	17 46 37 88
Tuesday	19	71 24	2 47.03	1.241	17 50 34.44
Wednesday	20	71.25	2 17.19	1.244	17 54 31.00
Thursday	21	71.26	1 47.26	1.246	17 58 27.56
Friday	22	71.26	1 17.32	1.247	18 2 24 11
Saturday	23	71 26	0 47.38	1.246	18 6 20.67
Sunday	24	71.25	0 17 47	1.244	18 10 17.23
Monday	25	71.24	0 12 38	1.241	18 14 13.79
Tuesday	26	71.23	0 42 14	1 237	18 18 10.35
Wednesday	27	71.21	1 11 80	1.233	18 22 6.90
Thursday	28	71.19	1 41.30	1.227	18 26 3.46
Friday	29	71.17	2 10.62	1.219	18 30 0 02
Saturday	30	71 14	2 39 73	1.209	18 33 56.58
Sunday	31	71 11	3 8.60	1.199	18 37 53 14

Mean time of the Semidiameter passing may be found by subtracting 0.18s. from the sidereal time.

The Semidiameter for mean noon may be assumed the same as that for apparent noon.

PHASES OF THE MOON.

	D. H. M.
☾ Last Quarter	4 18 45.7
● New Moon	11 16 1.9
☽ First Quarter	18 8 41.5
☺ Full Moon	26 9 35.0

	D. H.
☾ Perigee	12 2.8
☾ Apogee	26 9 4

	° ′ ″
Latitude of Harvard Observatory	42 22 48 1

	H. M. S.
Long. Harvard Observatory	4 44 29.05
New York City Hall	4 56 0.15
Savannah Exchange	5 24 20.572
Hudson, Ohio	5 25 43.20
Cincinnati Observatory	5 37 58.062
Point Conception	8 1 42.64

	D.	APPARENT R. ASCENSION. H. M. S.	APPARENT DECLINATION ° ′ ″	MERID. PASSAGE. H. M.
Venus	1	13 25 18.49	− 6 41 25.6	20 45.4
Jupiter	1	8 7 12.27	+20 33 55.5	15 24.9
Saturn	1	18 36 51.24	− 22 44 7.3	1 57.0

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CONTENTS.

History of the Compensation Balance.

Any arrangement by which natural effects can be caused to counteract each other is properly called a compensation. A balance so constructed that the natural effects of temperature shall be equalized is called a compensation balance. Such compensations have been effected in various ways, not alone by the balance, but by action upon the balance spring, and also by combined action upon both together. The earliest experiments in the measurement of time by the vibrations of a balance, developed the effect of temperature upon the time of its oscillations, and the difficulty of remedying it, together with its lack of isochronal properties, caused its almost entire abandonment for the purpose of critical use, as soon as the pendulum, with its isochronal properties, became known.

The earliest attempt to correct this troublesome characteristic of the balance, was by means of oil applied at the pivots, composed of such ingredients that its degree of fluidity should be proportionally graduated to the action of the temperature upon the momentum of the balance. The escapements at this time, were not detached, the crown wheel and verge being the type, and its action eminently depended upon the impulse it received; consequently the search for the means of increasing its rate of going by an increase of impulse, led to the application of oil for increasing frictional resistance at the pivots to counteract the gain from decreased diameter of balance, and increased action of the balance spring.

Berthoud attempted to so adapt the size, and consequently the frictional resistance of his pivots and oils to given weights of balance as to produce a compensation. This method was afterward called *natural compensation*, in distinction from artificial, and must necessarily occur in all machines where oil is used; its effect depending greatly on the quality. The action of the cylinder escapement is a familiar example of this form of compensation, its action being so marked as to render artificial compensation uncertain. The free escapements are most sensitive to this natural compensation, and its effects are such as to seriously interfere with exact adjustment by artificial means. These effects have compelled horologists to resort, for fine results, to those mechanical constructions which require the least amount of oil.

In giving a history of the progress of compensation for temperature, and the various devices resorted to for bringing it about, a natural division of the subject suggests itself, and will be appropriate, because this division is almost in the chronological order of invention :

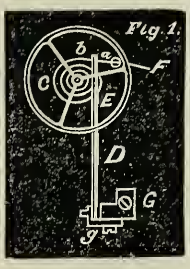
1*st.* Those appliances for compensation which produce their effect through the hair-spring alone.

2*d.* Such arrangements as depend wholly upon the construction of, and action upon, the balance itself; that is, those balances which carry their own compensation.

3*d.* Such as combine both action upon the balance, and also upon the hair-spring.

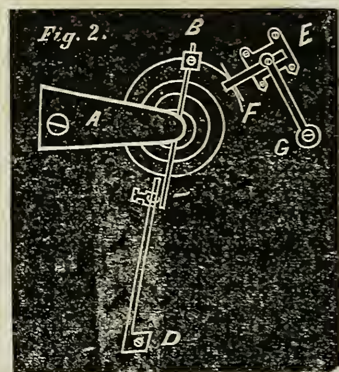
Mr. Harrison, of Barton, in Lincolnshire, England, was probably the first to apply self-compensating mechanism to the watch. In

1726, he describes what in his provincialism he calls a "*kirb.*" Fig. 1 shows the principal parts of his arrangement. A represents the plate of the watch, B a plain balance, C the balance spring, D a compound bar of steel and brass strips pinned together, G *g* a double cock to which the compensating bar is attached at *g*, in such a way that it can be made adjustable between *b* and *a*—the side next the hair-spring stud being brass, the opposite side steel. The action is this : by an increase of temperature the balance is enlarged, and the spring elongated and diminished in elasticity, causing the watch to lose time. The same increase of temperature causes the compound bar D E to be flexed, carrying the end in which are the pins through which the hair-spring passes toward *b*, thus shortening the spring ; these pins, of course, determining the effective length of the hair-spring. The converse operation takes place by the diminution of the temperature. This furnishes no means of regulating the watch to time, except by altering the hair-spring. The adjustment for temperature is effected by the small slide *g*, to which the compound bar is secured.



In 1760, about seven years before the British Board of Longitude published the principles of Harrison's time-keeper, Mons. Berthoud, the famous clock and watchmaker of Paris, contrived and introduced into the first of his marine clocks a compensating curb, acting on the spiral spring of the balance, and in principle like Harrison's, except that the back and forth motion of the curb was produced by the difference of two direct expansions, like the gridiron pendulum which Harrison had previously invented. His arrangement was complicated, and it will be sufficiently described without a drawing, by saying that it was a small system of steel and brass rods, exactly like what is now known as the gridiron pendulum. The rods were placed horizontally upon the plate of the clock, the centre wire extending a little in advance of the others, as the centre wire is prolonged for the pendulum; this central wire acted upon the short arm of a lever, which, in turn, acted upon another, the fulcrum of which was concentric with the balance staff, and carried the pins between which the balance spring was confined. By this circuitous route it applied the direct expansion and contraction of metal bars to the hair-spring, but was far too complicated and cumbersome to be applied to a watch. It was fully described in the " Traité des Horlogerie."

Some time after the Board of Longitude had published a description of Harrison's time-keeper, Berthoud improved Harrison's compensation by introducing a lever capable of being adjusted to any given quantity of effect without moving the cock that holds the compensating bar. Fig. 2 gives a view of the acting parts of this arrangement. A is the balance cock, B the curb lever, pivoted at the top to the cock A, and an under-cock, and as near the verge as possible ; C is the compound bar, fixed to the cock D, having at its free end a screw, bearing upon the end H, of the curb lever B, which has a slide upon it carrying the hair-spring pins, and a set screw to adjust its position coincident with the outer coil. The hair-spring was fixed to a somewhat curious stud E, adjustable to the plane of the hair-spring by standing on four



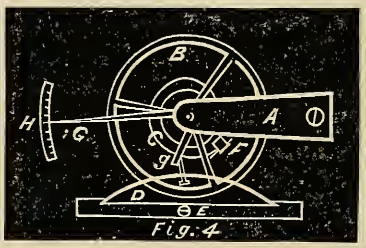
screws as feet. The stud F is movable to allow coincidence with the size of the coils of hair-spring, and is fixed by a set screw passing through the spring G, which swings on a repose screw at its further end. The action is easily understood. With an increase of temperature, the bar D is flexed or bent, as in Harrison's; the stud C is adjustable, to allow the length of the arm H of the curb lever to be adjusted to any given ratio; this curb lever being kept in contact with the compound bar by a spring under the cock A, which is not shown.

After Berthoud had made this alteration in Harrison's curb, it seemed applicable to the watch. The principal difference consisted in the stud being a fixed one, and the arm carrying the hair-spring pins being a bent lever, with its centre of motion on a separate bridge, and beyond the circumference of the balance.

Mr. Cumming, in 1766, published a book on the elements of clock and watchmaking, in which he gave an ingenious, though complex method of compensation, differing from those preceding him, and depending for its action on the difference of expansion in two metals. It is not positively known, nor does it at this day matter, which was the earliest of the two inventions, this or Harrison's; but both were progressive steps. Fig. 3 is a view

of his compensation. A is a rim of steel, and eleven small rollers, revolving on pins or studs, are placed upon this rim; against these rollers rests an interior ring of brass, with its larger extremity screwed to the plane of the steel rim. It is clear that the excess of expansibility of the brass rim will make its opposite ends approach each other as the temperature is increased, and recede as it diminishes, the free end pressing against the end of the lever at A, and movable about a stud at its centre; the opposite end having a slot through which a pin is inserted into the contiguous end of a second lever, *b*, movable about a socket at its remote end, concentric with the balance staff, and from which the hair-spring pins project. When the end *a* of the first lever is pushed out by the increase of temperature, it moves the lever, carrying the hair-spring pins forward, thus shortening it, the end *a* being kept in contact with the brass curve by a spring not shown in the engraving; the ratio of the two acting ends of the levers being adjusted to the proper quantity of motion by the screw *d*, which carries the stud about which the lever *a* revolves.

More frequent mention is made of the name of Berthoud than of any other in the accounts of these early researches in compensation ; he seems to have been an indefatigable experimenter, and his persistent studies brought to light the facts which form the basis of a series of successive advances. His next step is represented at Fig. 4. A is the balance



cock, B a plain balance, C the balance spring, D an arch of brass, with its ends resting in notches in the steel bar E, fixed by a screw to the plate of the watch, and yet capable of moving slightly upon it ; F the hair-spring stud ; G, g, a bent lever, with a pin in its short end *g*, its long end resting upon the index H ; the brass arch carries a small screw, the point of which is opposite the pin *g*, and between it and the screw the outer coil of the hair-spring lies. By the expansion of D, the screw approaches the pin till they grasp the spring on opposite sides, which limits the length of spring that comes into action. If they recede, the spring will act up to the stud; when they are at such a distance apart that the screw limits the motion of the spring in one direction, and the pin in the other, it becomes a species of curb, which limits the effective length of the spring to a point lying somewhere between the stud and the curb, and which will necessarily be nearer the stud the greater the opening between the pin and screw, and *vice versa*. The amount of this opening is regulated by the long arm which rests on the scale H, thus affecting the adjustment for a given amount of force, weight and momentum of balance; the same can also be produced by the screw in the brass arch. The law which governs the motion of this expanding arc is, however, different from that of linear expansion, and the manner in which the effective length of the spring is limited allows a long scale of lengths in a corresponding short scale of distance between the screw and pin, which must be disadvantageous to a nice adjustment for temperature.

Berthoud discovered these errors, and perseveringly labored for their correction. Instead of the curved arch for the purpose of controlling the space between the curb pins, he arranged two parallel compound bars to be carried by the regulator, the points of which embrace the hair-spring, allowing it to vibrate between them to an extent determined by their approximation, which distance was always proportioned to the temperature, for these bars were so placed that the curvature was upon opposite sides, causing their free ends to approach and recede, thus diminishing or enlarging the space in which the hair-spring vibrated. The amount of flexure of the compound bars was adjusted to the conditions of momentum by a block which was adjustable between them, thus limiting the amount of curvature.

A compensation similar in effect to the foregoing one by Berthoud, was introduced in common watches with success by Breguet, of Paris. This compensation is at once recognized as existing in many of the older Swiss watches now extant. As seen in Fig. 5, A is the balance cock, D a three-armed

piece to which is attached the compensating curb *a b*, constructed of strips of brass and steel, the brass interior in each part ; the end *a* screwed to the arm of the lever D, leaving the end *b* free to approach or recede from the outer coil of the hair-spring. As the temperature is increased, the interior end of the curved fork bears on a pin in the arm D ; these two limit the effect of the hair spring by increasing or diminishing the space in which it vibrates, in the same manner as those previously described. The arm *a* having a tendency to straighten by heat, and the arm *b* having an inclination under the same condition to become more convex, the joint effort of the two will diminish the space through which the hair-spring vibrates, and in effect shorten it, thus increasing the rate of going of the watch. The regulation to time is effected by the whole system swinging concentric with the balance pivot. The third arm carries a pin about the middle coil of the hair-spring, which was perhaps a banking pin, as it can have no office in compensation, and no mention is made of it in the original description.

In the year 1805, Mr. Jas. Scott, of Dublin, published an account of a compensating curb which acted in a manner somewhat analogous to that of Cummings. In Fig. 6, A is an in-

dex of steel, swinging in a groove around the verge ; to this is attached, by a screw and steady pin, a compound circular bar B, with the lamina of steel exterior, and the brass interior ; to this is fastened a second compound circular bar C, by means of a clamp and screw D, and a loose piece of metal interposed between the two bars ; this inner bar has its lamina of brass exterior, and the steel interior, the reverse in construction of the outer circle ; E is the stud in the plate to which the hair-spring is pinned ; two guide pins are set in the plate, a short distance from *b*, where the curb pins are fixed that embrace the hair-spring. Wherever the regulator may be moved to bring the watch to time, it carries with it the compound bars.

Suppose now the watch has been regulated to mean temperature, and it is increased to an extreme ; the tendency of the outer circular bar to open or increase its radius of curvature, will bring the interior bar and curb pins nearer the index, and shorten the spring a little, but this is not enough to produce the necessary effect ; the tendency of the interior bar, on the contrary, is to close ; that is to approach the curb pins toward the index by its radius of curvature becoming shorter ; the two combined motions moving them along the spring toward the index A. These actions are exactly reversed as the temperature is diminished.

One of the advancements made in this compensation is, that the absolute active length of the hair-spring is controlled by the curb pins sliding along it, no change being made in the amount of vibration between them ; the adjustment for temperature can also be controlled by the sliding clamp, giving to the compound bars greater action by placing it near their ends, and less by moving it farther back. The inventor states it as his rule for construction, to make the lamina the thickness of a common main-spring.

These examples of the progress of discovery of the effects of temperature upon horological instruments, and the efforts to correct them, will be sufficient to prove that the subject was faithfully experimented upon, and also shows a degree of mechanical ingenuity no way inferior to the present. During this time undoubtedly there were numberless devices contrived by private workmen that never reached the public eye, and of which no account has come down to us. For some time previous to the perfection of these compensations acting upon the hair-spring, invention had been busy upon the idea of the balance carrying its own mechanism for producing compensation, and a description of such of these as came to public notice will be given in subsequent numbers of the Journal.

A careful study of the history of compensation, by those who feel any particular interest in the subject, will do very much toward fixing immovably in the mind the principles involved, the difficulties to be overcome, and the various means that have been employed for eradicating those difficulties. The horological student should not merely glance casually over the drawings, but should endeavor to seize the idea which the constructor was working out, and to detect, if possible, the probable difficulty he would encounter in its practical application. With such a course of study, there will be no danger that he will ever squander time and money upon experiments which can only result in re-discoveries. The history and principles of any branch of mechanics being fully understood, inventors may safely proceed in investigation.

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Musical Boxes.

Almost from the earliest history of clocks and clock-work, dates also the history and use of mechanical music. Bells upon church towers, from being sounded at stated intervals by ecclesiastics, came to be acted upon by clock mechanism, and which, in the process of time, from striking the hours, was required to announce also the quarters. The lingering sweetness of these tones begot the desire for chimes, a species of music very common upon ancient churches, and which has descended to our time. The ringing of these chimes was a duty which demanded some musical skill, as well as considerable muscular effort. These duties were also, in time, put upon the clock machinery, and hence arose the invention of barrels for ringing these chimes.

From the ringing of chimes by a cylinder revolved by the clock in the bell towers, naturally enough grew the custom of so constructing the cylinder as to play simple airs upon the chime bells. From this beginning sprung barrel organs; that is, those musical machines which depend upon the action of air upon reeds or pipes for their tones. The principles of construction are the same, whether it be a chime of bells in a church tower, a hand organ on a beggar's back, or a music box in a lady's boudoir ; each are operated by a revolving cylinder with projections upon it for actuating mechanism that produces musical tones; the only difference being, that in those instruments where the tones are from pipes or reeds, the valves which admit the air must be held open during the continuance of the tone; consequently the projections upon the barrel must be more than points or pins, which would give only a single explosive note. To do this, a bridge or staple is used for such notes, and of a length proportioned to the time the note is to be prolonged.

The mechanism of any of these machines is very simple, all parts being easily comprehended with the exception of determining the position for placing the pins upon the barrel. Perhaps this process will be easiest explained by supposing the whole area of the cylinder to be spread out flat and represented on paper in the form of a parallelogram, in which all the notes of the piece must be written and so placed as to represent the position in which a pin is to be placed. To understand the principle upon which this is done: Suppose that upon a chime of eight bells, constituting a musical scale, a simple air is to be played which does not extend beyond the compass of these eight notes. The parallelogram representing the area of the surface of the cylinder is divided into a number of smaller ones, equal to the number of bars of music in the proposed tune, and each of these in turn subdivided into as many smaller squares as there are notes of the smallest value, in time, in each bar. Within one of these small squares is written a note of the music in that parallelogram which will give the proper pitch, and in that one of the small squares into which it is subdivided which will give the proper time.

If, after the notes are thus written on the sheet, it is wrapped around the cylinder, it will be seen that the place for each pin is shown by the dots upon the paper, and these points can be transferred to the surface of the barrel by a prick punch, the paper diagram removed, holes drilled, pins set, etc. When the music demands a more extended scale, the barrel must be long enough to reach through the required number of octaves, with a corresponding number of bells in the chime. This method of pricking illustrates the principle, and answers the purpose upon the large cylinders of chime clocks, but is too imperfect and tedious for pricking the barrels of music boxes. The exquisite mechanical delicacy of these boxes is the culmination of successive refinements upon the antique chime clock, as the modern watch is the crystallization of the old tower clock.

Mechanical music seems to have kept pace with the onward march of all the other arts, and the perfection of the music boxes of to-day is only excelled by the elegance with which they are encased. Few people have any correct idea of the present demand for this class of merchandise, nor of the value of some of these beautiful machines, nor of the exquisite musical effects that are produced by the introduction of reeds, pipes, etc., in combination with the tones proper of the musical box; much less have the general public, or the trade any correct idea of the mechanical methods of their construction, which has kept pace with increased demand.

The origin of musical boxes dates back to considerable antiquity, but being one of those arts which arrive at perfection only by slow growth, the precise date of their invention, or even of introduction, cannot be fixed at any precise time. Among the earliest forms which this species of mechanism assumed was that of a charm or seal, pendant from a watch-chain, and from that small beginning has grown the whole art of mechanical music, embracing every grade and quality, from the tiny charm to the grand orchestrion, and ranging in price from $3.00 to $3,000, and varying in the number of tunes performed from one to over one hundred.

In the music box, the rapidity of the successive notes is very great, and it is impossible to make one tooth of the comb make the requisite number of notes in succession without striking upon the following pin; therefore, there are two, three, or four teeth of the comb having the same tone or pitch, and placed contiguous, which allows the rapid recurrence of the same note by placing the pins side by side, following, instead of behind each other. The time in which the cylinder makes its revolution should be the same as would be required to execute the same piece by any other method, and depends upon the train of wheels and pinions leading to the "fly." In all the larger and more pretentious music boxes, this regulator, or fly, is adjustable; the wings which impinge against the air being capable of limited extension and contraction, thus retarding or accelerating the rate of revolution of the cylinder.

The tones of these teeth of the comb are regulated by their length and thickness; the shorter they are the quicker the vibrations, and consequently the higher in the scale is the pitch. To the long teeth, which are to vibrate slowly for the low notes of the scale, are attached masses of lead of sufficient weight to give the requisite tone. The tuning of these teeth is accomplished by altering their thickness by stoning, filing, or scraping, till the proper pitch is obtained. To prevent too long vibration of any of these teeth, a system of dampers is employed, which is nothing more than fixing on the under side of the low notes, whose vibrations are long and strong in consequence of the weight they carry, small pieces of steel spring, similar to pieces of a watch hair-spring, pinned into small holes drilled for the purpose; to the middle teeth of the comb small bits of goose quill are attached by cement, the short teeth, having a short vibration, requiring no dampers; these little dampers extend nearly to the point of the tooth, not touching it, but contiguous, so that the pin which is about to lift the tooth first presses upon the damper, forcing it up against the tooth, and for the purpose of preventing further vibrations of the tooth until the pin has passed. The disagreeable jingling sounds which are so often unpleasantly prevalent in inferior musical boxes, are mainly due to the absence or improper adjustment of these little dampers.

The modern pricking machine has an accuracy of construction equal to the watchmaker's wheel-cutting engine, and far greater intricacy. An intelligible description of all its parts is almost impossible, and only a general idea can be given without drawings. Essentially it consists of parallel ways, something like a lathe bed, fixed upon a table. Upon these ways is an arrangement for securing the blank cylinder upon an arbor, revolved by a system of wheel work like that upon the head of a screw-cutting engine lathe. The primary wheel, which revolves the cylinder, must have a number of teeth equal to the number of bars of music in the whole piece to be put upon the barrel, and a few teeth over to produce a blank where the barrel is shifted longitudinaly to change the tune. Above, and in the rear, is a round rod, fixed parallel to the bed of the machine, and equalling it in length ; upon this bar slides freely, by friction rollers, an arm projecting forward, its front end resting upon a flat bar lying in front of, parallel to, and above the blank barrel. Upon the middle of this movable arm, and exactly above the barrel, is arranged a vertical drill stock, which is rapidly revolved by an endless cord from a foot wheel beneath one end of the table upon which the machine is fixed. This cord comes up vertically from the foot wheel, over a loose pulley, then passes horizontally over the table, around the pulley of the drill stock, onward to the other end, over another loose pulley, and down to the driving wheel. By this arrangement of the cord it will be seen that the arm carrying the drill stock can be freely moved horizontally along the bars, and yet the rapid rotation of the upright drill stock is not interrupted.

This drill stock does not carry the drill, but only a point to mark the place where the pin hole must be drilled. Secured to the front of the flat horizontal bar is a vertical strip of steel, its upper edge projecting slightly above it and cut in V-shaped notches at a distance apart exactly equalling the distance between the points of the comb teeth for which the barrel is to be pricked. The front end of the sliding arm being placed in one of these notches, the pricking point which it carries, on being depressed till it touches the barrel, will mark the exact spot at which to place a pin to produce the note that notch indicates; sliding the arm to the right or left and depressing it into these notches, the pricking point marks the position where those high or low notes are to be produced.

The music, in manuscript peculiarly written for this purpose, is then placed before the operator, when she (for it is a lady who does this work at M. J. Paillard & Co.'s, who are the only manufacturers of cylinders in this country) first dots the barrel for every note in the first bar of the written music, sliding the movable arm up or down to such a position on the comb as the notes demand; the first bar being completed, the cylinder blank is revolved one tooth of the wheel which carries it, and the notes of the next bar pricked, and so on till a whole revolution is made, which of course pricks for every note of the piece. To prick the next tune the barrel must be moved longitudinally the full width of one pin, and if it has only 70 bars, and the first one had 80, then a wheel of 70 teeth must be substituted for carrying it, and the same process repeated pricks the second piece. The barrel is then placed in the drilling machine, which is only a bed for holding and revolving it, sliding upon parallel ways which afford a convenient means of bringing the pricks in position under a minute upright drill, revolved similarly to the pricking point. After the holes are all drilled the pins are very rapidly put in, being of steel wire the exact size of the hole. This wire has its surface sharply indented at intervals equal to the length of a pin, by a special machine which permits it to be broken off by a slight bend after being stuck in the barrel. After all are stuck in, they of course project at unequal distances, and to remedy this a small punch is used, in the end of which a hole is drilled in depth equal to the desired projection of the pin; this punch set over each one and forced down to the surface of the barrel brings them to a uniform height, but the ends are jagged and rough, and they must also be fastened in place, which is done by pouring into the cylinder melted cement peculiarly adapted to the purpose; while the cement is yet fluid the cylinder is rapidly revolved, which spreads it evenly over the inner surface, forming, as it cools, a firm rigid lining for the thin shell of brass of which the barrel is composed, and immovably fixing the pins in place.

The cylinder is now taken to the lathe to be turned true. Above it, as it is revolved in the lathe, is a rest of plate glass, as a guide to the file, keeping it constantly parallel to the axis of the cylinder. In this lathe the pin points are all carefully reduced until the points are all flat upon the end. The cylinder is then put in position in a strong iron frame, to which the comb is also secured, and its action upon the points of the comb teeth observed. If its diameter is still too great to act properly, it is again farther reduced in the lathe, and again tried. When correct it is passed over to the adjuster, who critically examines the action of each pin upon each tooth of the comb. Some will be set a little out of place in drilling, and some will have been a little bent in turning up the cylinder in the lathe ; which errors must be corrected by bending the pins into position. Occasionally a pin will get put in the wrong place, which must be remedied by breaking it off and inserting another by hand; some bent a little forward and some a little back, so that the drop shall occur at the right moment ; the action upon the dampers, and all the various minute but necessary adjustments are made, and it is then complete.

When new cylinders are to be constructed to an old comb, the difficulty is increased somewhat, for, as was said, the number of teeth required of a given tone depends upon the rapidity with which that tone is to be repeated ; in new work the barrel can be pricked at pleasure, and the comb adapted to it ; but when the comb is already made, both the music and the pricking must be restrained within the capacity of the comb.

The extent to which accompaniments are carried in some of the really grand music-boxes is wonderful. The introduction of such reeds as are used in the melodeon produce most charming effects, and the full orchestra is very successfully imitated by drums, cymbals, pipes, etc., etc.

The repair of musical boxes is often demanded of the watchmaker ; the description of the mode of construction will give general hints as to the locality in which defects are to be looked for. The train of wheel-work will of course demand his first attention. By removing the comb the train can more easily be examined than a clock train, for it is more simple and accessible. If that is all right, the pins and teeth must next be inspected. One of the greatest defects in old boxes arises from the wear of the mechanism used for shifting the barrel for a change of tune; this must be carefully looked to, and so altered as to bring all the pins into perfect coincidence with the point of the tooth. It hardly seems necessary to caution the workman never to take out the fly-wheel until the main-spring is fully run down, yet many accidents have thus occurred.

Old music boxes have an exceedingly disagreeable way of *screeching*, which is mostly owing to the loss or improper adjustment of the dampers, and must be replaced, if necessary, by new ones. Whoever expects to do a good job upon a musical box without careful, painstaking labor, will surely find himself mistaken; it requiring a patience equalling, if not exceeding, that for watch-work.

It is a serious question whether it is not better to invest a few hundred dollars in a musical instrument that gives, for the asking, exquisite music, to the extent of its capacity, rather than a greater amount for a piano, from which can be got only combinations of sounds at the caprice of the player.

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Horological Literature.

Every week brings to light additional evidence of the great need for the more general dissemination of technical information among the community of watchmakers. The ignorance which is prevalent, not only of principles involved in every-day operations, but of general information upon topics which are, in themselves, of interest, as well as pertinent to the occupation, is lamentable.

There are those who accuse us of being the least educated of any class of artisans whose labors take rank so near the professions and the fine arts. Such wholesale accusations, even were they literally true, merit some degree of charitable pity; for probably no branch of mechanic art has so little embodied literature that is accessible to the mass of workmen, which should go far towards excusing this ignorance. Only those who desire such information as books furnish, have the least idea of the difficulty—aye, the impossibility—of obtaining a work on this subject in any other place than New York, Boston, or Philadelphia. The most earnest seeker will find all his inquiries for such works vain. Each bookseller will but repeat the tale, "we have no such work, and know of none." Doctors, engineers, dentists, surveyors, architects, etc., etc., can fill whole libraries with books treating upon their various callings. The shelves of country bookstores groan with the weight of volumes upon every other "ology," but not one as thick as a knife-blade can be purchased upon Horology. The question is, why is it? Only one of two answers can be given : either there is no demand, or there are no such works.

To a certain degree, both are true; the demand is, of course, limited, and the works even more rare than the demand. There is not a city, town, village, or hamlet, where there are not as many watchmakers as there are dentists ; then, why should the needs of one be supplied, and the other not? Can it be possible that watchmakers are above learning, or that they have no desire for knowledge ? Either assumption is humiliating.

Books are subject to the same law of supply and demand as are other commodities ; book-makers are not the persons to publish books which no one will buy, there being no class of merchants who better understand the demands of trade than they. The science of Horology has an age of 500 years, and yet every English volume of its written history can be counted upon the digits of one hand. No doubt but the lack of English works upon the subject has been one great cause of want of demand. An abundant supply of any article tends to an increased use of it, but still the demand must precede the supply. A few horological adventures have been cast upon the sea of literature in the past few years, but with what success the publishers only know. There are numbers of valuable horological works in the French language, but no one will venture upon their translation and publication. There are also very valuable and complete works upon the same subject in the German, but they are sealed books to us, for the same reason. Metropolitan libraries contain some rare antiquities of the watchmaker's art, historically of inestimable value, but for all the good these relics do the trade in general they might as well have been written in Sanscrit ; no one will undertake the task of compilation, and no publisher will issue such a work, from fear that it will mould upon his shelves.

This is a fair statement of the condition of horological literature at the present moment; and yet there is not a middle-aged watchmaker in the land who has not spent, many times over, the amount necessary to have purchased for his own use a copy of every volume that has been written on the subject, in useless experiments in the art; experiments, the duplicates of which have been repeated, again and again, and fully described, many of them centuries ago, and their scope and bearing fully discussed. All such expenditures could have been saved, or turned to good account in new fields, had the past history of Horology been consulted. The investigations of our fellow-workmen in all past ages ought to be accepted by us of the present, and we should so know the extent of their labors as to prevent these endless repetitions of the past, and devote the inventive skill which equals, if it does not excel, theirs, to widening the circle of knowledge—pushing it on in continually advancing waves. The past recorded facts should be as seeds which have been planted to take root in us and spring up in new and improved forms. The lack of this general knowledge of our art causes each decade of mechanics to repeat, over and over again, the labors of each preceding decade; marching on, like the bewildered traveller in a forest, only to come at last again upon his own tracks.

In the present number of the Journal it has been necessary to give, in answer to a correspondent, a detailed description and drawing of an old clock constructed by Dr. Franklin, and which has substantially been re-invented every few years, because the history of what our predecessors have done has not been generally studied. Close upon the heels of this discovery comes another claimant for a new thing. R. P. S. says: "Now I propose to use the wood and metal pendulums, and get rid of the objections to each in the following manner: First attach to the back of the clock case a strip of wood of the best material for pendulums, that is, if the back of the case is not already so constructed as to answer the purpose; to this strip of wood, or to the clock case, fasten securely a stud or bracket of brass exactly behind the centre of the pendulum ball; also fasten at the top of the strip of wood another brass bracket at a distance above the lower one equal to the length of a seconds pendulum, with a slit in it through which the pendulum spring may pass; secure to the lower stud a metal rod of the same material as the pendulum rod, and extending upward through the upper bracket a distance sufficient to allow a portion of it to be bent forward at a right angle, thus forming a short arm from which the pendulum is supported by the spring which passes down through the slit in the stud attached to the permanent strip of wood. The actual length of the pendulum is measured from the slit to the centre of oscillation of the ball. Now it will be seen that the rod, expanding upward (being fastened at the bottom), draws the pendulum spring up through the stud and shortens it, while the pendulum rod, being made of the same material, expands the same amount downward, and keeps the ball at the same point, and swinging from the same place, *i. e.*, the place where it first enters the slit. The only variation in the rod will be the expansion and contraction of the strip of wood. The movement of the clock is entirely detached, the pendulum rod sliding through the pallet wire, as is usual."

R. P. S. could have turned his ingenuity into some more profitable channel had he known that in the year 1739 Deparcieux, a teacher of mathematics, and a member of the Academy of Sciences, at Paris, constructed an improvement on a previously invented pendulum by Regnauld, involving the same principles. Deparcieux fastened a square bar of ⊔-shaped steel by its upper ends to the back of the clock case, and inverted in it an ⊓-shaped piece of square brass rod, and from the cross piece at the top depended the pendulum, the whole being so secured to the clock case as to allow free motion up and down, and yet retain the necessary firmness to properly support the pendulum. The pendulum spring, by this arrangement, was made to slide up and down through a slotted stud fastened to the front plate of the clock movement. There have been almost endless "*improvements*" upon the attractive simplicity of this pendulum. All such arrangements only give the difference in compensation between wood and metal, and might be so arranged as to allow for the expansion and contraction of the wood itself, were the changes which it undergoes under all the varying conditions of temperature and moisture tabulated.

Mr. John Crossthwaite, of Dublin, attempted to remove this defect by fixing the rod to a marble base, placing cycloidal cheeks on each side of the pendulum spring, with the view to produce isochronal oscillations. All of these arrangements involve the necessity of shortening and lengthening the suspension spring, thus introducing an element of error which it is difficult to reduce to fixed laws, and is far greater than any probable error when a simple wood rod is used properly protected from hygrometric influence. In fact, eminent clockmakers are pretty unanimous in giving this form of rod the preference over any so called compensation which is not critically constructed, and consequently somewhat expensive. In looking over the history of Horology, the fact forces itself into notice that, for the past century, very few real discoveries have been made; even the executive ability of the earlier times, after the introduction of jewelling, would compare, without a blush, with modern hand-work.

The introduction of machinery in the production of watches and clocks can hardly be called an invention, no new theory or new principles being involved, but is the outgrowth of a necessity for cheap labor, in combination with a healthy growth of general demand for a perfection of construction which unskilled hand-labor is unable to supply. The requirements of Science and the modern eye have outstripped the ability of the unaided hand to execute. The perfection demanded by mechanical theories can now only be supplied by machine manipulation. The theory of a plane surface will not now accept one produced by hand; the perfect cylinder must be the product of the perfect lathe. Even to meet the demand of the educated artistic eye, light itself must be the painter of the present. This demand for accurate execution has turned horological invention toward the production of machines for constructing present forms, rather than improving the forms themselves. These exquisite machines in modern watch factories are rarely the invention of horologists, but are the creation of skilled mechanicians, and only designed to produce the forms demanded by horology. These facts prove no lack of ingenuity on our part; they only go to show its misdirection—how it is constantly frittered away in useless journeys over beaten tracks.

This ought, however, to discourage no one. What has already been done should but stimulate to further progress; perfection being yet a long way in advance of us all. The very imperfections our predecessors have discovered for us are the steps on which we are invited to mount, and which they certainly would have surmounted had time been permitted them. The great, and really only obstacle in the way is, as was hinted at the outset, that the progressive, investigating minds of our artisans are not fully informed of what has been done before them. The only cautionary advice they need is, to ascertain as fully as their circumstances will permit, what they are leaving behind when they "go ahead."

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Filigree Work.

Filigree, literally translated from the Latin, signifies threads and grains. It is a style of ornamental work in gold and silver of very ancient origin, and seems to have been an art invented and successfully practised by those people whom we, at this day, look upon as semi-barbarous. With the progress of civilization it had somewhat lost its hold upon popular taste, but during the middle ages the art of filigree working was brought from the East into Europe, and was very generally used for the construction of vases, needle-cases, small caskets for jewels, and largely in the decoration of church shrines, and for adornment of the images of Saints. The East Indians, Armenians, and Turks have produced some very elegant designs, and the fine gold filigree work of Sumatra is celebrated all over the Eastern world. These Eastern artisans will produce the most wonderful results by the use of the rudest tools. From a piece of hoop iron a draw plate is constructed; an anvil is improvised by fastening an old hammer head into a block of wood ; the points of two good sized nails are sharpened, and the heads fastened together by a string in such a manner as to produce a pair of compasses with which to draw the geometric figures which constitute the frame work of their design, and the metal is melted in a piece of earthen pot, by means of a joint of bamboo for a blow-pipe.

After hammering and drawing the metal to a size suitable, it is flattened by beating on an anvil, and is then twisted between two flat pieces of wood, and again flattened ; this repeated twisting and flattening being done for the purpose of producing a wire indented on the edges. From this wire, coiled, twisted, bent, and cut off in pieces that will exactly cover the design previously drawn on a piece of paper or soft wood, is the work constructed ; each piece being fastened in its position on the design by a glutinous substance prepared from the sago berry. When completed, the whole is sprinkled over with gold or silver filings and borax, and subjected to the fire, which burns away the wood or paper design, and the whole structure is soldered together. After boiling out in a solution of alum and salt, it is finished by burnishing the prominent parts. The little grains of gold or silver which are so abundantly bestowed over the flower and foliage designs, are made by filling small holes in a flat piece of charcoal with filings, on heating which with the blow-pipe, the contents of each little cavity melts and forms a perfect little sphere of metal. The Chinese and Malay filigree work is exceedingly delicate in its construction, the wire being drawn so fine that the work, when made up, has not sufficient strength to resist ordinary wear, but their designs show great paucity of artistic taste ; those of the Chinese being a few variations upon a pagoda, a Chinaman with long gown, umbrella and pointed hat, and the Malay work is mostly designs in foliage and flowers. Genoa, in Italy, is a locality from which much of the imported filigree work comes, each locality furnishing an especial style, and a dealer can decide, by a glance at a sample of work, from what locality it came. Mexico, Central and South America also produce filigree work in fine gold, but of ungraceful designs, and a dull dead color, quite unsuited to our trade. The manufacture of this style of goods has for several years been steadily increasing in favor; and particularly is this the case since manufacturers with artistic taste have given this branch of work more attention. Not only have the designs been vastly improved, but great care has been bestowed upon the construction, with a view to its durability as well as beauty.

In the manufacture of silver filigree work, pure metal, without alloy, is the material used; its ductility and ease of working more than compensating for any profit derived from alloying it. The ingots are first formed into square wire by being rolled through a mill with its rolls formed into grooves for producing that form, and graduating in size, so that after having passed through the smallest grooves it is sufficiently reduced to be further indefinitely extended in length and diminished in size by the draw-plate. This wire-drawing is done by a very simple means: A table or draw-bench, about five feet long, has upon each end a solid wooden roller, about four inches in diameter, and a foot or so long, fixed horizontally in bearings, and revolved by a crank, the draw-plate being fixed in a pair of jaws midway between the two rollers; the end of the silver wire is drawn through the plate by hand-tongs, sufficiently to attach to one of the wooden rollers, which being revolved by the crank, the drawing is continued, winding the wire upon it till the whole has passed through the first and largest hole in the plate.

The last end is now sharpened with a file sufficiently to allow it to be put through the next hole, when it is seized by hand-tongs and drawn through and attached to the wooden roller at the opposite end of the bench, upon which it is wound after again passing through the plate. Thus it is alternately wound upon one roller and unwound from the other, each operation diminishing the size of the wire and increasing its length 4, 9, 16, etc., times, as its diameter diminishes to $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$. In this way an ounce of fine silver is drawn to a length of about 100 feet.

After being drawn down to the proper size, its whole length must then be made into a *screw*—a screw a mile long or more. The object of doing this is to produce the fine notches which are noticed upon the edge of all the wire used in filigree work. The Malays, in their rude method, produced it, as was stated, by repeatedly twisting the flattened wire, and again flattening it. The modern workmen have settled upon screw cutting the whole surface of the wire to produce this desirable effect of roughening. Various devices have been tried from time to time by the use of milling tools, but practice, which is after all the real test of excellence in any method, has shown screw cutting to be the most expeditious and economical mode. At first thought, cutting a screw upon an endless wire seems hardly practicable, but the operation is exceedingly simple.

At the end of the draw-bench, and directly above the mandril and pulley of a foot lathe, is arranged a countershaft of about a foot length with a pulley on it which receives motion from the foot lathe by a band connecting the two pulleys. This countershaft is hollow, running in such bearings as to allow both ends to be open for the passage of the wire, and within this hollow revolving shaft is fixed a screw die. Loose grooved pulleys are fixed in proper positions to conduct the silver wire from the roller upon which it is wound into the hollow shaft, and through the contained screw plate, out at the other end, where it is wound upon the other roller of the draw-bench as fast as it is screw-cut by the die rapidly revolving by the foot lathe.

Considerable practice is required by the workman to successfully draw the wire through the screw-cutting machine; he must so proportion the force upon the roller which draws it through, that it is not drawn faster than the screw cuts it, which would produce a thread of too great pitch—that is a "cork screw" thread; nor must it be drawn too slowly, which would produce a double, or "drunken" thread. Experience alone is the guide in this operation, and can only be acquired through the sense of touch. The workman learns by the *feeling* just how fast to wind the wire through, and also with exactly what speed to run the foot lathe that revolves the screw-die. Fine silver wire can be run through the draw-plate at the rate of 60 to 70 inches in a second, and can be screw-cut nearly as rapidly.

After being threaded it is then drawn through a suitable draw plate to flatten it, which process entirely obliterates the screw upon the sides, leaving only upon the two edges of the flattened wire the fine lines dedesired.

It would be impossible to construct any article of utility, or even of ornament, from this thread-like material; consequently larger wire is used of various forms, from which the frame-work of all the thousands of beautiful designs must be built, the fine filaments being only used for the ornamental filling in of the design. To illustrate the method of construction: suppose a filigree card-case is to be made; four pieces of strong square wire are cut of the requisite lengths to form the parallelogram of one side of the case, which are pinned securely in position on a perfectly flat piece of charcoal, large enough to construct upon it one side of the case. Within this parallelogram a large star is to be the design upon this side of the card case; other pieces of the square wire are cut and so placed and pinned upon the charcoal, that the points of the star just touch the parts of the frame already in place. Having proceeded thus far, all the points of contact are firmly hard-soldered, which gives a strong skeleton of one side; the edges and other side are similarly built up, each by itself; and now comes the fancy filling in. The fine silver wire is taken, and enough is wound up by round plyers and the fingers, to make a spiral coil exactly like the hair-spring of a watch, and of such sizes, and in such numbers, as will fill the interstices of the framework of the card case. These little spirals of soft silver wire can, of course, be bent into all manner of shapes to fit the places they are desired to fill. If the coils of one of these spirals be all crowded to one side, a series of eccentric circles of the wire will be formed, and by bending, and coiling, and skilful manipulating, thousands of these beautiful forms may be produced. This facility of forming, in any shape, the pliable wire, gives endless scope to the fancy of the artist in filling in his design. After the whole filling has been done and securely fastened to the charcoal, silver solder, in the form of filings, is sprinkled evenly over the whole with borax, and carefully heated by the blowpipe. This process of soldering requires much care and dexterity; if too much solder be applied, it flows together into a mass, filling up the delicate lines upon the edge of the silver wire ; if too little, it fails to attach together all the points of contact between the different points of the figure ; or if the heat is not judiciously applied, some fragile part will be melted. The joinings of the various parts of the design, the endings of the wires, and all the little imperfections in the filling up, are concealed by the skilful application of little rosettes of silver wire, with a little shot or sphere of silver in the centre. A thread of silver wound upon a straight wire and slipped off produces a helix, of which an infinitude of figures can be constructed.

The rosettes are made by bending into a circle a piece of wire helix ; a beautiful cone is produced by placing above the first circle another a little smaller, and upon these a still smaller one, and upon the apex a silver shot ; in fact it would take a volume to describe even a small part of the forms into which the silver wire can be woven and intertwined. After the edges, ends, and top of the card case are independently formed, the whole are then secured in place and all soldered together; making, when complete, a most airy, graceful design, and at the same time possessing great firmness. After being boiled out (blanched) to a snowy whiteness, and the frame-work or skeleton, and such of the prominent parts as the taste of the artist suggests, are brightly burnished, a whole is produced at once elegant and useful.

The production of the little silver shot so liberally used in filigree work, is curious, yet very simple. Little bits of silver are cut up, no matter what shape, and mixed with charcoal dust in a crucible in such a manner as that the pieces shall not come in contact. They are then subjected to the heat of the forge, the charcoal is converted to ashes, which still separates the silver particles, which melt and form each a sphere by molecular attraction. It will happen that more or less of them blend together in the melting ; consequently, some will be ill-shaped, some larger and some small, but they can be sorted and sized for use by passing them through riddles.

In making up hollow balls, and hollow, pearl-shaped drops, the designs are first constructed flat, and the subsequent form raised in one or more parts, in exactly the same way as would be done if solid plate was used. The raised parts are then united by soldering, and the joinings concealed, if necessary, by exterior ornamentation.

As will be seen by the description of the mode of manufacture, this class of work is almost entirely hand-work ; and yet it is scarcely the proper appellation where so high a degree of artistic cultivation is necessary in all that pertains to good taste, and in the grouping of simple forms to produce pleasing designs. The prejudice against filigree work has heretofore been based, not so much upon the fancied frailty of the work, as upon the poverty of foreign designs, both in grace of form and variety.

There are some considerations which powerfully commend this class of ornamental work to the judgment and taste of buyers—reasons which do not obtain with regard to almost any other ornamental work. No matter how delicate and fragile the design, after having become soiled by a few months use it can be perfectly restored to its original beauty by the most trifling expense, and as often as is wished, without in any degree lessening its strength and durability. At any time the manufacturer will gladly reblanch the stock, and at once it comes out as pure as the driven snow. In fact, by a little practice in the art of blanching, dealers themselves can do it nearly as well as the manufacturers. This peculiarity is of considerable importance to the merchant; for if, after his stock has lain for some time, it becomes discolored, it is only necessary to re-blanch it, and he can show his customers an entirely new stock without any additional outlay of capital—as well as the fact that there is no class of jewelry which can undergo necessary repairs with so little detriment to its original beauty.

Dealers can successfully urge this consideration upon buyers of these goods, and can conscientiously recommend the American filigree work, as the mode of its manufacture wholly removes the objection so often made, that it is fragile. Vases, bouquet holders, card cases, etc., are constructed, rivalling in airy lightness the "baseless fabric of a vision," and yet of a strength far in excess of much of the so-called solid work.

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Pivoting.

Several persons have manifested a desire for more specific and minute directions for using the attachment for centring and drilling described in the last number of the Journal. Encumbering the pages of a monthly publication which is ostensibly devoted to the science of Horology, with minute mechanical details, may seem puerile to some of its readers; but such must remember that all who take the Journal for information have not had the advantages of proper instruction in even the rudiments of hand work, and that to such as have not, one single item of practical directions, plain and simple, telling just how to do a thing, is of more value and better appreciated than sound philosophy. For the reason that a large proportion of the readers are of the practical class, and are constantly clamoring for details of processes which they have no local means of learning, and since apprenticeship has become obsolete, and skilled workmen will not be bothered with teaching boys, there seems no other way for those who are really anxious to learn, except to pick up what they can from such sources as come in their way. By some subtle sympathetic affiliation, they have come to expect the Horological Journal to become a primary teacher.

To return to pivoting. Suppose the upper staff pivot is broken off, and another is to be put in; carefully remove the collet and hair-spring, if it be over-sprung; if not, first take off the roller, by means of the stake for that purpose, if you have one; if not, take it off with the plyers in this manner: bend into the shape of the letter U, a piece of thin soft brass or copper, and place it in the jaws of the plyers so that the copper will come in contact with the edge of the roller. The object of doing this is to protect the edge of the roller from any possible indentations by the plyers; the least roughness upon its edge will cause trouble when in contact with the guard pin in the end of the lever in an English watch, and in an American by contact with the angular guard point in the rear of the fork.

Every workman, however, instead of this bungling, make-shift arrangement, which is both consumptive of time and somewhat hazardous, should have for this purpose a pair of plyers lined with brass or copper, and a groove cut in them fitting the circle of the roller; this groove can be cut in a moment by a little mill-wheel or burr, of the proper size, running in the lathe. Such plyers are useful for many other purposes where articles are to be held—that the steel jaws would be liable to mar.

In holding the balance while removing the roller with the plyers, it must be held between the thumb and finger of the left hand; and if it is a compensating balance, great care must be taken to grasp it opposite the ends of the arms in such a way that no pressure comes upon the loose end of the compensating segment. After a gentle trial, if the roller does not easily start, the arm of the balance must be taken in a second pair of plyers and firmly held while the roller is removed. Having stripped the staff of its appurtenances, it is best next to remove it from the balance; this is not always done, but the watchmaker's golden maxim, that "the safest way is the best way," should always be followed. To remove the balance, place it in an upright staking tool, if at hand; bring a hollow punch down on the shoulder of the staff, and by a smart blow drive it through the balance; draw the temper as far down as you intend to drill the hole, which should be at least once and a half the distance the pivot is to project from it. Never attempt to drill a hardened arbor or pinion without reducing its temper, except in those cases where it is necessary that the acting parts should be hard. A tempered pivot in a staff or arbor which has been softened a sufficient distance to insert a pivot, is just as good as if the whole was hard. To more fully illustrate the use of the centre rest we will suppose there is no hole in it of a proper size for the stump you are to drill. Take a drill about the size of the stump, rather more pointed in form than for ordinary use, set it at such a position against the centre rest as you think convenient; run it till a countersink is formed half way or more through the rest; f om the bottom of the countersink just made, drill a hole quite through it with a drill of the size you intend for the pivot; by this means you have a good countersink to run the stump in, and concentric with it a small hole through which you can run the drill from the opposite side.

After using the centring rest for some time a great variety of holes of different sizes will be made, and you will almost always be able to find the right one ready made. Now place the bow on a collet upon the staff, and the stump of the staff in the countersink, which must be placed by means of the rest exactly opposite the nose of the lathe arbor, which bring up against the perfect pivot, and fasten the arbor by the set screw. You have now got the staff in good firm bearings, and as true to its own centre as if both pivots were perfect, and opposite the broken pivot you have a small hole, also exactly concentric with the staff, through which you can now introduce the pivot drill, the back end of which you can guide by the other lathe centre, in which it will rest.

By this simple arrangement, which has taken as long to describe as to do, you can have your whole apparatus in the lathe, and can manipulate it with no danger of breaking. This method of drilling, of course, is self-centring, and you may at once proceed with the drilling by revolving the staff by the bow, applying oil while drilling, and from time to time withdraw the drill a little, only just enough to work the oil in the hole and the chips out. Whenever the drill needs sharpening it is withdrawn without disturbing the staff, and is again replaced in the hole without the least danger of breaking off in it. If you prefer, and in some cases it is preferable, the article to be drilled may remain stationary and the drill revolved with the bow. After the hole is of sufficient depth, a rough pivot must be filed down as nearly round as possible, from steel as hard as the file will work, and fitted to the hole, which must be freed from oil by pegging out; the end of the wire before being driven in may be dipped in soldering fluid (muriate of zinc), which will fix it there immovably if properly fitted. A pivot thus replaced may be so nicely done as to defy detection by the closest scrutiny, and be to all intents and purposes as good in every respect as the original one. The novice in pivoting finds his greatest trouble first in centring, and then in making good drills. The subject of drills, both large and pivoting, has been amply discussed in previous numbers of the Journal.

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Effects of Heat on Stone Supports for Astronomical Instruments.

All who have read and reflected on the articles on Heat that appeared in former numbers of the Journal, or who have studied heat as a mode of motion, will possibly be prepared to receive the testimony of Professor Piazzi Smyth, Astronomer Royal for Scotland, on the practical effects of heat, as has been lately observed by him through experiments made on the stone pillars which support the transit instrument in the Royal Observatory, Calton Hill, Edinburgh.

Some of our readers own transit instruments constructed for the purpose of obtaining time by the transit of some celestial body, and by the aid of tables, which have been prepared previously, to show the instant the body ought to pass over the wires in the telescope of the instrument; and any deviation from the table shows the error of the clock or chronometer desired to be corrected or regulated. In the transit instruments we speak of, the vertical limb or graduated circle fixed on the axis of the telescope is seldom more than a few inches in diameter, because only an approximate accuracy is required in the circles for the purpose it is designed to be used. For the highest purposes of astronomy a transit instrument is made for measuring the relative angles and positions of celestial bodies, and for preparing, correcting, and confirming the accuracy of tables for the use of terrestrial surveys, and for the purposes of navigation.

These vertical limbs or circles, which are fixed on the axis of the telescope, are increased from a few inches in diameter to four or five feet, in order that there may be room to contain the minute and second divisions in the graduated circle. In proportion as the diameter of the circle, and the accuracy and delicacy of its division, increases, as well as the size and power of the telescope, the necessity for a *true* axis for the telescope and graduated circle to move upon, increases in a proportionate ratio. A large, true, and accurately graduated circle is for no practical use unless mounted on an axis having pivots absolutely true, and resting upon supports that are uninfluenced either by physical or other causes.

The transit instrument at Edinburgh was erected in 1830, and was then justly considered the finest in Europe. Its object glass is 6.4 inches in diameter, and since its erection it has been used in making an important series of star observations. Nevertheless, there is one thing which materially deteriorates the value of every observation made with it, namely, "the variability of position up and down, and from side to side, of the tops of the stone piers upon which the instrument rests."

These large stone piers were erected with great care, and are of Craigleith sandstone. The foundation of the piers is especially worthy of notice, as being almost nowhere else to be met with except in that undoubtedly the most ancient of existing buildings, the Pyramid of Jeeych. Instead of building the piers on the approved principle of a solid foundation of concrete, the builder, curiously enough, levelled the hard porphyritic trap rock of the hill upon which the Observatory stands, and placed the finished stone piers directly thereon.

Professor Smith's predecessor, the late Thomas Henderson, by a series of admirable observations continued from 1834 to 1841, found that "there was an annual fluctuation in the level of the transit axis following the law of the temperature changes in a thermometer kept under the floor." This effect, strange to say, was differential, and to so considerable an amount that endless varieties of explanations were given to account for the strange phenomenon; the case being rendered more difficult by the shortness of the axis of the telescope, which is only 44 inches.

Subsequent observations made by Professor Smyth led him to recognize, beyond all doubt, the truth of Mr. Henderson's conclusions, namely: that there was an annual fluctuation in the level of the transit axis, depending on the temperature; and not only so, but that there was a fluctuation likewise in the position of the instrument as regarded the azimuth of its axis, and to even four times the amount of level disturbance. This at first was supposed to be due to some weakness in the axis and bearings, and they were accordingly replaced by new ones in 1848; but subsequent observations showed no improvement in the annual fluctuation.

These circumstances induced Professor Smyth to suspect that the fault lay neither in the axis of the telescope, nor in the metal bearings, nor in the rock foundation, but in the piers themselves. To verify his convictions, and notwithstanding the fact that large stone piers are generally considered quite uninfluenced by small sources of heat, the Professor placed a few small hand lamps at a short distance from one of the piers, and proceeded to watch the result by telescopic observations in the mercury trough attached to the instrument. In every one of the trials, the Professor writes, "the moment the lamps were lighted, away went the level of the axis of the telescope, indicative of a forced alteration in the height of one of the stone piers. Except in one instance, when the weak radiation of heat by hand lamps was applied near the top of one of the piers, the first effect observed always was, strange to say, a shortening of the height of the pier; and it required much time to elapse before the normal effect of the heat in expanding was shown."

This apparent anomaly was, however, in reality, only a still more delicate, yet decided proof of how dreadfully sensitive these stone piers are to the faintest heat emanations, and explained at once the extravagances of the azimuthal over the level fluctuations noted from year to year, for it arose in this way. The first effect of a lamp shining on one side of the stone pier is to warm up, and therefore lengthen that side, and that side only; whereupon the pier necessarily becomes misshapen, and has its top thrown over so far toward the opposite side, with one corner higher than the other, that the whole vertical height is effectually shortened. But give the lamp time, and its heat gradually penetrates into, if not altogether through, the pier, which thereupon straightens itself up, and shows a greater height than at first, by the amount of heat that has entered into it.

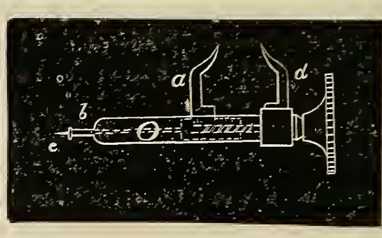
These experiments plainly show that the grand meridian instrument, whose position ought to be one of the most invariable things in the world, is mounted on stone piers so alive to every ray of heat that even a little hand lamp causes the telescope to look every way but in the plane of the meridian. The observations also show that, although the mean annual positions do not always correspond with the mean annual temperatures, yet they have come back after twenty years to very nearly the same identical positions they had at first, while the annual cycle of change has rarely been much interfered with.

In order to show that these results were in no way effected by the peculiar fixings of the piers to the rock, a horizontal force was applied to the top of the piers by means of weights attached to a cord passing over a pulley, and all the effect produced was a mere bending of the pier, for the time being, and a springing back to beyond the former position on the removal of the weights. Professor Smyth, too, has calculated that this temporary yielding was so slight, that it would take the force of two horses drawing at a dead pull at the top of the pier to bring about the amount of annular change, corresponding to a difference of 25° in the temperature of the surrounding air.

In the erection of piers for carrying transit or other instruments on whose invariable stability depends the *prestige* for high accuracy which all observations ought to possess, the builder has something more to look to than mere stability of foundation. For in this case the only real fault to be charged against the Edinburgh transit piers is "the physical nature of the stone employed as to the action of heat upon it;" and although the fault is so small, seeing that from midwinter to midsummer the whole difference in the height of one pier over the other is under 0.0009 of an inch, and the greatest azimuthal or horizontal displacement only .008 of an inch, still this change is most prejudicial to astronomical observations, and is one which causes endless trouble in computing and applying correctional quantities before the real results can be tabulated as duly authenticated.

New Caliper.

This tool consists of a round tube O, terminating in a much diminished hollow point, upon the extreme end of which *b*, is a thin disk; around the upper end of the tube is a collar upon which is fixed the curved steel finger or index *d*; within the tube is another shorter one, to which is attached another finger *a*, which projects up through a longi-



tudinal slot in the outer tube, which inner slide is tapped to receive and be actuated by the screw with a convenient milled head. To the lower end of the inner slide is fixed a thin needle-shaped follower *c*, passing down through the diminished end of the tool, and terminating in a fine pivot. It will at once be seen that by drawing this pivot within the tube, by the screw, the moment the point of the pivot coincides with the face of the disk, the index points (by construction) are at zero. In other words, they give the exact distance between the surface of the disk and the point of the pivot. The obvious advantage of this caliper is the automatic transfer of the measurement to an index which is conveniently applied to the work in hand. Its general application will be readily understood by applying it to the measurements required in putting in a staff.

Set the pivot of the caliper through the foot hole, and upon the end stone project the needle such a distance as you wish the shoulder to be formed above the point of the pivot, or form the pivot and shoulder without measurement, if preferred. Next set the caliper in the foot hole as before, and elevate the disk to a height that shall be proper for the roller, which is done by having the lever in place, the little disk showing exactly where the roller should come. Finish the staff up to that point, then take the next measurement from the end stone to where the shoulder should be, for the balance to rest upon. This is seen by elevating the disk such a distance above the plate as in the judgment of the workman is proper ; this point being marked, the staff can be reversed and measurements commenced from the upper end stone, by which to finish the upper half of the staff. Distances between shoulders for pinions and arbors can be obtained with the same facility ; a little practical use, and a little judgment, being the only requisites. This tool is the invention of Mr. F. Wasser, of the firm of Wasser & Danziger, who manufacture and have them for sale.

——o——

Friction.

EDITOR HOROLOGICAL JOURNAL :

I make no apology for intruding upon your valuable space and your readers' time and patience, as I trust that the importance of the subject under consideration will excuse me. All my knowledge of the laws of friction, limited and imperfect as it is, is the result of general observations natural to a mechanic during a long experience at his trade ; in my case eight years of apprenticeship and twelve years since then. I do not remember studying text-books on the subject, although the general course of my reading seemed to confirm my observations. In my opinion, a watchmaker is better qualified to judge upon this subject than most any other mechanic ; and, therefore, I have always paid great deference to their opinions on this, as well as upon other subjects ; especially to those who, so unlike myself, seem to have time to explore the fields of science, while I, far from content, am obliged to hover upon the outskirts. If it is so, it is very strange that friction, which can not exist without the contact of surface, should be uninfluenced by the extent of that surface. I suppose that it is universally admitted that friction can not exist without pressure, and yet it is equally admitted that it is influenced by the extent of that pressure. Why will not the same course of reasoning hold good in either instance? Perhaps the better way is, not to admit the truth of any theory until it can be demonstrated, or proved by direct experiment. I have recently noticed, in Comstock's Philosophy, the assertion "that friction does not depend upon the extent of surface in contact." And the illustration, as an example, is, to say the least, a rough one. It is, that a *brick* requires no more power to move it when upon its face than upon its edge. Such an experiment should be regarded with contempt by a watchmaker. It seems to me that experiments conducted by mechanics in the prosecution of their own particular calling, where the results have an immediate practical value, are of more importance than, for instance, a philosopher dragging a brick on a board. In the first place, I should like to settle, once for all, the statement of mine twice before referred to. I do not now, nor did I at the time of writing, consider it of any great importance. I knew very well that a watch could be adjusted to position without regard to the friction at the balance pivots, which an able translation in this JOURNAL declares to be merely "an adventitious circumstance which affects the extent of the arc of vibration, but not the time in which it will be described."

If the "and" between the extremes of rate is taken out, my statement woul read clearer, although no one should be misled by it. Written in a hurry, I do not remember whether it was my fault or the *types*. I kept no record of the experiments. The thought occurred to me at the time of writing. In a general way the result was as follows : The watch laying down gained ninety seconds more than it did hanging up ; and, after the alterations I alluded to, the difference was reduced to about ten seconds in either position. This was a good result, be the cause what it might; but no better than others have reached according to their teaching in this JOURNAL. If meaning can be conveyed by written language, I do not think I drew false inferences from the authorities I referred to. I have read the series of articles by "Horologist" with great interest, and I trust with profit, and I take pleasure in quoting, what I before only referred to, to show that he bases his whole theory of adjustment to position upon presenting equal surfaces to friction. So positive is he upon this point that he mentions Mr. Spiro for having previously alluded to it, and then repeats his statement in a subsequent article. I quote, page 107, Vol. II. "2d. Jewels with olive-shaped holes must be used for the balance, in which the friction is much smaller than in cylindrical ones." The above is one of four rules given for this adjustment by J. H. Martens, in regard to which "Horologist" goes on to say: "If these four conditions be carefully observed we will endeavor to show that the adjustment can be accomplished by varying the 3d. This theory rests upon producing equal friction in all positions. If, then, we present equal surfaces of the pivots to friction the object must be attained."

Is it possible that such plain language can mean anything different from what I think it does? If it was intended to mean that the convex bearings were intended not to lessen the friction, but to give the pivots greater freedom, how easy it would have been to have written it so. I am satisfied that so many careful writers would not have made that mistake. Even Mr. Gribi, in the Dec. No., when he says that I draw a wrong inference in supposing that the jewels are made thin and the bearings convex for the purpose of diminishing friction *only*, implies that he believes them *to be so for that purpose to some extent.* Or do I draw a wrong inference in this respect also? If he does mean that, and his words certainly imply it, my case is proved so far as he is concerned.

The other experiment I alluded to was exactly as follows. The pivot holes to a large duplex clock were drilled in a perfectly upright machine, with a twist drill No. 64 Stubbs gauge, driven at a great speed. I am satisfied that the holes were as cylindrical and upright as any thing of the kind could be. The depths of holes before cutting down, $\frac{1}{10}$ of an inch; balance, $2\frac{1}{2}$ inches diameter, vibrating $\frac{1}{2}$ second in an arc of 360°. The holes in fine hard bronze metal (I was not ready to jewel them), were cut down to $\frac{1}{20}$ of an inch, and the arc of vibration (the balance running only in a horizontal position) was increased to 380°. In this case, the whole weight of the train, diminished only by the radius of the wheel of repose, was forcing the pivots against the sides of the holes.

In regard to the general principles of friction, I am of the same opinion still, and if space permitted could mention many examples of the extent of surfaces in contact, increasing friction, and the reverse; which the familiar experience of all mechanics would admit to be true, such as the frictional machine for producing electricity by rubbers on both sides of a glass plate, or on the outside of a glass cylinder, which, if pressure only was necessary, they might rub with the same effect on the edges. Also the greater transmission of power by a wider belt will be placed partly to the credit of greater surface of contact. In the description of the Peabody 'scap't (Vol. I., No. 2), it is claimed that one half the friction of the ordinary fork is avoided, the pin being in contact with the fork only 20°. Sometimes the duplex pallet is formed at such an angle that the edge of the impulse tooth has to move up the face of the pallet. Mr. Hermann calls this an error, as it increases the magnitude of the rubbing surfaces. It scarcely requires a diagram to show that the distance of the surface in contact from the centre of circular motion, increases the friction.

It must be apparent to every one that as the distance from the centre of motion increases, so in the same ratio does the magnitude of the surface increase. Therefore, it seems that a part of this increased friction must be due to the greater surfaces in contact. If the balance pivots, for instance, are magnified to a diameter of one inch, and the holes in the same proportion, there would be a side shake of about 0.125 parts of an inch, which will allow of very great freedom. These pivots might also be one inch long, and if the balance made a complete revolution in one second, no matter how small the bearing surface in the holes, provided they were perfectly cylindrical, both pivots together would have rubbed on over six and a quarter square inches of surface, in that time; and in this ratio, whatever the size of the pivots may be, if the balance vibrates twice in one second, this square area is increased twofold, and so on as the speed is increased. If the arc of vibration is decreased, so is the surface over which the pivots rub, in like ratio. If the bearings in the holes are made convex, these six inches and a quarter are reduced to, say, less than one square inch. Now the question is reduced, if my figuring is correct, to this: will it require more power to move an object over six and a quarter square inches of space than over one ?

I can show, in another way, from an illustration of the same supposed magnified pivots that increase of surfaces in contact does increase friction. The above allowance for friction was taken from the pivots of a Newark watch by a split gauge, which readily distinguishes the $\frac{1}{5000}$ of an inch. Now, if the diameter of the hole is reduced 0.100, leaving only the 0.025 parts of an inch for freedom, the balance would stop, and all the power the train would bear could not keep it running. It is useless to say that the pivot would bind in the hole. A watchmaker can imagine a theoretically perfect hole, even if he can't make one, and the only binding in such a hole would be due to the increased surfaces in contact, without altering the distance of the rubbing surface from the centre of motion of the pivot in the least. If this particular reduction of the hole would not be sufficient for the purpose, I suppose it might be still further reduced ; and I have an impression that, in theory at all events, the pivots might touch every part of the inside diameters of the holes at the same instant without other pressure than the contact of the surfaces. Who can imagine such a case, and refuse to admit the only inference which can be drawn from it ?

That theoretical point, the centre of motion, has been mentioned several times. It is reached in practice with as much difficulty as perpetual motion. There is of course no resistance at that point, neither are there any surfaces in contact ; the one theory can not be separated from the other; the centre of motion is a point that has neither length, breadth, nor thickness, and of course, no friction. The nearest approach to this point is in the pivot upon which the compass needle moves, the balance pivots of a "Yankee clock," the knife-edge bearing for scales, etc. They all work with the least friction, both on account of their nearness to the centre of motion and the small extent of rubbing surface. But that there is both motion and surface on this small point is shown by the fact that they all wear away. The clock stops—the needle and the scales move with greater friction in the course of time. I have not written one-half that I should like to. Your patience and my other business alike forbid. I can not give what I do write half the attention that the subject requires, and my greatest excuse for writing at all is your invitation to do so, for which I return my thanks. If your readers can get at my meaning, they must overlook my style and manner of writing it. If they cannot get at it, I shall be surely doing them but little harm. If I am in the wrong, as we are all liable to err, I hope some one will take the trouble to set me right, for which favor I shall be grateful.

If your Tennessee correspondent had taken the trouble to have read the story from which I quoted, he would hardly have come to the conclusion which he expresses. Dan John was on a visit to a friend 10 miles from his monastery, and the story particularly states that this occurrence happened on the *third* day of his visit; so that the theory of the suppositious appetite, after his ten miles walk, does not apply; neither does the supposition that Chaucer would, in such a relation, call a man's stomach his "Kalender," for, probably, a man more circumspect in the use of words never lived. No task would be more agreeable to me than to prove the existence of the watch from Shakespeare's plays, but as he wrote over 200 years after Chaucer's death, and as watches were known long before Shakepeare's time, it is hardly necessary to prove their existence from his writings. My speculations on the words supposed to have been spoken by the monk were purely abstract, and I trust no one supposes that there can be any proof one way or the other.

Sag Harbor, L. I. B. F. H.

———o———

Letter Engraving.

EDITOR HOROLOGICAL JOURNAL :

When requisite that a set of spoons or forks shall be engraved alike, I have often used the transfer process, described in Vol. II., page 159 of the JOURNAL; but there is another way of obtaining the results, at less expense of time and labor. After one article is prepared, as for the paper transfer, place it on the smooth skin of the left forearm, and press the article into the flesh with sufficient force to leave its outline upon the arm, which serves as a guide for placing the others, most of the grease in the letters being left upon the skin, To transfer the letters to the other articles. place the end of the handle on the lines made upon the arm by the *first;* bring it down steadily, but firmly, until you feel that it touches every letter, then raise quickly. This process requires rapidity of motion, as after a time the grease becomes partially melted by the warmth of the arm, and absorbed, and the fine lines become blurred. The whole process may be accomplished in the time usually required to obtain the first impression on paper.

Silver-plated articles of the softer metals, such as ice pitchers, etc., may be ornamented with scrolls, German text, old English, and other fancy letters, without using the graver. After deadening the surface with tallow, and sketching the letters or design with the boxwood point, take a sharp-pointed stylus, the end of which must be hardened and finely polished, and holding it nearly perpendicular, follow the design, moving or drawing the tool toward you—the reverse of engraving. Fill up the body, or shaded parts of the letters, by fine parallel lines, or other devices suitable to the design. The burr raised by the tracing point will scarcely be observed after the work is completed. G. M. H.

Madrid, N. Y

——o——

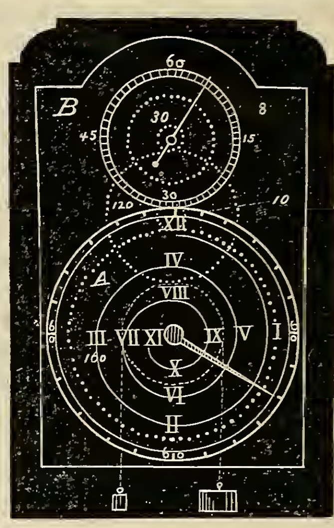
Ed. Horological Journal :

In your last number the answer of Mr. Gribi to B. F. H., concerning the friction of pivots was well put, and could not fail to afford light on a subject which to many seems dark, either from want of reflection, or perhaps of information. Still I think he might have opened up another view of it, if he had told us why he experimented with the pivot and jewels of the chronometer he mentions. I know he says he wished to make the vibrations of the balance more nearly equal each other in extent of arc in both vertical and horizontal positions, but there must have been a reason *why* he wished to do that, and I wish he had given that reason, also his *motive* for wishing to change the arc of vibration. As Mr. Gribi says, so say I, that it is to be hoped this subject will be thoroughly investigated, and I should be glad to hear again from him.

N. Y. City. H.

Answers to Correspondents.

M. M., *R. I.*—Your invention of a clock requiring but three wheels is not, as you suppose, new. Ferguson, the astronomer, constructed such a one, and before him, Dr. Franklin. For the benefit of yourself and of any others who may be reinventing three wheel clocks, we will give a full description of it :



In the drawing, the wheels and pinions in the rear of the dial-plate are represented by dotted lines. The great wheel *A*, of 160 teeth, has upon its axis a pulley through which motion is given to the train by means of a cord and weight. This wheel revolves once in four hours, driving a pinion of ten leaves in $\frac{10}{160}$ ($\frac{1}{4}$) of an hour. On this arbor is the second wheel of 120 teeth actuating the second pinion of eight leaves in $\frac{8}{120}$ of fifteen minutes, or in one minute, to which arbor and pinion is attached the scape-wheel of 30 teeth, which impels, by the ordinary pallets and fork, a seconds pendulum.

The economy of wheel-work in the movement is compensated for by the arrangement for reading the time upon the dial.

On the face is a spiral line, as shown by the engraving. The hours are distinguished by Roman characters, and count from XII. in the order following the spiral I., II., III., etc., placed at intervals of one-quarter of the circle.

These hours are pointed to by a hand carried by the arbor of the great wheel which revolves once in four hours ; it also points to the 60 minutes of each hour, which are repeated four times, and denoted by the Arabic figures in the minute circle. The seconds are indicated in the usual manner, by the seconds hand. As the hands now stand, the time indicated is 20 minutes past one, five, or nine, and it is presumed that a mistake of four hours could hardly happen in reading the dial. The objection that at night it might be easily read wrong, is, perhaps, one reason why it has never come into more general use, for there is no doubt but it can be made to keep time if carefully constructed.

Tycho Brahe, the astronomer, as early as the middle of the fifteenth century, also had a three-wheel clock, the great wheel of which contained 1,200 teeth, and had a diameter of three feet ; but he candidly confesses that he detected errors in its performance.

A. F. C., *Ill.*—You will find information about watch benches on pages 18, 19 and 95 of the present volume, which will answer your queries. It may, however, be well to add a word about the best method of fixing the "bead" along the front edge to prevent things falling off. Have the front of the bench planed to a perfect straight edge, and the strip, which may be either glued or fastened by screws to this edge of the bench, and which is usually formed into a half-round bead on its top, should have its upper inside corner bevelled off toward the surface of the bench ; or, what makes a much neater job, have this bevel concaved. To fix the vise upon the bench, provide a slip of hard wood the same as the bench top, about two inches long, and thick enough to come flush with the top of the concave border, and nicely fitted to it, and of sufficient width to allow two holes to be made in it, to receive the two spurs on the upper arm of the vise. If these spurs are so long as to reach through, they must be that much shortened. By this arrangement the vise can be placed at any position upon the bench without the necessity of cutting through the bead for the arm of the vise. The edge of the piece of wood fitting the bead closely, will prevent the vise from swinging from its position.

S. A. G., *Ind.*—The ideas you advance in your communications are better adapted to benefit those who *use* watches and clocks than those who repair them, and would do more good in some publication that has general circulation, than in a trade paper. There is no manual extant new and practical. Mary Booth is only a translator, and wholly unacquainted with watch-work, as her translation abundantly proves. Thanks for your expressions of approbation of the Journal.

W. B., *Georgia.*—You can entirely remove the mercury which has accidentally got on jewelry, without heat, by immersing it in diluted nitric acid ; a very little polishing will then restore it perfectly; nitric acid a little stronger will remove the film of copper which is deposited upon steel, when it has been immersed in pickle, which always holds copper in solution.

J. A. J., *Iowa.*—It is, as you say, sometimes difficult to get good brushes. New ones should always be put to the roughest work until the sharpness of the ends of the bristles is softened down by use ; they ought not to be put upon fine work until this is done. Some excellent workmen use new brushes first upon clean sharp sand-paper to grind down and soften the points ; others draw the brush across the sharp edge of freshly broken glass, which scrapes the bristles down, making each particular hair thin and soft at the point. The complaint you make that many of the soft brushes you buy have the undesirable quality of "losing their hair at an early age," is a fault much more easily remedied in a brush than in a human. A solution of shellac in alcohol, thin enough to flow readily, if *applied to the bottom* of the bristles of the brush, will flow into the holes in which the hair is set, and will harden there in a few moments, and fix them firmly in place. The shellac, being insoluble in water, does not interfere with washing out the brush as often as necessary.

W. H. McC., *Iowa.*—You are not the only victim that has been caught by the attempt to clean rubber jewelry. It can only be restored by the process of entire re-polishing. The best way to do that is to send it directly to the manufacturer.

J. C. M., *Maryland.*—You will do well, perhaps, to experiment upon an alloy, which is stated by Dr. E. Dingler, in the *Chemical*

News, to resemble gold in its appearance. The alloy consists of

Copper	58.86
Zinc	40.22
Lead	1.90

It may be such an alloy as you are in search of.

R. P. S.—Whalebone is not a suitable material for pendulum rods, even were its expansion and contraction nothing. It has elasticity, which quality is not admissible except the impulse is given to the pendulum at the centre of percussion.

When the impulse is obliged to travel along a rod to reach that point before it can act upon the mass of the ball, it should be received on a rod as rigid as possible. You can easily comprehend the idea by taking the other extreme. Suppose the ball of 15 lbs. suspended by a thread, and you attempt to give it impulse through the usual pallets and fork, the necessity of rigidity in the pendulum rod is instantly apparent.

S. W. L., *Illinois.*—You will find a description of the manufacture of main-springs on page 98, Vol. III., of the JOURNAL, and on page 74, Vol. I., an elaborate description of the best method of polishing steel flat.

D. C., *N. H.*—You can get all the parts of rubber and steel eye-glasses in duplicate of the manufacturers, and you will find it a great saving of time in repairing them. Some of the spectacle manufacturers make the bows identical in size, so that the lenses are interchangeable, thus obviating the necessity of keeping on hand a large stock; and it also saves the dealer much trouble who has not the necessary facilities for grinding lenses.

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EQUATION OF TIME TABLE.

GREENWICH MEAN TIME.

For January, 1872.

Day of the Week.	Day of Mon.	Sidereal Time of the Semi-diameter Passing the Meridian.	Equation of Time to be added to Apparent Time.	Diff. for One Hour.	Sidereal Time or Right Ascension of Mean Sun.
		S.	M. S.	S.	H. M. S.
Monday	1	71.07	3 37.21	1.187	18 41 49.69
Tuesday	2	71 04	4 5 56	1.174	18 45 46.25
Wednesday	3	71 00	4 33.56	1.160	18 49 42.81
Thursday	4	70.95	5 1.21	1 145	18 53 39.37
Friday	5	70.89	5 28 48	1.128	18 57 35.93
Saturday	6	70.83	5 55.33	1.110	19 1 32.49
Sunday	7	70.77	6 21 74	1 091	19 5 29.04
Monday	8	70.70	6 47 66	1.071	19 9 25.60
Tuesday	9	70.63	7 13.07	1.049	19 13 22 16
Wednesday	10	70.55	7 37.96	1.025	19 17 18 72
Thursday	11	70 47	8 2.27	1.001	19 21 15.28
Friday	12	70.39	8 26.00	0.976	19 25 11 83
Saturday	13	70.31	8 49.10	0.950	19 29 8.39
Sunday	14	70.23	9 11 56	0.922	19 33 4.95
Monday	15	70.14	9 33 35	0.894	19 37 1.51
Tuesday	16	70.05	9 54 45	0.865	19 40 58.06
Wednesday	17	69.95	10 14 83	0.836	19 44 54 62
Thursday	18	69.85	10 34.49	0.805	19 48 51 18
Friday	19	69.75	10 53.41	0.773	19 52 47.73
Saturday	20	69 65	11 11 58	0 741	19 56 44 29
Sunday	21	69.54	11 28.98	0.709	20 0 40.85
Monday	22	69 43	11 45.61	0.676	20 4 37 40
Tuesday	23	69.32	12 1.44	0.643	20 8 33.96
Wednesday	24	69.21	12 16.47	0.610	20 12 30.52
Thursday	25	69.10	12 30.70	0.577	20 16 27.08
Friday	26	68 99	12 44.14	0.544	20 20 23 63
Saturday	27	68.88	12 56.79	0.510	20 24 20.19
Sunday	28	68 77	13 8 65	0.477	20 28 16.74
Monday	29	68.66	13 19 68	0.443	20 32 13.30
Tuesday	30	68.55	13 29.90	0.410	20 36 9 86
Wednesday	31	68.43	13 39 34	0.377	20 40 6.41

Mean time of the Semidiameter passing may be found by subtracting 0.18s. from the sidereal time.

The Semidiameter for mean noon may be assumed the same as that for apparent noon.

PHASES OF THE MOON.

	D. H. M.
☾ Last Quarter	3 9 59.2
● New Moon	10 2 58.9
☽ First Quarter	17 0 2.1
⊙ Full Moon	25 5 14.6
	D. H.
☾ Perigee	9 15 8
☾ Apogee	22 11.7

	° ′ ″
Latitude of Harvard Observatory	42 22 48.1

	H. M. S.
Long. Harvard Observatory	4 44 29.05
New York City Hall	4 56 0.15
Savannah Exchange	5 24 20.572
Hudson, Ohio	5 25 43.20
Cincinnati Observatory	5 37 58.062
Point Conception	8 1 42.64

	D.	APPARENT R. ASCENSION. H. M. S.	APPARENT DECLINATION. ° ′ ″	MERID. PASSAGE. H. M.
Venus	1	15 34 47.15	−16 24 2.7	20 53.6
Jupiter	1	7 55 26.61	+21 13 11.9	13 11.2
Saturn	1	18 52 13.59	−22 30 14.1	0 10.4

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History of Compensation Balances.

NUMBER TWO.

From all the records extant, there seems not much doubt but that Harrison was the first person to suggest the idea of making the balance itself compensating—carrying within itself the power of self-adjustment for temperature. Peter le Roy, the French watchmaker, was as undoubtedly the first person to carry out the idea in actual construction in the year 1766.

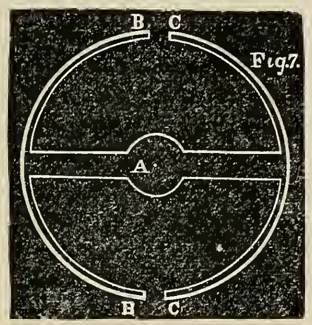
It will be sufficient to give a general idea of his thermometric balance, without a drawing. The arrangement consisted of two glass tubes, open at one end and terminating at the other in a bulb, similar to the bulb of a thermometer. Each of these tubes was so bent, that the tube extended down the balance staff nearly to the bottom, and there turning at a right angle outward as far as the periphery of the balance, then upward at right angles to the balance, where it again turned toward the centre of the balance, and with the bulb in close proximity to the staff.

One of these bent tubes is secured to each side of the staff, and resting upon a brass circle of considerable less diameter than the balance. These two tubes are filled through the open end, with a certain quantity of mercury, which, of course, will stand at the same level in both the upright parts of the tube; all the space above the mercury and also the bulb being filled with alcohol.

The action is this: When the balance and spring become enlarged by heat, the alcohol also has its bulk increased, and the only relief for this increase of bulk is through the arm, driving the mercury down the outer perpendicular tube and forcing it up the inner one; thus, in fact, forcing, by increase of temperature, a quantity of the ponderous fluid from the circumference toward the centre of revolution ; thus diminishing the momentum of the balance.

The two similar tubes being fixed to the balance and staff, diametrically opposite, and both acting alike, the equilibrium of the balance is not disturbed. By a diminution of temperature the converse action ensues; the alcohol has its volume diminished, the mercury following it up by the atmospheric pressure upon its surface through the open end of the tube, giving a preponderance of weight toward the outside of the circle of revolution. The adjustment to time was effected by mean time screws in the balance, and the adjustment to temperature must have been obtained by varying the quantity of mercury in the bent tubes.

Le Roy seems to have preferred this thermometric balance to those he afterward constructed entirely of metal. The frangibility of the glass tubes, and objections to its want of portability, prevented other makers from copying it, and it never came into general use. Le Roy also tried the compound bars of brass and steel, not to be applied as in Harrison's method, to action upon the hair-spring, but as a rim to the balance itself. In Fig. 7, A is the arm or bar of the balance; B B, and C C, two semicircular portions of the rim of the balance, formed by riveting together laminæ of steel and brass in such a manner that the brass is exterior and the steel interior. In writing of

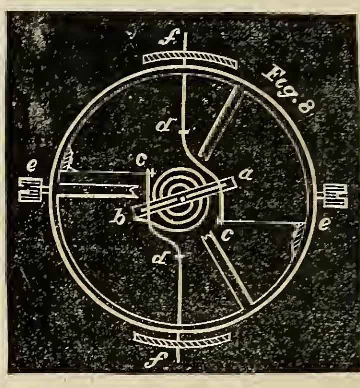


its action he says that, "it made a considerable portion of the circumference to approach the centre of the balance by an increase of temperature." In its action he found it to compare very well with his mercurial one, and it is surprising that he should have expressed his preference for his thermometric one, rather than for the compound metallic one, which had both stability and portability to recommend it.

He also contrived an index attached to a compound balance rim, for indicating its action and thus ascertain the laws which governed its motions.

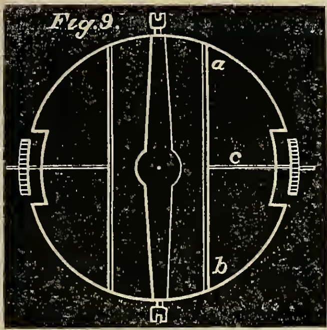
Much controversy has taken place as to whether Mr. Arnold, Sr., was really the inventor of his compensating balance, or whether he borrowed the idea from Le Roy. Mr. Arnold says that his first attempts to improve clocks and watches began in 1764, but it was not until 1767, that he turned his attention particularly to chronometers. The first compensating balance which he brought into actual use is represented in Fig. 8.

The rim and arms are of brass; the compound bar is, as usual, of brass and steel, and coiled around the balance arbor a little below the mechanism which lies between it and the plane of the balance; the exterior part of this compound bar is brass, and the interior steel; *a b* is a piece of steel, movable about the arbor, and having a longitudinal slot each way, from the centre to nearly each extremity, *a* and *b* · the end *b* has the exterior end of the compound spiral bar attached to it, so as to partake of its motion under all changes of temperature; *c d* are two bracket pieces, carrying each a pin under



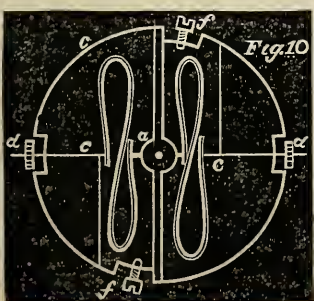
them that exactly fit the slot, and consequently they partake of the motion of the compound spiral; the ends *c* of the bracket pieces are attached to the balance rim at the points *e*, by the straight slender spring *e c*. To the ends *d* of the brackets are attached the long pins *d*, *f*, which pass through small steady bridges on the rim, and carry the segmental loads *f*.

The action is thus explained: when the temperature is increased, the exterior end of the compound bar moves in the direction from *a* to *c*, and carries with it the end *a* of the cross-piece, the opposite end *b*, of course, moving in the reverse direction; these opposite motions of the two ends *a b* carry the two brackets in such dlrection that the weights for compensation approach the balance and lessen its momentum; a decrease in temperature producing the opposite effect by opposite action. The slight springs *c* do not interfere with the inward and outward action of the weights, simply confining them to the plane of their action, and limit the direction of their motion. Between 1775 and 1778 this compensation was applied to ten or twelve different chronometers; in principle it is simple, but its construction is somewhat complex. The next balance of Mr. Arnold's is much more simple than the former, and is represented in Fig. 9. The rim and the diametric bar are of steel; in the rim an offset or recess is made for the compensating weight; the compound bars *a b* are a laminæ of brass interior and of steel exterior; the ends of these bars were in some cases pivoted, and entered into holes through the rim of the balance, and some were secured by a screw at one end, leaving the pivoted end free. The small rods *c*, which carry the ad-



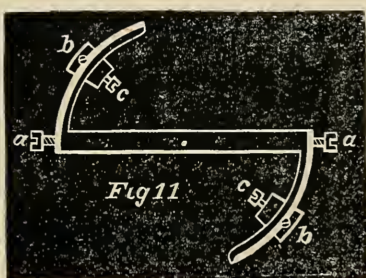
justing weights, were of steel, moving easily through a hole in the rim of the balance. Its operation is simple. By expansion the compound bars became flexed inward, thus withdrawing the compensating weight nearer the centre. The adjustment was made by varying the weight as compared with the weight of balance and adjusting screws, or by altering the distance of the adjusting weight from the centre of the balance.

It is stated that about 20 of these were made between 1778, and 1780, and performed very well. One of them, a gold chronometer, became famous, having been carried by Dr. Maskelyn for 18 months, at the Royal Observatory, under different degrees of temperature, and subject to the usual agitation of the pocket, change of position, etc. Its rate was published, which established its credit so high that it was sold for 1,000 guineas. The only objection urged against them was attempted to be remedied in Fig.



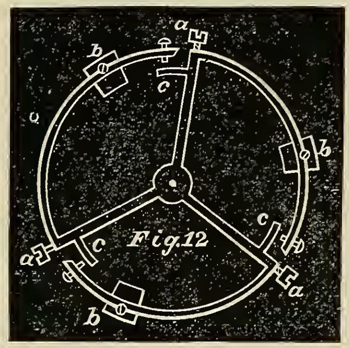
10, where the compound pieces are arranged in the form of a long S. This form was adopted by Emery, a Swiss workman in London. The two halves of the S are joined in the middle, and the brass, as before, is interior throughout ; the interior end *a* is attached to one of the shorter crosses of the balance ; the exterior end bears on the pins *c*, which carry the compensating loads ; these long pins are held in position by the two slender springs *e*, as in Fig 11. The relative weight of the loads of compensation *d*, and the weights *f* for adjustment to mean time, limit the effect produced by the expansion bars, supposing the distance from the centre fixed, but if the weights remain unaltered, the effect to be produced may be adjusted by varying the distance screws from the centre of the balance. Some 40 of these balances were made from 1779 to 1782. The length of the S piece, in the last balance, having been found difficult to execute of uniform thickness, shape and length, a modification was substituted, differing from it in having the ends united by an interposed piece of solid metal, thus dividing the S into two parallel compound bars. Only a few of these were made, because of the more simple form which was patented and adopted in 1782, by Mr. Earnshaw, and known among the workmen as the Z balance, in distinction from the S balance.

This balance has only two compensating pieces, and these quite short, being little more than a quadrature each. In Fig. 11,



a a are the mean time screws ; the sliding pieces have a concave groove, deep enough to form a bed for the expansion bar, and secured by the set screw *c;* it will of course be known that these blocks are for adjusting to temperature. These weights he makes by turning in the lathe a brass ring, which is then cut into 14 equal parts by the cutting engine, so that each piece is the 14th of a circle. This form of balance did not prove very successful, and was the occasion of some sharp correspondence between Mr. Earnshaw and the Board of Longitude. Another balance of Earnshaw, claimed and patented by him, was undoubtedly the production of Mr. Firminger, the assistant of Dr. Maskelyn, of the Royal Observatory.

Mr. Brockbank, the partner of Earnshaw, was the first artisan to unite the two metals by fusion. Hitherto the laminæ had been fastened by pins or rivets. He also turned the rim out of a solid compound plate, thereby insuring uniformity of figure and weight, which two properties are essential to produce what the name purports—a balance.



This improved balance, Fig. 12, has three radial arms, uniting at the centre, each carrying the third part of a compound circular rim. This circle is first turned out of a solid compound plate of steel and brass, a circular plate of steel of the required diameter being immersed in a crucible of melted metal. This rim gives, by division, three equal portions. At the end of each of the three radial arms, which are of steel, are three adjusting screws *a*, for time and position; the free end of each arc is loaded by the weights *b*, which have grooves in which the balance rim slides, and which are fastened by set screws; also in the free end of the segments is a small screw pin exactly opposite a projection on the arm, which seems to be simply a guard to prevent the accidental crushing, or improper bending, of the compound arcs.

Mr. Arnold experimented upon various forms, which were never adopted in practical use. The zeal with which he pursued this subject, devising each new form to, if possible, remedy some ascertained defect in its predecessor, clearly shows an originality and fertility of invention, totally at variance with the accusation made against him of plagiarism.

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Bronze Clock Cases.

An accumulation of wealth by communities and individuals of the present day, which was not dreamed of by our ancestors, and the shifting on to the broad shoulders of the modern giant, steam, of a large proportion of the muscular labor incidentally necessary to the maintenance of every well-regulated community, has given to the present generation ample leisure to pursue the higher arts of civilization, and has fostered and developed a taste for, and a progress in, the various departments of fine arts, which will ere long remove the stigma so long attached to us of the New World, as being devoid of artistic taste, and the skill necessary to produce creditable specimens of art.

It seems scarcely fair to charge the want of years and experience to us as a fault; at the worst it is but a misfortune, which the lapse of time will diminish, year by year. Art does not spring into existence in complete armor, like Minerva from the head of Jupiter, but is a plant of a slow growth, and cannot thrive amidst penury—wealth being the proper soil for its development.

As a slight but characteristic example of the growth of taste, who is there so young as not to remember the form and features of an antique English watch, so awkward and uncouth in figure and size as to be christened a "bull's eye?" For the sake of convenience and appearance, its form was gradually modified by diminishing its thickness, and subsequently its diameter, and so on down to our own time; and now no expense of jewels, no stint of artistic skill, is permitted in constructing the dainty vestments of "Time."

The gradual growth in taste, by the lapse of time and the accumulation of wealth, which affords that elegant leisure so essential to it, is simply and beautifully shown by a comparison of the clock of then and now. A hundred years ago it was, in appearance, but a repulsive machine of wheels, and wires, and strings, placed upon a rude shelf affixed to the wall—devoid of form in itself, and doubly disgusting from the accumulation of dirt, because the housewife, however tidy, must on no account touch the clock. Thriftiness soon found a remedy for this difficulty by enclosing the movement in a box, and a grain of taste was evinced in painting and ornamenting this case, and in placing it upon a more pretentious bracket. Still the unsightly weights were there, and the great iron bob, with its monotonous swing, was constantly in sight; and although taste might not have been offended, prudence suggested another box to protect these parts from a careless and curious progeny. This box undoubtedly annoyed the inborn sensibility of some one, and it was rendered less obnoxious by adornment; and gradually, little by little, it became a respectable article of movable furniture, sharing equal with its fellows in the bestowment of finish. Ultimately its huge form, adorned as it was with inlaid woods and metals, became repulsive; its dimensions were curtailed, and it was shortened for the mantle. In this form it was artistically ornamented (for the times) by painting and gilding, and landscapes, where yellow houses, sheltered under azure trees, beneath violet skies, were reflected from green rivers. Architectural designs with turrets and pinnacles followed, executed in fancy woods. By this time models of a higher taste began to be imported by the better educated, which were rudely copied in iron, all "golden and green" with ornamentation, yet evincing progress in public taste. From this time on, constructive art has followed fast upon the footsteps of taste, and has admirably sustained the race after the beautiful, till at present there is no conception of high art too exquisite for the drapery of a time-piece.

It is curious to trace the metamorphosis which an art conception undergoes before its appearance in commerce as a graceful screen for some utility. An idea conceived in the undulations of the artist's brain, takes its first visible form in soft plastic wax; this fragile creation is next embedded in liquid plaster, from which the wax model is removed, and its place supplied by a plaster cast. This cast is next used to form a matrix in fine hard brass, and from this matrix issues the metallic embodiment of the artist's thought, in material hard enough to withstand the rough usage of commerce.

The markets are now filled with these art productions, and our own artists and mechanics are scarcely behind their older brethren abroad in the skilful execution of designs, both original and copied. Representations in bronze of the purely ideal do not as yet find a sufficient market to make their production pecuniarily successful; but in such articles as are useful, and semi-useful, the double charm of utility and ornament produces a larger demand; and of this class are gas fixtures and clock cases. The former are almost wholly produced in hard metal (fine brass), and the latter in soft metal. A brief mention of the mode of construction may not be uninteresting to those who are largely interested in their sale, and who may not have had an opportunity to see, as we have, the process, in the manufactory of Mitchel, Vance & Co.

The designs are, of course, either the original conception of their artists, or are copied from the most approved models. These designs, carefully worked out in plaster models, are, when perfected, used to produce a mould in brass in which to cast the soft metal. These moulds, when the figures to be cast are elaborate, must be made in many parts, so that they can be removed from the casting; some designs requiring as many as a hundred different pieces. Some idea of the labor of perfecting these moulds may be formed, when it is remembered that each piece must fit so accurately its fellow-pieces as to prevent the fluid metal from escaping; these pieces being fastened together by screws through lugs upon the outside. The moulds are of considerable thickness, not alone for strength, but to produce a conduction sufficient to chill the metal when poured in; this property being taken advantage of to produce hollow castings without the necessity of a "core." The metal used for these bronzed castings is pure refined American zinc, which takes the mould beautifully, filling out the finest lines, and requiring but little retouching after being taken from the matrix. In casting, a quantity of the melted zinc is taken up in a ladle and poured into the mould, and when full it is immediately poured out again. The surface only of the melted metal which is in contact with the cold matrix being chilled, and the centre of the mass yet fluid, allows it to be poured out, leaving a film of metal next to the mould, of a thickness proportioned to the time it is allowed to remain, and the temperature and thickness of the mould itself. The consideration of these relations constitutes the skill of the caster, and the lack of judgment in reference to these conditions produces defective casts.

The mould is then unscrewed, all the parts removed, one by one, and the enclosed cast released. After all the various pieces which are to make up the figure are thus produced, they go to the soldering table to be joined together. Throughout the building, to all those points where an air blast is required, air tubes are carried, filled with air under considerable pressure from a rotary blower, and to these pipes are attached rubber tubes, wherever required, terminating in a nozzle and stopcock, to which nozzle is attached a rubber tube connected with the gas pipe. Either the gas or air can be shut off or admitted at pleasure, and this arrangement constitutes a compound blow-pipe of considerable power, in the flame of which zinc turnings will burn with vivid brilliancy. The flexible tube also permits the flame to be readily turned upon any point, the operator directing it with one hand, while with the other he holds upon the parts to be joined, the solder in the form of wire. As soon as the adjacent parts of the figure become heated to the melting point of the solder, it flows into perfect union with the zinc.

In those clock cases where there are flat surfaces, they are planed with a milling tool, and finished to a dead surface by emery wheels. Wire brushes are also sometimes used for perfecting the finish of irregular surfaces. To insure the identity of that part of the frame to which the clock movement is to be fastened, a separate ring is cast with all the necessary recesses, projections, and screw holes, etc., and this movement ring is lastly soldered to the frame, thus insuring a perfect fit of the movement, although imperfections may have occurred in fitting together the different parts of the case.

At this stage it goes into the electro-plating bath and receives a coating of brass, thus virtually turning it into a brass casting, which is admirably adapted to receive the final bronze finish. These bronze lacquers are of every obtainable shade of metallic tints which it is possible to produce by the impalpable disintegration of the metals themselves, as well as their oxides, and it is to the skilful and artistic application of these metallic coatings that the finest effect is due. Sufficient heat is used in lacquering to cause it to flow evenly over the surface as a final finish.

Imitation marble cases are also made, rivalling in variety of form the real stone. All dealers know the marble on the foreign clock cases is but a veneer of genuine, backed up by a composition stone. In constructing these marbleized cases, the various parts are moulded from the plastic material, colored, japaned, and baked; the parts are then polished and put together by cement, in precisely the same manner as the real. An objection is often urged, both to the imitation and real, that the thin delicate parts, the corners and edges, are liable to fracture through carelessness, and that when so damaged they are difficult to repair. This fault is likely to be remedied, if not wholly removed, by the judicious use of ornamental metallic bases, corners, and tops, thus promoting both strength and beauty.

An absurd prejudice prevails with some persons against imitation bronzes, and many who are loudest in their denunciations of them would find it impossible to distinguish the true from the false. Where the beauty of an article depends almost wholly upon form, and not at all upon intrinsic value, what is the difference whether it is of bronze or zinc? and especially, where the durability of the article is not in question. Of what consequence can it be whether the one endures forever and the other only a lifetime? There can be no difference in the artistic merit, where both are cast in the same mould, only one of hard and the other of soft metal. Any method of multiplying meritorious art productions at a moderate cost is of incalculable value in elevating and correcting public taste. The lower the price at which they can be produced, the sooner they are brought within the reach of a large class of persons of moderate means, whose refined taste longs for gratification, but whose restricted finances forbid its gratification. It also so multiplies these art specimens as to bring them more constantly before the public eye, thus insensibly schooling it to a higher appreciation, and eventually leading it on toward the point where nothing short of truly artistic forms will be tolerated.

The photographic art is a striking illustration in point; its general introduction within a comparatively few years, and the infinite diversity of its application, has done more to correct public taste than did the previous hundred years of the painter's artistic labor. The horrid colored prints, and the dreadful lithographs, which formerly hung upon the walls of the middle and lower classes, have been supplanted by the cheap but really beautiful specimens of photographic art; copies of all the productions of the great masters in sculpture have lent aid to elevate the public taste for art products.

There is no field of industrial art which affords a wider scope for the introduction of artistic forms than in the production of gas fixtures, as there is no limit to the combinations of beautiful forms and figures; consequently it is not surprising that it forms the principal feature of all our bronze casting industries. Who is so totally devoid of taste as not to prefer seeing a gas flame issuing from the tip of Mercury's wand, than to see it blazing from the end of a rough iron pipe? Does not a dial supported upon the wings of "Time" show more pleasantly the flying moments

——"Than an ugly clock
Rudely fastened to a graceless block?"

——o——

Engraving.

In answer to many inquiries for engravers' tools, directions for forming and tempering gravers, instructions in the art of engraving, etc., etc., some hints will be given which may be of service to those who can do no better than make the attempt at self-instruction. All the tools necessary can be bought of the material dealers, and will be much better and cheaper than can be made at home. A full description of all that are necessary will be found on page 158, Vol. II. of the JOURNAL.

Engraving is a general term applied to the art of cutting ornamental or other designs upon any surface; technically the definition is confined to a more limited range. Bank-note engraving includes that upon steel and copper for the purpose of printing or taking impressions from, and does not practically concern our trade. Lithographing is often erroneously called engraving on stone, but it is not engraving, the design being only drawn on the surface of the stone with an ink peculiar to the requirements of the business; wood engraving is sufficiently explained by its name, and does not come within the needs of the jeweller; seal engraving is also another misnomer, as the lettering is nearly all done by dies or punches, which are driven into the metallic surface; plate, letter, and jewelry engraving are the varieties that are practised by the watchmaker and jeweller. It is, however, one of those arts of skill which can never be learned from books, nor by the most careful and elaborate written instruction. There is no theory, no science, and no particular principle involved in its practice. It is a kindred art to penmanship, and oral or written instruction, beyond a few simple instructions, will never perfect the student in it; his progress depending entirely upon practice and a natural taste *directed* by approved models. Who could ever become a proficient in the game of billiards by being told, or reading, how to shoot the balls? To be an engraver at all, one must have the "divine afflatus" born in him; and to become a good one, requires, in addition, tedious practice; and to become first rate—a proficient—it is an indispensable requisite that this long practice be guided by the constant supervision of a thorough master. The basis of the whole art is good taste, and an inherent aptitude for drawing. A good penman has no more advantage as an engraver than one who is deficient in that respect. A shocking bad writer may be a good judge of penmanship and yet not have the necessary command or practice of muscle to execute the conception of his mind. Skill in drawing is a fundamental requisite, as all designs, previous to being cut, must be sketched or drawn; and if the first sketch is not equal to the demand of taste in the artist, it is obliterated and another made, and so on till the sketch becomes satisfactory. These repeated attempts may be upon so simple a thing as a single capital letter; and to prove that taste and skilful drawing are required, it is only necessary to mention an incident in the writer's own experience to show it.

An elegant penman was desirous of having a set of forks engraved, and was especially anxious that the engraving should be up to his ideas of style. Knowing him to be fastidious in his taste, it was suggested that he himself should draw the copy, then there could be no failure. The surface of the fork was deadened, the stylus was given him, and he confidently sat down to write the name. He wrote and erased; erased and wrote; wiped the perspiration from his hands and forehead; tried it again and again; finally gave up the attempt in despair, with a sensible order to the engraver to do it as he pleased.

In lettering upon silver or plated ware, the progress of the student who is so unfortunate as to be obliged to be his own teacher, may be somewhat facilitated by knowing a few fundamental facts in the commencement. There should in all cases be a proper proportion observed in adapting the size of letters to the space they are to occupy. There, as before intimated, the taste of the artist *must* be the judge, as no rules can possibly be given. If, after the sketch is made, they seem too large, rub it out, and draw them smaller, and observe the effect upon the eye; if they appear too small, try again; these repeated trials will soon so educate your judgment as to gradually lessen your failures. Then again the location of the design, its position as a whole, either to the right or left, or up or down in the space, will make or mar the effect. Repeated trial will be necessary to meet the requirement of your taste, and these repeated attempts to harmonize form and position with taste and judgment will react upon each other, to the rapid improvement of both.

The spacing of small letters in a name, as well as the relative size of the small letters and capitals, has a wonderful effect upon the general appearance of the work; there, again, must patient trial take place if improvement is desired or expected. In drawing the small letters the utmost pains must be taken in this respect, and much judgment will be needed to bring about the desired result. Where *n*, *m*, *u*, occur together, they ought to be so separated as not to run into each other and have a crowded appearance. The letters *e*, *c*, *o*, *i*, must, on the contrary, be placed so near each other that the general effect may not be that of being scattered. Double *l*, *t*, *f*, will need very careful attention in these respects, as no rules can be given that will have any other than a general application.

The angle of inclination has also a great influence upon general effect, and the only important direction to be invariably followed is, that whatever angle is adopted it must be rigidly adhered to in the specimen; nothing so surely spoiling the beauty of lettering as the various letters showing different angles of inclination, suggesting a want of sobriety, either in themselves or the engraver. This defect is not so obvious in capital letters as in the small ones; yet with them, too much care in this respect cannot be exercised.

There are no books published that give instruction on this subject, but there are various copy books of letters and designs, with combinations of capitals, that are valuable as copies for drawing from. The copies in the books of penmanship are not adapted as copies for engraving, because they are designed as running hand copies, and it will be found, on trying the experiment, that the effect is not agreeable when engraved. The script lettering upon bank notes is a sample of the best style, and no better study can be recommended.

The beginner will experience his greatest difficulty, at first, in properly shaping and sharpening his graver; to do this intelligently he must know exactly what it is expected to do—what it really performs in the act of engraving. The word *grave*, a trench or ditch, sufficiently indicates what is to be done, and the method of doing this is called engraving. One of the simplest, and perhaps one of the best illustrations of engraving in a magnified form, and therefore the more easily studied and analyzed, is the act of ploughing. The plough is the graver, the earth the plate to be cut, the motive power being applied in front of the tool, not behind it as in the graver, but this makes no difference in the analysis of the action of the tool.

Suppose now that this huge graver is forced through the soil in such a manner as to make a ditch, trench, channel, or cut ; it will be instantly comprehended that the form of the plough will determine the shape of the cut, also the character of the soil will modify the character of the resulting groove. The ordinary plough, if forced through tenacious clay, will leave a cut perpendicular upon one side, flat at the bottom, and inclined upon the other side ; by varying the shape of the plough the groove it forms is correspondingly varied.

The angle or pitch of direction which the plough point takes with relation to the surface of the ground, is an essential consideration in the depth to which the groove will be cut, and this matter is regulated in the plough by varying the point of attachment of the motive power, and this point has a critical influence upon the draw of the instrument: if it is so attached as to throw the point of the plough constantly *downward*, the tendency and consequence will be to run into the ground to an indefinite depth; or if kept out, it will be at the expense of constant counteracting exertion by the ploughman. On the contrary, if attached too low down, the tendency and result will be to throw the point *out*, and the same exertion will be necessary to keep it below the surface; but if the draw be at the right place, the plough point will take a position at a distance below the surface and maintain it, requiring no labor except guidance by the ploughman. Thus it is with the point of a graver; the angle that the face of the graver makes with the plate determines the tendency of the tool to run either out or in the metal; and this inclination of angle is controlled by the amount of elevation of the handle above the plate. This elevation must be sufficient to allow room for a handle, and for holding it; consequently the angles which the point makes with the plate will be of an inclination tending to draw the instrument deeper and deeper below the surface. This tendency can be counteracted only by lowering the hand toward the plate; as this cannot be done for want of space, what's to be done in such a dilemma? A little of two corrections may be applied: first a portion of the lower side of the handle may be cut away; that is, the side upon which the point is formed, and which is technically called the "belly" of the graver ; this will not, however, allow it to be sufficiently depressed and yet leave room for holding it as firmly as is necessary. The other partial correction is produced by honing away the two under-surfaces of the (square) graver, thus forming the belly—which is nothing more than changing the straight line upon which the point is formed into one a trifle curved. It will readily be seen that the degree of this curvature of the belly will determine the amount of elevation allowed to the handle.

In using the graver, the action of the plough will be a good study, supposing the handles to be the handle of the graver. In driving straight forward, the character of the cut will be governed by the position in which it is held; if the belly is kept exactly under the upper corner, a cut will be made having its sides equally inclined till they meet at the bottom; if it is rolled over towards the left, the cut will be perpendicular upon one side, and a long incline upon the other ; if it is revolved toward the right, the perpendicular and inclined sides will be reversed. In cutting curved lines, it is of importance which side of the cut is perpendicular and which inclined, because, in making the curve, the handle of the graver describes a large circle, the point being a constant fulcrum; and the moment the body of the graver deviates from following the point in a right line, that moment the belly has a tendency to, and in fact does, touch either one edge or the other of the groove already cut, depending upon which side the deviation occurs. This action will be fully comprehended by supposing the graver to be laid down its whole length in a straight cut, and the front end be held down, and the attempt be made to swing the handle to the right or left; the consequence will be, that one or the other of the corners of the cut will be torn away by the effort ; and this is why the graver must always be rolled over *toward* the convex part of a curved line, as in that position an incline is smoothly cut by the face of the graver, which allows the belly to come out on the convex side without touching the corner, thus leaving the cut smooth and polished.

This peculiar motion of the graver is of constant service in forming the widened parts of script letters, both small and capitals. One of the earliest motions to be learned in manipulating the graver is the turn necessary for cutting the shade on either side of the centre line. Also a source of trouble to the learner is the constant apparent inclination of the graver to *slip out*, making a "bee line" off into space. This is a trick of the graver, that will do to study carefully. The belly, as will be remembered, is a curved line, convex toward the face of the plate, and if the hand which drives the graver is lowered it instantly throws the point upwards, and a "slip" is the consequence. Contrariwise, if the hand is a little too much raised, the point at once "digs in," and either a cut wider than was intended is the result, or the graver comes to a dead stop. Practice alone will give the necessary muscular control to carry the hand at the level which is so necessary to prevent this catastrophe.

On a plain surface the danger from this source is not great, and the requisite skill is soon acquired; but when the surface is considerably convex, the tendency to slip is much increased. The method of holding the graver is a matter of some consequence, as its action can in some degree be governed by this means. The middle, third, and little fingers are those that are necessary for holding the graver, the handle being pressed up into the hollow of the hand by these fingers, leaving the thumb and forefinger at liberty. The forefinger is used to keep the graver pressed against the thumb, which is held stationary against the plate, or whatever is being engraved; the muscular action to propel the graver is within the hand, not in the arm, and the length of stroke in a right line is rarely more than an inch; the graver sliding along the ball of the thumb, and being kept steadily against it and down on the plate, by pressure from the forefinger, which moves with the graver. When the cut is to be farther extended, the thumb is moved forward, and again planted firmly on the plate, the graver drawn back by the muscles of the hand, the point placed in the cut, and another forward movement made. This slight of hand movement is much easier made than described; and it will be found out after a little trial, that the thumb is the main reliance in guiding the graver in cutting straight lines and curves. Its usefulness in this respect is easily proved by attempting to cut a straight line of considerable length without its assistance. The thumb is of still greater assistance in forming curves, for in that case it is used as a fulcrum, about which the graver is revolved, thus insuring a perfection of form which could not otherwise be readily obtained.

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Reminiscences of an Apprentice.

"OUR JOURNEYMAN"—FRICTION.

"Our journeyman" was a few years older than I was. He had partly learnt his trade in a neighboring town, and afterwards he went to London for a couple of years, and returned with the concentrated essence of all the knowledge that exists in that great centre of skill and experience. He knew the way to do everything, and there was nothing that he did not understand. Any one of the innumerable descriptions of clocks and watches was all the same to him, and he was equally skilful in jewelry and silverware. As a general thing, the young men of our town were jealous of him after he came back, and blamed him for "spreading himself out," "putting on airs," etc; but I noticed that some of my companions who had been in cities not half so big as London, came back and put on airs too; and surely "Our journeyman" had the right to spread himself out farther than them, seeing London was a far bigger city, and he was longest away from home. People were fond of telling a story about him, although I never believed it, that when he arrived home from London he asked the porter at the railway station the way to his mother's house; but you see people in country towns are so ready to make remarks on people better than themselves. Supposing the story to be true, however, was it any wonder that one being so long in London, and learning so much, should forget all about the streets of our little insignificant town? Some incredulous persons may think that a head containing all the knowledge he possessed might burst, and so it might, only that his mouth and tongue acted as a safety valve, and prevented any such catastrophe. I always considered "Our Maister" to be a clever man, but I thought "Our journeyman" to be far greater because he had been in London, and talked a great deal about it, while "Our Maister" had never been there, and could not talk so much. When the two got into any little argument about the work that was being done, as sometimes they did, "Our journeyman" would invariably silence "Our Maister" by telling him that that was the way we used to do in London; but although silenced, "Our Maister" would shake his head, smile, and insist upon having things his own way, the same as he did with me, which I thought was a little presumptuous on his part.

"Our journeyman" did not make his drills or sharpen them as well as I could, but then I thought that in such a great place as London they might have some way of making holes without drills, which might account for his making such bad ones. I also noticed that his gravers were neither so evenly ground or whetted as mine or "Our Maister's" were; but I tried to explain in my own mind that in London perhaps they kept a man for the purpose of sharpening gravers, which would account for "Our journeyman's" want of experience in this particular. The pins that he made were neither one shape nor another; but I did not think much about that because it could not be expected that a man who had been in London would condescend to be particular with such a trifling little thing as a pin. "Our Maister" sometimes spoke to him about the condition of the points of his screw drivers—that they bruised the heads of the screws in the watches; but I thought it mean of "Our Maister" to grumble so much about so common a thing as the point of a screw-driver, which I did think was altogether below the dignity of a man who had been two years in London. "Our journeyman" possessed many secrets, and why should he not have trade secrets after being in London? He would not tell any of them to "Our Maister," and it could not be expected he should, either; but he often promised to tell me something if I would do certain things for him, and in this way he got me to do a great many things that I had no business to do. When he told me any secrets, it was always something "Our Maister" had told me before, or something I knew without anybody telling me; but then I thought I was too young to be able to understand the big secrets, and I waited patiently till I should get older.

If "Our Maister" was from home for a day or two, "Our journeyman" usually attended on the customers; and on these occasions he fairly teemed over with London fashions and styles of jewelry; and if that had not the desired effect on the customer, he treated them bountifully with selections from his stock of Cockney phrases. Some of the customers were perfectly delighted with the clever young man, and thought he ought to have a shop of his own, and thought "Our Maister" was only an old fogy. Other customers, again, if they could not wait till "Our Maister" came home, would transact their business with me. "Our journeyman" did not like this, and told "Our Maister" that I was not polite to the customers; but it was only because I would not tell lies, and say the things all came from London, when I knew very well that many of them were made in our own shop, and I also knew that "Our Maister" always wanted me to tell the truth. One day, however, I got square with "Our journeyman," and I kept myself square with him ever after. He was putting a watch together, and asked me to hand him a bottle of mucilage. I got the mucilage for him, and I waited to see what he was going to do with it when putting a watch together, but he turned his back and told me to go away, that I would find that out soon enough; so I went away, thinking it might be some of the big secrets that I was too young to comprehend. Some way or other, however, I looked over his shoulder, and saw him fastening in a screw with mucilage that had overturned with him when putting the watch together. "Oh," says I, "is that the way you used to do in London?" and I quite innocently remarked that when a screw overturned with "Our Maister" he always made a new one. He was awful mad at my seeing him, and got up and chased me round the benches with the large drill bow till I promised not to tell "Our Maister" when he came home ; and as I never had any intention of telling, I consented to his proposition on the condition that he would never tell anything more about me, and the bargain was closed to the satisfaction of both of us.

"Our journeyman" had the most profound contempt for books and magazines on any subject connected with the trade. He made it a point never to believe any thing about the business that he saw in print. Cumming's Elements were all nonsense; Ried's Treatise made him go to sleep; and as for Berthoud and Jurgensen's works, they were only foreign gibberish. All the old works were antiquated, and no modern workman could derive any benefit from them; and as for the new publications, they were nothing but humbug, and he knew it, for had he not been two years in London, and what more was necessary for him to be a judge? A friend sent him some of the early numbers of the *British Horological Journal* regularly, but although it came from London he would never read a word of it ; but "Our Maister" always read it through and through when he could get a copy, and I liked to read it too ; but here I must remark that neither "Our Maister" nor I had been in London, which may account for us having a desire to read the Journal. I have seen "Our journeyman" tear it up and use it as wrapping paper, just to show how little he required the teachings of any journal or book connected with the trade. I remember a man used to come round sometimes, to take orders for a trade journal that was in the course of publication. He always happened to call when "Our Maister" was out, or I think he would have subscribed. I liked to glance over the sample copies, and I wished I had money enough to be a subscriber, for I saw many things to interest me, but "Our journeyman" was far sharper than I was, and was not to be imposed upon so easily. He flung the publication at the man, and said that it was nothing but an advertising dodge; that in London the wholesale watch dealers gave away illustrated catalogues which contained more information than the publication did, and they gave them for nothing ; so you will observe that nobody could impose upon "Our journeyman," he was so awful sharp and clever.

There was a half pay army officer a resident of our town who had great proclivities for science, and a weakness for using high language. He never would call a spade a spade, or a watch a watch. His watch was his Horologium, and sometimes he would come into the shop to get the Horologer to eradicate the defections of his Horologium. About the time of one of his visits one of our townsmen had taken out a patent for an improvement on frictional gearing and it was the general subject of conversation in our town at the time. "Our Maister" remarked that he was always under the impression that friction was not caused by the extent of the rubbing surfaces, but by the pressure that was upon them ; but in this frictional gearing the surfaces were made large, apparently to create friction, and thus prevent the wheels from slipping; so "Our Maister" asked the learned visitor how the theory that there was the same amount of friction in a narrow surface as in a broad one could be reconciled with the results obtained by the experiments made to establish the efficiency of frictional gearing. Our learned visitor replied that the reconciliation of the theory in the one instance, and the practice in the other, was exceedingly simple; and went on to explain that "in applicate mechanics two quiescent discs, with their periphery free from abrasion or dentation, contrary to the usual practice of Horologers and other mechanicians, had a reduplication of circumferential potent energy imparted to them as homogeneous solids moving round a permanent axis, not by pressure alone, but also by the cohesion of the molecules of matter that constituted the periphery of the once quiescent discs; and that the line of pressure, being toward the centre, directs these aggregate combinations of forces into a polygon, which finally collapsed, and the tangible forces, rushing off at a tangent, imparted motion to the material discs or wheels, the velocity ratio of which was equal to the quintessence of the aliquot part of the circumference of the discs, if no unguent be used." "Our Maister," after this volley of science, was perfectly stunned; his glass fell from his eye, he gasped for breath, and could not utter a word in reply; but "Our journeyman" was quite unconcerned, and thought the explanation a clear one; but that while he could never believe that there was the same amount of friction on the narrow surface as on a broad one, still there could be nothing plainer than that when the polygon burst, the forces flew off at a tangent, and gave motion to the wheels. In fact, when he was in London, he had often seen the same thing himself. That day the old scientific gentleman went away proud that his own learning had been appreciated, and happy that our town possessed such an intelligent young man from London.

It is to be regretted that too much pretentious London knowledge, and too much science at one time, squelched "Our Maister;" nevertheless, it is to be hoped that his practical experience on friction will be made public on some future occasion.

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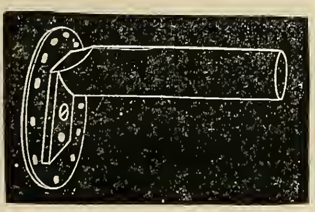
Centring Arbor.

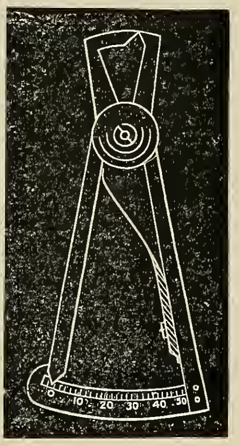


The above cut represents one of the many useful accompaniments of Mr. Grossmann's lathe, but is equally applicable to the ordinary or the American lathe. It is an arbor, having one end bent at right angles, and formed for fitting upon its face a steel disk by a screw through its centre, and a steady pin to secure it in position. Around this disk and near its edge is a graduated series of holes. The solid arbor is cut away opposite the upper hole to allow an arbor or pivot to project through a sufficient distance to centre it with a file, using the cut-away part as a rest. The exigencies which constantly occur to the practical workman, give birth to an infinity of small mechanical conveniencies.

Swiss Gauge.

The following cut represents the caliper or gauge in most general use among the Swiss watchmakers. It is exceedingly simple in its construction, and needs no explanation.

Its practical application will be best illustrated by an example: Suppose the repairer wishes to replace a pinion which is lost. After selecting the proper size and number of leaves, the question arises, how is he to know the height and length of the different parts of the pinion? With this gauge it is very easily ascertained. Suppose it to be the 4th wheel pinion; screw the cock in place on the plate, and with the gauge measure the distance between the outside of the two jewels, which will measure, say 36°, then remove the cock and measure the thickness of each jewel. The cock jewel being $1\frac{1}{2}$°, and the plate jewel 2°, which together equals $3\frac{1}{2}$°, and $\frac{1}{2}$° for end shake; subtract this amount, and there will remain 32°, as the length between shoulders.



To find the length of the pinion leaves, measure the distance from the outside of the plate jewel to the top of the 3d wheel, which is, say 12°; this is the measure to the top of the plane of the wheel, but the pinion should be a little higher for safety; 12° from the shoulder of the pinion to the top of the leaves gives the thickness of the jewel (2°) for safety. The shoulder for riveting the wheel upon will depend upon the escape wheel pinion, and inspection without measurement will easily determine it.

The measurement for a centre pinion will be from the outside of the plate to the outside of the bridge; deduct from this the sum of the thickness of each, which leaves the distance between shoulders. The seat for riveting on the centre wheel will be the number of degrees between the outside of the plate and the top of the going barrel, plus 2° for safety, minus the thickness of the plate.

These examples will be sufficient to suggest the means by which working measurements can be taken of almost every part of a movement necessary to be made, and is a vast saving of time over the ancient and *dis*honorable "cut and try" method. With a little practice, and a reasonable amount of care, a part can be fitted with a reasonable expectation that no alteration will have to be made when it is put in place.

These gauges, as found in the tool stores, usually have the spring too stiff, and before use it will be best to reduce it to a thickness barely sufficient to close it surely, because otherwise in using it upon very delicate parts, the sense of touch, which has to be mainly relied upon, is not sufficiently sensitive under the action of a strong spring

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Analytical Horology.

INTRODUCTION.

EDITOR HOROLOGICAL JOURNAL:

There are constant calls for practical articles by readers of Horological literature—demands for plain directions to infallible results: how to make a watch go, and how to make it keep time; a sort of Horological notation, requiring only to be fingered off in solid material. Apart from the impracticability of such Horological cookery receipts, seekers after this kind of production are scarce aware of the low and dependent position they are assigning to themselves. An example or two will perhaps illustrate this fact. A workman is intrusted with the execution of a piece of mechanism; from the commencement to the finish he has to rely, step by step, on the direction or design furnished to him; he progresses with and completes his task successfully, without having any idea of the laws involved in its construction, or the condition of final success, and may be as ignorant of the ultimate effect of his labor as if the operation had been carried on by some one else. I grant that, under similar circumstances, a man may go through the world and prosper; but he is never entitled to any credit for what is achieved by his instrumentality, except his own manipulation, and is a mere living tool in the hands of the prime mover—the designer. Under altered conditions such a man may, however, be awkwardly situated.

For instance, here is a watch repairer whose idea of practice consists in the knowledge how to get a depth over stopping—to stretch a wheel tolerably true—succeed in getting a wheel to pass freely through the pallets—and to scrape a pendulum spring. The balance is associated in his mind as a sort of pulse by which to tell the state of the motive power. A watch is put into his hands that performs irregularly, and which he is expected to rectify. What a blessing it would be if he could now find a practical article where he could read off what to do, and which would assure success. But as such is not possible, what is he to do? Under such circumstances there are three ways of proceeding open to him.

The first, and which in this example is closed against him, would be to examine the conditions involved until the error, or the effect thereof, is discovered, and then to make the necessary alteration.

Second, to consult some one able to give him proper instructions that will insure the desired effect; or,

Third, to plunge into it, cut right and left, and trust to chance for success.

We see hereby that, before the alteration could be attempted, there must pre-exist a full idea of the work to be done. It is this which establishes the scientific character of our trade over many others, on account of which some watchmakers give it a bad reputation. Such being the case, most watchmakers will admit that in a Horological sense true practical articles mean more than mere receipts; that true practice means more than the mere ability to carry them out in solid material; that the most practical man is the one who has a perfect knowledge of the conditions, laws and forces involved in a mechanical contrivance, and can arrange their harmonious co-operation, and execute true designs in solid material with the least amount of time and labor, and that the most practical articles are such as will assist a workman to gain such a point.

It is in this direction that papers, appearing under the above heading from time to time, will aim. They will trace the various Horological sections, and analyze their single and compound properties, geometrically and mechanically. This mode of proceeding may appear novel and visionary, but it is a mode that each good workman has to adopt daily. Whenever he takes a watch in hand, he proceeds, by an analytical method, to investigate the parts with the view of detecting error, and he who goes most intelligently and inquiringly to work is almost sure to meet with the best success. The plan laid down is, therefore, consistent with practical method, and is an extension thereof, and an examination of all the points involved in the depths and escapements as to their relative bearing on the solution of the great Horological problem—"equal motion in equal periods of time."

J. Herrmann.

London, Eng.,
21 *Northampton Square.*

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Mr. Grossmann's Reply to "Clyde."

Editor Horological Journal :

You have been kind enough to mention to your readers the reasons that made me rather slow in my correspondence, and I am very much obliged to you for doing so, as my silence with respect to "Clyde's" remarks in No. 2, Vol. II., of the Journal, on my suggestions referring to improvements in the mercury pendulum, might have been interpreted as indifference to the subject spoken of, or to the public spoken to. I wish to uphold my opinion on the matter as expressed in the June issue of your journal, and to give the reasons why I think it correct; but before entering into "Clyde's" remarks, allow me to refer to a previous correspondence of the same author, Vol. I., No. 10. For greater completeness, and in the interest of those readers who have not this number within their reach, I beg to repeat the article in question :

"For several years past I have been engaged in investigating all the questions that are involved in the pendulum as applied to the measurement of time, and all concerning the beautiful natural laws that govern the vibrations of the simple pendulum, and the more complex and incongruous questions involved in constructing the compound pendulum, and the numerous methods of compensating it.

"The object of the present communication is to point out a fact in connection with the mercurial pendulum that appears to me to be a contradiction between the relative differences in the expansion of mercury and steel, as is accepted by the trade all over the world, and the amount of mercury used in the ordinary class of pendulums, whether the mercury be contained in one large jar or a number of smaller ones. All authorities agree that the linear expansion of mercury contained in a vessel about two inches in diameter, is five and a large fraction times greater than steel. Ried, in his 'Treatise on Clock-work,' makes it not quite 5.75, while on the authority of Charles Frodsham, its greatest expansion under the same circumstances is 5.81 times greater than the *same length* of steel that usually composes the rod.

"Having cited these authorities, which are sufficient for the present purpose, let us suppose that forty-two inches of steel is the amount to be compensated (it is usually more), and, for simplicity, let us assume that mercury expands *six* times more than steel; in round numbers seven inches of mercury would compensate forty-two inches of steel. That is to say, by an excess of heat the rod has been lengthened, and the bottom of the jar let down, say one inch, while the same heat has caused the *top* of the mercury to rise one inch also, and the reverse action would be produced by cold. But it is plain that the centre of oscillation being at a point a little above the *centre* of the mercury, this point has only been altered by the action of the mercury *one-half* of what it has been altered by the action of the steel; or, in other words, while the heat has lengthened the rod and let down the whole seven inches of mercury that constitute the bob, only one-half of it rises up to compensate for letting down the whole mass.

"In these approximations I take no account of the weight of steel or other material that constitute the jar, rod, etc., or the shape or expansion of the jar, nor the effect of heat or cold on the pendulum spring; all these combined having a tendency to considerably increase the seven inches of mercury that I have assumed; neither do I take into account the effect of the various escapements on the vibrations of the pendulum, but must be understood to be arguing about compensating a free pendulum, independent of the varying forces of any mechanism that impels it. And I would solicit the opinion of your readers in America or Europe on the subject."

When reading this I was rather surprised to see how a person who had evidently been seriously reflecting on the subject, could have got into so strange an error; and I would have written immediately to explain the matter, had I not thought it very likely that one of your American readers might do the same thing, and it have been published before my letter could have reached you. This expectation, however, has not been fulfilled; and since I am obliged to speak of the mercury pendulum again in answer to "Clyde," I think it right to give him at once the explanation he has asked for.

I have Ried's Treatise at hand, and there are different statements in it relating to the expansive ratio of mercury as compared with that of steel. On page 350 he says: "The expansion of mercury is said to be fifteen times that of iron." On page 354 he gives Berthoud's Table, in which the expansion of soft steel is 69, and that of mercury 1,235; or as 1 to 17.9. Page 355 states, according to De Luc, the two expansive ratios to be 112 and 1,835; or as 1 to 16.56. On page 361 he says: "Philosophers seem not to be agreed respecting the expansion of mercury, in comparison with that of other metals, some making it 15, others 16 times greater than steel." Immediately afterwards Ried tries to draw a conclusion about the expansion of mercury from the ultimate effect of the mercury in Graham's pendulum; certainly an unfortunate idea, since he leaves out of his calculation that only the half of the mercury column can come into consideration for raising the centre of oscillation, to say nothing of the corrections for the gravity of the jar and rod, and for the expansion of the jar, all of which unite to diminish this ultimate effect. By these omissions he finds that it appears that the expansion of mercury is not quite 5.75 times that of steel. "Clyde's" remarks show sufficiently that he is quite aware of all the above-mentioned circumstances, and therefore it is strange to see him quote this erroneous* statement of Ried without any consideration of the proceeding by which this latter came to that opinion.

Ried's excellent treatise was written at a period when natural science was not so much developed as now, and in all such matters it would be more advisable to quote authorities of more recent date. I do not know what Frodsham says, but if he makes the linear expansion of mercury 5.81 times that of steel, a man of his qualification can only have meant it under the afore-mentioned suppositions; but then, of course, he has used an incorrect expression. There are modern authorities enough who corroborate the figures first quoted by Ried, and *they all agree* more or less exactly with the tables of Lavoisier and Laplace, who give the expansion of soft steel as 0.001079, and that of mercury 0.018018; or nearly 1 to 16.7. These figures have to be corrected, when constructing a pendulum, according to the dilatation of the jar; and the expansive ratio of mercury in a glass jar will be 0.016348, and in an iron jar, 0.015598. In the first case, taking the expansion of steel as a unit, we obtain 15.15 to be that of mercury, while in the other case it is only 14.46.

These proportions found by Lavoisier and Laplace are generally accepted in the scientific world, and serve especially as a base for the correction of the barometer readings in different temperatures. If any scientific instrument can be considered as giving a correct idea of the expansive ratio of mercury, it is the thermometer, for its reading is a direct measuring of dilatation; but the steady rate of a mercury pendulum is of a vastly different nature, and hence the mistake of Ried, which "Clyde" has adopted. I come now to answer "Clyde's" criticism concerning the improvements in mercury pendulums proposed by me in No. 1, Vol. II., of the JOURNAL.

In the first place, "Clyde" objects to the

* Ried's statement would be quite correct, indeed, if he had called it the ultimate effect of the mercury in a pendulum of the dimensions and materials as he describes it, instead of the expansive ratio of mercury as compared to that of steel.

statement that in artificially heated rooms a difference of temperature like 3° R. could exist within the limits of a seconds pendulum's length. To support my statement, I refer to the universally acknowledged laws of nature ; but "Clyde" does not deny them, he only thinks their influence of much less importance than what I quoted. I certainly do not wish "Clyde" or any of your readers to place my own experiences higher than what he sees with his own eyes, but the above statement has been made long before me by several persons who are considered standard authorities in the scientific world. I have before me a memoir of Mr. Kessels, of Altona, published in an astronomical annual, the editor of which was the celebrated Schumacher, of Altona, one of the greatest astronomers of our century, stating, on the ground of repeated experiments, the difference spoken of to be 3° and even 4° R. This memoir is written in French, and is very interesting, and if you should think it useful, I would with pleasure translate it for the Journal.

If the experiments made in the United States do not lead to the same observations, I think the mode of heating the rooms there may, to some extent, account for it. In Germany all rooms are heated with stoves, which is indeed very different from the open fire and the hot-air pipes in use in your country. Besides, so far as I know, the rooms in your country are on a general average higher than ours.

The length of my pendulum is no mistake, as "Clyde" supposes.

Further, my opponent admits that there is apparently something plausible in the theory of making the compensating parts of the same thickness; but, at the same time, he declares it a fallacy to do so in practice. He comes to the conclusion that the mercury of the Graham pendulum is acted upon even quicker than the thin steel rod, in consequence of the supposed greater susceptibility of the mercury; and he accounts, by this hypothesis, for the paradox mentioned by him in his article in No. 10, Vol. I.

Next to this, he finds I have forgotten the difference between the mercury pendulum and the gridiron one, arising from the circumstance that in the former the ball (mercury) increases and diminishes in length, while in the latter the entire ball is raised and lowered. According to my opinion, this difference is not of so much consequence, for in both cases the ultimate effect is to raise and lower the centre of oscillation.

The comparison of the small sliding weight serving to regulate a pendulum does not well apply to the circumstances in contemplation. It is true that any alteration of the place of that weight, either up or down the rod, will influence the rate in a different way, when this weight is over or under the centre of oscillation. But suppose the jars of my pendulum to reach from the bottom to the top of the pendulum; will not the centre of oscillation be in the middle of its length then? and will it not remain there if the compensation is correctly calculated? It is always the centre of the mercury column which must be considered, and not the top of it, if we speak of the compensating effect.

"Clyde" further finds that the mercurial pendulum with a glass rod comes nearest to the theoretical pendulum—"a heavy point suspended by an immaterial line;" and he finds this a virtue. I am also inclined to prefer simplicity, but it seems to me that any attempt to invent a compensating pendulum would be useless, if no allowance on this point could be granted. A gridiron pendulum with nine brass and steel rods is at least as far from the ideal as the one proposed by me.

Thirdly, "Clyde" refutes my claims as to the reduction of the resistance of the air to the least amount. I will not contradict Galileo's theory, but I fancy the situation of a body falling from the top of the Leaning Tower, in the open air, is somewhat different from that of a pendulum bob vibrating through the narrow enclosure of a clock-case, though I willingly admit that both these movements are emanations of the same source of gravity.

It is a grave error of "Clyde," after calculating that my mercury jars have a total surface of 160 square inches, and Graham's jar only 43.4 square inches, in stating the resistance to the motion of bodies to a fluid medium is in the ratio of their surface. It has always been admitted as an undeniable fact, that *the shape* of the bodies is in an essential relation to this resistance. If this axiom was not acknowledged, I should conclude that a ball instead of a lens would be the best form for a pendulum bob, since the ball encloses the greatest amount of matter in the smallest surface. And it might also be considered immaterial whether a lens cleaves the air with its edge, or whether it goes through it with its circular face, since the surface of the body remains the same in both cases, etc., etc. This increased surface of mercury jars in contact with the surrounding air, is exactly what I aimed at for bringing the mercury to the same condition as the rod in respect to its susceptibility to changes of temperature.

I am perfectly well aware of the difficulty of improving an instrument so perfect as Graham's pendulum, but this difficulty ought not to be for all time a barrier to any attempt at improvement; and if "Clyde" persists in thinking my arguments erroneous, I hope he will do me the justice to acknowledge that I did not think superficially about this matter, as he gives me to understand, much to my regret.

After further reflection I have not taken out a patent for this pendulum; still I can not, with the best of my ability, see the proposed analogy between a patent pendulum and patent medicine. However, this matter is rather out of connection with the scientific part of the subject; and if I could hope to get a little nearer in accordance with "Clyde" on the pendulum itself, his dissenting opinion on the patent matter would not cast much shadow on the esteem I always feel for those who zealously study the theoretical part of their calling.

M. Grossmann.

Glashutte, Saxony.

In the March number we expect to present another chapter of Mr. Grossmann's Essay, which has been interrupted since the close of the last Vol., and also have the assurance of receiving other articles from him regularly hereafter.

In this issue we give the introduction to a series of articles from Mr. J. H. Herrmann, on subject of vital importance to the watch repairer, and one upon which he is able to impart valuable information.

Facts about Frictional Adjustment.

Ed. Horological Journal:

I am a little surprised at the remarks of B. F. H., on my last communication on "Adjustments to Position," and, judging from the tenacity of his opinion, think it will be difficult to convince him he is wrong; still, as he has invited criticism, and it would probably be expected that I should reply, I will do the best I can, trusting it may be received in the same friendly spirit in which it is written, and in this behalf I beg leave to first briefly review his last article.

From adjustment to position we have glided down into a question in physics: "is friction proportional to pressure, independent of the extent of surface in contact?" to which B. F. H. replies in the negative. He thinks it strange that friction, which cannot exist without contact of surface, should be uninfluenced by the extent of surface, and asks why, if it cannot exist without pressure, the same course of reasoning would not hold good in either case? Suppose it were answered, we don't know why; would that prove his inference to be correct? friction is a law of Nature in all matter, and we know many of those laws are inexplicable to our reason. The particular characteristic of friction under consideration is, however, not so inexplicable, because it is within the scope of experiment, and can be positively ascertained. He alludes to an experiment mentioned in Comstock's Philosophy, showing that a brick requires no more power to move it when upon its face than when upon its edge, and he thinks such an experiment ought to be looked upon with contempt by a watchmaker. How strange that it did not occur to B. F. H. to verify the experiment personally before condemning it, since in his opinion a watchmaker is better qualified to judge upon this subject than most other mechanics.

Comstock, though no watchmaker, was probably familiar with all the principles involved in a watch; certainly was familiar and could demonstrate all the laws of nature, in which ninety-nine out of an hundred watchmakers would fall far short. But I shall return to the brick question again further on. In the statement I made in the Dec. No.

of the Journal, concerning the result of the experiments of B. F. H. mentioned in the No. preceding it, that "it does not convey a clear idea to the reader," I had reference more to the manner of observing the effect, than to improper wording of the account. The practice of observing the changes in the rate of a watch, when making alterations for the adjustment to position, is, if not altogether worthless, perfectly useless, and a mere loss of time; for it proves nothing, unless accompanied by observation of the change in the arcs of vibration. I have referred him to "Horologist," page 129, Vol. II. of the Journal for the reason. If we admit that the nature of a hair-spring may be such that it will cause long or short arcs of vibrations to be of either shorter or longer duration, we could not tell from a change in the rate only, whether an alteration at the pivots had caused more friction or less, unless we first ascertained the nature of the hair-spring; but by simply observing the change in the extent of the arcs of vibration after an alteration, we know and can see the effect independent of observing the rate, and that, whatever may be the nature of the spring; for, knowing that more friction will decrease the arcs, and less friction will increase them, we are able to see the effect of the change in the difference of the arcs.

Two important principles underlie this adjustment to position; each of them is a self-evident truth, and one is deduced directly from the other, namely: *equal friction will produce equal arcs of vibration; and, equal arcs of vibration are performed in equal time;* thus, if we can produce the same resistance of friction at the balance pivots when in horizontal position as there is when the balance is hanging vertically, it will describe equal arcs of vibration in both horizontal and vertical positions, and from this we know, without waiting to prove it by its rate, that it will keep equal time also in both positions. I find it difficult to bring the above principles within the comprehension of some watchmakers; it must be because they are not accustomed to reasoning.

The correspondent signing himself "H," N. Y. City, and who thinks my article well put, would have had no difficulty in perceiving my motive for wishing to change the arcs of vibrations, had he thoughtfully read my article, and had he appreciated the truth of the above principles. The adjustment to position in a watch is only then of importance, when it is not intended to be adjusted to isochronism; still even in that case it will not only do no harm, but enable the workman to pursue finer adjustments with more certainty and greater accuracy. But I must return to my text. If meaning can be conveyed by written language, etc., etc., says "B. F. H.," and he goes on quoting "Horologist," "Spiro," "J. H. Martens," and even my own expressions in my last, he has not drawn false inferences, etc.; certainly, from the language he quotes, his inferences are correct, *i. e.*, that friction is proportional to the surface in contact; but let me assure him that the authorities he refers to are positively in error. I know J. H. Martens, whose work is otherwise very valuable, makes that statement, that the friction is less with convex bearings than in cylindrical ones; and following in his footsteps, Horologist goes further, and deduces the same theory as to friction; but I can speak for Horologist as being able to see the error of his way. My own words, quoted from my last article, as to convex bearings, ought not to be interpreted as he does, for I afterwards plainly declare my belief in the law of friction as proved by scientific men, although I did not otherwise urge my conviction so positively, for the sake of moderation; but I do not believe that convex bearings diminish friction. I simply meant to remind my friend that those who advised convex bearings first, may have done it simply with a view of giving the pivots more freedom, or of preventing the possibility of their binding in the holes, rather than expecting to reduce the friction; both inferences can be deduced, but unquestionably the former only can be true.

Now, concerning the duplex clock, of which he is satisfied that the holes were cylindrical and upright, let me suggest that he can in no wise be so certain that they were drilled *perfectly upright;* the best upright tools are inaccurate, and the twist drills bore a cylindrical hole, I know, but their centres are not always perfect, which makes them wabble. One of the best tools for uprighting has been for a long time known to be the universal lathe; the Swiss set all their jewels on it, but they never trust to its centre; for after having centred the plate to the hole which is to be jewelled, they insert a pointed peg in it, resting it a little distance from the point on the T rest, thus forming a lever which multiplies the motion at the other end if the hole is eccentric, and which motion amounts to a considerable quantity in some tools; certainly for the depth of holes he mentions it is possible that the pivots may have been binding. Be this as it may, the result would hardly prove that the extent of surface had anything to do with increase of friction. The electrical machine has nothing whatever to do with the subject under consideration; and the notions concerning the Peabody escapement, as also the duplex pallet, are mere theories, without any proof or means of demonstration. Concerning the friction of belts, I can find nothing in the best authorities to show them an exception to the established laws of friction in general.

My diagram was for the purpose of simplifying the subject; but from what follows, and what he says about the theoretical point called centre of motion, I think B. F. H. did not rightly understand my meaning. The object of my argument was, to prove the assertion that for the same balance the friction at the pivots varies as their diameters; and this for the purpose of showing that the established law of friction proportional to pressure, etc., does in no way contradict the possibility of adjusting a watch to position by equal friction. If B. F. H. will read it again, with these elucidations, he will probably be better able to appreciate the value of the diagram.

In the next instance he wishes to show that if the arc of vibration, or velocity, is increased; so, in like ratio, are the surfaces in contact increased; and if the arc is decreased, so is the surface over which the pivots rub, in like ratio. But according to his own notions this is a contradiction of ideas, for, as he says, increase of surface adds to friction, and greater friction we know diminishes speed; but he would have us understand that increase of friction is coincident with increase of speed, and decrease of friction with decrease of speed, which, from the known characteristic of friction, is impossible. The best authorities also tell us, that friction is entirely independent of speed or velocity.

Moreover the figuring concerning the supposed magnified pivots is incorrect, if the statement is correct. He supposes pivots of one inch diameter and one inch long, and if the balance made a complete revolution in one second, no matter how small the bearing surface in the hole, etc., both pivots together would have rubbed on over six and a quarter square inches of surface. Now very much depends upon the thickness of bearing surface in the holes; the assertion could only be approximately true if the bearings were just one inch thick; in that case the amount of surface rubbed over would be 6.28 of square inches on both pivots together; but suppose the bearings reduced to a knife edge, then the whole rubbing surface could only be expressed in linear measurement. Now let us see, with the above magnified pivots, how much rubbing surface we would have respectively on the sides of the pivots and on the end of it, supposing the end perfectly flat, and allowing one half the diameter of the pivots for the thickness of bearings in the holes. In this case the surface rubbed over on the sides of both pivots together would be just one half the above, *i. e.* 3.14 square inches. The diameter of pivot being one inch, the circumference of the disc which the end of the pivot would present to friction would be just 3.14 inches. Now the area of a disc is equal to the circumference of it multiplied by one-fourth the diameter; then, $3.14 \times .25 = .785$ of a square inch. According to my friend's notions of "friction increased by increase of surface," equal friction in all positions could hardly be produced between such quantities; and yet I can assure him that I have adjusted many watches perfectly to position with just such proportions of bearing surfaces to diameter of pivots, and that simply by making the end of the pivots more or less flat.

The mention of an imaginary problem applied to the pivots of a Newark watch is hardly worthy of notice, except to suggest that the wording of one sentence be a little altered. Instead of saying: it is useless to say that the pivots would bind in the hole, it ought to read: it is important to mention that, etc., etc. To avoid making the pivot and hole so small, and all the trouble connected with it, I would suggest that he insert the smallest little wedge into one of the pivot holes alongside of the pivot, and he will be surprised to see what a wonderfully small contact of surface is capable of producing enough friction to stop the watch.

This is about all, except that he illustrates the existence of friction, however near the centre of motion, and however small the surfaces, and if he would have applied himself to a little further study he would have found that the smaller the surface to a given and constant pressure, the faster it wears away; showing that the amount of friction is not diminished by making the surface smaller. I have investigated this subject to a considerable extent since writing my last, but I have searched in vain for an authority stating otherwise than that friction is proportional to pressure, and independent of the extent of rubbing surfaces. In the November number of the Journal, B. F. H. mentions a work, "Parker's Philosophy," which he states makes a contrary assertion; I have not been able to procure it, but shall do so at the earliest opportunity.

In the same number he says that there is no work on philosophy within his reach which makes the assertion quoted from "Dynamics." For a complete and satisfactory analysis of the subject I would respectfully refer him to the following standard authorities:

"Appleton's Dictionary of Mechanics," "Encyclopædia Britannica," "Chambers' Encyclopædia," and "Zell's Encyclopædia." Besides these there are many text-books of different respectable authors, all of whom agree without one exception on the point in question.

Ferdinand Berthoud, in his "Essay sur L'Horlogerie," mentions Amontons as the first man who made the assertion, and quotes Musschembrock, Desaguliers, and others, supporting and proving it correct; thus, for more than two hundred years past, the law of the proportionality of friction to pressure, independent of extent of surfaces in contact, has been held and believed by all the best authorities; and I venture to say that there could probably not be found an intelligent engineer in this country who holds a contrary opinion; if there is such an one, let him step out and favor us with his views.

But I have promised I would return to the brick question, and here I am. I have four new bricks; each of them weighs exactly five pounds; I have also a spring balance capable of weighing twenty-four pounds. If I take one of the bricks and set it on its edge on a pine board, then tie a string around it and attach the hook of the spring balance to it, it will draw three pounds and a half horizontally when it moves; when I lay the brick on its side and repeat the operation, it will again draw three pounds and a half. I then lay one brick on its edge again, and put another one on top, and the two together will draw seven pounds; when laying them side by side, and on their largest surface, they will not draw quite seven pounds. I then place all the four bricks upon each other, the lowest one being on its edge, when they draw very nearly sixteen pounds; but when laid flat, beside each other, covering the largest surface it is possible for them to do, they draw only thirteen pounds. To the correctness of this experiment I can produce the testimony of several eye-witnesses, as also to the experiment made with the chronometer mentioned in my last, and if B. F. H. can gather any light on the subject from these few well-meant criticisms it will afford me much pleasure.

Theo. Gribi.

Wilmington, Del.

———o———

Substitute for the Fuzee.

Editor Horological Journal:

Knowing that the craft are looking to the Journal for practical information, and that you cordially invite all to contribute to the general fund, I venture to suggest to those who have been troubled with such old English watches as have been pronounced worthless, by reason of the spring box and main wheel becoming worn out, that they can, at a moderate expense, be put in such shape as to give very satisfactory performance again. The plan is to remove the main wheel and spring box, and the centre wheel pinion, replace the pinion by one of the American watch, and replacing the spring box and fusee by the American going barrel, using the ordinary American click and ratchet wheel. With this change it is but little different from the American watch; it has less friction than before, a better motion, and is less liable to stop.

A watch thus altered has been going eleven months and in so satisfactory a manner, that the owner declares that it is a better time piece, runs more correctly, and in every way gives him less trouble than at any time since he has carried it, and expresses his conviction that the expense of making the alteration was really a saving of money. Verge watches may be treated in the same manner, with great advantage in many cases.

S. H. G.

Lexington, Ind.

——o——

Answers to Correspondents.

O. P. H., *Ky.*—Professional watch jewellers have no especial method of handling small loose jewels—an ordinary tweezer being the tool they use for that purpose. By long practice, the habit is acquired of taking them up without their "flying away," as you complain of, or snapping out of the tweezers. A very convenient way of inspecting them, when you are in search of a particular one for a particular purpose, is to attach to one end of a piece of peg wood a bit of beeswax, roll it between the fingers to a sharp point, and flatten or sharpen the other end of the stick as you find most convenient for moving the jewels about on a paper for selection. When one is to be taken up and tried in the place you are to use it, use the point of wax, to which it will adhere sufficiently for the purpose of inspection.

In handling hole jewels and end stones which are set, as it is necessary to do in cleaning watches with set jewels, it is convenient to have a pair of brass tweezers with a groove cut in the point, which can be conveniently done by a circular cutter or burr running in the lathe, of the diameter of a medium-sized jewel. One groove can be cut across the point of the tweezers (if the jaws are wide enough), and the other parallel to, and near the edge of the jaws.

From such a groove the jewel will rarely escape, and it can be held firm enough to be brushed and pegged out.

M. W., *Delaware.*—Your friend was right. You can regulate a watch to a fair rate in one position in an hour, if you have a clock with a seconds hand. It is only necessary to set the seconds together, and within two or three minutes the tendency, fast or slow, will be seen; move the regulator, set the seconds again, and in perhaps five minutes you can again observe its tendency; move the regulator and set again, and so on. When nearly to time it may require fifteen minutes to determine how it is running, but with careful attention it can be brought very close within the hour.

T. H., *Florida.*—You say you are often troubled to get out the circular piece in which the lower end stone to the balance staff is set, without scratching it or the plate, and that you think others find the same difficulty, because you see so many that are mutilated in that way. This is easily accomplished by taking out the screw, and with the point of a peg set in the countersink for the screw head revolve it far enough to cover the screw hole; then with a point from the opposite side of the plate through the screw hole push off the piece.

If it should be so tight in its place as not to revolve easily, which is seldom the case, you will be obliged to take some steel point to move it, and it will then be necessary to use care not to allow the tool to slip, for if it does, an ugly scratch will be the consequence.

J. S., *Charleston, N. Y.*—Ried's Treatise on clock and watchmaking is largely made up of matters of historical interest giving an account of the invention of various escapements, and the evidences by which the inventors endeavored to establish their claims to priority. It also contains the mathematical theories of wheel-work, with formulas for determining the teeth in wheels and pinions in various watch-trains, and a large amount of valuable information upon clocks and pendulums, and descriptions of town and astronomical clocks. But, for a beginner, it is too theoretical, and much of it is not easily understood except by those considerably advanced in mathematical education. It is a valuable book to those who are advanced in the trade, but when examined by the young beginner, he is likely to be discouraged.

A candid answer to your question would be to advise you to get (if you can) the back numbers of the JOURNAL, for in them you will find not only theory, but the practical experience of the best workmen in the country, and expressed in such simple and plain terms that any workman can comprehend and practise what he reads. The first volume is out of print and you can only obtain one (if at all) from private hands.

T. Z., *Ind.*—The trouble you have with rubber and shell eye-glasses is easily remedied. In taking out the old glasses for the purpose of replacing them by others of a different focus, you only need to heat the *glass* slowly and carefully over the flame of your alcohol lamp, which will communicate sufficient heat to the rubber or shell frame to soften it so that you can push out the glass with the greatest ease. In putting in others, grind the glass to the proper size, heat it and the frame as before till sufficiently softened, and put the glass in its place. Shape the frame properly while yet soft, and when cold it will be all right. Holding shell or rubber in boiling hot water will soften either.

G. C., *Arkansas.*—You can give the dead black color to your brass tools by using the following solutions, but whether it will withstand use for any considerable time is doubtful: Make a strong solution of nitrate of silver in a porcelain or glass dish, and in another one prepare a solution of nitrate of copper, then mix the two solutions and place the brass in it, heat the article evenly till the desired color is obtained. This process is used for giving the black color to optical instruments.

M. P., *Minn.*—The process of nickel plating without a battery, communicated by Prof. F. Stolba, *may* answer your purpose; the experiment will not be expensive, and if successful, all right; if it fails, no harm will be done. He says it is based upon the action of the salts of nickel in the presence of chloride of zinc. The process is to take a quantity of the concentrated solution of chloride of zinc, place it in a clean metallic vessel and add to it an equal volume of water; this is heated to the boiling point, and hydrochloric acid added, drop by drop, until the precipitate produced by adding the water disappears; now add a small quantity of zinc powder, which will produce a zinc coating on the article as far as the liquid extends; enough nickel salt, either the chloride or sulphate, is now introduced to color the liquid distinctly green. The objects to be plated are now put in it, with some zinc clippings, and the liquid brought to a boil; the nickel is precipitated in the course of fifteen minutes, and the articles will be found completely coated. The deposit varies in color, as the character of the surface varies. Polished surfaces will receive a bright coating, roughened surfaces will be gray, and care must be taken that they are entirely free from dirt, grease, or rust.

W. W. B., *Nebraska.*—You wish some information how to keep your varnished clock cases looking *new*; you say that after they have been on your shelves awhile the bright lustre of the varnish seems impaired, etc. That is true, and to know the why, is to explain the remedy. You very well know that the glass in your window also loses its transparency in a few weeks, and you can hardly fail to know that it is because dirt accumulates on it, and your experience tells you that more gets upon the inside of it than on the outside. If you draw your finger across a looking glass that has been hanging a month without attention, its track will be plainly visible on the glass; and more than that, if you look on your finger you will notice it actually black with the dirt which comes from the surface. This coating of dirt which attaches to the glass, is a deposition from the atmosphere, which is filled continually with impalpable molecules of all sorts of things, so light in themselves as to float in the air, and probably whenever the surfaces of articles in the room are slightly damp from condensation of constant moisture, these floating atoms attach to the surfaces; these accumulations go on from day to day and week to week, till a perceptible coating is formed, sufficient to remind the housewife that "she must wipe off that looking-glass," and the shopkeeper to set "Jim" to clean the windows. The smoother and more highly polished the surface, the more readily this film seems to attach; but probably it does form equally as much upon rougher surfaces, only it does not show so plainly. Now you will understand that this is the cause of the varnished surface of the clock cases losing its lustre, and this difficulty is greater where they are exposed without protection by a glass case; but even that will not protect them entirely, for no side or even counter show-case is tight enough to keep any description of goods from tarnishing, sooner or later. The best remedy is to wipe the clock cases carefully with a soft cloth, dampened with a weak solution of borax or sal-soda, and immediately polish the surface with a very soft old linen cloth, or an old silk handkerchief. In the next number of the JOURNAL, if space will allow, an excellent receipt will be given for a French polish.

A. B., *Vt.*—Catgut is the most reliable band for a watchmaker's lathe, as it is also for larger foot lathes. Steel hooks and eyes of all sizes are sold by the material dealers for joining the ends of such bands, and is the most convenient and reliable means of joining them.

S. N. M., *Mass.*—Very convenient *little* step chucks made in the face of the ordinary spring chucks of the American lathe, are exceedingly useful for holding set jewels, little collets, etc., etc.; they do not in the least interfere with the ordinary use of the chuck, because these steps are so shallow.

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EQUATION OF TIME TABLE.

GREENWICH MEAN TIME.

For February, 1872.

Day of the Week.	Day of Mon.	Sidereal Time of the Semi-diameter Passing the Meridian.	Equation of Time to be added to Apparent Time.	Diff. for One Hour.	Sidereal Time or Right Ascension of Mean Sun.
		S.	M S.	S.	H. M. S.
Thursday	1	68.32	13 47 98	0.344	20 44 2.96
Friday........	2	68.20	13 55.80	0.310	20 47 59.52
Saturday......	3	68.10	14 2.82	0.277	20 51 56.08
Sunday.......	4	67 98	14 9 03	0.243	20 55 52.64
Monday.......	5	67.86	14 14.45	0.210	20 59 49.19
Tuesday	6	67.74	14 19.07	0.176	21 3 45.75
Wednesday ...	7	67.62	14 22.89	0.143	21 7 42.30
Thursday......	8	67 50	14 25.91	0.109	21 11 38.86
Friday	9	67.39	14 28.14	0 076	21 15 35.41
Saturday......	10	67.28	14 29 57	0.044	21 19 31.97
Sunday	11	67.17	14 30 22	0.011	21 23 28.52
Monday.......	12	67.06	14 30.07	0.021	21 27 25.08
Tuesday	13	66 95	14 29.15	0.053	21 31 21.63
Wednesday ...	14	66.84	14 27.45	0.085	21 35 18 19
Thursday.	15	66.73	14 25.00	0.116	21 39 14.74
Friday	16	66 63	14 21.81	0.147	21 43 11.30
Saturday	17	66.53	14 17.89	0.178	21 47 7 85
Sunday........	18	66.43	14 13.22	0.209	21 51 4.40
Monday.......	19	66.33	14 7.83	0.239	21 55 0.96
Tuesday	20	66.24	14 1.74	0.267	21 58 57 51
Wednesday ...	21	66.14	13 54.99	0.294	22 2 54.07
Thursday	22	66 05	13 47.59	0.321	22 6 50.62
Friday.........	23	65 96	13 39.55	0.348	22 10 47.18
Saturday......	24	65.87	13 30.89	0.372	22 14 43.73
Sunday.	25	65.78	13 21 63	0.397	22 18 40.28
Monday.	26	65.70	13 11.78	0.421	22 22 36.84
Tuesday	27	65.62	13 1 37	0.444	22 26 33 39
Wednesday ...	28	65.54	12 50 43	0.467	22 30 29 94
Thursday	29	65.46	12 30.98	0.488	22 34 26.50

Mean time of the Semidiameter passing may be found by subtracting 0.18s. from the sidereal time.

The Semidiameter for mean noon may be assumed the same as that for apparent noon.

PHASES OF THE MOON.

		D. H. M.
☾	Last Quarter........................	1 22 10.6
●	New Moon........................	8 13 52 1
☽	First Quarter........................	15 18 24.1
○	Full Moon........................	23 22 56.4

		D. H.
☾	Perigee........................	7 2 3
☾	Apogee........................	19 2 4

	° ′ ″
Latitude of Harvard Observatory	42 22 48 1

	H. M. S.
Long. Harvard Observatory..............	4 44 29.05
New York City Hall..............	4 56 0.15
Savannah Exchange..............	5 24 20.572
Hudson, Ohio	5 25 43.20
Cincinnati Observatory	5 37 58.062
Point Conception......	8 1 42.64

		APPARENT R. ASCENSION.	APPARENT DECLINATION.	MERID. PASSAGE.
	D.	H. M. S.	° ′ ″	H. M.
Venus.....	1	18 7 1.81....	−21 49 22.9.....	21 24.1
Jupiter....	1	7 38 22.42....	+22 0 35.2.....	10 52.3
Saturn.....	1	19 7 41.02....	−22 10 1.3	22 20.4

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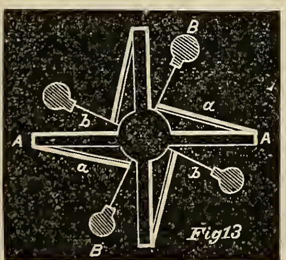
History of the Compensation Balance.

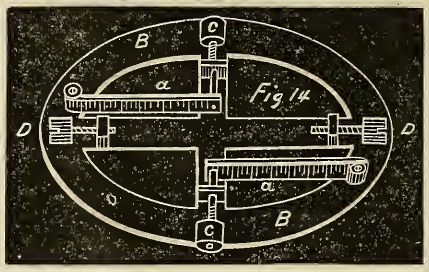
NUMBER THREE.

Somewhere about the year 1787, F. Berthoud proposed the form shown in Fig. 13.



A, are four radial bars or arms, attached to the staff in the usual manner; the compound metal bars, *a*, are secured to the extremities of the radial arms, and have their free ends formed into a screw, for attaching the balls, B, by a long socket which allows of adjustment by screwing them in or out from the centre of motion to adjust the momentum, and also to poise the balance. Their mode of action will be comprehended at a glance, and needs no description. He acknowledges that the effect depends on the length and thickness of the compound bars, and that many trials are necessary to get the proper proportion, which is an objection to its general adoption.

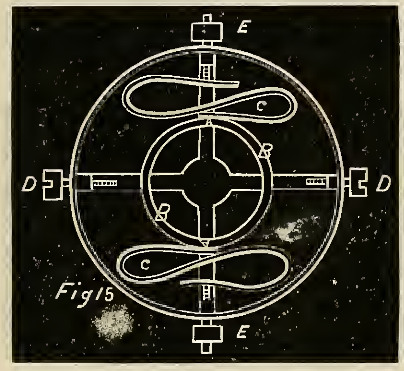
Another arrangement by the same artisan, is shown in Fig. 14.



B is a light flat brass balance, having four cross arms. Two compound bars are fixed to it at one end, and the adjusting weights, *c c*, at the other. D D are the mean time screws. The compound bars are brass exterior and steel interior. The adjustments for temperature may be made in two ways, either by altering the relative size of all the screws, or, which is easier, screwing one pair in and the other out.

It is hardly necessary to say that in all the constructions, where the momentum of the balance consists more of the moving weights of temperature than the weights for mean time, the effects of compensation bars will be proportionally greater than when the mean time screws are in excess; and as the amount of flexure in the compound bars remains unaltered, consequently the velocity of the inward and outward motion is not capable of adjustment in any other way than by altering the ratio of the length to the thickness.

Emery's balance, Fig. 15, is a modification of that of the elder Arnold. This form was much admired in France for the permanency and accuracy of its regulation. The balance is of brass crossed out with four arms, a flat steel ring, B, being screwed to the arms; *c c* are two compound bars of the S form, like those in his earlier balance. D D are mean time screws, carried by projections from the plane of the balance. The weights for adjustment to temperature, E, are nuts running upon the outer end of slender rods running through guide projections from the plane of the balance, and attached to the outer end of the compound bar, *c*, the inner end of which presses against the steel ring B. The adjustment must be effected by altering the relative momenta of the screws of mean time, and those of temperature.



A balance by Mr. Hardy was the result of the desire to make the compensating load approach or recede from the centre in a direct line, and depended for its action upon the direct linear expansion of two metals. A steel diametric arm had erected upon each end a vertical branch, with screw cut to carry a heavy tapped nut, which was the compensating load. The steel arm near each end had its thickness very much reduced, so as to be easily bent; underneath this arm were placed two parallel brass bars, one-half of the width of the steel arm, and secured to it by their opposite ends, leaving each other's opposite end free, but resting against a projection on the under side of the steel arm, and below the vertical branch.

The theory of its action was, that the brass strips, elongating by an increase of heat, expanded *more* than the steel, and, bearing against the projections, the thin part of the steel arm yields upward, thus tilting the upright branches which have their seat upon it, inward, obviously causing the weight nuts to revolve in a diminished circle. The adjustment for quantity of effect is by raising or lowering the weights, as circumstances require. Of course this involves the necessity of the balance being of considerable vertical height, and is quite impracticable except for ship chronometers.

Recordon, the successor of Emery, at Charing Cross, used a compensating balance perforated along its circumference with screw holes in which screws for adjustment to temperature and position were adjustable at pleasure. It is supposed that this arrangement was the original contrivance of Pennington.

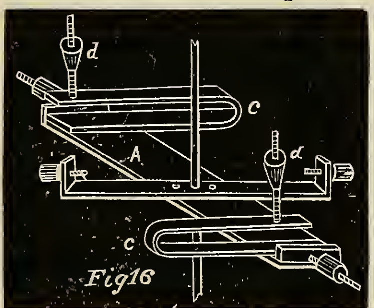
These examples and illustrations of the principal and most successful constructions for compensation bring the subject up to about the year 1800, and fully shows the diligence and perseverance of our predecessors in search of the principles involved in the production of a perfect compensation balance; nor can a more striking example be found of true mechanical genius than that shown by Arnold in applying the unequal expansibility of metals to the accomplishment of the desired end. The perfection of construction now attained, and the rigid and critical examination of the actual results obtained in the performances of these balances under all possible conditions, developed the fact that there was a residuary error due to changes of temperature, which no adjustment of the balance could correct.

Harrison, although a competitor for Parliamentary rewards, confesses, with a candor only to be found in a true philosopher anxious to discover truth for its own sake, that the objection to balances of two different metals is, that small pieces of metal, and metal in motion, do not change their temperature at the same time with large pieces and pieces in motion, nor yet steel so soon as brass in similar circumstances. It was found that if the compensation was adjusted to the two extremes, as 32° F. and 100° F., then the chronometer gained at the mean temperature; and if adjusted to any two mean temperatures, it would lose for all beyond them. The attempts to counteract this peculiarity was called *secondary compensation*, and not for some time after this error was discovered was its cause fully comprehended.

The variation in the force of the spring proceeds uniformly in proportion to the temperature, but the inertia of the balance cannot be made to maintain the same uniformity, it varying more rapidly in cold than in heat. The moment of inertia of the balance varies less in passing from mean to high temperature than in passing from mean to cold; consequently, if adjusted for mean and cold it will not have decreased enough at an equal increase from mean to hot, and the chronometer will lose; and if adjusted to the two extremes it will gain in the mean temperatures. Many constructions have been devised for this correction; but as they are all similar in principle, it will be sufficient to give a description of one by Mr. Eiffe, who communicated several methods to the Astronomer Royal in 1835.

The primary compensation bar, or a screw in it, was made to reach a spring set within it, with a small weight attached at some mean temperature, and as it bent farther it carried the secondary compensating weight along with it. It is objected to this method that it is not continuous; yet the whole motion, not being more than the thickness of paper, is so small that this and other compensations upon the same principle appear to have been quite successful.

Another class of balances may be represented by Mr. Dent's. He has published a pamphlet describing several forms of his invention; but the one he specified as the best is shown in Fig. 16. It consists of a flat compound bar, A,



bending upward by an increase of temperature, so that if the weights were merely set upon the upright stems arising from the ends of the bar, they would approach the axis of revolution; but, instead of these stems rising from the arm itself, they are set upon secondary compound pieces, *c*, of staple shape, which are set on the cross-bar. As these secondary pieces themselves bend upward, they cause the weights to approach the axis more rapidly, as the heat increases. By a proper adjustment of the height of the weights upon their stems, the moment of inertia of the balance can be made to vary in the proper ratio to the variable elongation and elasticity of the spring.

Engraving.

NUMBER TWO.

As a study for the action of the graver under various angles of inclination, some soft metal, as britannia ware, block tin, or a plate of pewter, may be taken, as the inclination of the graver to *run in*, on the one hand, or *slip out* on the other, are magnified; these tendencies being less in proportion to the hardness and tenacity of the metal. The student can thus see the effects produced by using the graver in the various positions mentioned in the previous article, and can at the same time acquire skill by drawing the letters in an enlarged form previous to attempting them with the graver, which is best done with a "dry point" or "scratch," which is nothing more than a piece of steel wire about the length of an ordinary graver, having a gradual taper down to a fine point—not sharp, like a needle, but so rounded as to scratch slightly a polished metal surface—and must be sufficiently thick and strong to prevent any springing under pressure, and may or may not have a handle of ivory or wood.

With this scratch draw on the surface of the soft metal an *m*; the first cut will be from the bottom of the first stem of the letter, with the graver rolled to the right far enough to produce a cut of the full width of the stem; the graver will, of course, start from a point on the surface of the plate, and the cut will gradually widen as it penetrates the metal until its width equals that of the body of the letter as drawn. When that width is attained, the graver must be kept to that position while it is driven up to the top of the stem; at that point it must be rolled suddenly over to the left upon its own point as a fulcrum, which will throw the chip out, leaving the upper end of the cut rounded over toward the left hand edge of the stem, with just the proper form to blend into the first curved hair line of the letter, which may now be made by turning the plate partly around so as to set the point of the graver lightly at the very corner where the chip was thrown out, and make a smooth flowing curved cut for the hair line; this curve will be best given by a combined motion, half by swinging the plate with the left hand, and half by swinging the graver by the right. This double movement is not necessary, it being simply an economy of motion, for were the plate alone removed, it would have to be for the whole amount of the curve, and so if the graver were moved about and the plate remained stationary, the swing of the hand and arm in those curves which embrace the greater part of a circle, would be very awkward and inconvenient.

The hair line must not terminate abruptly, but, as the end is approached, the cut must be gradually decreased in depth till it ends at the surface; or the hair line may be commenced at the other end, and terminate, by a careful junction with the stem of the letter at the top; in this case the graver may run into the previous cut at once, but care must be taken not to *commence* the hair line abruptly. It is well to become familiar with both these movements, for it will in practice often be convenient to make them in both directions, to save the time required to turn the plate about. It will be noticed that the stem is not yet complete, as the bottom of it requires to be perfectly square; as it now is, it comes to a point on the left hand side, just where the graver was first set upon the plate. To do this, the graver must be firmly set into the metal at the point where the stem was commenced, and in such a manner as to have the right hand edge of the graver cut the bottom of the stem in the horizontal lines upon which it stands.

The second stem is cut in the same manner, only that the hair line is run into the body of the first ones. The last one must be a little differently formed, it being rounded at both ends, as both ends are terminated by hair lines, curving in opposite directions. The graver, in this instance, cannot be set, for the commencement of the cut, upon the base line, but must begin so far above it as to allow room for the terminal curve, which is to be continued as the final hair line. This last stem of the letter is made by two cuts instead of one, as in the others. Set the graver a little above the base line, and on the left hand margin of the body of the stem, and roll to the right, so as to cut the full width desired, driving it to the upper end and throwing the chip out at the top, as before; then revolve the plate half round and repeat the same operation for the other end of the stem, which will complete the body of it, with the two ends properly rounded for the production of the hair lines, as before described.

This method of cutting the body of this last stem leaves standing diagonally through its centre an elevation of the metal; that is, the whole body of the stem is not cut to the same depth throughout, like the first two. This arises from the fact that it is cut from two opposite directions; but if it is desired to have them all alike, this centre can be afterwards cut away, or, what is perhaps the better way, cut all the stems from both directions. In case this is to be done, first cut from the bottom upward, then from the top downward, and when the graver has arrived at the base line, lift the chip square out, which will leave the foot somewhat ragged, and which must be squared by a cut with the side of the graver along the base line. This method will leave the cuts all alike in every part of the letter, and the general effect will be good.

The next study will be the curves necessary to form *o*, *c*, *e*, *d*, *g*, etc., the outline of which must be correctly sketched as before. Suppose it is *O;* commence the cut at the top very lightly, and with a gradually increasing pressure, and a gradual rolling of the graver toward the right till the middle of the swell is reached; then with a diminishing pressure, and a gradual return of the graver toward the left, throw the chip out at the surface of the plate on the base line; at the same time this compound action of the graver is going on, the plate and the hand holding the graver must make a partial and simultaneous curved motion corresponding to the curve of the letter. This forms half of it, and the other half is simply a hair line continued around until it meets the starting point. The letter *e* is, for the first part, made in precisely the same way, with the hair line thrown away a little toward the right, and ready to join any succeeding letter; the upper and last part being formed by starting a hair line about the middle of the body of the letter on the right, with a continued swell, till the upper line of the letter is reached, and then make the junction with the starting point by a sudden roll of the graver to the left, at the same time lifting out the chip. This method of forming the contact between a short swell and a hair line, will require some patient practice; but when once the idea of what is to be done becomes firmly fixed in the mind, as it may be by carefully studying these letters enlarged, it will become exceedingly easy.

The *a* can be formed by the same cuts as the *o*, for the first part, and the previous directions for the stem will be sufficient for the second part of the letter, only remembering that it is to be commenced at the top; or it may be done, and often is, by first making the swelled curve, then the first cut of the stem, both of which cuts can thus be made without reversing the plate; then turn it and complete the cut of the stem, and finish both hair lines. In practice, any method by which time can be economized, without sacrificing effect, is of the greatest importance, because an infinitude of small unnecessary motions consume an amount of time which may prove disastrous to the profits of the workman. Take, for instance, the word *mutton;* if each part of each letter is completely formed by itself, it will require about thirty-two separate cuts, and the plate will be revolved the same number of times back and forth; but if all the cuts in the whole word which are to be made in the same direction are done at once, it may be made by only two or three times shifting the position of the plates. This "sleight of hand" will be treated of hereafter.

The letter *c* is formed like the *e*, with the exception of the dot at the top, which is made by setting the graver firmly into the metal from the top and giving it a sudden roll toward the right, and at the same time lifting out the chip thus formed; or it may be done with a "round point" graver, which can as well be described here as any where, as it is an indispensable tool. It is a *thin* graver, and several sizes, varying in thickness, will be found useful; the lower or cutting edge is a part of a circle, or rounded so that the furrow it ploughs through the metal is a half round groove, in width corresponding to the thickness of the tool; such gravers are seldom sharpened on the belly—the face only being ground and honed at an angle of about 45°. The thinnest of these round gravers is used for periods, the tops to *c*, *r*, the dots for *i*, the terminal part of *s*, etc. From what has been previously said, as to economy of time, all those parts of a word requiring its use will be omitted until the word is completed, and then the tool changed and the omitted parts put in. The long stems, *t*, *d*, *p*, *q*, etc., will next claim attention, and, although apparently the easiest to form, are really the most troublesome, and require more careful practice than any cut thus far described; particularly is this the case with those extending both above and below the line. This arises from the fact that the cut is very long, and requires the graver to be driven almost the whole length of stroke the hand is capable of, and it must also be uniform in width and depth; the least change of elevation in the handle of the graver will either drive it too deep, or, what is still worse, permit it to dart across the plate, carrying ruin in its course.

———o———

Reminiscences of an Apprentice.

FRICTION.—WAS I OR "OUR MAISTER" WRONG?

"Our Maister" was one of those men that belonged to what is termed the old school. He was not content with teaching his apprentices the art of handling the tools, and the usual mechanical manipulations of the trade, but he also insisted that they should understand the philosophy of what they were doing. As an apprentice I was what may be called a free thinker, and sometimes did not agree with "Our Maister" in his teachings, but left the paths he tried to guide me in for those of my own choosing. Soon after commencing my trade I commenced to do little jobs for myself outside of the usual working hours. I had got beyond the age for using spinning-tops myself, yet, as an embryo mechanic with plenty of tools at my disposal, I used to put sharp steel points on the spinning tops of my younger friends, and sometimes made them new tops of a better pattern than those they could buy in the shops. One dinner hour "Our Maister" came up to my bench and lifted up a spinning-top I had been making, and in a kind and encouraging way asked me why I had made the point so sharp. I said that sharp points ran round easier and spun for a longer time on hard smooth pavements than blunt ones did. "Our Maister" asked me the reason of this, and I said there was less friction on sharp points; but he could not see the philosophy of this new wrinkle in spinning-tops, and left the bench, smiling and shaking his head; but as I was perfectly satisfied that spinning-tops with sharp points *did* run easier on hard pavements than blunt ones, I thought that I could afford to let him smile at me.

A few months after this we were making a new clock that was intended to be a little better than usual, and in making the bridge that the hour wheel runs on, contrary to our usual custom I hollowed out a portion of the centre of the pipe, after having fitted it to the hour wheel socket, leaving only a bearing at the two ends of the pipe. I had seen the same thing done in clocks that I had cleaned, and "our journeyman" said it was the way they used to do in London, and advised me to do it in all the bridge pipes that I made. When "Our Maister" saw the bridge he asked me why I had hollowed out the centre of the pipe, and I answered that I thought it would save friction; but he told me that it did not lessen the friction in the least degree, and only made the pipe weaker, and easier broken, and I was peremptorily ordered never to do it again. Now, this was a stumbler to me; and for the first time my faith was shaken in "Our Maister's" judgment. How could it be possible, I thought to myself, that a long bearing could have no more friction than a short one. It was against common sense, and besides I had seen the millwright and the blacksmith do the same thing in machines they made, and they ought to know how to lessen friction. When I got an opportunity I spoke to "our journeyman" about it, and he told me that "Our Maister" was a fool; that almost every bridge pipe that he saw, except those made in our shop, were hollowed out in the centre; and, he added, with an emphasis, they do the same thing in London. So I thought that if every body else did it, and if it was done in London also, "Our Maister" must be altogether wrong in this particular; although I did not dare continue to do anything my own way after he had ordered me to do it his way.

One day I was making pivots and happened to turn one down a little too small, and before I had it polished it was much smaller than the gauge we usually used for that particular pivot, and for uniformity I made the pivot on the other end to the same size. When "Our Maister" saw them he asked me why I had made these pivots so small; and, thinking that I was smart, I told him I thought that it would save friction. "Save friction!" he exclaimed, "there is the same friction on a small pivot as on a large one; and for the future you must not think so much about reducing friction, but make the pivots exactly to the gauge I give you." Now, if "Our Maister's" opinion, that there was the same friction on a long bearing as on a short one was difficult for me to understand, this new doctrine, that there was the same amount of friction on small pivots as on large ones, was altogether incomprehensible; and I had a second time to ask an explanation from "our journeyman," but he only made fun of "Our Maister" and his ideas, and remarked that if there was as much friction on small pivots as on large ones, what was the use of making small pivots at all, when they were so difficult to make? I thought this a good practical answer, and all at once a suspicious idea crossed my unsophisticated mind that the reason pivots were made so small in watches was, that they cost more to make them, and made the watches dearer, and that also they would be easier broken when customers let their watches fall, and in that way give good paying jobs to the watchmakers.

Sometime after this a customer brought a musical box, and complained of it playing the tunes too slow. The box was given to me to clean, and after being cleaned and oiled with fresh oil, it played faster; but the customer said it was not quite so fast as it played when new. I examined it all over and noticed that the end of the top pivot of the fly was worn flat, and remembering my experience with spinning-tops, went to work and made a sharp point or centre on the top pivot of the fly. The operation proved successful, so far as the musical box was concerned, for it played as fast as it did when new, and the customer was satisfied; but I thought that "Our Maister" tried to rob me of the credit due me, for, on a remark from the customer that the friction had been reduced, he said that there was the same amount of friction on a sharp point as on one broader, and the customer left the shop looking a little puzzled. Now, this last opinion expressed by "Our Maister" regarding friction was too much for me to believe. I did not know much about the friction on long and short bearings, or on large and small pivots, but I thought I did know a little about friction on sharp points; for had I not had experience with spinning-tops, and had I not made the musical box play quicker by sharpening the point of the top pivot, and what more proof was necessary to show that I had reduced the friction? I spoke to "our journeyman" again, but this time he was so thoroughly disgusted with "Our Maister's" opinions on the subject of friction, that he would not even condescend to talk on the subject; only saying that "Our Maister" was "a cure—a perfect cure." Now, I had never been in London, and didn't know what a "cure" was, but by the way he shaped his face, I thought it must be something dreadful.

In a day or two the subject as to whether there was the same amount of friction on a large bearing surface as there was on a small one, was incidentally spoken about. "Our journeyman" showed us a watch movement with a detached escapement, and we could all see plainly that the balance took larger vibrations when the staff was in a vertical position, and rested on the rounded end of one of the pivots, than it did when it was in a horizontal position, and rested on the circumference of both pivots; and although there was nothing could be clearer to my mind than that there was less friction one way than the other, "Our Maister" was so stubborn as to still maintain that when the weight of the balance remained the same, the friction on the pivots was the same in whatever position the watch was placed, and without regard to the extent of the bearing surfaces, if these surfaces were true and smooth. This, however, was too much for "our journeyman" and me to believe, and I wish the reader could have seen us as we privately had our little fun laughing at "Our Maister's" absurdities.

One evening I met some of my comrades and told them the new opinion I had formed of "Our Maister" since he commenced to express his views on the subject of friction. One of them, a student who had read law for one session at the college, said it was evident the old fellow was *non compos mentis.* This idea pleased me, and when I went home I told my father all "Our Maister" was saying about friction, and I thought that he was a "*cure*," and *non compos mentis*, but during the course of my remarks I saw plainly that my father did not desire his son to have the distinguished honor of making "Our Maister" out to be a fool. The two were associated together on the committees of several societies in our town, and my father knew him thoroughly, and I shall never forget the look he gave when I said "Our Maister" was a fool, and after administering a severe repremand, he ordered me off to bed; but I thought this was a curious way of deciding whether a broad or narrow surface had the same amount of friction, and lingered in the room, thinking I had a right to speak in my own defence; but on saying something impertinent, my father got up and struck me with the palm of his hand, and then taking up a small walking cane, struck me with about the same amount of force with that. "Now," says he, "take that; and perhaps it will illustrate to your feelings the evil effects of pressure on a small surface, as compared with a large one;" and to say the least of it, I thought it was a striking illustration that the effects of pressure under the narrow surface of the cane was much greater than it was under the broad palm of the hand.

The Principal of the Academy in our town called at the shop one Saturday to get his watch regulated, and, as was his usual custom, recognized me as an old pupil, and asked how I was progressing in learning the art of watchmaking. "Our Maister" answered, "very well, only he thinks." The Principal suggested that that was a commendable fault, and "Our Maister" admitted that it was, provided he could get me to think the right way; and began telling the Principal of my deficiencies in some of the principles of natural philosophy, and that I inclined to adopt the popular fallacy that there was less friction on small bearing surfaces than there was on large ones, and requested him to give me a private lesson on the subject of mechanical friction, and show me the models designed to illustrate the laws of motion, that belonged to the Academy. The Principal cheerfully consented to the proposal; indeed, he said he was glad it had been made, because for some time the clock at the Academy, quite contrary to its usual habit, had become somewhat irregular in its behavior, which he took to be a mute appeal for a little attention. So it was agreed that I should come out on Saturday afternoon, as the students would then be away, and bring such tools as were necessary to clean and oil the clock, and that in the evening he would give me the proposed lessons. What came of this excursion will be told in the next number.

Coral.

"Of small *Corall* about her arm she bare
A pair of bedes, gauded all with grene,
And thereon hong a broche of gold fullshene."—CHAUCER.

"A turret was enclosed within a wall of alabaster white,
A crimson coral for the queen of night,
Who takes in sylvan sports her chaste delight."—DRYDEN.

Beneath and beyond the beautiful, blushing, wrought coral ornaments which ladies wear, they seldom see the dangers and toil encountered to procure these dainty blossoms from the deep dark sea; neither do they properly appreciate the patient labor bestowed upon the natural product before it assumes the fairy forms so bewitching in their "pink and perfect" loveliness. The origin of coral as an ornament is lost in antiquity, but the charm of its flesh-like tints always has, and ever will secure it, a permanent hold upon the good taste of society.

Early in the history of art it was used to some extent by sculptors, but the character of the stone is such as not to admit of that delicate minuteness in detail of which the harder gems are susceptible. There is extant an antique head of Medusa cut from coral, the eyes of which are of some white substance, like shells, let in, and is supposed to have been an amulet. The ancients were very partial to analogies between the substance and the subjects which they desired to represent in art. Thus Perseus, after having cut off the head of Medusa, concealed it under some coral plants, which, on the instant, became petrified, tinging them from green to vivid red with the blood which flowed from it.

The great commercial centre of the coral trade, and also of production, is Italy and its vicinity. The Mediterranean furnishes, along the coast of Sicily, Majorca, Minorca, as well as along the Spanish coast, most of the coral of commerce. Genoa is, perhaps, the greatest coral mart. The pink coral, which is so much prized for its delicate tint, is mostly derived from the African coast of the Mediterranean; the Red Sea and Persia also supplying fine coral in limited quantities. Its procurement is as distinct an industry as pearl fishing, and gives employment from April to July to a courageous and hardy class of fishermen. Compact coral is attached to the surfaces of rocks at the bottom of the sea, at depths said to be from 300 to 600 feet, and grows in the form of a leafless shrub or branch, starting from a foot like a hemispherical skull-cap, firmly adhering to the rock and difficult to detach; from this arises a single stem, rarely an inch in diameter, its branches ramifying in various directions, diminishing as they extend, each branch ending in a blunt taper form.

These coral branches are always found perpendicular to the surface of the rocks to which they attach, regardless of the position of the rock. A certain amount of sunlight seems necessary to their production, as they are most abundant in the crevices and on the face of rocks with a southern aspect, and are seldom found attached to northern exposures. They rarely exceed 10 or 12 inches in height, or a thickness greater than the little finger. To attain their full size requires about ten years; a longer period does not appear to add to their stature, but the fishermen fancy, after that age, they become more corpulent—grow in diameter and more intense in color.

Of course, no one at the present day entertains either of the ancient notions, that coral is of mineral or vegetable origin—notions which were prevalent, even among naturalists, as late as the middle of the last century; and so firmly had the idea of its vegetable origin become fixed in the minds of the learned, that the discoverer of its true character, as a zoophyte, would not give his name to the French Academy of Science, to whom he reported his discovery, fearing the ridicule of those learned men. Its true character, as one of the *radiata asteroida*, is now fully established, and every one knows the red coral (*corallium rubrum*) to be the production of secretions of lime (95 per cent. carbonate) from the sea water by those living polypi that attach to its surface as a habitation.

Coral fishing is not alone laborious, but attended with positive danger, both from entanglement in the nets, as well as from sharks, which abound in those localities. The nets are large crosses of wood, with equal arms, to which are attached strong nettings, wound with loose hemp, to form material for entangling the coral as it is broken from its hold upon the rocks by the wooden cross. To the centre, on which a load is placed to sink it, is attached the line by which it is lowered; a diver follows it down, pushing it into such crevices and crannies of the rocks as are suspected to contain coral. After being loaded, it often requires the united effort of several boats and their crews to haul it up. The coral is then disentangled from the net, and the boats filled. In this condition, the coral insects, adhering to the surface, form a slimy coating, which, on drying, leaves the coral proper covered with a layer or crust of grayish-white substance.

The process of manufacturing is entirely hand-work, the only tools used being files, gravers, and bow-drills. Aside from cameos and small human and animal figures, almost the whole product of the fisheries is wrought into leaves, flower-buds, branches and beads. The rough coral is first cleared of its crust, which then reveals the character of the sample—whether solid or porous, good or bad color—facts which determine the use to which it can be applied. The only manipulations in finishing are to remove the file and graver marks by pumice-stone and water, and polishing with tripoli. The irregular surfaces always produced preclude the possible use of any machinery in this manufacture.

Fragments of small branches, the size of wheat, are simply pierced with a hole through the centre, strung on a thread, and are known in commerce as ragged coral, for infants' armlets and necklaces. This form includes all sorts of irregular pieces, ill-shapen as they chance to be, not exceeding a certain size.

The next advance toward shaping is by selecting small pieces of about uniform size, filing them a little thinnest in their central part, and forming a rather deep cut around each end; these formed pieces are pierced through the centre like the others, and when strung they will assume a position at right angles to each other, thus producing a string of coral eminently "ragged."

Large pieces are fashioned into flowers, mostly of the dahlia and rose pattern; pieces having deep bell-shaped cavities being taken advantage of to form flowers of the fuschia type. Dahlia blooms are the easiest to produce, on account of their regular foliated structure; roses require more labor, as the petals are curled and corrugated in nature, in an irregular manner, which requires considerable skill and labor to imitate by art. Graceful forms of the branched coral are often simply polished as they are, and worn in their original shape.

As no two pieces of coral occur exactly alike, great artistic judgment is required in adapting the design to the peculiar shape of the natural specimens in hand; often the piece, in its general outline, suggests what it shall be formed into. A bit is taken up, its general resemblance being that of a frog, and by a few cuts here and there the transformation is completed, and a little polishing brings out a figure true to nature, and well adapted for a scarf-pin head, a stud, or cuff-button. A branch with a crook in it, and a little protuberance at the end, conveys the idea of a leg and foot, and a little labor on the original form turns out of the artist's hands a beautiful "charm," so that really in this department of the art less labor is involved than at first sight appears. Choice pieces of good size, color and compactness, are laid aside for the formation of large spherical beads, or to be used for cameos, or bas-reliefs, which are of course expensive in proportion to the art labor bestowed upon them. The general form in which the coral jewelry comes to us is, sprays of flowers, buds, leaves, and fruits, skilfully clustered together on stems of gold.

The method of mounting is to form, of strong gold wire, a flat outline of the intended design, which outline is intersected in various cross directions by other pieces of the same wire, in such position and curvatures as the contemplated article requires. To this frame-work are soldered a wilderness of small, short, upright gold wires, upon the ends of which all the leaves, buds, flowers, etc., are to be fastened. The base of each bud or leaf is drilled with a deep hole, into which the little gold stem is pushed and cemented by shellac; these wire stems, carrying the coral leaves, are then bent into such easy, graceful positions as the design requires, gradually assuming the form of sprig, bouquet, or cluster, surmounted may be by a Cupid, butterfly, humming-bird, or beetle.

The diversity which this style of construction permits is, like gold or silver filagree, only limited by the skill of the artisan, and the value depends almost wholly on the labor bestowed upon it. It is a style which will always maintain its caste, for the reason that all imitations that can by any possibility deceive any one, involve an expense in construction which renders their profitable production impossible; consequently the wearer of coral goods enjoys the consciousness of having a real specimen of art manufacture, and without the mortification of meeting at every turn a base imitation, difficult to detect from the real.

Round beads, ragged coral on strings, and also the cut and seed coral, strung, are sold by weight. The exporters resort to a peculiar method of putting up masses of coral to augment its weight. Each string of beads terminates at either end in a surplus of three or four inches of the silk upon which it is strung; a dozen of these strings are put up in a bunch, and the loose strings at each end are ingeniously twisted into a silk cord as thick as one's little finger, and about four inches long, and as firm and hard and heavy as can be made. Of course these masses of solid cord somewhat augment the weight, but no remonstrances can change this custom. The price of the coral is not enhanced by this method of selling, although the whole is bought and sold as coral. Few are aware of the extent of this branch of the jewelry trade, unless their attention has been particularly called to it. Some of the heaviest dealers in these special goods have branch houses in Genoa and Naples, and others require resident buyers to keep up the supply of desirable coral goods.

The rarest pink coral half sets and full sets reach in price up among the thousands of dollars, and yet very beautiful goods of the dark coral can be bought as low as fifteen dollars the set. Necklaces of spherical beads, of rare size and color, command prices reaching to five or six hundred dollars; in fact, the value, like that of pearls, is based upon the rarity of the specimen as well as its inherent beauty. In the huge iron safes of the few coral importers lie buried marvels of taste and beauty, impatiently waiting an invitation from Mammon to make their appearance in good society. The delicate light tints in coral are admirably adapted to, and greatly enhance the charms of, a blonde. The rich dark coral, in artistic designs, are exceedingly becoming, and give piquancy of effect to complexions even as dark as brunette. The judicious introduction of coral ornaments in the hair is very effective, and its general adaptability to various toilets is a study for an artist.

Present Styles of Lockets and Chains.

A large proportion of the practical watchmakers throughout the country are also dealers in jewelry, and it is proposed to furnish such—"not a fashion article," nor an elaborate art treatise upon styles, designs, etc.—but such information ot the kind of goods the American people decidedly prefer, as will assist remote buyers in their selections. It is well known in the trade, that, out of the larger cities, or even in them, except among the ultra fashionable, the purely foreign designs do not obtain; besides, those whose trade demands this style of goods are always in the position to inform themselves on the subject. Imported goods, both in their designs and price, do not, without some modification, meet the general demand of the country trade; still these foreign patterns furnish our own manufacturers a basis for adaptation, and they draw largely upon them for designs, combining, arranging, and modifying, to meet the requirements of their own customers. A fair example of this transformation is shown in the present style of lockets, which have been, and will continue for some time to be, a popular ornament, and will embrace every variety of style and price.

Among other importers who have bestowed great care in the judicious selection of foreign lockets, Mr. E. Bissinger displays a bewildering variety, both in workmanship and material. There seems to be no limit to the forms adopted, but the prevailing one is oval, of dead gold, or, as some dealers prefer to call it, Roman gold, which, over-laid with polished gold tracery, or polished gold surfaces, ornamented with dead gold *applique*, and set with pearls and pyramidal cut turquoise, is the general character of the medium-priced fine goods; the higher class being set with diamonds, rubies, and all the precious stones, and open for the reception and preservation of mementoes. The reverse is usually plain, but sometimes concaved, for the reception of lapped gold monograms.

Black, green, and pink stone cameos are largely used as fronts to lockets, and very elegant ones for half mourning are of solid black onyx, upon the polished surface of which repose bouquets of gold, pearls, and chip diamonds, the reverse recessed for the reception of relics. The forms most prevalent in black onyx are heart-shaped, oblong, and oval; the same are also used for full mourning, but with the merest trace of ornament on the surface. The highest styles of lockets are from an inch to an inch and a half in length, and are worn pendant from a necklace or neck-chain. These, however, have no distinctive style, but the preference may perhaps be given to the massive cable link in dead gold.

For some time jewelry manufacturing has been slowly undergoing a kind of geological disintegration, the various branches quietly and almost imperceptibly separating into distinct classes. The business having assumed such vast proportions that no one concern can give the requisite attention to all the departments, the natural result has been a devotion to specialties, and thus far the arrangement has proved satisfactory, enabling the manufacturer to produce better and cheaper goods by the profitable introduction of special machinery, and by devoting all the energy to one class of goods that formerly was scattered over many. The medium and low-priced lockets are for the most part filled gold; that is, a gold shell stiffened with hard solder, and are elegantly and elaborately ornamented with engraved and enamelled work, the style of engraving known as vermicelli being mostly put upon them, and the oval form taking precedence, and the black onyx imitated in black enamel for mourning. Charms, which were formerly an indispensable attachment for a gentleman's vest chain, have given place to lockets, gold and stone; the former mostly plain, engraved or enameled. Plain onyx, either square, oblong, key-stone, or oval, are extensively worn; also stones cut in cameo, or ornamented upon one or both sides with monograms inlaid, cut or of gold imposed upon the flat surface, are in demand for gentlemen's wear. Gold fruit, spheres, hearts, etc., with the whole surface covered by engraving, and opening through the centre to give access to the lockets within, form very pretty charms for the same purpose. The unlimited demand for these goods of home production has induced many manufacturers to make them a specialty; and it would be difficult, if not impossible, and certainly unjust, to specify any *one* as first and foremost in this trade. Brown, Cook & Co. have been long known as especially devoted to this branch of manufacture, and their safe contains a range of variety and quality from which any dealer can safely select. Miller Brothers, among others, are making fine lockets of moderate price a specialty, and in fact the magnitude of the business can hardly be appreciated except by personal inspection. Even plated and gilt lockets have their special manufacturers.

In ladies' chains the long "opera" styles, which have been so long in use, are the prevalent mode. In the higher class goods very elaborate ornamentation is bestowed upon the slide, which, in itself, forms an elegant ornament, being set with stones, in initials or monograms, and heavily fringed with gold. Very beautiful designs are executed in red, yellow and green gold, producing very pleasing effects by the intermingling of dead and polished surfaces. A form still more recent, called by some "royal opera," by others "matinee," is a necklace, the ends terminating in beautiful dead gold tassels, and supporting a rich pendant, from which the chain proper springs, and which have lavished upon them great wealth of ornament. The chain is removable, thus converting a "matinee" into a necklace or chain at pleasure. Long links do not seem to meet with as ready sale as formerly, as smaller links are, on the whole, preferred. The "roller" link has retired to the position it ought never to have left, that is for necklaces and bracelets. The use of this link for chains was not so much the fault of manufacturers as of buyers, who were desirous to have a low-priced chain with a great breadth of gold, which, of course, must ever be at the expense of durability, a quality which watch chains particularly ought to possess. Necklaces in gold of moderate price must necessarily be light and of small links. The gold wire of which the massive cable link neck chains are made in dead gold, is drawn through a fine grooved wire plate with copper wire drawn in it, and after the links are bent and cut the copper is dissolved out by acid, leaving what is apparently a heavy link, a mere shell. Messrs. Warren, Spadone & Co. have a beautiful arrangement of this kind of necklace, which allows of its being separated so as to form, if desired, a pair of bracelets. An inducement to buy which, with many, would be that three beautiful articles could be had for the price of one.

The very general use by gentlemen of locket charms as an ornament for the vest chain, make it indispensable that they have a few supplementary links hanging from the hook or bar, to which they can be attached. Vest chains are the converse of ladies' chains in the style of link, long links being the rule at present, and massiveness perhaps best expresses their general characteristic. Bright and dead gold intermingled is the principal style of ornamentation, and graduated links, that is the two or three centre ones heavier than those which form the extremes, or the centre links may be of a style different from the others, and in polished red gold, affords a pleasant contrast with yellow when combined in the same chain. Small intricate fancy links seem passing away, but the good old massive curb chain maintains its conservative dignity, and keeps a tenacious hold upon public favor. Vest chains seem to have permanently superseded the guard chains, which were so generally worn by gentlemen. The necessity for something which would resist the nippers of the pick-pocket necessitated a massive chain, far too heavy for convenience, when long enough for a guard, and they will not again come into general use.

In connection with the subject of solid chains, where, unlike most other kinds of jewelry, the material forms a considerable portion of the expense, it seems proper that quality should enter somewhat largely into the consideration of buyers. In fact it does materially affect the chain trade and no branch of the manufacturing business is more serioulу interfered with by irresponsible persons. Such goods as have their principal expense in labor, instead of stock, are not liable to the same ruinous competition from dishonest compounders of metal, for labor is labor, and it can in no great degree be "alloyed" without detection; but the perfection which the art of coloring low karat gold has arrived at places an honest manufacturer somewhat at the mercy of the dishonest one.

An attempt has recently been made to regulate this matter governmentally, by the introduction into the New York Legislature, of an insanely foolish bill, full of pernicious provisions, not for the protection of honest manufacturers and ignorant buyers, but to afford a magnificent opportunity for fleecing jewelry manufacturers and dealers, and fattening a herd of rapacious "Commissioners." The fact that there is a necessity for some means of protection to innocent and confiding buyers who are constantly being swindled by dishonest dealers, is seized upon by the framers of the bill, and they expect to sail upon this tide of popular feeling into a snug harbor where they can quietly enjoy good salaries and rich perquisites. The loss to the community by the necessarily enormous expense of this system of espionage—not to mention the greater incidental expenses—would far exceed all damages from the abuses it proposes to correct. Fortunately there is no probability of its passage, unless good sense and honesty have entirely deserted our legislative halls. That karat marks stamped on gold goods by the manufacturers themselves, and with adequate penalties for the fraudulent use of such marks, would be a mutual benefit to all, no one will deny. To place this business in the hands of government officials would be like putting a "jimmy" into the hands of a burglar and expecting him to earn an honest livelihood with it. A reputation for honesty, fairly earned by years of unwavering business integrity, is, after all, more to be relied on by the purchaser, than any system of karat marks likely to be adopted. In gold chains quality of stock is an important item of their cost, and purchasers should give little encouragement to those dealers who *promise* full quality at a trifle under ruling prices; as, in all transactions with such parties, the probabilities are largely in favor of the buyers being cheated; in fact there is no excuse for dealing with unreliable persons when there are such houses as Warren, Spadone & Co., Carter, Howkins & Dodd, Wheeler, Parsons & Co., Durand & Co., Enos Richardson, P. E. Robinson, and others, "whose word is as good as their bond;" and those who do so, and find on examination that what they bought as 10 k. chain was only 6 k., and what should have been 14 k. was only 10 k., deserve no sympathy, and ought to pocket the loss, profit by the experience, "and sin no more."

In all departments of the jewelry trade manufacturers are now busy getting up fresh stocks and new designs in anticipation of a lively and prosperous spring trade. Next month the Journal will give further seasonable hints of such prevalent and desirable styles in other departments of jewelry as will, it is hoped, be serviceable to buyers.

"Clyde" to Mr. Grossmann.

Mr. Morritz Grossmann:

Dear Sir,—In this communication I prefer to address you directly, and I hope that you will excuse the liberty I take, because my reason for so doing is to prevent the recurrence of that unpleasant feeling which I fear exists in your mind, caused by the supposition, on your part, that I considered you treated the principles involved in your improved compensation pendulum thoughtlessly or superficially. Now, sir, no one who has studied any of your writings can accuse you of treating any subject superficially; but in these few past years this question of improving the compensation of pendulums is one which has occupied the attention of many inventive minds in this most inventive country, and although many patents have been taken out for supposed improvements in this line, I regret to be compelled to state that, with scarcely an exception, the inventors have displayed no more knowledge of the principles involved in the improvement of the compensation of a pendulum than if they had been compensating the handle of the town pump, so that it would have the same amount of leverage in winter as in summer. To this class my remarks regarding patent pendulums were addressed; certainly not to you, or to any other individual so deeply skilled in the science of Horology. The only analogy I know that exists between a patent pendulum as it is understood in the United States, and patent medicine as it is understood to be all over the world, is that the one proposes to cure the irregularities of the clock, the other the physical irregularities of man, and they are usually both equally effective.

You have been kind enough to notice my communication regarding the mercurial pendulum and the expansion of mercury, which appeared in the tenth number of the first volume of the Journal. The paradox that you point out as existing in Ried's Treatise may be partly explained by the fact, not generally known, that the greater portion of this book was written originally as the horological article for the new edition of the *Edinburgh Cyclopedia*, and which was afterwards enlarged and published in book form under the name it now bears. The tables you quote are not to be found in the original article, but only the statement that mercury expands nearly 5.75 times more than the steel rod. I do not know who is responsible for the addition of these tables, which substantially agree with the cubical expansion given to mercury by most of our later authorities, and which appear to be so contradictory to the conclusions Ried himself arrives at. My quotation from Charles Frodsham, regarding the expansion of mercury, was extracted from the second edition of a small work entitled "A Few Facts connected with the Elements of Watch and Clockmaking," by Charles Frodsham, 84 Strand, London, and on page 36 of this work it is stated that "mercury, in glass, expands from 5.73 to 5.81 times that of steel rod."

I am not prepared to support either Ried or Frodsham's opinions regarding the expansion of mercury; neither am I willing, at present, to admit that they are substantially wrong, for it does seem to me that mercury is acted upon differently when in a vessel swinging backward and forward through the air, like the jar of a pendulum, than when it is in vessels usually employed by philosophers in their experiments to determine its cubical expansion. I propose to set this question at rest, and have been engaged contriving some arrangement with a view of practically testing, by giving some visible or audible proof to the senses, whether the steel rod or the mercury in the jar of the ordinary Graham pendulum moves first by a change of temperature, when swinging backward and forward on the clock, and also to show how much they do move for a given change in the thermometer. An experiment of this kind is a delicate one, and consumes a great deal of time, while I, like most mechanics, can only afford to be employed upon it as a recreation in hours of leisure, and it may be sometime before I find any result sufficiently well verified to be published. However, as regards the expansion of mercury and steel, my opinion, which is principally based on the experience of every-day life, is that the mercury moves before the steel, in the ordinary Graham pendulum, by any change in the temperature, and especially if the change be sudden. This is also the opinion of other practical men of the present day; and if we go back eighty years it was also the opinion of men prominent in the profession at that period. Troughton's mercurial pendulum is based on the supposition that the mercury in Graham's pendulum is too readily affected by changes of temperature; and the sole aim of Troughton was to keep the mercury as much as possible from the direct influence of the surrounding atmosphere, and it is said clocks with this pendulum perform very well.

I need scarcely remind you of the fact, that if we take a number of uniformly well made clocks, with Graham escapements and uncompensated pendulums, with metallic rods of precisely the same length, and each rod composed of precisely the same quality of the same metal, and set them running independent of each other, but all going exactly under similar circumstances, no two of them will keep exactly the same rate; they will neither lose exactly the same in warm weather, nor gain exactly the same in cold; and none of them will gain or lose as much as they ought to do, theoretically, for the amount the pendulum has been lengthened or shortened by the various changes in the temperature. Now, from this does it not seem probable that the variable friction which the Graham escapement presents to the free excursions of an ordinary compensated pendulum, affects in an irregular manner part of the compensation that the mercury gets credit for? Take away the resistance of this escapement to the free vibrations of the pendulum, and immediately the necessity for more mercury becomes visible. My suspicions in this matter were first aroused, not by the reading of books, but by the behavior of several clocks having their pendulums less under the varying influence of the mechanism of the clock than the pendulums of any other clocks in existence, so far as I have been able to learn. I notice that the same phenomenon has been observed in England, only in a less degree, because the pendulums were not so free from the varying influences of the mechanism as the pendulums I had an opportunity of observing.

Whether mercury expands six times or sixteen times more than steel, and if the centre of oscillation be raised up by the expansion of the mercury as much as it has been let down by the expansion of the rod, and *vice versa*, and if the action of both be simultaneous, why is it that a column of mercury eight and a half inches long, and about two inches in diameter, is not sufficient to compensate a *free* pendulum, although the jar, which is of iron, is no heavier than is necessary to secure strength enough to contain the mercury? The opinion that there is a necessity for a longer column of mercury in order to effect a perfect compensation in a pendulum, is very general. However, I am inclined to think that the more we follow popular ideas, and the longer we make the mercury columns, the more we violate the laws and principles upon which the motion of the simple or ideal pendulum is based upon; but I will say more on this point as I proceed with these remarks. This is one of the reasons why I despair that we shall ever be able to make any improvement that will be of any practical value upon Graham's pendulum. Various improvements upon Graham's original plan have been suggested and adopted very extensively of late years; but imperfect as Graham's plan is, looking at it from one point of view, in practice it compares favorably with any that are popularly considered to be superior in some points of their construction. Should this assertion be doubted, I can produce well authenticated rates of the running of different clocks having movements with Graham's dead-beat escapement, in every respect the same in construction and equal in workmanship, but having mercurial pendulums all different in construction, and the clock having the pendulum the same as Graham made it, runs as regular as any of the other clocks having mercurial pendulums of a more modern construction. If there be any superiority in the regularity of any of the rates of these clocks it is in favor of the one with the old Graham pendulum; and although all the clocks run as regular as any clocks do, none of them run with that absolute regularity that is so much desired for some purposes.

I will now proceed to make some further remarks on your own pendulum. You still adhere to the belief that there is a difference of temperature amounting to as much as seven degrees Fahr. for every three feet, from the floor to the ceiling, in rooms heated by stoves, as is customary in Germany, and that this great difference is based upon natural laws. If these laws be universal we ought to see some evidence of their existence in the United States, because stoves are also used to a very large extent in this country, and in the smaller towns the ceilings of the rooms generally are not high.

In addition to what I have already stated on this subject in my first notice of your pendulum, I may mention that a short time ago I had the curiosity to try the experiment under the most extreme conditions I could find, selecting a room with a low ceiling and with little, if any, ventilation. The room was heated by a close stove, and the greatest difference I could find in the temperature was eight degrees Fahr. in a distance of ten feet.. Still I am inclined to give considerable weight to any observations made by such a distinguished person as Mr. Kessels of Altona. I have seen an astronomical clock that bears his name, and which is in use in the United States Coast Survey, and I will say that, for a portable clock, designed for field service, I never saw one where more sound judgment was displayed in every detail of its construction, and I am not inclined to think Mr. Kessels to be a gentleman likely to jump at a conclusion; and, as one of the readers of the Journal, I would rejoice to see his memoir published in these pages.

Although you state that the length of your pendulum is no mistake, as I supposed it to be, yet, with all due deference to your statement, I cannot think that it will beat seconds, without some further explanation; and I base my conclusions upon the following calculation. The total length of your pendulum is 48.43 inches, but for simplicity I will call it 48.5 inches from the point of suspension to the bottom of the four mercury cylinders. I will now draw a line through the centre of the rod, from the axis of suspension to a point 39.2 inches below this axis, which is about the distance the centre of oscillation of the pendulum should be from the axis of suspension in order to make it beat once in a second; consequently the point at the end of this line that I have drawn will be 9.3 inches from the lowest extremity of the pendulum. The four mercury cylinders are 17.7 inches high, the half of which is about 8.8 inches. Take 8.8 inches from 9.3 inches, and the point at the lower extremity of the line will be .5 of an inch above the centre of the mercury cylinders. Without taking the weight of the rod into consideration for the present, this point will be very near the centre of gravity of the bob, and not far from its centre of oscillation. There is, however, about 30 inches of the zinc pendulum rod extending above the mercury cylinders, and as this rod is .69 of an inch in diameter, its weight must be very considerable, and will tend to raise the centre of oscillation of the whole mass which composes the pendulum, a considerable distance above the point at the end of the line I drew down through the centre of the rod, and consequently the pendulum will not beat seconds, according to my way of thinking; but I will be pleased to learn if all the figures in your first communication are correct, and if they are the dimensions of a pendulum actually in operation, and which makes exactly one beat in a second.

I think you misapprehend my meaning as regards the inference I drew from the small weight sliding on the pendulum rod, which was much used as a means of regulation in clocks in former years. It is true that this weight will influence the rate in opposite directions, according as it is placed above or below the centre of oscillation, but the rate of the clock will not be influenced in proportion to the distance the weight is moved from the centre of oscillation. In a pendulum where the matter which composes it is distributed in the same proportions as in an ordinary Graham pendulum, we will suppose a small weight of a certain size, constructed to slide on the rod, and at a distance of 35 inches from the axis of suspension it causes the clock to gain 4 seconds per day. If we slide the weight 5 inches nearer to the axis of suspension the clock will gain nearly 8 seconds per day; 5 inches more and the gain will be nearly 10 seconds per day; 5 inches more, which will bring it to a point about 20 inches from the axis of suspension, and the rate will be only 11 seconds per day gaining; the next inch will produce no difference. At 15 inches from the axis of suspension the rate will be reduced to 10 seconds per day gaining; 5 inches farther up, the clock will gain 8 seconds per day; another 5 inches and it will gain only 5 seconds per day; and when the weight is one inch from the axis of suspension the clock will gain about one second per day. If we suppose the rod to extend a few inches below the centre of oscillation, and the sliding weight transferred to this rod, the effects of moving the weight will be more visible than it was when it was above the centre of oscillation. From this statement we get an idea of how many contending forces are operating against each other in the material pendulum, and that these opposing forces increase in proportion as we depart from the ideal pendulum.

In mentioning this subject previously, my aim was to show what would be the result if you could carry your mercury columns the whole length of the pendulum in order that they and the rod should be influenced the same by any change in the surrounding atmosphere. It is plain that, the expansion of the mercury having a different value as it ascends the rod, the object you aim at in constructing your pendulum would thereby be defeated. In your last communication you say: "But suppose the jars of my pendulum to reach from the bottom to the top of the pendulum, will not the centre of oscillation be in the middle of its length then, and will it not remain there if the compensation is correctly calculated?" I would beg leave to suggest that in your pendulum the centre of oscillation cannot remain in the same place, by changes of temperature. If the jars extended the whole length of the pendulum, the centre of oscillation would be somewhere about the centre of the mercury column, and about the neighborhood of 24 inches from the point of suspension, which would make it too short to beat seconds; consequently it would be necessary to increase the length of the pendulum to an enormous extent to get it to beat seconds; and all the conflicting forces I have already hinted at would be proportionally increased.

I admit that the shape of a body has an influence upon its passage through a fluid medium, but a cylinder may be supposed to have a surface favorable to an easy passage through the air; and it is only cylindrical-shaped bodies that are supposed to be in the question at present. You have four long small cylinders in your pendulum and your aim is to have them entirely surrounded by the atmosphere, with the idea of facilitating the expansion or contraction of the mercury with which they are filled. In accordance with Galileo's theory, that bodies of the same shape and density, without regard to their size, meet with the same resistance passing through the air, I still claim that *one* of your four small cylinders meets with as much resistance from the atmosphere as Graham's large cylinder does; and if you suppose the narrow enclosure of a clock case to be different from the open air, you must remember that Graham's pendulum is in the same condition as yours in this respect.

I hope that this discussion will continue and be carried on in language easily comprehended by the readers of the JOURNAL. I would be stating a falsehood, were I to say that I did not wish to get the best of this argument; still my main object is to be able to see my ideas as others see them, and get at the truth. I am open to conviction, and if you can show us a rate of a clock having one of your pendulums, which is better than the rates of clocks having Graham pendulums, or pendulums of any other construction usually employed on standard clocks, or by any process of reasoning that yours *has* the advantages you claim for it, I should be most happy to acknowledge it.

CLYDE.

Friction vs. Bricks.

ED. HOROLOGICAL JOURNAL:

My only excuse for returning to this subject is, that, as I introduced the brick question, I would like to show it up a little. Your correspondent expresses his surprise that I omitted to try so simple an experiment. I am rather ashamed to confess that, at first, I thought of doing so. This impulse, however, was destroyed by an unsuccessful search through a pile of bricks in the hope of finding one that had a plane surface, either on the face or the edge, and I am uncharitable enough to believe that your correspondent was quite as unsuccessful, in this respect, as myself; and that the experiment with the bricks cannot, under any possible circumstances, prove anything; because, if it does prove anything, it proves that *friction is increased as the extent of the surfaces in contact is diminished*, which is reducing the matter to an absurdity. I might, if I chose to take advantage of his experiment, point out that the reason for the increased friction on the edge of the brick, over the faces of all of them, was due to the fact that that edge was flatter, and actually touched more surface than the broadsides of all of them; for the most that any one claims for surface friction is that it is equal, independent of the extent of surfaces in contact. Therefore the experiment should have given equal results; otherwise the result showing less friction would indicate less surface; it could not possibly indicate greater. But, as I stated before, I have no faith in such an experiment. I never intend to question any one's statements, and decline to call upon his eye-witnesses, as the experiment itself proves altogether too much.

I regard authorities in mechanics, as well as in law, as entitled to the greatest consideration, simply because it must be taken for granted that the matters have been carefully considered before conclusions were arrived at. The character and reputation of authorities must be taken into account; also whether they are affirmative or negative; for, if it is impossible to prove a negative in law, it is quite as much so in mechanics. If a man says he has done a certain thing, it will outweigh the testimony of a thousand that it cannot be done. I was a little amused, as well as surprised, at the coolness with which your correspondent ignored my authorities, as well as contradicted his own; as for instance, page 134, present volume: "But when applied to the journals of machinery they are said to suffer considerable modification, varying with the speed and the surfaces in contact." And again in February No.: "The best authorities also tell us that friction is entirely independent of speed or velocity." The only sense in which I used "speed" was intended to mean a given time, and the power required to overcome the friction during that given time. It is evident that there is greater friction in the revolution of a pivot twice in one second than only once in the same time, and that it requires greater power to overcome it, also, in plane surfaces rubbing over each other in a given time. I quote from Mr. Grossmann, page 242, Vol. II.: "Besides, the sliding friction of the wheel on the pallet planes is of a very different nature from the rolling friction of the wheel teeth; and this former kind of friction increases considerably with the extension of the planes to be traversed." A precisely similar statement is made by the author of "The Pendulum," page 229, Vol. II. It is hardly necessary to pursue the subject farther in its relation to pivots and their bearings, for it is the universal practice to make the bearings convex. In fact, from the very nature of things, it is very seldom that they can be otherwise. Jewels are drilled from both sides, and finished with a tapering wire, and brass holes are finished with a round broach slightly tapering, so that when holes are finished in this way, it makes no difference what the length of the pivots may be, as they can rub only on this convex bearing. The editor writes, p. 77, Vol. I.: "And the pivots of the pinions by being a little longer do not materially increase the friction." I make this quotation to show the general experience, as even under the above circumstances the editor appears to have thought that the friction might be increased to some extent, more or less. Ried, p. 233, says: "It is in some degree a desideratum for a pocket watch to have the balance-pivots and holes made so that the balance, with its spring, when in a state by itself, and free of any communication with the wheels, should vibrate the same length of time, whether it is in a vertical or horizontal position. We know when it is in the latter that it will continue to vibrate twice the length of time that it will do in the other. We are humbly of opinion, that the balance, with its spring in an isolated state, could be made to vibrate the same length of time in both positions. But who will be at the trouble and expense to make such experiments as will lead to this. Mr. Earnshaw's pivots, with flat ends and shallow holes, should come very near to this object." I trust I shall not be considered ill mannered, for quoting Mr. Gribi against himself. My excuse is, that it is the most direct and positive testimony that can be offered; and from the delicacy of the experiment contrasts strangely with the example of the brick. Page 28, Vol. II.: "It dare not be in the same line with the inclination of the tooth in locking, for to effect a good draw and create the least friction by it, the point of the tooth only must be in contact with the surface of the jewel." The clearness and minuteness of the whole article show that it was the result of his own experience, and as such I place great reliance on the quotation. In Webster's Dictionary, word Friction, is a picture of a pair of wheels, without teeth, for transmitting motion by contact of their surfaces. The definition states that the surfaces are made more or less V-shaped, so as to increase or decrease friction as required. To show that this is applicable not only to rolling friction, a precisely similar case in sliding friction is given by Holtzapffel, in "Byrne's Metal Workers' Assistant," who says that the more acute the angle of a screw-thread is made, the greater is the surface friction, because the extent of surface is increased. He also states that the durability is increased by the enlargement of the bearing surfaces. He does not notice any inconsistency between these two statements, and, if time and space allowed, I think that I could show that there is none. In a description of the American lathe, page 48, Vol. I., is this statement: "These are advantages to be found in no other lathe, as a much less strain on a holding screw will insure firmness, the bearing base being so great." Comment is unnecessary.

I decidedly object to altering my experiment on the supposed pivots of a Newark watch, by inserting a wedge (one of the most powerful forces in mechanics) between the pivots and its bearing, unless Mr. G. can show that the power of a wedge *consists only in its surface friction.*

To Mr. Gribi's repeated solicitations to measure the arc of vibration to know the amount of friction at the pivots, instead of noting the time of the running of the watch, I can only state that I find it difficult to measure the arc of vibration of a $2\frac{1}{4}$ inch balance, nearer than 2° or 3°, and I am not quite sure that I can as near as that, although I use a good glass protractor. What then shall I do with a $\frac{3}{4}$-inch balance? But I can give him a simpler plan, based exclusively on his own theory, which plan will not require noting the time, nor the arc of vibration, nor, in fact, anything else. It is simply to hollow out the end of the pivot, and then put the watch together, completely adjusted to position. To be sure, Ried says he *endeavored* to reach the same end in this way, about 50 years before his time of writing. That he was not successful, is evident from his recommending shallow holes and flat pivot ends. This also shows that he did believe in the influence of the extent of surface. I have not the slightest doubt that many watches have been adjusted to position by flattening the pivot ends. In fact I have been trying to show all along, that I have done it myself. The terms "more or less flat," will not suit Mr. G.'s theory, because, if he can do it with *less*, it shows that he balances the friction of a large diameter with a small one, which is inconsistent.

In concluding these remarks upon sliding friction, I wish to call attention to the fact that I have written little or nothing as to the *extent* of that friction, confining my views as to whether it *varied at all* by increasing or decreasing the surfaces in contact. In some parts of a watch I think it may be varied considerably; in the pivots and holes, whatever the theory may be, the general practice has been and now is, to make the surfaces in contact as small as possible, so that the pivots might be an inch long without increasing their surface bearing. My only *object* has been to get at the rights of the matter.

B. F. H.

Sag Harbor.

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Metal Castings.

Editor Horological Journal:

In answer to inquiries in the Journal which have not been replied to, I take the liberty of giving the methods of casting small articles, as it may be practised by jewellers and others. Of the general advantages of these processes, nothing need be written. Of their practical adaptation to jobbing purposes, it is only necessary to consider the amount of time and money spent in sending small articles many miles to a foundry. When this value of the time and money is of little importance, it would be well to remember that in foundries they cast regular kinds of composition, and that they cast all small orders from the particular metal they may be working at that time, whether it is suitable for the article or not, so that it is often almost impossible to obtain just such a composition as may be required. The great number of alloys which copper forms with other metals, indicates their innumerable uses in the industrial arts. Sometimes it must seem necessary to have the alloy just suited to the work in hand, and the certainty of obtaining it is worth a little extra trouble. A table of the alloys of copper and zinc given in a back number of the Journal, will be found handy of reference in this matter.

A furnace is necessary as a beginning. The ordinary cylinder stove is a good substitute for the brassfounder's furnace, and the 12 or 14 inches size, with a good draft and a plentiful supply of hard coal, will melt 20 pounds of brass.

This large quantity will seldom or never be required, and a smaller quantity can be melted very easily. On a late cold morning, with a brisk fire, I melted 5 pounds of copper in 20 minutes. The crucibles used by jewellers will answer for brass up to their capacity, and will be good for two or three meltings.

Metals that melt at less than a red heat can be cast in plaster of Paris moulds, made to open for the removal of the model; or if it is of wax, the mould may be made solid, and the pattern melted out. Moulds, to separate, can be made as follows: Fill a paper box, of suitable size, with a stiff mixture of plaster of Paris and water; level it, and sink the model in a proper manner into the plaster about half its depth, or so that it will draw out without injuring the mould. Also place two or three brass wires in the plaster in an upright position, to be guides or steady pins for the upper mould; or a shallow conical depression can be made in the partially dried mould, which will be filled by a corresponding convex when the other half is cast. Dry this part of the mould, and fit a a sheet of tissue paper over the face of it and around the edges of the pattern, to prevent the two parts of the mould from sticking together. Tear off the bottom of the paper box and slide the sides up high enough to receive the plaster for the upper part of the mould, fasten the box in its place with a string and fill in with plaster. When thoroughly dry, separate the mould, remove the pattern, and bake the parts at a moderate heat, so as to be certain that all the water is expelled, when it is fit for use. There are two general processes for casting gold, silver, alloys of copper, etc. The oldest in use from time immemorial, in China, Japan, and India, consists in forming the model of such a material that it can be burned or melted out of an otherwise solid mould, which is then filled with the metal. The other process, in general use in Western Europe and America, is to mould the pattern in sand so that the mould may be separated, the pattern removed for future use, and the mould reclosed for the reception of the metal.

By the first mentioned process, figures of the most irregular shapes can be cast with the least difficulty. The patterns are usually made of wax, but they may be made of any very combustible material, such as pine wood. Insects, small animals, fruits, leaves, and other natural productions can be used as models, and placed direct in the mould. There are many substances used to form the moulds; several kinds of clays, and, also, clays mixed with horse dung; also river mud washed clean. Perhaps as good as any is a composition of one-third plaster of Paris and two-thirds brick dust, mixed with water. All these moulds should be burned at a red heat, but not those made entirely of plaster of Paris. For smooth castings the brick dust is separated into fine and coarse, by throwing it into water. The coarser particles will fall to the bottom in a minute or two, the water is then poured into another vessel, and the rest of the brick dust will gradually settle down as a fine powder. This fine dust is mixed with fine plaster, and an even layer of it is carefully laid on and all over the model, which is then covered with the coarser mixture to a sufficient thickness. Small wires or cords should lead from the pattern to the outside of the mould, so that, on being drawn or burned out, they will leave apertures for the escape of the confined air from the mould when the metal is poured in. The mould is dried gradually and heated until the wax runs out, or the combustible model is reduced to ashes, and is then baked in a stove or oven to a red heat. The runner or ingate for conveying the metal to the interior of the mould should be fixed to an end of the model, and moulded with it. The runner may be shaped like a funnel, and should be of a considerable size, that the weight of the extra metal may condense that in the mould, making a sharp and well-defined casting. Care must be taken to remove all the ashes of the model from the mould, which can be done by blowing through the holes made for the escape of air. When the metal is poured in, the mould should be very hot. The Hindoos lute the mould to the mouth of the crucible, and heat the mould while the metal is melting; then, by simply reversing the crucible, the metal runs into the mould. This process is a very beautiful one, and work of the very highest art is done by it. The utmost care, however, must be exercised, as the pattern is necessarily destroyed, and, if the casting is a failure, there is no chance for another trial.

The materials usually employed for brass castings in this country are loam and very fine sand, only a small proportion of loam being required. Sand that has been used is considered the best for brass castings. Half a bushel would be a sufficient quantity for small job work, and can be procured from the nearest foundry. Shallow wooden boxes, without tops or bottoms, are used for holding the sand, and should be made of a suitable size; or iron flasks, for the same purpose, can be bought at the foundries. Each half may be from one to three inches deep, and they are held in position by dowels or steady pins, which must allow them to be easily separated, but fit tight enough to prevent lateral shake. The bottom flask is laid on a board, and rammed full of damp sand, and struck off even with a straight edge. The pattern is then embedded half way into the sand, and the sand made to fit nicely around the edges, with a small trowel or case knife, and the surface of the sand dusted with dry brick dust to prevent the other half of the mould from sticking to it. The top flask is then placed in position, and also rammed full of sand in a careful manner.

The runner may be moulded from a wooden pattern, reaching from a suitable part of the model to the top of the sand; or it may be scooped out of the sand after the flasks are separated and the pattern removed. Although it is necessary to mould the sand while damp, yet the metal should not be poured until the mould is well dried. The part of the mould which receives the metal should be dusted with flour, or smoked over a kerosene blaze, as the fineness of the castings is improved by doing so. If the models are hollow, or have deep holes in them, the difficulties will be increased, and require very minute instructions to mould them. The cores for such work may be made of the brick dust and plaster mixtures, dried and burned before use. They are inserted in their proper place in the mould, and, of course, are left there when the metal is poured in. Patterns should be made a little tapering on the sides which enter the sand, so that they may be easily removed, and should also be made smooth, and covered with shellac varnish, or else all the glue scraped from the outside, so that they will not tear up the sand on taking them out of it. Sharp corners or angles in the patterns should be avoided, as they break the sand down at those points, and the castings are liable to crack in cooling. Provision must always be made for the escape of air through other holes than the runners, and just before casting turn the mould upside down to let the loose sand drop out.

The metals should be hot enough to fill every part of the mould, but should not be too hot. Brass is hot enough to pour when the zinc escapes in a blue flame, and a white cloud of oxide. Alloys of copper and tin should not be too hot, or the tin will strike to the surface, making the casting so hard that it cannot be filed. However, the amateur will not be likely to get his metal too hot in a common stove. For certain specified alloys new metal must be taken, while in some work old brass may be used altogether.

B. F. H.

Sag Harbor.

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Bands for Lathes.

EDITOR HOROLOGICAL JOURNAL:

In answer to a correspondent in the February number of the JOURNAL, catgut is recommended as the most reliable band for a watchmaker's lathe, also for larger foot lathes, and steel hooks and eyes for joining the ends of such bands. My experience with lathe bands, made from various materials, leads me to give the preference to good cotton cord, such as is used for fishing lines, as a material for small and even for moderately large lathe bands. Catgut may be superior in point of strength, but it is not a reliable material when rats or mice are running around. Iron or steel hooks and eyes do well when they are of the proper size, and when they run over pulleys of large diameter; but when the diameters of the pulleys are small, my experience with iron hooks is, that they do not run so smooth as is desirable, and that the band soon breaks near to the place where it is joined to the steel, just on the same principle as a band made from any material breaks first near to where a knot is tied, or near to any extra thick or unyielding part in its length.

Cotton cord can be spliced so that it can scarcely be detected where the join has been made, by first stretching the cord well, and cutting it to the proper length, allowing two or three inches at each end to make the splice.

Then open out the strands and cut out about one-half of the threads that compose each strand, and proceed to splice it in sailor fashion. A band properly made from cotton cord will scarcely ever wear out, and is specially to be recommended for lathes where the pulleys are small in diameter, and where a smooth regular motion is desirable.

A watchmaker from the West told me lately of a method he used for making lathe-bands, which is new to me, and so simple that I cannot refrain from mentioning it. His plan was simply to take thread of a suitable quality and wind it round from the top of the pulley on the lathe, down and under the large wheel, and up again over the top of the lathe pulley a sufficient number of times to get the band the desired thickness, and the two ends of the thread are then fastened together by a common knot. This knot is so small, compared with the size of the band, that its presence is never felt when the band is running; and the band being composed of a series of threads, it easily adapts itself to the shape of tho grooves in the lathe wheel and pulley, whether they be round or flat.

J. H. B.

N. Y. City.

Answers to Correspondents.

W. W. B., *Nebraska.*—In the last number of the JOURNAL, a receipt for a French Polish was promised. This polish differs from varnish both in its ingredients and in the mode of application.

It is composed of best

Shellac	3 parts
Gum Mastic..........	1 part
Gum Sandarac.........	1 "
Spirits of Wine (Alcohol)	40 "

The mastic and sandarac must first be dissolved in the alcohol, and then the shellac; the process is best performed by putting the materials in a bottle and loosely corking; place it in a water bath heated to about 173° F.; after all the gums are dissolved, the clear solution may be poured off for use. In applying it to flat surfaces, a coil of cloth is made by tearing off a long strip of drugget or thick woollen and rolling it up into a coil one or two inches in diameter and thickness, and securing it by binding it tightly around with twine; the torn edge forms the *face* of this rubber, being more soft and pliant. Apply the varnish to this face of the rubber by repeatedly shaking the bottle with the mouth against the rubber, and it will absorb enough to commence the polishing with; after saturating the rubber, cover its face with a double fold of soft linen cloth, the edges gathered over the rubber to form a handle, by which to manipulate it. Moisten the face of the cloth with raw linseed oil (colored with alkanet root if the wood is dark), applied to its centre by the finger. With this go quickly and lightly over a surface of ten or twelve square inches, with circular strokes continued until it is apparently dry, then advance to an adjoining space and do that by blending the two together, and so on over the whole surface; the varnish, being enclosed in the double fold of cloth, merely moistens it, and the rubbing must be continued till the surface is nearly dry.

In applying the second coat the varnish may be used without the oil, and applied exactly in the same manner. Three or four coats are necessary to give sufficient body for the final finish, which may now be proceeded with by applying to the inside of the rubber a little alcohol with the varnish, and covering it with the cloth, going quickly and evenly over every part of the surface; next the linen cover to the rubber may be wet with a little alcohol and oil, but no varnish, which will give a beautiful gloss. To such parts as are inaccessible by the rubber, ordinary varnish must be applied with a brush. For darker woods a harder varnish is made of 1 part shellac, 8 parts alcohol. This process is tedious, but gives beautiful results.

E. A. H., *Mass.*—The complaint you make about tho snapping of charcoal under the blowpipe can be remedied by using soft-wood charcoal; that is, pine, basswood, willow, whitewood, etc., or the charcoal from most of the hard woods may be safely used if sections *across* the grain are taken, and the heat applied only on the end of the grain. Coarse-grained woods, although soft, as chestnut, hemlock, etc., are especially troublesome in the respect you speak of.

J. B. *Vincennes, Ind.*—Seals or stamps for making impressions on wax or, whatever else, are not usually cut; the letters are driven in by steel types or punches. The expense of a set of punches for the purpose is considerable, and unless the amount of business of that sort is considerable it would be better to engrave them. The most ready and convenient way to lay out the letters on the face of the seal, is to place its face on a piece of paper and mark upon it the outline of the seal; then within that outline draw the letters or design you wish, with the softest (No. 1) lead pencil; get as much of the lead as possible on the design, then coat the face of the blank seal with a thin film of wax, and lay the face of the design upon it, and burnish the back of it lightly, and you will have the design transferred to the seal in reverse, from which you can cut, or, if you wish to trace them more permanently, it can be done by tracing through the wax with a dry point. Know of no way that photographs are *transferred* to plates to engrave from. Prints are taken from negatives by wood engravers to save the labor of drawing the design.

There are several chemical processes partially successful for producing printing plates from photographic pictures; negatives upon glass have also been used to print from by etching their surface chemically.

D. M. W., *Texas.*—The dies you wish for punching out wheels require very fine workmanship, and a proper press and dies would involve an expense hardly warranted by any want short of establishing a business of that character. If you wish a few, or even a great number of blank wheels punched "similar to those in the American watch," you can undoubtedly get any of the factories to furnish them to you infinitely better and cheaper than you could get them up yourself. The probable cost of such punches you can ascertain by corresponding with W. E. Cass, Newark, N. J.

M. E. M., *Tenn.*—Manufacturers of glaziers' diamonds sell an instrument for the purpose of cutting out circular glass for clock bezels, but any handy wood-worker can construct you an effective substitute from a board about two feet in length by eight inches in breadth; near one end of which, and resting upon it, place a disk of wood in diameter equal to any size glass you will require to cut. This round turn-table is held in place by a stud fixed in the board and entering into a hole through the centre of the disk, and upon which it can be revolved; beyond this disk fasten along the centre of the board a strip of wood, four inches or so wide, and thick enough to have its upper surface an inch above the turn-table; through the whole length of this strip cut a groove or recess half an inch deep and two inches wide, and in this groove fit, to slide easily, a strip of wood long enough to reach from the centre of the turn-table to the lower end of the frame; near the end of this strip, over the turn-table, cut a hole through it at such an angle, and of such a size, as will hold a glazier's diamond in the same position that it would be held in cutting glass by hand. You will now see that by putting the diamond down through this opening, it will meet the surface of a piece of glass placed upon the turn-table at any desired point between the centre and the circumference, and by being pressed upon, and revolving the turn-table, a circular cut will be made. By sliding farther from the centre of the turntable the strip which holds the diamond, circles of larger diameter may be cut. One of this construction has been in use for years and found very satisfactory.

W. W. C., *Jackson, Mich.*—Have never tried alcohol for applying shell gold, and should not think it would work well; the method of preparing the shell gold indicates the proper menstruum for its application. It is only gold leaf ground to an impalpable powder with honey, which is then washed away, and the powder dried, when it is mixed with gum water and spread upon the inside of the shell. Gum water is the proper vehicle; but no difficulty has been found in the practice of wetting the brush with saliva, and thus applying the gold powder.

H. S., *Iowa.*—It is very difficult to give intelligible directions as to the identification of a diamond. An expert, one accustomed to their appearance, has no hesitancy in pronouncing upon the genuineness of a stone the moment he sees it, but he would be as much puzzled to describe *how* he knew, as you are to understand it. The secret lies in an indescribable something pertaining to the *lustre* of the stone; there is a certain vitreous, penetrating reflection of light from the polished surface, unlike that reflected from any surface of a softer nature, and produces a sensation on the eye similar to that produced on the tongue when applied to wood and metal alternately. This peculiarity of reflection is well illustrated by the difference in the appearance of the image reflected from a clean looking-glass, and one with a film of dirt on its surface; in the one case the image is perfectly clear and brilliant, in the other it has a filmy, indistinct appearance. A little practice with a diamond will help you in acquiring this skill.

Take an ordinary paste-stone, not particularly well polished, stand with your back to the window, hold the principal face of the stone as near the eye as you can and not touch it, and observe the reflected image of external objects in or across the street, and you will see them indistinctly and apparently through a hazy atmosphere. Then take a diamond, apply its table or largest facet to the eye in the same manner, and immediately the whole visible landscape is clear and brilliant, and there is an entire absence of that misty appearance. Even the best imitations will show a difference in this respect. The effect of these reflections approximates those of the real stone in proportion to the hardness and perfection of polish of the false stone; but this test should not be relied on except when you have a real diamond by which to compare the reflections.

W. W., *Meaford, Ont.*—Inquiries similar to yours have been received from other persons, and as there are principles involved in the action of drills, whether they are large or small, it may correct much misapprehension to say, that in drilling more or less pressure is necessary to produce penetration; and this pressure, other things being equal, it will be found necessary to increase in proportion to the hardness of the material to be drilled. In consequence of this law, there will be a limit to the effectiveness of the drill, as the size diminishes, which will be arrived at when the size of the drill does not possess sufficient strength to resist the necessary pressure upon it, and which is really the true cause of the want of action in small drills upon hard steel, assuming their proper construction. It is for the same reason that the graver cannot be used for turning down hard pivots to their smallest diameter, for below a certain size they do not possess sufficient strength to resist the pressure necessary to make the graver cut, and all farther reduction in size must be done by abrasion (grinding), or by the use of the file with the pivot adequately supported; hence the impossibility of drilling minute holes in hardened steel without letting down the temper. It may be done by using diamond dust, but the process is tedious, and you will find it more economical to remove the pinion or staff than to resort to it. The "stub" can be softened without removing the wheel if it projects enough to be seized with long-nosed plyers, which should be used for the purpose, holding the "stub" by them and *heating the nose* with the blow-pipe. There are no drills in market except the ordinary pivot drills, and these are only intended to be a convenient form from which each workman can make such as he requires.

J. H. S., *Ohio.*—Heretofore the application of gas for small melting purposes has not been very successful in an economical point of view, and there is no arrangement that we know of likely to suit your wants. It is possible that "Fletcher's gas furnace and hot blast blow-pipe," described in the *London Chemical News*, may be worth your trying. It is as simple as an ordinary Bunsen's burner, but the flame is solid to the centre. Copper will fuse in any part of it, and to make a crucible furnace of it only requires a support for the crucible, and a fire-clay jacket to prevent radiation. The lower part of the combustion chamber is 6 inches by 3 inches, open at the bottom, in which the gas is partially mixed with air, which mixture is conducted to the top of the burner through a mass of fine tubes, with an arrangement to supply, between each, the amount of air necessary to consume it instantly. A flame consuming by this means about 20 feet of gas per hour is about 2 inches high and almost colorless. The whole of the available heat is generated below the object to be heated, which is therefore not cooled by the passage of unburnt gas and air. The point of greatest heat, as with the blow-pipe, commences at the point of the blue cones, one-half or three-fourths of an inch above the tubes; and, if the flame is protected by a ring of fire-clay, continues uniform for some inches above. With gas fully turned on, it will melt 3 ounces of 18 k. gold on pumice stone. Steel wire burns readily, and wrought-iron wire is easily fused. With the blow-pipe the extreme power is exerted to the best advantage on small objects when the jet is turned down to a small cone about 1 or $1\frac{1}{2}$ inches high. For soldering and heating crucibles the gas should be turned on full, so as to make a large rough flame, the heating power of which is about double that of the common blow-pipe. You may find some modification of this apparatus necessary for the workshop.

Z. W., *Georgia.*—The "patent process for cleaning watches" which you seriously inquire about is too ridiculous for a sober answer; it should be classed with clock-cleaning by boiling out in soap and water, and is about as much like watch-cleaning, as dipping a dirty handkerchief in cold water and holding it on the stove-pipe to dry is like washing and ironing. Don't you do it exept as an experiment to prove what immense ears some *horses* wear.

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EQUATION OF TIME TABLE.

GREENWICH MEAN TIME.

For March, 1872.

Day of the Week.	Day of Mon.	Sidereal Time of the Semi-diameter Passing the Meridian.	Equation of Time to be added to Apparent Time.	Diff. for One Hour.	Sidereal Time or Right Ascension of Mean Sun.
		S	M S.	S.	H. M. S.
Friday	1	65.39	12 27 01	0.508	22 38 23.05
Saturday	2	65.32	12 14.57	0.527	22 42 19.61
Sunday	3	65.25	12 1.67	0.546	22 46 16.16
Monday	4	65.17	11 48 32	0 564	22 50 12.71
Tuesday	5	65.11	11 34.55	0.581	22 54 9.27
Wednesday	6	65.05	11 20 37	0 599	22 58 5.82
Thursday	7	64.99	11 5.80	0.615	23 2 2.37
Friday	8	64.93	10 50.85	0.630	23 5 58.92
Saturday	9	64.89	10 35.53	0.645	23 9 55.48
Sunday	10	64 83	10 19 88	0.659	23 13 52.03
Monday	11	64.79	10 3 90	0.672	23 17 48.58
Tuesday	12	64.75	9 47.61	0.685	23 21 45.14
Wednesday	13	64.71	9 31.02	0.698	23 25 41.69
Thursday	14	64 67	9 14 16	0.709	23 29 38 25
Friday	15	64.64	8 57 03	0.719	23 33 34.79
Saturday	16	64.61	8 39.66	0.728	23 37 31.35
Sunday	17	64 58	8 22.07	0.737	23 41 27.91
Monday	18	64.54	8 4.30	0 745	23 45 24 46
Tuesday	19	64.52	7 46.34	0 752	23 49 21.01
Wednesday	20	64 50	7 28.22	0.757	23 53 17.56
Thursday	21	64.49	7 9.97	0.762	23 57 14.12
Friday	22	64.48	6 51 62	0.766	0 1 10.67
Saturday	23	64 47	6 33 18	0 770	0 5 7.22
Sunday	24	64.46	6 14.67	0.772	0 9 3.78
Monday	25	64.46	5 56 13	0.773	0 13 0.33
Tuesday	26	64 46	5 37.59	0 773	0 16 56.88
Wednesday	27	64.47	5 19 05	0.772	0 20 53 43
Thursday	28	64.47	5 0.53	0.771	0 24 49.98
Friday	29	64.48	4 42.07	0.768	0 28 46 54
Saturday	30	64 49	4 23.69	0.764	0 32 43.09
Sunday	31	64.50	4 5.41	0.759	0 36 39.64

Mean time of the Semidiameter passing may be found by subtracting 0.18s. from the sidereal time.

The Semidiameter for mean noon may be assumed the same as that for apparent noon.

PHASES OF THE MOON.

	D. H. M.
☾ Last Quarter	2 7 28 8
● New Moon	9 0 53.5
☽ First Quarter	16 14 25 1
○ Full Moon	24 13 43.6
☾ Last Quarter	31 14 32.1

	D. H.
☾ Perigee	6 2 4
☾ Apogee	17 22.0

Latitude of Harvard Observatory .... 42° 22′ 48″ 1

	H. M. S.
Long. Harvard Observatory	4 44 29.05
New York City Hall	4 56 0.15
Savannah Exchange	5 24 20.572
Hudson, Ohio	5 25 43.20
Cincinnati Observatory	5 37 58.062
Point Conception	8 1 42.64

		APPARENT R. ASCENSION.	APPARENT DECLINATION.	MERID. PASSAGE.
	D.	H. M. S.	° ′ ″	H. M.
Venus	1	20 36 4.54	–18 38 12.1	21 58.7
Jupiter	1	7 27 39.24	+22 26 13.2	8 47.8
Saturn	1	19 20 2.96	–21 49 40.5	20 38.6

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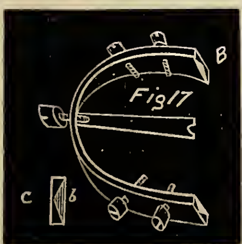
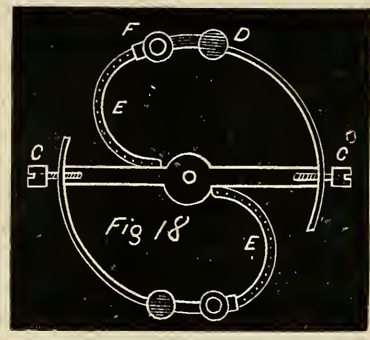
History of Compensation Balances.

NUMBER FOUR.

Mr. Dent's last contribution to horological science was what he called a "prismatic balance." This name was given it on account of the shape of the steel of the rim, a section of which is shown in Fig. 17, the parallelogram *c* representing a section, and *b* the steel within the brass of the balance, the weights for adjustment being sliding blocks upon the rim. It is based upon the principle that a prism of steel will bend more easily from the edge than in the opposite direction; consequently the motion is greater when curved by heat than when straightened by cold, which are the conditions required for the balance. The difference, he says, is not so great as it ought to be to counteract the error. When the range of temperature is very wide, say from 10° to 100° F., Mr. Dent has found them quite near enough for the ordinary variation of temperature, and more than usually steady in their rate; for the best are at times very capricious in their action, showing that there yet remains something to be studied besides compensation, for extremes of range.



Loseby's mercurial compensation balance has, besides the usual compensating weight D (Fig. 18), near the end of the compound bar, two



small bent thermometer tubes, the bulb at F, in which a little air is also sealed up with the mercury. As the temperature is increased, the weight and bulb not only approach the centre, but a portion of the mercury also is driven along the tube, thus carrying more of the weight toward the centre at a rate increasing more rapidly than at F. The action is as continuous as that of Dent's, and the adjustment for primary and secondary compensation independent of each other. Its fragile character, and the care required for construction, even were its performance entirely satisfactory, prevent its general adoption. Both Effie's and Dent's have been in use by other makers, but Loseby's has been neglected.

It would be utterly impossible to describe a tithe of the forms which have been given to modern balances; but none have developed any new principles. Balances have been made with concaved, dish-shaped rims, also with compound rims of larger masses of metal and lighter weights, allowing the adjustment weights to be moved greater distances for minute adjustment, and many have been proposed of peculiar construction, but not having been put to a practical test no evidence of superiority has been shown. The very general introduction of compensating balances into modern watches, both adjusted and unadjusted, has made their construction a special department of the trade. In Europe, balance making is a business of itself, and as far as we know is almost wholly hand-work. In the American factories different methods are adopted by the various companies for making balances, all of course possessing a general similarity, a description of which may be of interest to the reader.

From the best attainable steel plate the blanks are punched a trifle larger than the intended diameter of the steel of the balance, in the centre of which a hole is drilled and broached out to fit perfectly a pin in the lathe centre, and also a guide hole midway between the centre and circumference which fits a carrying stud; the blank is then turned off to gauge diametrically, and faced; upon this steel blank is driven a ring, punched out of sheet brass, and of suitable size to fit, but both thicker and wider than the proposed balance. Before being driven on, the edge of the disk is moistened with a solution of borax, and along the joint are placed pieces of silver solder, or what is better, and which some factories use, a composition similar to brass, but a trifle more fusible, and the whole heated to the fusing point of the solder. This process necessarily expands the brass ring so that the solder flows in forming (it is expected) a perfect joint. The intervention of this film of solder prevents the ring from assuming its former position on cooling, thus causing a tension which, were the balance turned up, finished and cut in that condition, would produce a distortion from a circular form. To remedy this tendency, as far as may be, the blank is placed in a suitable machine, and the periphery hammered by a succession of minute strokes while revolving, by which the brass becomes hardened, condensed and stretched, so as to allow it to rest easily in its position without any molecular constraint. The blank is then again centred on the same pins, the holes having been protected from scale by plumbago, and the diameter turned down to a shade larger by gauge than the completed balance is required to be, and the face turned true; it is then reversed on the lathe and the opposite side faced, and one side is then stoned to a perfect plane. This plane surface is then recessed out to a gauge, both for depth and diameter, leaving the rim of steel and brass in each balance exact duplicates of every other, and perfectly concentric with the centre hole. This method of course depends on the accuracy of the lathes for perfection, and in these, as in all the automatic machines of the factory, the utmost care is bestowed upon their construction.

The next step is to cross out the arm or bar of the balance. This is done by a circular burr or cutter, underneath which the balance is placed upon a bed, which is raised up until the saw has cut the line of one edge of the bar from near the centre hole to the circumference; then the bed is shifted by an index to a position to cut the other angle of the arm; the whole is then turned half round, and the other edge of the arm similarly formed. The steel must then be freed from the rim by a circular cut from one end of the arm around to the other, which is accomplished in the lathe by a back and forth motion. This leaves more or less roughness or burr, both to the edge of the arm and along the inner edge of the balance, for the cuts were not made *quite* to the proper line; to finish and render them exact, the balance is placed in a "gig" or "templet" of hardened steel, and the adhering burr removed by a scraper until the templet is touched in all its parts. Some factories, for cutting out the superfluous metal between the arm and rim of the balance, use a semispherical rotary cutter or burr, the diametric edge of which cuts the line of the arm, and the spherical part coinciding in curvature with the inner circle of the balance, removes all the steel on one side of the arm at once, and a semi-revolution of the table brings the other half in position to be similarly cut away. The flat of the arm, inside, is stoned off by a swing lap, and grayed by a boxwood one with stone dust. Drilling and tapping the thirteen holes on each side automatically on the machine, is the work of but a few moments. The upper edge and the outside of the brass rim are then polished with Vienna lime, and after being washed and dried, it is ready for the screws.

Another patented method is to turn a rod of steel perfectly true, both as to diameter and parallelism, and cover it throughout with brass melted upon it, from which, after proper hammering to condense it, it is turned up to a gauge and cut up into disks suitable for balances. These disks, chucked from the circumference, are turned and finished in the usual manner. This plan gave excellent balances, but, for reasons independent of their action, is abandoned at present. Still another way, adopted by other parties, is to roll the solder out into thin foil and interpose it between the brass ring and steel disk previous to driving it on. Heat, of course, is then applied to perfect the union of the parts.

Turning the balance screws is the same process as for all the other screws, except that the sides of the heads are polished by a lap, revolving parallel to the axis of the screw. They are made of brass, aluminum bronze, and gold, uniform in size, but varying in weight, as the material varies of which they are made. This density of material gives a facility for poising and adjusting without altering the size of the screws, which, if done, gives to the balance an inelegant appearance. Other makers resort to the very neat expedient of drilling out the screw head to more or less depth to vary their weight. In this case the heads are not slotted for a screw-driver, the screws being turned by a square obtuse taper driver.

The mode of making watch balances by hand, as practised by balance makers, is almost, if not exactly, identical with the process of making marine chronometer balances, the only difference being in size and weight, a description of one applying equally well to both. Prepare a piece of fine cast steel, about the same diameter and thickness as the balance is intended to be, turn the edge concentric with a hole through its centre, and face up one side perfectly. In these balances the brass is *melted* on to the steel, thus uniting the two metals without the intervention of solder, which in fact introduces a third metal into their construction, the action of which, it is claimed by some, modifies, to a greater or less degree, the results that would be obtained by steel and brass alone. To melt on the brass, the prepared steel is placed in the bottom of a small crucible, or what is equally good, a thick piece of earthenware, with a hole or recess in it of sufficient depth. If earthenware is used, it should first be annealed in a slow fire, and then coated over with plumbago. The late Mr. R. F. Bond, of Boston, used soapstone, which was found to be well adapted for the purpose. Before placing the steel in the crucible, it must first be thoroughly clean, and the centre hole protected from oxidation, and the edge then coated with a paste of clean borax and water; small pieces of fine brass are placed around the edge as it lies in the recess, and heat gradually applied to the whole till the brass is melted, and thoroughly attaches to the steel disk. Great difficulty is often experienced in getting brass that will flow readily, and adhere to the steel in a compact homogeneous layer, free from holes, which would of course render the balance worthless. The Scoville Manufacturing Co.'s Lancashire brass, though excellent in other respects, has proved for this purpose defective, and resort is usually had to remelting old English watch brass, which gives desired results without farther trouble.

The steel disk, with its adhering mass of brass, is then chucked on the lathe by its flat side, and the brass turned down to the proper thickness; the steel is then recessed out, leaving the bottom thickness equal to the requirements for the arms of the balance, which are then marked out, and on each side of it holes drilled through, which allow files to be introduced to cut away all the steel not necessary to form the arm or bar. The screw holes are then laid off, drilled and tapped, the balance polished, and it is ready to be fitted to the staff.

In constructing compensation balances, whatever method is adopted, and whatever care may be taken in selecting homogeneous material, and notwithstanding the fact that all subsequent operations upon it are duplicated as minutely as mechanical skill can do it, there yet does occur in them an individuality of behavior wholly unaccountable; and although identical in construction, they are not so in action, and must uudergo a rigid inspection to determine their personal characteristics before they can be relied upon. Of course, in a hundred balances thus made, some will approximate theoretical results, some will prove to be exactly as intended, and some will in some process of their creation become "possessed with a devil," which no amount of adjustment will cast out; and, like some human beings, seem to have inherited innate tendencies to evil which the most careful training will not eliminate.

——o——

Engraving.

NUMBER THREE.

In the case of the long straight stems, the safest way is, until confidence and skill of hand are acquired by practice, to first cut the stem light, and deepen and widen it to its proper size afterward; of course the extreme ends must be cut square, as directed for the tops and bottoms of the stems of small letters, and the stems should extend above and below the line double the height of the small letters. From what has been said about connecting the stems and curved parts of the small letters together, it will be at once understood how to join these to the long ones. There is another class of stems, represented by *l* and *g*, which are commenced either at the top or bottom; if an *l*, and the plate is in a position to commence at the bottom without turning it, the hair line is the one to be first done, carrying it up nearly straight till near the top, then, with a slightly increased depth of cut, turn the chip out toward the left; then reversing plate, start from the top in a hair-line, gradually widening the cut, and at the same time rolling the graver to the right; this will produce a straight line on the left; the gradual widening of the cut toward the right gives the stem of the letter a slightly curved appearance, quite as much as the letter requires. Always avoid giving to *h* and *l* a hump-backed curve; *h* and *y* are the same thing reversed. The only remaining small letter which has any peculiarities of construction is *s*, which is easily and quickly made by first cutting the hair-mark upward, the extreme upper end a little deepened and carried slightly above the upper line, and the chip lifted straight out; then commence the heavy part at the base line, and near the first hair-stroke cut gradually round, swelling it toward the right, and bring it into the hair-line near the upper line of the letters; then exactly on the first hair-line a little above the base line make a round dot with the round point graver and it is complete.

Capital letters ought now to receive some careful study, not so much in the matter of cutting as in drawing, as will have been experienced if any practice has accompanied these instructions. Here directions are of not much use, the whole being but continued practice, in copying good models. A few suggestions about the best points at which to commence the cutting of curves, may be useful to the learner.

A B C M l g h y.

In cutting the *B*, set the point of the graver at the last point of the hair-mark of the stem; turning the plate around slowly and carefully, follow the tracing of the letter till it become necessary to swell the body of the stem; to do which, gradually roll the graver toward the right, running it out just above where the loop encircles the stem; turn the plate and commence at the other end of the stem with exactly the same cut, until they run into each other, which will produce the stem properly shaded on both sides. For the next cut it is generally convenient to commence at the loop and cut upward, crossing the stem near the top and continuing the hair-line around to its termination, either cutting the swelled part by rolling the graver, or by going over that part the second time, giving it the proper width; the lower or last part is produced by the same cuts.

The hair-line of *C* is first cut, then the body, commencing at the top and continuing on around to the end, mutually revolving the plate and hand to produce the curvature. The swell of the body is most readily cut from the top. The mistake beginners usually make with this letter is in giving too great a curve to the body, which produces a humped-back appearance, which ought to be carefully avoided. The middle heavy stroke in *M* should be cut from both top and bottom. No other special directions will be needed to enable the learner to progress to respectability in cutting script letters; persistent practice in drawing them correctly, in conformity to good models is, however, indispensable.

There is a peculiar style of ornamentation quite prevalent applied to initial letters; why it is used, or for exactly what purpose, is difficult to determine. It is a series of inverted commas, ' ' ', springing from the stems and various parts of the letter, entirely at the caprice of the engraver, the first and largest one nearest the stem, followed by two or three others diminishing in size. It may be that this style of dotting was invented for the concealment of such defects of drawing as were too glaringly apparent in the naked letter, but it must be confessed that they do sometimes give to script monograms, when properly applied, a finished appearance. These dashes are produced in two ways, one by the ordinary graver being suddenly rolled over to either the right or left and the chip instantly lifted out, or by a flat-bottom narrow graver, commencing the cut with the corner of it, and lifting the chip when it has been rolled so as to cut the full width of its flat bottom.

It is sometimes desirable to give effect to large letters upon water pitchers, salvers, etc., to ornament the body of the stems somewhat. This can be done expeditiously by using the half round graver for a process called "wriggling," which will be readily understood by placing one corner of a flat-bottom graver on the plate and rolling it over to the other, then back to the first one, and so on; at the same time driving it forward, which will produce a zig-zag line, very useful for many ornamental purposes. For ornamenting the body of letters in this manner, the round point is preferable, because it better accommodates itself to shape and depth of the cut.

This style of ornament is well adapted to filling up the bodies of such large letters as are usually cut upon coffin plates, many of which the watchmaker, in towns too small to support a professional engraver, is called upon to execute, and a word upon this subject may not be out of place. Upon them the lettering should be simple and bold, and in as few lines as possible, and should be so large and legible as to be easily read without close inspection. Filling up the bodies of such large letters by "wriggling," produces a pleasing effect, and yet does not interfere with their simplicity.

There is now much demand for old English lettering on silver and plated ware, both for initials and for inscriptions upon presentation articles. There is some misapprehension by customers as to the letters they really order engraved, many supposing that the form known among engravers as Old English, is called German Text, which is a letter but little in use and is not popular, especially the capitals, on account of their obscurity—that is, the primary form is so enveloped by ornamental flourishes and fanciful appendages as not to be obvious to those who are not familiar with them. The old English letter is not very difficult to execute after the necessary skill in drawing them is acquired. The flat-bottom graver is of very general application in this case, because with it are formed the bodies of all the small letters. Not much instruction will be needed to do respectable work, with more or less practice, of course. Take, for example, the word **London**. The lower part of the **L** may be outlined by hair-lines and the interior cut away with the flat graver, the body of the letter to be done in the same way; the **o** may be commenced at the bottom of the body of the left half of the letter with a graver the full width of the stem, setting the graver square in the metal and driving it boldly to the first angle; then take a new start for the upright part, repeat the same for the next half, and so on, for the bodies of all the other letters, or, which is sometimes preferable, do all the parts that have the same angle through the whole word, both above and below, before changing the plate; then shift the position and do all the uprights, which must then be connected by the proper hair-lines.

Another very effective way of cutting old English is to cut the letter in outline and fill up the body of it by lining it across diagonally with a "line graver," the flat or cutting surface of which is ruled in fine parallel lines; if no such graver is at hand the lining can be done by an ordinary one, but not with equal uniformity, and at much expense of time. Also a very pretty letter is formed by cutting one edge of the body of the letter with a *narrow* flat tool, and the other edge in hair lines, filling the centre as before; or, when the letters are of considerable size, the filling up can be rapidly done by "wriggling."

Flourishes about the letters produce an effect quite the reverse of pleasing, unless used with much moderation, and applied with more taste and judgment than usually falls to the lot of beginners, especially such as, from the necessity of the case, must be self-instructed. The learner will not fail to notice, if he pays that attention to the subject which he must do if he has any expectation of becoming in any degree proficient, that the ornamental lines which most please the eye and produce the best effects are exceedingly simple, and the student is inclined to believe that no difficulty will be experienced in producing them; but let him make the attempt to throw about a double name with a middle initial a few curved lines called "flourishes," and the probabilities are that his *few* lines will not please him, and he will continue to add to them in the vain hope that presently it will look right; whereas the more they are multiplied the worse it appears. The best way in such a case is to rub out and commence anew; draw and re-draw before cutting; study some model which does please you, and closely observe the form and position of the curves. Even with the model before you, it will at first be difficult to produce the same effect, and the reason why is what must be found out by the slow and tedious process of practice. An excellent study is to copy in a blank book kept for the purpose any combinations of ornament and lettering that particularly please you. The time it takes for such slight sketches is but trifling, and you will soon accumulate a collection of samples which can be drawn from as occasion demands, and it is surprising to observe the rapid improvement in taste which follows this excellent practice. Or, what is better, if it is possible, obtain one or more of the various publications which designers and engravers now publish, containing not only alphabets of various styles of letters, but monogrammic combinations of initials as well adapted for studies as for actual copies. These works save to the learner many a sorrowful failure, and are of inestimable value to those who from their isolated situation are obliged to rely upon self-instruction for what they know of engraving.

The first, middle, last and continuous thing to be carefully attended to, simple and unimportant as it seems, is to keep the tools in good order. Nothing so surely spoils the work and temper of the artist as dull and badly shaped gravers, and as they *cannot* be properly sharpened on a dirty stone, its condition becomes of much importance, and these crude hints to learners cannot be better concluded than by giving, in a few words, the key to success in the art of engraving—always have the stone clean, and plenty of limpid oil upon it.

Reminiscences of An Apprentice.

FRICTION CONTINUED.—AT THE ACADEMY.

The Principal commenced by stating that all authorities, at home and abroad, were agreed "that friction was in proportion to the pressure on the bearing surfaces," "that it was independent of the extent of the surface of contact," and "independent of the velocity in which one body is driven across another." In support of these statements he showed us a model, with an inclined plane, made of a slab of polished marble, and so constructed that the inclined plane could be adjusted to any desired angle with the top of the table. On this inclined plane there lay a block of hard wood, one side of which was perfectly smooth and flat, and the other side hollowed out so that only a small portion of its surface rested on the marble. At the upper end of the marble a pulley was fastened, over which run a cord, one end of which was fastened to the block of wood, and the other to a weight hung perpendicular with the floor. This weight pulled the block of wood up the inclined plane just as easily when the broad surface of the wood rested on the marble, as when the narrow surface did. If the marble was set at a small angle of incline with the top of the table, a smaller weight pulled it up the incline than was required when the incline was adjusted to be very steep; but in in every instance, and under every variety of circumstances, the wooden block was pulled up the incline as easily when the largest surface of the wood touched the marble as it did when the narrow surface was in contact. "Our journeyman" examined the model very critically, evidently expecting to detect some trick about it; but the block of wood behaved exactly in the same manner with him as it did with the Principal.

Although the results exhibited by the model seemed plain enough, I could not understand how such a law could be universal, and asked why it was that sleighs were made with narrow runners, if it was not to prevent friction. The Principal answered that sleighs were generally pulled over uneven surfaces, and that these laws would only hold good when the entire length and breadth of the road's surface was equally smooth, hard, and dry, which never happened in the case of ordinary roads. I then asked why skates were made with only one narrow steel runner, for I was sure that I could go faster and easier on the ice with skates than I could do with only my shoes on. The Principal answered that no ice was perfectly flat and dry, and in this case the adhesion of the leather to the damp ice, was greater than steel. I then asked why the runners were not made broader, and he answered that, although broad and narrow steel runners presented precisely the same amount of friction when the ice was smooth, yet for skating purposes it was desirable to concentrate all the bearing directly underneath the centre of gravity of the person skating, so that the pressure on the narrow runners will make them take hold of the ice, and thereby enable the skater to guide his movements more dexterously. I then asked, if friction did not depend on the extent of the surfaces in action, why it was that the other day when we put a thick band on the foot-lathe it worked without slipping, while the old thin band would often slip. The Principal replied that it was the same with bands or belts used in driving large or small machinery, as it was with other bodies in contact. The thick band on the foot-lathe being heavier, caused a greater amount of pressure on the surface of the driving-wheel and pulley, and also its being thicker enabled it to withstand a greater amount of tension without stretching or breaking; and that it was a grave mistake to suppose that broad bands or belts were applied to machinery for the purpose of creating an extra amount of friction by the broader bearing surfaces of the belts and drums; that the object was simply to produce extra weight and a sufficient amount of strength to bear the strain on the belts, and that broad surfaces were more liable to run for a longer time without abrasion than narrow ones. He also explained that the same principles were involved in frictional gearing; the bearing surfaces of the wheels were not made large or broad to create friction, but simply to be able to withstand the amount of pressure that was upon them, without wearing away too quickly.

I then asked the Principal if there was the same amount of friction on a small surface as on a large one, why it was that, in turning thin pieces of metal on an arbor, the thin piece sometimes slipped, but a thick piece with a long bearing never slipped, if it was well fitted? He explained that exactly the same principles were involved in making articles hold on an arbor when they were being turned, as were in the case of frictional gearing. An article would hold on an arbor if fitted so that the arbor touched the entire surface of the hole, because then all the molecules of metal came into contact; and they were not bruised because there was enough of them to withstand the resistance of the pressure in turning. Whereas, if only a portion of the surface of the arbor touched the work, there were not a sufficient number of molecules in contact to withstand the resistance of turning, and the molecules becoming bruised, the work slipped.

He next showed a model illustrating circular motion, which consisted of a round steel bar, turned perfectly straight, true, and smooth, and resting on a piece of plate glass, also perfectly true and level. A very fine thread passed once round the steel bar, and on each end of the thread equal sized weights were suspended so that the one exactly balanced the other when the round steel bar rested on the plate glass. A small piece of brass was then placed on the top of one of the weights, and it being now heavier than the other, it descended slowly and pulled the other weight up. The round steel bar was then lifted off the plate glass and rested on two very narrow glass bearings, and the weights adjusted to be in equilibrium, as before. The small piece of brass was then added to one of the weights as before, but, although the axis rested on very narrow bearings, the weight did not descend any faster than it did when the round steel bar or axis rested its entire length on the plate glass. On each end of this bar or axis were two pivots, considerably smaller in diameter than the body of the bar itself; the supports were now placed underneath these small pivots, and no part of the bar touched anything except that part of the pivots that rested on thin bearings; the weights were then adjusted as before, and when the small piece of brass was added to one of them, the weight commenced to move at a much more rapid rate, compared with what it did when the body of the bar rested on the same narrow bearings.

Here, remarked the Principal, is a fine illustration of the fact that circular motion, like sliding motion, is not affected by the extent of bearing surface, and that long and short bearings have an equal amount of friction *when their surfaces were equally perfect;* and it also shows, in a striking manner, how the effect of friction is reduced as the pressure approaches the centre of motion of the revolving body, and explains clearly the true reason why small pivots offer less resistance to motion than large ones. The Principal then continued to say, that we must have observed that the round bar moved equally as easy when its entire length rested on the broad bearing of the plate glass, as it did when it only rested on the two narrow bearings, which could not have resulted if there was more friction on the long bearing than on the short one. He also explained the reason why the round bar turned as easily on the long bearings as on the short ones was, that in the one instance the pressure was equally distributed among all the particles that constituted the bearing surface, and that the pressure was but slight upon each particle in proportion to their number; whereas, in the case of the short bearings, the pressure was greatest upon the comparatively few particles that composed them, and if the pressure was greater than the particles could bear, abrasion immediately took place, and a rapid wearing away of the parts speedily followed. I now asked why it was that long bearings in some kinds of machinery were turned away in the centre with the idea of reducing the friction, and was informed that the true object of turning away the centre of a long bearing was to facilitate the fitting of it in cases where very accurate fitting was required, as, for instance, the long centres in some astronomical and surveying instruments; for it was always easier to get a good fit when the bearings rested on a part of each end, than when their entire length came into action; and to hollow out any bearing with the idea of reducing the friction, when the bearing surfaces were *equally smooth and regular*, was entirely erroneous.

The Principal then proceeded to explain another kind of circular motion, and brought out a model which looked like an ordinary surveyor's compass, or a mariner's compass without the card board, to illustrate his ideas. He first rested the magnetic needle on a rather broad flat point, and the motion of the needle on that point was slow and sluggish. He then changed the centre of the needle and rested it on a point the same in diameter as the first one, but hollowed out in the centre so that only its outside edge would touch the needle; but the needle did not move any easier or quicker on account of it resting on a centre that was hollowed out, but rather moved duller and slower. He next placed the same needle on a very sharp point and it immediately commenced to move backward and forward, quite lively and sensitive. This, he said, was another illustration of the effects of friction on bodies moving round their own axis when the friction was at different distances from the centre of motion. A cylinder of steel, having a plain circular *end* as a rubbing surface, if the pressure be equally distributed, which is the case when the rubbing surfaces of the pivot and its bearings are both true planes, the amount of friction on the flat pivot is found to be two-thirds of that of a cylindrical journal of the same radius, and under the same pressure; but when the *end* of the journal is hollowed out so that but a fine edge rests on the end bearing, the friction then is about the same as it is on the cylindrical journal. "You observe," he continued, "that this magnetic needle moves lively when resting on the sharp point because the friction caused by the weight of the needle is near the centre of motion; the friction of the hollow support, being farther from the centre, the motion of the needle is slower; and when the needle rests on a perfectly flat point of an equal diameter with the hollow one, the amount of friction is equally distributed over the entire bearing surface, and, part of it being near the centre, the effect of the whole is not so great as when it rests on the hollow surface, and all the friction is farther away from the centre of motion."

The Principal was proceeding to explain, that when an unguent was used, these results would vary according to the character and nature of the unguent, when "our journeyman" remarked, that he did not think it necessary to bring unguent into consideration in treating of the subject of friction. He said unguent was an old-fashioned appliance, now out of date, and was perfectly sure watchmakers never used it, as he had never seen a bit of it all the time that he was in London. It was at this juncture that our philosophical friend, the half-pay officer, came into the class-room. He had been on a visit to the Principal's family, and called in to bid him good-night, and had heard "our journeyman" say something about unguent, but it was evident he did not hear the whole of his remarks, for he immediately broke out into a rhapsody, exclaiming, "Wonderful! Amazing! to think that, even in this 19th century, the psychological powers of the human intellect should so circumambulate this hitherto insurmountable impediment to motion, as to annihilate the evils resulting from the asperities of carbonized iron impinging against the concave peripheries of the antagonistic bearings, without the use of an unguent. Heretofore, the effects of these asperities were increased by the atoms of carbonized iron that are disentegrated into cubical, octahedral, dodecahedral, or other configurated forms, and when no unguent was used, these anhydrous molecules were instantly seized with great avidity by the oxygen of the surrounding atmosphere, and converted into the oxide, sesquioxide, or peroxide of iron, vulgarly known by mechanicians as rust, and if the process was not checked by the presence of an unguent, the entire elements of the carbonized iron, commonly called steel, were in a short period of time entirely dissipated. What a mechanical achievement! No unguent now required!" and, looking round the room, first at the diagrams that hung on the walls, and then at the models that were before us, exclaimed, "Do my visual organs penetrate the epoch of this great consummation?" Our eloquent and credulous philosopher now shook hands heartily with "our journeyman," only nodding good night to the Principal and "Our Maister," and left. This burst of enthusiasm of his, however, altogether demoralized both the Principal and "Our Maister," for they could do nothing but stare at each other, and the continuation of our instructions in the philosophy of friction was abruptly brought to an end for that evening.

In a day or two after this "Our Maister" was in a talking humor, and commenced to speak to us on the subject of friction, and what we had seen and heard at the Academy the other evening; but "our journeyman" expressed his disgust with the whole affair, and said he did not believe in anything we had seen; that nobody was better able to tell about friction than watchmakers, and nothing could illustrate the effects of friction better than a watch. "Our Maister" could not agree with him on that point, and informed him that almost all instruments of precision that were constructed on a large scale for various purposes, displayed the results of friction in a greater degree, and much more readily than a watch, because the various parts of a watch were so small that the mechanical errors that undoubtedly did exist in the finest watches were so minute that their evil effects did not show except when they were so great as to alter the rate of the watch. "Our journeyman" remarked, that we could see that a watch balance vibrated farther when it rested on the round end of one of the pivots than it did when working on both of them, and he still thought it was caused by a difference in the amount of friction, for that was what he had learned in London. "Our Maister" looked at him pitifully, saying, it might be the opinion of *some* men in the trade in London, but he was certain that it could not be the opinion of men high in the profession. Some London watchmakers hollowed the ends of balance staff pivots, and although the practice did not work well on account of it introducing other errors, still it showed that they recognized the same laws of friction as we had seen demonstrated at the Academy.

"Our journeyman" then asked, if friction was not caused by the extent of the bearing surface, why it was that the jewels for the balance pivots and other jewel holes were made convex or olive-shaped, instead of being made perfectly straight and flat. "Our Maister" answered, that he understood that these holes were made that shape for several reasons. One was, that they could not conveniently be made perfectly straight, flat, and smooth, and consequently they were rounded a little; and another reason was, that if these holes were perfectly straight, it would be more difficult to set the jewels so that their inside surfaces would be absolutely parallel to each other; whereas, when the holes were convex, or olive-shaped, if they were not absolutely paralled it did not make so much difference. Another reason for making these holes a little rounded was, that, although the bearing of the pivot was only on the centre of the jewel, it had a sufficient length of bearing for the amount of pressure that was on most watch-staff pivots, and the extra length or depth of jewel that did not come into contact with the pivot, served to strengthen the jewel and prevent it from breaking so easily.

" Our Journeyman " still looked incredulous, and, thinking that a visible illustration would be more convincing to his mind than argument, "Our Maister" took a lever watch, and pressed a stiff hair against the balance staff, which made no perceptible difference in the vibrations; he then applied the hair with the same amount of pressure on the outside edge of the balance, which immediately stopped the watch.

I soon began to think that, although " Our Maister " had never been in London, he knew more about the principles that underlie our business than " our journeyman " did, although he had been the whole of two years in London. " Our journeyman " would not be convinced on any point, because he did not want to be convinced; but with me it was different. After these facts had been explained a new flood of light, such as I had never before dreamed of, began gradually to dawn on my understanding. The reason that the spinning-tops spun round easier and longer on sharp points than on broad ones, was now plain to me. The reason that there was the same amount of friction on long and short bearings I also understood. The reason of the same amount of friction being on a large and a small pivot, and the reason why the one was to be used in preference to the other, was also clear to me; and I understood the reason why the musical box played quicker after I had sharpened the end of the top pivot. The reason why the balance pivots of a watch had always the same amount of friction on them in whatever position the watch was placed, I could easily comprehend; and I could also understand the reason why the *ends* of pivots, when they were *perfectly* flat, offered less resistance to motion than they did when they were hollowed out, and only the outside edge was in action. The subject of friction, which to me was before only a dreamy superstition, was now beautifully plain and simple; and instead of thinking " Our Maister " to be a fool and an old fogy, I felt thoroughly ashamed of myself for my superficial knowledge when I had enjoyed ample opportunities of knowing better, and sorry for the presumption I displayed in thinking that I knew more than " Our Maister."

Wear upon Centre Pivots.

The cutting away of centre pivots, particularly the lower plate pivot in English watches, is of very frequent occurrence, as the experience of all watchmakers will prove. The frequency of black dirt in considerable quantities, even when very little or no apparent wear is visible, is also often noticed.

This accumulation will be found at this pivot when there are no similar symptoms of wear at any other of the whole train, and the question is often asked by those who prefer to ask questions rather than solve problems for themselves—Why is this so? For the purpose of illustrating a method of study which would be of immense benefit to such young mechanics as are constantly, during their primary instruction, meeting with, to them, inexplicable results, it is proposed to look at this matter somewhat in detail.

The first natural inquiry is, whence comes this black dirt at this particular pivot, and seldom to any other in the watch? Most certainly not from the exterior, for then each other one would be similarly and equally affected; and the cause must lie within or about that particular pivot itself. As this is not outside dirt, what is it, and is there any other substance like it about other parts of the watch? Gather a quantity of this black dirt and spread it out as thin as possible on a piece of white paper, and on examination with the eye-glass it will appear to resemble crocus (oxide of iron) and oil; and if a chemical analysis was made of this substance it would prove to be mostly that. The next inquiry will be as to its origin. The oil, of course, was put there by the watchmaker to lessen the friction between the acting surfaces of the pivot and hole; and the inference naturally is that the oxide of iron must have been derived from the pivot, for the brass hole could not supply it, and, as was before shown, it did not come from outside; consequently the pivot itself must have supplied it, as will be clearly proved by actual observation, for it is found to be worn away.

In this class of investigation, analogies will often lead in the direction of a solution; consequently you say, how would it be possible for me to wear away a piece of steel in the manner the pivot is worn, if I wished to do it? Evidently by the use of some abrading material; in fact it could be dcne by the same substance (crocus) that is found at the pivot, if applied by some soft metal with considerable pressure. In this connection the action of abrading materials must be carefully studied. To do this, consider first the action of a hone, where the primary object in using it is to produce the very thing under discussion; and then the anomalous use of oil on the hone to facilitate wearing away hard steel, and the same use of oil on the pivot to prevent it. This seeming paradox is easily comprehended by a study of the action of the stone and steel. Suppose a needle point is applied to the surface of an oil-stone, the least amount of rubbing destroys the point, and that without any perceptible pressure. Now, if you apply to the same stone a piece of steel with a surface of considerably more extent than the needle point, and with *no more pressure* than was applied to the needle, the oil will be found to be a lubricant, and the stone will not produce on it the slightest effect; the steel will glide back and forth without coming in contact with the stone, because sufficient pressure is not used to force the oil out from between the steel and the stone. The necessity for any oil on the stone is simply to float away the particles of steel which the stone abrades, so that they shall not intervene between the two rubbing surfaces. That this is so is clearly proved by using the stone until the oil becomes so thick and viscid as not to float the particles away, or by using a stone without oil it becomes glazed or covered with adhering metallic particles. Oil that is not fluid adheres to the surface of the stone with such tenacity that extraordinary pressure is required to bring the steel and stone in contact.

Every mechanic's experience shows the increased difficulty of making a stone "bite" as the extent of the surface of the tool increases, and more pressure is required to effect it. Returning now to the pivot surfaces, all these studies of the stone will be found applicable, and aid in a solution of the problem, why the soft brass acts the part of the stone,—every mechanic knowing that brass bearings, without lubrication, will almost inevitably cut away steel journals; this pivot must slide on the brass, and to allow it to do so without "biting," what will be the necessary conditions? The first evidently is to keep oil between it and the brass. We have seen in the analogous action of the oil-stone that two ways are available for doing this; one is to expose a large bearing surface, the other to diminish the pressure between the surfaces. For if the pressure upon the pivot is so great as to force the oil out, and allow the naked metals to come in contact, abrasion must follow necessarily; and so long as the oil continues fluid about those two surfaces the particles of steel will be floated away, and from their infinite minuteness will be soon oxidized, and in their new character of *crocus*, become themselves abraders by adhering to and filling the pores of the brass, thus hastening the grinding process in a geometrical ratio. These reflections indicate very clearly how and where the "black dirt" comes from at the centre-wheel hole.

Fully understanding a difficulty, and clearly comprehending the cause of it, usually renders it extremely easy to apply the proper remedy; and one of the chief advantages he who has a thorough knowlege of principles has over one who is ignorant of them is, that the one who knows can at once apply the proper remedy; while the other squanders his time in fruitless efforts to remedy, by chance, what he does not fully understand. Whenever a centre pivot is cut by continued wear one or both of two things must be wrong: either the main-spring is too strong or the pivot bearing too thin. If it is found on examination that the main-spring is only strong enough to properly run the train, then the bearing of the centre-wheel pivot must be too thin; or, in other words, the relation between the extent of the bearing surface and the pressure is faulty. The only remedy in this case is to increase the depth of the pivot hole, which is equivalent to offering greater extent of supporting surface between the pivot and the hole, so that the oil may serve the purpose for which it was applied—as a lubricant.

If the learner is an inquisitive lad, who has had the misfortune to be deprived of an opportunity for the study of natural philosophy, he may ask why the upper pivot does not wear in the same way, for there the surface is smaller than the other. The reason is, simply because the pressure is not so great, having the advantage of leverage in supporting the pressure from the main-spring. The case will at once be comprehended by supposing a small boy and a large one are required to carry a load on a pole; the load is the centre pinion and the resistance of the train upon it; the upper pivot is the small boy, and the lower the large one, who supports the greater part of the load by placing it near his own end of the pole.

What are a watchmaker's brains good for unless used for the solution of such difficulties (and they are numberless) as are constantly occurring in watch-work,—not one of which cannot be solved by a patient process of reasoning, which is not beyond the ability of any person of ordinary education and intelligence? The great difficulty is to get them to investigate, except with file and hammer. All "mysteries" they solve with punch and plyers, not with brains, preferring "patent" and "secret" processes to patient thought. Alas! what sorrowful examples of this style of research do watches often present. Could the great mass of the trade be persuaded that there was "no mystery but ignorance," rapid advancement might be hoped for.

Jewelry.

Fashions, as history is said to do, are often found to repeat themselves; like plants, they come up, culminate, die out, and are forgotten, till some octogenarian recognizes their regeneration in some prevailing style. Each successive generation fancies itself vastly in advance of those that are past, not only in knowledge and morals, but in taste also, and treasures up as curious relics whatever samples of the fashions of earlier times they can become possessed of; rarely recognizing in them the grim, gaunt skeletons, which they are, of present modes. The fact is, that all style, all form of adornment, all "fashion," is but the varied drapery to conceal the bony, hard, unsightly structure of some utility. Nature herself has mercifully concealed the harrowing spectacle that perambulating skeletons would make, if she had not carefully covered them with a beautiful drapery of flesh; and man has but amplified upon the divine idea in clothing himself, as the dictates of his measure of taste demands. The absolute necessity for protecting the body from damage by accident or injurious temperature, is the frame-work or utility, upon which the millions of costumes among mankind are hung.

It is pleasant to philosophize upon and study these progressive phases of humanity, and deduce therefrom a reason for the universal opinion that we of the present are ahead of any other age. Of course it is easy to trace the "natural descent" of costume from the primeval fig-leaf through the Indian blanket down to the modern "robe." To us it seems a comely advancement from thorns and thongs, to broaches and buttons; and modern cosmetics appear an agreeable improvement upon the savage paint which terrifies an antagonist into meek captivity. Few will differ as to which is the more agreeable, to have the "tattooing" done upon the modern necklace or bracelet, removable at pleasure, or upon the neck and arm, forever permanent.

Fault ought not to be found with "fashion," for it is but an agreeable adornment of real utility, and he must be indeed a cynic who would not choose a pleasant rather than a disagreeable necessity. Ascetics cannot preach down the love for decoration until they can change the nature which God himself has implanted in the human mind; and it certainly cannot be criminal to favor the proper gratification of such love of the beautiful as nature has seen fit to bestow upon individuals or peoples. Jewelry is no exception to these laws, and is, in nearly all its forms, but a refinement—a clothing in such beautiful shapes and material as shall make the use of an absolute necessity pleasurable. The forms assumed, from time to time, are the results of the caprice of shifting taste, guided in part by external influence, and in part by innate perceptions of beauty. The extent of this outside influence upon styles is not generally recognized; and few are willing to believe that those who give forms to jewelry also manufacture the taste that craves them. The designer produces a drawing, harmonizing as much as possible his own cultivated taste with that generally prevalent. If, on being submitted to those who, as merchants, come more immediately in contact with the public than does the designer, it is approved, the design is then executed in metal and its effect studied. Occasionally the produced goods so differ in their general effect from the original drawing as to be at once condemned;

others are changed a little, here and there, as experience and taste suggest, and then the model article is decided to be a success. The next step is to educate the community to like it. To effect this, a quantity of the article is made up, enough to supply to each customer a few as samples; these are urged upon the public market by the retailer as a new style, and generally enough are found of that class of customers who buy every *new* thing to absorb the whole of the "first edition." This process gives it general introduction, and if orders for duplicates come in, the future of that style is established. On the contrary, if it falls dead on the public taste, it is never more heard of. These experiments are profitable to all parties concerned. The manufacturer gets a fair remuneration for the outlay in getting up the new pattern, the retailer always gets a fair profit on all really new styles, and the buyer is perfectly satisfied because it is the very latest thing out.

The perpetual longing for change gives ample encouragement to produce these ever varying forms of ornament. Americans, unlike some older nations, have no reverence for ancient personal ornaments. They would smile at the preposterous idea of wearing the jewelry of their ancestors. Ornamental trinkets are bought to serve the purpose of to-day—to be sold as old metal, if the style should change to-morrow. In many parts of Europe national jewelry may be found which has for years—ages almost—been without change of form or material; at sight one can say this is from Belgium, that from Holland, the other is Spanish. A French peasant woman would never think of selling her ear-rings; to her they have become individualized; they are "family jewels," and are as truly and legitimately descended as herself, and she little cares what is the style in Paris; she reverences and wears them because they were her mother's, and expects her daughters to do the same. This sentiment is not good for "trade." Our own dissatisfied way of using to-day and casting away to-morrow, furnishes our artists a boundless field for production, and they are not slow in cultivating it.

The forms that gold half-sets assume are almost infinite, each manufacturer having produced numerous samples for public approval. The delicate pendules which have had so successful a run, an extreme representative of which is the fringe and tassel, is slowly yielding to a still more unique style, the forms tending toward angular outlines, and so suspended as to allow them graceful action.

The surfaces are mostly lapped gold, and ornamented by *applique* designs in yellow, green or red gold, or with pierced knife-edge work, of intricate Arabesque and Moorish designs. Combinations of swinging loops and hoops are still much in use, variously relieved by pleasing contrasts of bright and Roman gold intermingled. Quaint Egyptian forms are much affected by some manufacturers. Of "high caste" jewelry, adorned with hieroglyphics copied from Champollion, or some grotesque symbolic devices, there are many unique designs. These styles, however, are exclusive, and do not come into general use; consequently dealers who venture largely into that class of goods will very probably be "stuck" with dead stock.

Stone and coral cameo heads, in bold relief, are accumulating in the safes of the jewellers for the spring trade. These are mounted in airy, graceful forms of knife-edge gold tracery —also in dead gold beaded-edge tracery, with only enough pendant ornaments to give life and vivacity to the general effect. Massive, heavy lifeless styles are to be avoided. The goods now being introduced indicate a progress in taste, which, if continued, as the public demand plainly says it must be, will ere long leave very little to be desired from foreign artists in gold.

Sleeve Buttons and Studs are, as ever, staple stock with jewellers. They include every imaginable shape, and the range of material of which they are constructed runs through every form of solid matter, from wood to diamonds. There appears no probability of any speedy return to links. Sleeve buttons with stud backs, surmounted by large fronts, form the bulk of the styles; some of these fronts are immense, but such are so little in demand as not to be safe stock for dealers to invest much in. Button fronts are ornamented in every possible style of gold, precious stone, enamel, and cameo work. Monograms are very much used in all branches of ornamental art, so designed, and the letters are so interwoven that the individuality of each is sufficiently obscure to lead curiosity on to attempt a disentanglement of the puzzle. These monogram and initial buttons give endless trouble to retail dealers, who are remote from manufacturing centres. In monograms of course no stock can be kept on hand; the combinations of letters being so various, and the forms and tastes so diversified, that they can only be furnished to order. Even the receipt of orders for monograms is troublesome and hazardous unless the dealer can show the customer samples from which to select. Fortunately designers and engravers now furnish the trade with these beautiful creations in abundance, from which selections can be made, and the risk of not suiting the buyer entirely obviated. With initials the difficulties are not so great; yet in the experience of every dealer the occasion is sure to happen that if he has every letter of the alphabet except Z, that is sure to be the one called for; but even in this case ordering from the manufacturer is easy if he is known.

Probably the trade never experienced such a general demand for stone cameos as at the present time. Amethyst, and other semi-precious stones, coral, and onyx in all its natural tints, and in many artificial ones, are largely used, not only for sleeve button fronts, but for chain slides, necklace pendants, rings, and in fact every golden vehicle for carrying a stone cameo is seized upon and pressed into service. There are also skilful imitations, as well as base ones. The best of these consist of real stone heads, cemented upon a stone back-ground, and these are in no way inferior to genuine onyx except in the possible danger of the parts separating, and the most valuable half being lost. The next deception is in cementing, in the same manner, a shell head upon a stone back; here the effect may be equally good, but the expense of producing the shell head is far less than one of stone. Some of these little frauds are easily detected, others are so beautifully perfect as to almost defy the closest scrutiny. The basest of all these imitations do not come within the department of gold goods; they are only pressed porcelain, which disappear downward by a degeneracy of quality into the region of cheap crockery ornaments. The general tendency of all first class jewelry is toward a reliance upon skilled labor rather than intrinsic value of the material used.

Studs continue, as usual, of every possible shape but of small size, and the bulk of the manufacture is spiral studs; of necessity a few with stud backs are called for because every dealer has among his customers, whose wants he must provide for, a few who will adhere to the old style. They are, however, offset by that other class who will accept nothing except it is absolutely new.

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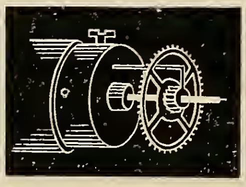
Attachment for Live Spindle Lathe.

One of the inconveniences in using the "Jacot" attachment to the live spindle lathe is in carrying the article while being operated on. This difficulty may be overcome by the use of a carrier or dog, which will both hold the wheel or pinion in place and carry it at the same time. In the face of the solid chuck (in the American lathe), drill a hole as deep as possible without reaching the face of the cone, and distant from its centre far enough to clear the solid part of the web of a wheel in which the pinion is riveted; from the outside of the chuck drill another hole down to meet the first one, and tap it for a set screw; fit into the hole in the front of the chuck a soft steel wire, run it to the bottom, and at ¼ inch in front of the chuck, bend it down at right angles toward the centre of the mandrel, and at the centre turn a loop in the wire only large enough to allow any arbor or staff to pass through it.



To use this carrier, first screw a piece of brass in the chuck and centre it as a guide to the rear pivot; then take the carrier and pass the loop over the arbor and rest it on the face of the pinion or wheel, as the case may be, the long straight part of it passing between the arms and into the hole in the chuck so far as to bring the rear pivot of the wheel firmly to its seat in the brass centre; fasten the carrier in this position by the set screw, and the wheel will be held there easily, the front end of the arbor and its pivot free to be manipulated either by the "Jacot" or by running the shoulder through a centring rest.

By this arrangement the wheel does not fall out, and is firmly carried around by the dog resting against one of the arms; and yet has such a *yielding* support, if the wire of which it is made is not too thick, as to be as safely finished on the "Jacot" as if the bow and collet were used. Several of these carriers, of different lengths, may be required; but they are so easily made that no difficulty from that source need prevent their use. Also some may be required to hold pinions and wheels, where the shoulder is very short. In this case the turned down part may be thin steel (piece of mainspring), with the guide-hole drilled through. For carrying a staff or pinion without the wheel, a small dog must be screwed to it.

Lathe Bands.

Ed. Horological Journal:

The remarks of J. H. B. in your last number on "bands," brings to mind my own experience in that line. I have used almost all the different kinds, with the exception of the thread spoken about, and am free to confess that I cannot agree with him in regard to it (although I have never tried it) for one or two reasons. First, it will consume a little valuable time, and more patience, to pass the thread through the holes in the bench and over the wheel and pulley enough to make it useful. Second, I imagine that if one of the strands gets broken that it will be some trouble to fasten the broken ends, and as the threads are small, it will not take much wear to part them. The first kind of belt that I used was cotton cord, and I found that it stretched too much, and troubled me a good deal; I then went into the silk business, but with no better success; next I tried the cat-gut, but here again I found trouble, as it was difficult to fasten the ends together, and it always broke when I was doing a job, causing me much trouble, and I finally hit upon a thing which I have used a long time with little, if any, trouble. I went to a shoe store and had cut for me a string of calfskin, long enough for the purpose, and nearly square, wet it and rolled it with a board until nearly round, then let it dry, fastened one end in the vice, and used sand paper to take the corners off; wet it again and rolled as before, stretching it all I could. Instead of the hooks, I made a hole in each end about the sixteenth of an inch from the ends, and after cutting it off the right length, passed a piece of brass wire through, bent it down, leaving it flush with the end; passed the other end through, bent that down and cut it off with the plyers. The wire can be pressed into the leather so that the belt will run perfectly smooth, and should the belt stretch it is easy to open one end, make a new hole, bend the wire down as before, and your belt is ready for use.

I tried the hooks, but found the wire preferable. I have used the belt more than a year, and think, of the two, it improves. Let any one try the experiment, for it is a success, and he will say it is the best thing he ever used.

W. H. C.

Cazenovia, N. Y.

Had W. H. C. tried the thread band, his first objection would have vanished; for he would have discovered that by putting the thread *once* around and tying it, he could then have wound a thousand yards or more on by the treadle, and as rapidly as he chose to turn the wheel. His second objection is quite valid, for there will be more or less slipping and riding upon each other, and the band will not prove very durable. A very neat and expeditious way to round the leather band would be to broach out a hole in a piece of metal to the correct size, leaving the edges as sharp as possible, and draw the leather through it, which would produce a band perfectly round and smooth.

Protection against Thieves.

Ed. Horological Journal:

From time to time have appeared published accounts of jewellers being robbed; not so often by stores and safes being broken into, as by what is known as the "snatch game." This method of stealing involves no great amount of skill in the "artist," but only a desperate determination to "do or die" in a bold attempt to "lift" a tray of diamonds, a fine watch, or a valuable chain. A good address and stylish wardrobe are required for the "diamond business." A locomotive engineer's suit, or a conductor's cap, inspire the dealer's confidence when a Montandon, Dent, Matile, Vacheron, Borel & Courvosier, or United States watch is to be "raised." Against this style of work, burglar-proof safes and strong shutters are useless, and the utmost caution on the part of shop-keepers does not always frustrate the designs of these thieves.

Having had some expensive experience with this class of customers, I set my invention at work to devise some way to circumvent these operators. The result has been the adoption of a simple arrangement that gives me a feeling of great security in most cases, although not applicable to all. As it may serve a good purpose to others, or stimulate some one to produce a better contrivance, I give it to you for publication.

The sudden exit of the thief, with all the plunder he can get in his hands, is the usual "dodge," and to instantly prevent this, I placed above the store door an iron arm about six inches long, stoutly hinged to the casing, and standing straight out into the room. The outer end of this arm is shaped into a hook so that it permits the door to open only six inches (or the length of the arm), which is not sufficient to allow a person to pass out. This arm ordinarily is turned up vertically against the door casing and is prevented from falling by a spring catch. To operate this hook a small bell wire, with the necessary cranks, extends along and down the wall, and running along under the inner edge of the counter, and within easy reach, as far as the cases containing valuable goods extend, and is there fastened. By giving this wire a slight pull at any part of its length, the spring catch is released, the hook arm falls and the door is surely prevented from being opened more than six inches, and if the hook is made strong enough, no amount of force can open the door any farther.

To insure the instantaneous fall of the arm, it is best to place behind it (when turned up), a spring which shall surely throw it down before it is possible to open the door. By this arrangement, the merchant or clerk, or any number of them that may be serving at cases containing stealable goods, have command over the exit from the store, without leaving their position. These wires can be extended to such localities as seem desirable, and the whole arrangement concealed by some ornamental work, if it is thought proper; but if the trap in which he is to be caught is visible he will naturally seek some more favorable location for operations. The feeling of security is ample compensation for the trifling outlay of money it costs.

M. M.

St. Louis, Mo.

Tool for Bending Clock Wires.

Ed. Horological Journal:

I have made a very convenient tool for bending the wires of the striking part of American clocks, when a trifle out of place, without taking the clock apart. It consists of a handle about three inches long, similar to a screw-driver handle, with a steel shank inserted in it about the same length, terminated by a solid head about $\frac{1}{2}$ inch long and $\frac{3}{8}$ diameter; through this cut, diametrically, a deep slot like that in a screw-head, wide enough to take in easily any wire in the clock. With this tool any wire inside the clock can be reached and bent.

E. L. May.

Defiance, Ohio.

Method of Drawing the Temper from Broken Staffs, etc.

Ed. Horological Journal.

In your March No. in answers to correspondents you give a process for drawing the temper of broken staffs, pinions, etc., by taking hold of the broken stub with a pair of long-nosed plyers and heating them. I have used a somewhat different way, and found it very convenient when necessary to lower the hardness.

Take a piece of copper wire about one and a half inches long, flatten the ends, and bend it into the U form, making the ends meet, and squaring them off, insert the end of the broken stub between the ends of the wire, and take hold of the sound end of the staff or pinion with a pair of plyers as far up as you wish it to remain hard, then with a blow-pipe heat the copper wire red hot and it will conduct the heat very rapidly to the staff.

The copper wire being an exceedingly good conductor, the bent part only need be heated, running no risk of heating or discoloring any other part of the wheel.

A. F. Trufant.

Weymouth, Mass.

Watch Oil.

Ed. Horological Journal :

In looking through a file of the *London Mechanics' Magazine*, I find a statement of the conclusions which the Astronomer Royal had arrived at with regard to the chronometers which were submitted for test. He states that the material and workmanship of all the chronometers is very good, and, that among them all there is very little difference in this respect. In uniform circumstances of temperature every one of the chronometers would go almost as well as the astronomical clock. The great cause of failure is the want of compensation, or the too great compensation for the effects of temperature. Another very serious cause of error is brought out clearly in the trial, namely, a fault in the oil, which is injured by heat, while some of that used by another chronometer maker is so bad, that after going through the same heating as the first-mentioned one, the rates of the chronometers were changed (on returning to ordinary temperature), by 80s. per week. The Astronomer Royal asserts his belief that nearly all the irregularities from week to week, which generally would be attributed to bad workmanship, are in reality due to the two foregoing causes.

The suspicions of so eminent an observer, ought to have weight with those who are so earnestly endeavoring to perfect these timekeepers, and ought also to lead them to suspect that there was something more than merely mechanical defects at the bottom of some of the irregularities of the chronometer. When the Astronomer Royal admits that the material and workmanship are much alike, and the performances under like circumstances are wonderfully similar, ought not this source of error, under changed circumstances, to be sought for in something wherein the instruments differ? The machinery being alike, the performance alike in like conditions, by changing the conditions the rate no longer agrees; differences occur, which ought not to, and the error, to a certain extent, remains permanent, for they will not again resume the former rate by return to former conditions. Does not this point to some other source of irregularity than mechanical defects? In all the discussions, all the "papers," all the philosophy, all the science which has been brought to bear upon this subject for the past fifty years—how much has been said, how much of careful rigidly critical experiment has been given to the subject of lubricants for these fine horological machines? Volumes of scientific discussion and practical experiences have been given to lubricants for other purposes. The thorough researches of Morin have established the laws that govern the action of frictional surfaces of all possible description, "*except* where unguents are used;" the moment they were applied he confesses that all *laws* were set at defiance. Approximate results were of course deduced, but the summing up of the whole subject was that "effects were modified in proportion to the kind of lubricant used." How absurd, then, to imagine for a moment that so pre-eminently sensitive a machine as a marine chronometer should not be as susceptible to the influence for good or evil of the unguent used as the car-axle; if the action under its use upon the one is measured by pounds, the other indicates equally as as clearly its influence by 10ths of seconds. Why do not those horologists who seem to have plenty of time and money to devote to the elucidation of these matters take this subject in hand, and establish the laws (if any can be found) that govern the action of delicate lubricants, and also determine as definitely as they have of other substances the exact method of production, the elementary constituents and proportions, and consequently discover some method by which these lubricants shall have such uniformity of constitution that the action under given circumstances can be known and relied upon?

It may be that in my ignorance I do not comprehend the difficulty, or, perhaps, the impossibility, of doing this. I only judge that few scientific explorations of this great horological desert have ever been undertaken, because I cannot hear of many learned reports from such expeditions; and if no accounts of discoveries have been made public, there ought, at least, to have been learned reports of their failures. I, for one, should like to have some one, or many, report, if they have any facts on this subject, that the trade may have some light upon what is good oil, what are its constituents, and does identity of elements and proportions always give identical results, in *all* its properties? How nearly alike in elements are those different oils which by general use are considered good? If such animal and vegetable oils as are isomorphous differ in any other respect, and if so, how, and how can it be accounted for? And a host of other questions, upon the answer of which (in my opinion) depends the solution of many of the changes of rate in chronometers and regulators.

Boston, Mass. A. L.

Scientific Ornaments.

Ed. Horological Journal:

I have seen in an English paper an account of a wonderful philosophical or mechanical style of jewelry said to have been made in Paris—in which electricity is used in connection with jewelry—scarf pins, broaches, etc., and they are worked by small electric batteries carried in a box in the pocket. Among the curious things described is a rabbit which beats with two drumsticks alternately on a bell, a skeleton head which moves the eyes and opens the mouth, a grenadier beating a drum, a monkey playing a violin, and a bird composed of diamonds, whose wings and tail move as in the act of flying. The batteries which actuate the little mechanisms are very minute, and consist of pieces of zinc and platinum, or zinc and carbon, fastened to the lid of the box, while a saturated solution of the sulphate of mercury occupies the bottom of the box. When the box stands upright, the elements do not reach the liquid, but when it is inverted or placed on the side, the electric action commences and communicates motion to the figure. In the case of the rabbit, the motor is an electro magnet, with a bracket on which the armature is jointed; a little spring raises the armature, and the commutator, which is on the opposite side, is so arranged that when the armature touches it the current is interrupted until it returns to its former position, when it is again attracted in the same way. In this way simple reciprocating action is obtained, which is easily communicated to the arms of the rabbit, causing one to ascend while one descends; in a similar way the other figures are caused to move.

Is this simply a *canard*, or do watchmakers (the inventor is said to be one) spend their wits upon such nonsensical toys? Did you ever see one of these gewgaws? G. F. T.

We have never seen any of these minute scientific ornaments described by G. F. T., but think it quite possible to produce them. They may be "nonsensical" as far as utility in themselves goes; but the line of demarcation between useful and useless is too ill defined for any one to say positively upon which side of it some things lie; skill anywhere, in any department of art, is worthy of respect, if not of approval.

Study upon Vibrations of Pendulums.

Ed. Horological Journal:

The following curious experiment was devised by Mr. Samuel Alsop, and is an excellent study for those who are experimenting upon pendulum vibrations.

Stretch a cord tightly from one side of a room to the other, at any convenient height; from this hang at equal distances from each end two equal pendulums, *i. e.* strings of equal length with equal weights attached. Now set one of these vibrating transversely to the sustaining cord. In a few moments the other pendulum will begin to swing, and as the motion of this second one increases, that of the first is lost, until the first comes absolutely to rest, and all the motion has been transferred to the second. As soon as this condition has been reached, the action becomes reversed, the second pendulum giving up its motion to the first, till the second comes to rest and the first swings through a large arc. This alternation and transfer will in fact continue until the resistance of the air has brought the whole system to rest.

This action, though curious and mysterious, is easily explained. The pendulum first started tends to set the other in motion by slight deflections in the supporting cord in a horizontal direction, but the vibration thus established in the second one is of necessity a little behind that of the first; and this relation, once established, is maintained throughout on account of the equality and consequent synchronism of the pendulums, so that however short the arc traversed by the first, and however long that of the second, the former is always a little ahead of the latter, and is thus dragging it on, each vibration giving up to it a little of its own motion to the very last. A. A. C.

Philadelphia, Pa.

New Inventions.

Watch Escapement.—*D. J. Mozart, N. Y.*—This escapement he calls "a double regulating and impelling mechanism," and is intended to avoid the following defects of the ordinary lever escapement, which he enumerates as follows: "The ordinary escapement has a projecting pin or ruby on the staff, which gives an impulse from the double pronged lever alternately in opposite directions. The impulse is given when the ruby pin is in the central position and exerts its influence to the very end of its extent, or, in other words, till the power of the hair-spring exceeds that of the impulse. The hair-spring will then in the attempt to adjust itself carry the staff back until the ruby pin is again in the central position, when it receives impulse in the opposite direction and so forth, every stroke using the entire force of the impulse as against that of the hair-spring. This arrangement, although satisfactory in a limited degree, is nevertheless unreliable as to exactness, since too much reliance is placed on the slender hair-spring whose slight power varies under the least change of temperature and atmosphere. The division of the movements of the second hand, more than any other part of the watch dependent on the exactitude of escapement, becomes difficult by the use of the old mechanism, and has, whenever affected, added greatly to the complication and expense of the watch." He says that by his improvement he is enabled to give the impulse at the end of each swing of the balance, and not at the middle as before, and thereby confine the vibrations of the balance wheel between certain definite limits; a beautiful precision is thus produced by simple means, and the subdivision of the seconds movement made easy by the application of detent arms to the arbor which gives quarter seconds.

Watch Escapement.—*Abel Coombs, Burlingame, Kansas.*—This is an arrangement by which the lever acts on the roller pin during its vibration in one direction. The lever having only one acting pallet, and that nearer the staff than can be arranged when two are used, the second is only a short return pallet. He says, "the train only stops as the balance swings one way, while in the common arrangement it stops every time the balance swings either way; the less stopping and starting a watch has to perform the better for the whole machinery, and it is less likely to cease running, as it has only half the stoppings to overcome. By this arrangement the roller table is constructed with the banking notch on one side of the roller pin, and therefore the watch can only overbank on one side of the same, whereas in the common way they may overbank on either side, owing to the notch being in front of the roller-pin. Also, as by this plan, the lever moves farther at one beat, it is more likely to overcome any obstruction in the train." He also claims to gain power by getting a wider sweep of the lever, in consequence of which he can increase the size of the roller, and arrange the roller-pin farther from the roller axis, thus gaining leverage on the balance, and in consequence of enlargement of the roller the banking notch may be made deeper, so that the banking pin will reach into the roller so far that it cannot overbank, which all other watches with detached levers frequently do, and stop immediately, or "throw off" and catch the banking pin on the edge of the roller in the line of the balance staff, which also stops the watch. "My lever alway stops on one side of the balance staff, while common levers in passing the line dip into the roller in front of the pin but slightly, whereby, the sweep being narrow, the roller small, and the banking necessarily shallow, the watch is frequently stopped."

Improved Keyless Mechanism.—*Smith & Folsom, Cincinnati.*—A stem winding arrangement, having one or more intermediate wheels which are constantly in gear alternately with either the winding or setting mechanism, the intermediate wheels revolving parallel to the dial plate, movable perpendicularly thereto by the means described. The arrangement of the parts is such that the intermediate wheel, while preserved in a condition of parallelism with the dial plate, and in gear with the contrate-wheel, is rendered capable of being shifted in the line of its axis so as to gear either into the winding wheel or with the setting wheel. When the front case closes, its inward projecting rim is brought in contact with the bevelled head of a slide which it forces in and depresses the intermediate wheel and causes it to gear with the winding wheel. Thus in its normal condition it is geared into connection with the pendant stem, so that by rotating it the watch is wound. In setting the hands the slide must be pulled out, which allows the intermediate wheel to spring into gear with the cannon pinion or minute wheel, and thus permit the hands to be set. This shifting the intermediate wheel axially, has no effect to disturb the adjustment of the hands by the act of ungearing, as those are liable to do which shift in the direction of their plane.

Fastening for Shirt Studs.—*Earnst Bredt, N. Y.*—Two disks (front and back), with short hollow necks, which can be fastened together by an inner hollow shank, or by a shank attached to any ornamental device that it is desired to place upon the front disk. This mode allows various ornamental appliances to be put on them without the necessity of special construction, thus greatly facilitating the manufacture.

Shirt Stud Fastening.—*A. Hartman, N. Y.*—This stud is so made that two arms hinged to the rear of the plate are kept by springs, diametrically across the back when in a normal position, forming a bar across the inside of the button-hole, but capable of having their outer ends brought together vertically to the plane of the button when it is to be put in or out of the shirt front.

Watchmaker's Chuck.—*Job Mansir, Richmond, Maine.*—A modification of the double disk slip chucks, for holding wheels by the web loosely while the pivot is being centred, and capable of being forcibly closed by thumb screws in the rear of the chuck.

Holding Tool.—*Butch & Thoma, Lancaster, Ohio.*—Useful tool for watchmakers, arranged so as to remove staff rollers, balance from the staff, holding and sizing screws, and putting on rollers.

Pen and Pencil Case.—*Wm. S. Hicks, N. Y.*—Capable of extension for a pen holder, and closing in a compact form for the pocket.

C. E. Rice.—Main-spring attachment, noticed in a previous number of the Journal.

Compensation for a Pendulum.—*H. B. James, Trenton, N. J.*—Is applied to the ball itself, and in principle is a compound bar (brass and steel), coiled into a spiral, and so arranged as to raise or lower the bob, or to actuate weights attached directly to the spiral.

Ornamenting and Dressing Glass or Metal Surfaces.—*George F. Morse, N. Y.*—This device is a modification of the "sand blast," patented by R. C. Telgman, and exhibited in the Fair of the American Institute. It consists of merely a receptacle for Corundum No. 3 and Emery No. 24, elevated about eight feet high, and from the bottom of which depends a small tube through which these intermixed particles flow by gravitation, the rate of flow regulated by a slide across the top of the tube. Upon the surface of the glass or metal to be ornamented is placed a pattern cut out of cloth, paper, rubber, or any substance of such nature as to resist or throw off the action of the dressing material. The parts not protected by this pattern from the action of the falling material will be cut away, leaving in pleasing contrast the cut and uncut surfaces, and by continuing the process indefinitely, figures can be produced in any desired degree of intaglio or relief. It is said that various metals may be ornamented with the most intricate and beautiful chasing, the ornamental designs sometimes having the appearance of costly engravings.

Lever Staffs for Watches.—*William E. Banta, Springfield, O.*—By this arrangement the lever and pallets of a watch can be below the balance, and yet the lever staff be of the same length as any arbor in the watch. This is accomplished by bending the pallet arbor into an offset or loop around the balance, through which it can vibrate. In other words the semi-diameter of the balance may be greater than the distance between centres of the lever and balance, thereby giving a short lever a long staff or arbor, thus securing more steadiness.

Stem Winding Mechanism.—*Assigned to D. Constant Jaccard, St. Louis, Mo.*—In this arrangement the hands cannot be set except when the case is open, and the connection is made by firmly pressing in the stem, the act of shutting the case throws the winding attachment into gear, making the actions to a great extent automatic.

Dust Ring for Watches.—*George Hunt, Springfield, Mass.*—This is a spring band, applied between the watch plates. The under side of the top or bottom plate is bevelled at the edge, the bevelled portion extending to a shoulder. The dust excluder is a metallic spring band, which is laid around the train so as to rest against the bevelled portion of the plate, the ends being made to overlap and fasten by a screw.

Stem Winder.—*Jaques Laurent, New York.* —By this device, the stem is connected and released from the winding arrangement by a semi-revolution of the pendant bow, about the axial line of the stem, thereby allowing the chain swivel free play at all times on any portion of the bow.

Automatic Repeating Clock.—*C. W. Roberts, Chicago, Ill.*—This is arranged for striking the hours and quarters, and which, by a peculiar construction, will always be struck correctly, no matter how much the time side may be set ahead, because the hour snail is simultaneously turned. In ordinary clocks the striking can only be made to coincide with the hands by "striking around" by a twitch wire, whereas in this it is never wrong.

Watchman's Time Check.— *Vielle & Robellaz, New Albany, Ind.*—Watchman's detective clock for the purpose of enabling those who employ watchmen to ascertain whether their duties are faithfully performed.

Cleaning Watches and Clocks.— *W. W. Thompson, Smithville, Georgia.*—This is accomplished by immersing them in pure naphtha or other volatile liquid of similar nature, and twirling them about so that all parts may be exposed to its action, then dried in air a little heated.

Dust Cover for Watch Frames.—*Abel Coombs, Burlingame, Kansas.*—It consists of a plate in two halves, covering the whole movement, each half hinged to the other diametrically. This plate is not arranged as a common hinged cap to a case, but constitutes a part of the watch movement, and its especial object is to exclude air, light, and dust from the oil in the pivot holes, and protect the movement from the breath, spittle, or dirt.

Main-Spring Hook.—*H. B. James, Trenton, N. J.*—This hook connects the outer end of the main-spring by means of a link to a stud on the face of its barrel, between the centre and periphery of the same, for the purpose of reducing the leverage, and consequently the power of the spring upon the barrel during the first two turns of unwinding, before the outer spiral comes in friction-tight contact with the rim of the barrel, also a suitable arrangement of stop-work to prevent over-winding.

Stem-winding Mechanism.—*H. V. Woerd, Waltham, Mass.*—This is designed to correct a difficulty which attends the attempt to move the hands by the crown wheel, ordinarily used to connect the stem and hand-moving train. The teeth of this wheel often strike on the top of the teeth in the intermediate wheel, failing to properly engage immediately therewith. The present device moves the hands by contact of frictional surfaces, produced by a sleeve upon the stem being forced against a loose contrate pinion, always in gear with the dial wheel; consequently the hands can only be moved while contact is maintained, and the normal position of them is not disturbed thereby.

Pegwood Sharpener.—*Anthony Kehl, Indianapolis, Ind.*—An instrument similar to a pencil sharpener, to be fastened upon the bench; so constructed as to be removable readily at pleasure.

Watch Keys.—*J. L. Moore, Bridgeport, Conn.*—A cheaply made adjustable key, formed by bending half round steel wire into the form of a loop, the two ends coming in contact for a distance, sufficient to form the pipe of the key; V grooves are then formed upon these two inner faces which are in contact, and which produces the winding square. The outside of the pipe is threaded for a nut, by which the key is adjusted to any size.

Watchmakers' Chuck.—*A. K. P. Walker, Richmond, Maine.*—This is one of the form known as slip disk chucks, for holding and centring wheels by the web, and designed to be held in the step chuck of the American Lathe. The disks are drawn together by slit head screws, actuated from the front.

Watchmakers' Chuck.—*H. H. Haskett, Le Roy, Ill.*—This is a double disk slip chuck, drawn together by screw flanges, but with a screw collet jaw fixed upon the outer disk for holding the article to be manipulated.

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Answers to Correspondents.

"Escapement," *Pa.*—You ask a candid opinion about your new escapement, and, at the risk of letting down somewhat your expectations, I will say, "candidly," that there does not appear such great advantages to be derived from new escapements that many seem to anticipate. The late Mr. Charles Frodsham says: "The especial value of escapements in general is very much overestimated; for, when each of the three well established escapements, the Arnold for chronometer, the duplex and lever for pocket watches, are equally well made, and tried with the same balance and balance-spring, the result of their performance is not so marked as is generally believed, nor the superiority of one escapement over the other so evident, as many persons have been led to imagine.

"The true seat of the time-keeping principle of every watch or chronometer resides in the union of a perfectly tempered balance-spring, and a perfect compensation balance, the weight and diameter of which is in just proportion to the motive force."

This you will find to be the opinion of the best and most experienced constructors. Whatever progress is likely to be made will be in the direction of simplification, thereby, if possible, lessening the cost of manufacture without sacrifice of the known good qualities of the escapements in general use. In yours, certainly, you cannot claim greater simplicity, and the other advantages are questionable.

J. F., *Columbus, O.*—You are quite excusable, for one way to learn is to ask questions. The *Vernier*, which you say "you have often seen mentioned, but do not understand," is not exactly an instrument in the usual acceptation of the term, but an arrangement of two differing scales, so applied to each other as to render very small distances visible to the eye, and consequently capable of being "read off" or named with the utmost precision. It is a beautiful mathematical contrivance, which you will appreciate when you understand it. It differs from the micrometer, which cannot be used in any large measurements, and which is, strictly speaking, an instrument, in being applicable to the measurement of minute quantities of any magnitude.

The Vernier was invented in 1631, by Capt. Pierre Vernier, of Brussels. As originally constructed by him, it consisted of two scales placed side by side, sliding upon each other, the total length of any number of equal divisions upon one being divided upon the other, one more than the same number of divisions upon the first. You will understand it without a drawing, by taking a thermometer scale, which you know is divided into degrees, differing in instruments as the length of the column of mercury is different. On such a scale, particularly if short, and consequently the divisions small, it is difficult to "read" or tell off the exact height of the column, unless it happens to fall *on* one of the lines of the scale; but the Vernier applied to such a scale makes these small parts of a degree accurately visible to the eye. By the side of the thermometric scale place another capable of sliding up or down, and across this draw two lines exactly, including 11° of the other scale, and this space subdivide into 10 equal divisions by lines, which number from the upper one downward, commencing with 0, will make each division of the Vernier scale $\frac{1}{10}$ longer than the thermometer scale, and consequently the 1st division on it will overlap the degree mark on the scale by $\frac{1}{10}$, the 2d division line on the Vernier will overreach the 2d of the scale by $\frac{2}{10}$, the 5th line will overlap the 5th on the scale by $\frac{5}{10}$, and so on to the last division, which will indicate $\frac{10}{10}$, which is coincident with the 11th of the scale. Suppose, now, that the top of the column of mercury reaches to 11° and some part of the 12th°, which is not known exactly; move the Vernier till its 0 coincides with the top of the column, then follow down its divisions till one is reached which coincides with a division on the scale, and that division of the Vernier indicates the 10ths of a degree which the 0 point has advanced upon the 12th° of the scale. Again, assume that the mercury column is at $12\frac{1}{2}$°; by placing the 0 of the Vernier at the top of it, the 5th division will be found to coincide with a line on the scale, and will be "read off" as 12.5°.

The same arrangement applied to linear measurement gives, by proper subdivisions, as small quantities as can be desired. Take a foot-rule and divide the inches into 10ths, and place a Vernier upon it, as described for the thermometer scale, and the readings are 10ths of 10ths of an inch, which, of course, are 100ths; and by dividing the inch into equal parts smaller than 10ths, still more minute parts of an inch can be read; or the Vernier can be made to read 20ths by dividing 21 parts of any scale into 20 equal parts for a Vernier for that scale, so that the coincidence of any one of the 20 lines of the Vernier with any line of the scale indicates the number of 20ths the zero of the Vernier has advanced upon another division of the scale.

This method of reading forward upon the scale and backward upon the Vernier being somewhat inconvenient, has led to a more modern construction, which allows both scale and Vernier to be read forward. For this purpose the extent of nine divisions of any scale is subdivided into ten equal parts for a Vernier, making each division of it $\frac{1}{10}$ less than that upon the scale. In this case the numbers on the Vernier commence at the bottom with zero; consequently, if it is advanced till its first division coincides with a division of the scale, the upper end of the Vernier indicates $\frac{1}{10}$ of a division of the scale. This arrangement permits both readings to be forward.

The same arrangement is applied to divisions upon circles, and the accuracy attained in astronomical instruments is truly wonderful. In them the divisions are so small as to require the aid of a magnifying glass to determine the coincidence of lines upon the arc and Vernier, and to insure the utmost accuracy three or four or more Verniers are placed upon different parts of graduated circles so as to eliminate errors of graduation and to insure correct readings.

From this description you ought to be able to construct for yourself a rude Vernier upon a piece of card-board with common dividers; by so doing you will quickly master its principles and be able to read readily by a Vernier wherever you meet it. For the watchmaker there is no more useful instrument for measurements than a small steel Vernier caliper, manufactured by Brown & Sharp, and sold in most tool stores.

M. T., *New Orleans.*—Watch balances made of dense wood, or other non-conducting material, as glass, etc., have been experimented upon from time to time, since balances were in use. It was by the use of a glass balance that Mr. Dent proved the effect of temperature upon the rate of chronometers was not due to action on the balance except in part, but that most of the change of rate by change of temperature was due to effect produced on the hair-spring.

By actual and careful experiment with a glass balance he found with the temperature at

32° F.,	it made	in an	hour	3,605	vibrations
66°	"	"	"	3,598.5	"
100°	"	"	"	3,590	"

If the chronometer had been adjusted to beat 3,600 per hour at 32°, it would have lost $7\frac{1}{2}$ and $8\frac{1}{2}$ seconds an hour, or more than three minutes a day for each increase of 34° in temperature, which is 15 times the amount that a common iron pendulum, beating seconds, would lose under the same increase of temperature; showing that there was an effect greater than was due to simple elongation of the spring. This effect he attributes to the degeneracy of the elastic force of the spring by the increased temperature. The time you spend in experiments in that direction will be lost, except in the addition it brings to your stock of positive knowledge; a result which all carefully conducted experiments bring, whether successful or otherwise.

G. A. M., *Me.*—To dissolve shellac in ammonia, put into any suitable vessel the desired quantity of shellac; place this in another larger vessel containing hot water, and pour upon it rather more than enough boiling water to cover it; now take liquor ammonia and pour in slowly, but steadily, and stirring the melted shellac till dissolved. If too much ammonia is poured in, the solution will be very dark and spoiled; if too little, it will not be sufficienty dissolved. The natural color of the shellac ought to be preserved. When cold it must be filtered, and is then ready for use, and will keep for an indefinite time.

E. P. B., *Washington.*—If you will examine the construction of the black chains, you will at once discover the way to repair them when broken. Each link is a hollow sphere, raised from a plate of metal of peculiar shape; at first half raised, by dies, then the small double headed solid link, which connects two spheres together, has one of its ends laid in, and another die closes the metal up around it into its perfect form, enclosing within it the head of the solid link. These chains, as you will observe, are flexible only to a certain limit; if bent beyond that they break. To repair them, open, with the edge of a sharp knife, the joining where the two edges of the hollow sphere come together, far enough to allow the introduction within the sphere of the solid link head, then close it up to its place and the repair will never be seen, and will be as firm as the original.

B. F. H., *L. I.*—Iron may be bronzed by applying to it a coating of varnish or paint, the basis of which is pale clear shellac dissolved in alcohol, in which bronze powder is held in suspension. These bronze powders are largely imported in all colors, red, yellow, white, green, etc., and from which any desired tint can be produced by skilful admixture. The principal ingredient in these powders is the bi-sulphide of tin. The iron must be thoroughly cleaned before applying the varnish. Old bronzing can be entirely removed by a hot solution of caustic potash.

C. L., *Fort Atkinson, Wis.*—The space necessary to properly illustrate the subject of engraving could not be spared in the pages of the JOURNAL, and really is not necessary, for the several publications already in market of fancy alphabets, monograms, and ornamental designs, supply every need in that line.

G. F. L., *Cleveland, O.*—The criticism you make upon the improper use of the signs of arc for measures of time are just, and care ought to be taken to make the proper distinction in writing. The following table shows clearly the difference:

4 seconds	of time	= 1 minute	of arc
4 minutes	"	= 1 degree	"
60″	"	= 1 minute	"
60′	"	= 1 degree	"
30 degrees	"	= 1 sign	"
3 signs, or 90 degrees		= 1 quadrant	
12 " 360 "		= circumference.	

W. M. B., *Minn.*—To give a brown tint to steel, dissolve in four parts of water, two parts crystallized chloride of iron, two parts chloride of antimony, one part gallic acid, and apply with a sponge or cloth, and dry in the air. Apply and dry till the color attains the tint required, then rub well with oil. This is said to resist atmospheric moisture.

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EQUATION OF TIME TABLE.

GREENWICH MEAN TIME.

For April, 1872.

Day of the Week.	Day of Mon.	Sidereal Time of the Semi-diameter Passing the Meridian.	Equation of Time to be added to / subtracted from Apparent Time.	Diff. for One Hour.	Sidereal Time or Right Ascension of Mean Sun.
		S.	M S.	S.	H. M. S.
Monday	1	64.52	3 47.24	0.754	0 40 36.20
Tuesday	2	64.54	3 29.22	0.749	0 44 32.75
Wednesday	3	64.56	3 11 35	0.742	0 48 29 30
Thursday	4	64 57	2 53 64	0.734	0 52 25.86
Friday	5	64.60	2 36 13	0.726	0 56 22.41
Saturday	6	64.63	2 18.81	0.717	1 0 18.96
Sunday	7	64.66	2 1.71	0.708	1 4 15.52
Monday	8	64 70	1 44 83	0.698	1 8 12 07
Tuesday	9	64.74	1 28.21	0.687	1 12 8.62
Wednesday	10	64.78	1 11 85	0.677	1 16 5.18
Thursday	11	64 82	0 55.77	0.665	1 20 1.73
Friday	12	64.86	0 39 97	0.653	1 23 58 28
Saturday	13	64.91	0 24.47	0.640	1 27 54.84
Sunday	14	64 97	0 9.28	0.626	1 31 51.39
Monday	15	65.02	0 5.57	0.612	1 35 47.95
Tuesday	16	65.08	0 20.08	0.597	1 39 44.50
Wednesday	17	65.13	0 34.23	0.581	1 43 41.05
Thursday	18	65.19	0 48.01	0.566	1 47 37.61
Friday	19	65.25	1 1.40	0 549	1 51 34.16
Saturday	20	65.32	1 14 39	0.532	1 55 30.71
Sunday	21	65.37	1 26 95	0 513	1 59 27.27
Monday	22	65.44	1 39.06	0.494	2 3 23.83
Tuesday	23	65.51	1 50.73	0.475	2 7 20 38
Wednesday	24	65.58	2 1 93	0.455	2 11 16.94
Thursday	25	65 65	2 12.63	0 435	2 15 13.49
Friday	26	65.72	2 22.84	0 415	2 19 10.04
Saturday	27	65.79	2 32.54	0.393	2 23 6.60
Sunday	28	65.87	2 41 72	0.371	2 27 3.15
Monday	29	65 94	2 50 37	0.348	2 30 59.71
Tuesday	30	66.02	2 58.47	0 325	2 34 56.26
Wednesday	31	66.09	3 6.01	0.302	2 38 52.82

Mean time of the Semidiameter passing may be found by subtracting 0.18s. from the sidereal time.

The Semidiameter for mean noon may be assumed the same as that for apparent noon.

PHASES OF THE MOON.

	D. H. M.
● New Moon	7 12 32.0
☽ First Quarter	15 10 11 3
⊙ Full Moon	23 1 37.4
☾ Last Quarter	29 20 21.4

	D. H.
☾ Perigee	1 9 6
☾ Apogee	14 18 1
☾ Perigee	26 18 8

Latitude of Harvard Observatory .... 42° 22′ 48″ 1

	H. M. S.
Long. Harvard Observatory	4 44 29.05
New York City Hall	4 56 0.15
Savannah Exchange	5 24 20.572
Hudson, Ohio	5 25 43.20
Cincinnati Observatory	5 37 58.062
Point Conception	8 1 42.64

		APPARENT R. ASCENSION.	APPARENT DECLINATION.	MERID. PASSAGE.
	D.	H. M. S.	° ′ ″	H. M.
Venus	1	23 4 37.61	– 7 19 50.3	22 24.6
Jupiter	1	7 28 10.66	+22 25 50.8	6 46.6
Saturn	1	19 28 55.57	+21 33 8.5	18 45.4

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History of Compensation Balances.

NUMBER FIVE.

The completed balance, as described in previous articles, after having the screws run in, is then ready to be staked on the staff; after which it is poised by placing the screws in proper positions, and adjusting their size, or length of head, or by substituting those of differing density to perfect the poise; truth in its plane of revolution must also be obtained.

The next step will be to cut the rim through. The exact place where this is done differs with the differing ideas of the makers; some preferring to cut them as near the arm as possible, so as to have the extreme attainable length of the compound bar for action; others take an opposite view and cut them a considerable distance from the arm.

Experience is the only teacher in determining this point. Makers whose constructions are constant in the quality and quantity of metal used, will, by careful experience, find the amount which certain increments of temperature deflect the rim, and cut them in accordance; some will be found more susceptible than others, and such will require less length of the compound rim to produce the requisite amount of motion to the free end of the balance, than those balances where either the metal on their construction makes them less sensitive. These differences can only be known by actual trial. There is, however, a convenience and safety in having the cut in watch balances far enough from the arm to afford a safe hold upon the balance when handling it, as it must always be seized by the ends of the arm, and if the free end is a little away, the danger of bending it by thoughtless pressure is lessened.

Nine-tenths of the balances when cut will "fly open" more or less, and some will spring out of flat; in either case the process of truing must be gone through, and here no machine is adequate except the fingers; all the bendings must be by such gentle curves, and produced with such care, that the hand labor of the operative is indispensable. After its perfect truth is again established, the springing is done, and the watch brought as near as may be to mean time. It is then in condition to be tested for the effects of extremes of temperature. For convenience in these adjustments some arrangements like the following are generally adopted. Where adjustments are not done as a business, any one's ingenuity will suggest simple, inexpensive methods for obtaining any required temperature.

Fig. 1 is a view of a very complete hot-air chamber for maintaining the extreme of heat; it is a double-walled wood box, A, with a metal cistern *a*, from which there rises within the chamber at each side a steam tube *b*, a draw-cock *e*, and in the apartment underneath, a gas burner *f*, for heating the water in the reservoir. At the rear wall is fixed a compound metal bar *c*, bent in the U form, its free end connected by a cord passing over a grooved pulley at *g*, which

ABSTRACT OF THE PRINCIPAL CHANGES OF RATES OF CHRONOMETERS

Name of Maker.	No.	Address of Maker.	Construction of Balance.
C. Frodsham	3423	84 Strand, London	C. Frodsham's new reversed balance
Weichert	2216	112 Rothsay Terrace, Cardiff.	Auxiliary compensation
Kingston	5321	13 High street, Ramsgate	Auxiliary acting in cold
Davison	4668	6 Side, Newcastle-on-Tyne	Auxiliary compensation
Gowland	1284	178 High st. West, Sunderland	Ordinary balance, with slight alteration
McGregor	4173	Clyde Place, Glasgow	Ordinary auxiliary compensation to balance
Sewill	3009	61 South Castle st., Liverpool.	Auxiliary compensation
C. Frodsham	3461	84 Strand, London	Continuous auxiliary to the balance
P. Birchall	1150	12a Stonefield street, Islington.	Ordinary balance, with a slight alteration
Parkinson & Bouts	1171	59 Gracechurch street, London	Auxiliary to balance, acting in extremes
Isaac	497	147 Liverpool road, Islington.	Double arm balance, without auxiliary
E. Dent & Co.	3106	61 Strand, London	[No information received]
G. Davison	4675	6 Side, Newcastle-on-Tyne	Auxiliary compensation
Kullberg	1802	105 Liverpool road, London	Kullberg's flat rim balance without auxiliary
J. Fletcher	2679	147 Leadenhall street, London	Auxiliary compensation
Usher & Cole	$\frac{7}{457}$	46 St. John's Sq., Clerkenwell.	Auxiliary to balance
Whiffin	350	10 Cloudesley Square, Islington	Auxiliary compensation
Hennessy	4673	5 Wind street, Swansea	Auxiliary compensation
Kullberg	1799	105 Liverpool road London	Kullberg's flat rim balance, without auxiliary
Isaac	1152	147 Liverpool road, Islington	Ordinary balance, auxiliary acting on jewels
Chittenden	793	10 Wilton road, Hackney	Auxiliary as in former years
Lowry	770	66 High street, Belfast	Auxiliary compensation
Glover	354	8 Wrotham rd., Camden Town.	Auxiliary compensation
Reid & Sons	1492	41 Gray st., Newcastle-on-Tyne	Auxiliary acting in all temperatures
Parkinson & Bouts	1162	59 Gracechurch street, London	Auxiliary to balance acting in extremes
J. B. Fletcher	2969	148 Leadenhall street, London	Auxiliary compensation
Highley	5435	45 High street, Sheerness.	Auxiliary acting in cold
J. Fletcher	2921	148 Leadenhall street, London.	Auxiliary compensation
Vissière	326	31 Rue des Drapier, Havre	New auxiliary compensation
J. B. Fletcher	2885	148 Leadenhall street, London	Auxiliary compensation
Blackie	826	24 Amwell street, Clerkenwell	Ordinary balance, but with different proportions.
Shepherd & Son	1737	53 Leadenhall street, London.	Auxiliary to balance.
Whiffin	347	10 Cloudesley square, Islington	Auxiliary compensation
Brotherton	5417	11 Spencer street, London	Construction as in former years
Crisp	2176	174 St. John's st. rd., London	Auxiliary compensation as in former years
Gowland	2747	178 High st., W. Sunderland.	Auxiliary compensation
Hennessy	4682	5 Wind street, Swansea	Auxiliary compensation
McGregor	4172	Greenock	Poole's auxiliary compensation to balance
Shepherd & Sons	1723	53 Leadenhall street, London	Auxiliary to balance
Reid & Sons	1215	41 Gray st., Newcastle-on-Tyne	Auxiliary acting in cold
D. Reid	1870	41 Gray st., Newcastle-on-Tyne	[No information received]
Williams & Co.	97	2 Bute Docks, Cardiff	Auxiliary compensation
Blackie	657	24 Amwell street, Clerkenwell	Original auxiliary
Reid & Sons	2210	41 Gray st., Newcastle-on-Tyne	[No information received]

The chronometers were 2 days, except Dent 3106, which was 8 days; Reid 2210 was pocket. Trials lasted from Jan. 14 to Aug. 5.
The sign + indicates that the rate is gaining.
During March and again during June the chronometers were placed in the chamber of a stove heated by jets of gas. The gas flames are exterior to the chamber, into which none of the injurious products of combustion can enter.

actuates the supply-cock in the gas pipe leading to the burner *f*. A glass door, *x*, permits inspection of the watches within, and the condition of the thermometer. The compound bar *c*, by the movement of its free end, maintains the temperature at any degree to which it is set. The whole arrangement is secured against the possible admittance of any moisture which might be injurious to the movements.

The refrigerator, *a*, is also a double-walled box, though far less complicated than the heating apparatus. Within its walls is fixed a

ON TRIAL AT THE OBSERVATORY, GREENWICH, 1871.

Least Weekly Sum.	In what temperature.	Greatest Weekly Sum.	In what temperature.	Difference between the Greatest and Least.	Greatest Difference between one Week and the next.	Extremes of Temperature.
s.	Degrees Fahrenheit.	s.	Degrees Fahrenheit.	s.	s.	
−10.4	76 to 95	− 2.6	37 to 42	7.8	3.7	53 to 57
−12.3	53 to 57	− 1.0	46 to 54	11.3	4.5	36 to 49 56 to 84
− 9.2	37 to 42	+ 0.8	52 to 58	10.0	5.3	89 to 45
−11.1	79 to 94	− 2.5	36 to 42	8.6	6.1	66 to 94
+ 1.0	42 to 49	+13.1	66 to 84	12.1	4.7	do.
−10.9	79 to 94	− 2.5	52 to 58	8.4	7.1	89 to 45
−13.3	65 to 81	− 1.8	36 to 42	11.5	5.6	42 to 37
+ 1.6	46 to 54	+13.3	76 to 95	11.7	5.7	95 to 62
− 3.7	53 to 58	+ 6.0	79 to 94	9.7	6.8	56 to 53
−13.6	65 to 82	− 5.3	40 to 49	8.3	7.8	46 to 81
−10.0	40 to 49	+ 3.3	63 to 71	13.3	5.4	89 to 45
+ 6.0	42 to 49	+19.2	64 to 70	13.2	7.0	do.
=10.5	36 to 42	+ 7.1	63 to 71	17.6	4.9	95 to 62
−14.5	79 to 94	+ 0.5	45 to 51	15.0	6.3	89 to 45
+ 1.1	76 to 95	+13.0	52 to 58	11.9	7.9	do.
+ 2 0	65 to 89	+12.5	48 to 57	10.5	10.4	do.
−21.2	65 to 81	− 5.0	64 to 70	16.2	7.9	do.
−19.8	do.	− 5.6	52 to 58	14.2	9.1	46 to 81
−14.5	42 to 49	+ 4.2	67 to 73	18.7	7.3	do.
−10.2	40 to 42	+12.1	67 to 73	22.3	6.1	63 to 73
−11.0	65 to 89	+ 2.9	37 to 42	13.9	11.1	89 to 45
− 8.9	65 to 81	+16.1	62 to 67	25.0	6.0	46 to 81
− 3.9	45 to 51	+15.9	36 to 42	19.8	9.3	36 to 49
+ 2.4	63 to 69	+20.8	79 to 94	18.4	11.2	95 to 62
−12.1	62 to 67	+ 4.6	56 to 63	16.7	14.0	50 to 60
+ 6.9	62 to 67	+31.3	48 to 57	24.4	10.7	48 to 57
−12.2	37 to 42	+15.9	67 to 73	28.1	10.7	40 to 49
−15.1	65 to 81	+ 9.5	45 to 51	24.6	12.8	95 to 62
− 4.7	40 to 42	+29.0	76 to 95	33.7	8.5	46 to 81
− 2.2	69 to 94	+21.8	53 to 58	24.0	13.5	46 to 84
−22.5	69 to 94	+ 2.9	64 to 70	25.4	19.4	95 to 62
−20.3	62 to 67	+14.9	36 to 42	35.2	15.3	do.
−20.4	42 to 49	+19.3	64 to 70	39.7	13.5	46 to 81
−27.4	do.	+ 6.2	48 to 57	33.6	17.5	42 to 54
−19.5	36 to 42	+26.7	56 to 63	46.2	13.3	95 to 62
−14.0	65 to 89	+18.4	36 to 42	32.4	23.5	46 to 81
−25.1	65 to 81	+ 9.0	do.	34.1	22.8	do.
−24.9	42 to 49	+12.5	79 to 95	37.4	24.6	do.
−37.1	79 to 94	+ 3.2	36 to 42	40.3	25.2	89 to 45
−19.5	36 to 42	+20.5	69 to 83	40.0	26.0	46 to 81
−32.7	do.	+42.5	63 to 71	75.2	25.1	do.
−50.0	do.	+65.9	76 to 95	115.9	45.0	do.
−20.4	do.	+13.9	66 to 84	34.3	17.9	89 to 45
+ 0.1	40 to 42	+54.4	66 to 84	54.3	10.5	46 to 81

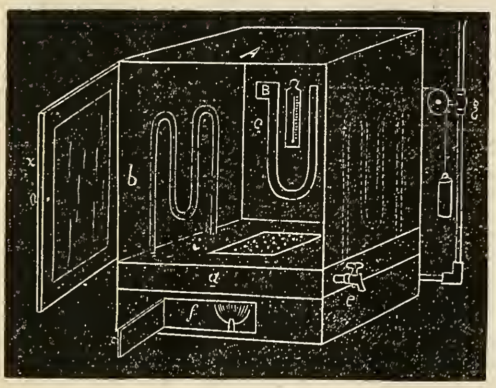
The chronometers are placed in order of merit, their respective positions being determined by consideration of the irregularities of rate exhibited in the table above.

The chronometer Blackie 657 was found stopped on July 10; on examination by the maker it appeared that the main spring had broken. Reid & Sons 2210 was withdrawn from trial on July 17, by the maker, by permission.

metallic chamber, on the inside of the door of which is hung a thermometer; on the top a door permits the whole space between the interior and exterior box to be filled with broken ice. As will be seen in the sketch, the outer shell below comes to a point where the waste-cock, *c*, is inserted, which allows the water from the melting ice to escape, leaving it dry and always in contact with the wall of the chamber. This arrangement gives a pretty constant temperature of about 35°, but if it is desired to decrease it still more, salt must be intermixed with the broken ice. A glass door in this box is useless, for the condensation of moisture from the external air upon the glass, kept cold by the interior air, prevents observation through it.

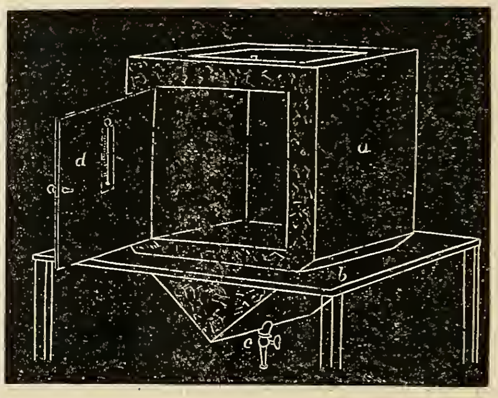
Suppose now that the watch has been found to be gaining at the rate of ten seconds per hour, and it is subject to a temperature of 35° for an hour, and that under these circumstances it gains fifteen seconds per hour; it shows that the adjustment screws are not near enough to the free end of the compensating arc, for the bal-

FIG. 1.



ance does not sufficiently compensate for the decreased temperature, and one of the screws on each side must be moved forward, and another trial made; if on another trial the rate proves to be a gain of ten seconds per hour, it may be next subjected to a temperature of say 90°. Under this trial, if its gain be three seconds over its mean rate in the same time, the compensation is not sufficient, and the weight must again be moved a little forward. If, on again trying it in the heat, it proves correct, that is, gains ten seconds an hour, it must then go back in the ice-box for trial. It may now lose say two seconds per hour upon its mean rate, showing over-compensation; the weight must accordingly be withdrawn a trifle; after trial again if it loses one second, it may then be tried in the high temperature, and if found to lose one second an hour on its mean rate, the adjustment is assumed to be correct for the two extremes at which it is taken. In this illustration, for convenience of description, an hour was assumed for observation; of course, in practice, an hour's trial would scarcely suffice to bring the whole movement, in all its parts, to the required temperature, and would not develop the full effect of its influence upon the running of the watch. Six hours' running would be a fair length of time for preliminary trials; but as the point of compensation is approached nearer and nearer at each repetition, more time must necessarily elapse to accumulate small errors into an observable quantity. And the ultimate determination will require at least twenty-four hours of trial in each extreme to give the correct indication, and to average errors incidental to other conditions than those of temperature. On trial now in the mean temperature, or the temperature ordinary to the shop, it will, most likely, be found to gain on the rate it had previous to adjustment. Why this is so is not easy to explain, and in fact is not well understood; the simple fact is known, by repeated experiments, that if adjustment is effected for the extremes of temperature, the watch will gain in the mean temperatures; and if adjusted to degrees not extreme, when subjected to extremes it will be found to lose. From this it will be seen that adjustment to temperature is but a patient "cut and try" process. When the principle is understood, patient trials and repeated shiftings of the weights of adjustment are all the requirements necessary.

FIG. 2.



The adjustment of marine chronometers is not as difficult as the adjustment of pocket watches, for the reason that its size makes it more convenient to handle, and also the compensation weight is a movable slide upon the balance rim, which can be much more readily shifted for small amounts than where small screws are to be moved from one hole to another, as in the watch balance. Among watchmakers generally, who are not familiar with marine chronometers, an impression prevails that the rating and adjusting of them is a difficult matter, and that the highest skill is required for the purpose. A moment's consideration will correct this impression and show that the watch is a far more difficult machine to adjust and bring to time than ship chronometers, which are always regulated in a horizontal position. They are expected, and in fact required to be kept in that position, because the great weight of the balance, if allowed to rest upon the sides of the pivots rather than upon their end, materially changes its rate of going as well as augments the danger of the pivots being broken more easily by any untoward accident, and to insure the maintenance of this position they are hung in gimbals. This reduces the rating to adjusting the balance to any desired range of temperature, and then the bringing the chronometers to time by the mean time screws. In the watch the same must be also done, and then the real difficulties commence, for the adjustment to position is a feat far more difficult to perform than to temperature.

In factories, as has been elsewhere stated, for all grades except the *fine* watches, to individually adjust each movement requires more time and attention than can be given them; consequently the balances are all made as nearly identical as possible, and also as near as the highest mechanical skill can do it, in conformity with all the known laws which govern their action. The movements are then completed with the exception of gilding the balance cock, which is left gray, because the repeated putting on and off in making the adjustments is liable to mar it. Any convenient number of these movements are then subjected to both extremes of temperature; more or less of them will prove to be correctly adjusted, and these, of course, are selected; others will come near the truth, and probably one or two further tests and slight alterations will perfect the compensation; the rest go to market as unadjusted, and yet they are near enough to be far more correct in performance than a plain balance, and may be taken by the retailer, who, by a little personal attention to each movement, can perfect their compensation. In high class watches, where great attainments in exactness are required, the whole process of critical adjustment to temperature, position, and isochronism, is completed before the movement is gilded, so that no subsequent handling will be required after the process is completed, leaving the movement in the highest merchantable condition.

The attempts at the correction of secondary compensation, that is, the variation which occurs between the extremes, is the "ignis fatuus" which has led as many horologists into a bog, as has that mythical point in the pendulum which has its residence somewhere between the centres of oscillation and gravity. That this is a serious difficulty in the critical adjustments to temperature which marine chronometers require, will be seen by an inspection of the accompanying abstract of the rates of chronometers on trial in 1871. And although most of the competitive instruments have arrangements for auxiliary compensation, yet it is well known that very few of the chronometers sold by the same makers for actual use at sea have any auxiliary compensation, proving that any of the devices now known for that purpose are not of practical utility.

For very valuable remarks on this subject the reader is referred to Vol. II., page 180, as well as for a full explanation of the mode of testing these competitive chronometers, and the compilation of the observations in tabular form. These tables are also exceedingly useful for yearly comparison, and show at a glance whether noticeable progress has been made in horological art. Indeed the vicissitudes of temperature to which marine chronometers are subjected in actual service, are not so great as those employed in the test trials at the Royal Observatory; consequently the appliances for adjustment for secondary errors are not so essential for commercial instruments as for those placed on trial. It is reported that chronometers, which have been carried on polar expeditions, have been kept constantly at temperatures considerably above the mean of the extremes to which they were adjusted. Pocket watches usually encounter greater extremes than ship chronometers, for, while in the pocket the temperature approximates blood heat, and at night they are not unfrequently placed in positions where the temperature is not much, if at all, above the normal condition of the external atmosphere, being extremes rarely encountered in a ship's cabin.

Burglar-Proof Safes.

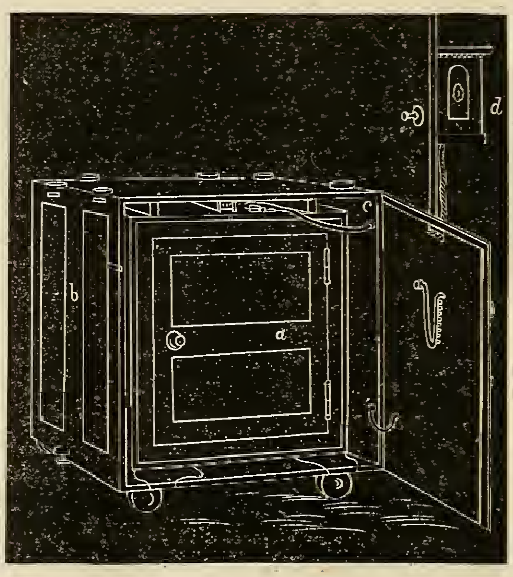
No class of the mercantile community so pre-eminently require burglar-proof safes as jewellers; and the hitherto impracticability of constructing such of a capacity adequate to their wants, has been felt as a serious inconvenience, as the cost of construction increases in geometric proportion according to size; and beyond certain moderate limits, no great expectations are entertained that they will prevent the depredations of those who are determined to "break through and steal."

Between the makers and the breakers of safes, the race has been neck and neck. Masses of chrome iron and hardened steel have found their match in nitroglycerine and diamond drills, and each in turn has won the gold. No safe was safe; the strongest box could be broken by a force a *little stronger;* and the most faithful watchman might get drowsy, or the bravest policeman be throttled. Electricity, which pervades the earth and the air, and is ever wakeful, has been invited, time and again, to take ward and watch over vaults and vouchers; but in all previous constructions the conditions were not favorable; the arrangements for its faithful co-operation, under all possible contingencies were not perfect; in some conditions, and under some circumstances, were not in harmony with all known electrical laws, and, consequently, its action lacked the absolute certainty which is an essential requisite for perfect protection.

Among the notices of new inventions will be found the "Electric Burglar Alarm," invented and patented by Messrs. W. Duncan and C. C. Rowell. This is a successful application of science to the mechanic arts, in conformity with natural laws, that leaves nothing more to be done to make electricity a sure and faithful guardian of every description of valuables properly placed under its charge. The progress of discovery may possibly bring out new laws with which this plan is not in conformity, but till then we believe the "Electro Pneumatic Safe Protector" can be implicitly relied upon to give an alarm, however and whenever the safe to which it is applied is meddled with, and that the JOURNAL cannot confer a greater boon on the trade than by placing before them a full description of this invention, which they will, as a class, more easily understand than the community in general, for the reasons, firstly, that they are more or less acquainted with the general principles of science, and, secondly, that they can more readily comprehend the mechanical arrangements by which they are practically applied. In a pecuniary point of view it will save the trade a direct outlay of millions of money in the purchase of such safes as attempt to attain burglar-proof qualities.

We also feel professional pride in this successful achievement, from the fact that one of the inventors, Mr. C. C. Rowell, is a practical watchmaker, and, though not personally an Apollo, stands very high [6 ft. 3½ in.] in our beautiful art. The obstinate perseverance with which he has followed up this invention, successfully overcoming every obstacle that natural laws placed in his way, are alike creditable to his skill as a mechanic and electrician, and worthy of imitation by those who have an ambition above mere manual labor.

A description of this burglar alarm will be attempted, not alone as matter of interest to the trade, but as a profitable study upon the harmonious application of undulatory force to mechanical purposes.



An ordinary fire-proof safe, *a*, is surrounded by a metallic shell, *b*, and so arranged that when the air is permanently exhausted from between its narrow walls, as it may be by a little air-pump, *c*, an electric current is established between a small battery and an alarm box, *d*, fixed in any desired locality. Any attempt to open the safe or puncture the shell instantly discharges the alarm.

In describing fully the details, its electric action, for the present, will be omitted. The first mechanical problem to be solved, was how to completely enclose an ordinary safe in an absolutely air-tight envelope, which must be done in some comparatively cheap way, in order to make it of any commercial value. It must also be capable of application to any safe already made, and in any position, and of any size or shape; and also permit the enclosed safe to be readily accessible. At first thought these requirements seem impossible to fulfil, but the simplicity with which it has been accomplished is only equalled by its perfect success. To illustrate: Suppose a square safe of any given size is to be enveloped. Of course it has six equal sides, and this will require six shallow tin boxes to be made, an inch in depth, and in size corresponding to the sides of the safe, and these tin boxes must be perfectly air-tight, so that, when exhausted, no air can enter. Some will at once say this cannot be done, for the moment the air is withdrawn from this shallow box, the pressure upon the large surface which the sides present will collapse them instantly. This objection the inventors saw and provided against by filling the space with a wood lining, both the surfaces and edges of which are grooved spirally, so as to furnish a continuous air passage, and yet leave a firm support upon which the sides of the box can rest; an arrangement which leaves but little air space to be exhausted. These six shallow tin boxes, when placed upon the six sides of the cubical safe, completely envelop it; and the next step is to so connect them all together as to make a completed box, and yet have an air passage communicating between each adjacent section. This is accomplished by means of hollow brass angle knees placed in the corners, a passage through them communicating with the interior of each adjacent box. The broad soles of these knees furnish a surface for rubber packing rings of an inch or more diameter, and are drawn together by an ornamental nut outside, securing the whole firmly together in a manner positively air-tight. Of course one of these sections is hung as a door. To maintain its air-tight connection with the other parts, there is attached to the inside of the shell, near the lower hinge of the door, a rubber tube, the other end of which makes an air-tight connection with the inside of the door. This tube permits the door to be swung open to its full extent, without disturbance of the air-tight condition of the whole arrangement.

Another peculiar and important adjunct to this air-tight shell (as a whole) must now be explained. It is well known that a disk of thin metal, of any considerable size, which is not perfectly flat, but a very little convex from hammering, which slightly stretches one surface more than the other, will, when rigidly confined around its periphery, require but very little force to change the convex into a concave surface. This distortion of a plate of metal from a perfect plane is what plate workers call a "buckle" in the plate; and this is why the bottoms of tin pans and pails that have been long in use will go out or in with a "snap," by a little pressure on them. A thin brass disk of this sort, about seven inches in diameter, forms part of the inner surface of any one of the sections of the shell; but it is usually placed in the top by preference. Of course this disk of brass is unsupported by the wood lining, thus permitting it to collapse inward and outward freely. The consequent action of this disk, under pressure upon either surface, is to collapse with the well-known "snap," and it will remain thus until the pressure is removed, when it will instantly resume its normal position. This disk is the key to the whole invention, and plays the same important part in starting the alarm, as the trigger of the gun does to its discharge.

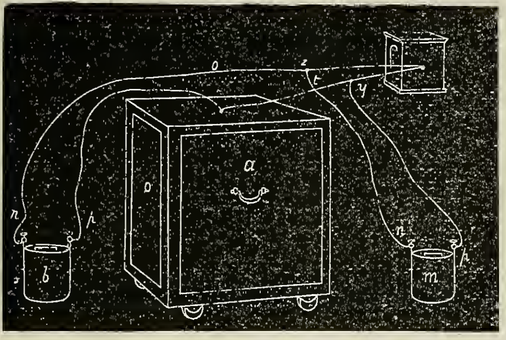
A very slight exhaustion of the air from the grooves which surround the wood lining of the six sections is all that is required to collapse this disk upward. This exhaustion is done by a few draws upon a small air pump, which is permanently attached, by a short piece of rubber tube, to the inside of the shell, and at any time the slight exhaustion requisite can be known by inspection of a mercury gauge fixed to the inside of the door, which not only indicates the amount of exhaustion, but the point at which the disk will collapse.

On the door it is necessary to place only an ordinary lock, nothing complicated being required, because, by an arrangement not yet described, the moment the door is opened, or the shell punctured in any part, the alarm is discharged; or should any unusual increase of temperature, as a fire in the room or in the building, occur, the alarm will give instant notice of it. This apparent complication, as detailed, resolves itself into perfect simplicity as a whole. The electrical arrangement may seem complex, but when so described as to be perfectly understood, as a whole, it is so simple, that to use it, even rudimental electrical knowledge is not required; whoever can open and shut a safe with a combination lock has all the knowledge requisite to use this alarm.

Knowing the satisfaction that there is in being able to understand the reason for processes in constant use, leads us to the attempt to show as clearly as possible that this alarm will do exactly what it is said to do, because it is impossible for it to do otherwise. To remember a few facts, which every one knows are facts, aided by a few diagrams showing how these facts are taken advantage of in this construction, will be all that is necessary. It is known that electric currents pass over or through a continuous wire so long as electricity is generated in connection with it, and the wire or circuit, as it is called, remains unbroken. This circuit or circle is merely the path over which the electricity travels from one side or element of the battery which generates it, by chemical action, to the other; and another fact must be always borne in mind when reading or thinking on this subject, that electricity, although the embodiment of activity and energy, is nevertheless, too lazy—or more properly too saving of that energy—to travel a single inch out of the nearest way to reach the opposite pole. It will not hesitate a moment at a journey of three thousand, or ten times three thousand, miles to reach the opposite side of a battery which may be only an inch away, if there is no nearer mode of reaching it; but let the inch which intervenes be bridged over by a conductor, and no inducement can persuade the current to take the longer route. Another fact is, if there is the slightest break or interruption of continuity in the conductor the current ceases, and nothing short of connecting the break will induce it to go on. Again, it is known to every one that if the conducting wire is carried around and round a piece of soft iron, like thread on a spool, the surrounded iron becomes a powerful magnet, and remains one so long as the current passes, and that the moment the current ceases the iron is no longer a magnet. Telegraphing is, in fact, but the making and unmaking of this electro-magnet, in a preconcerted way, which indicates letters. Now, this electric alarm is nothing more than using the attraction of the soft iron magnet which is in the alarm-box, to prevent the alarm from running down; and the moment the electric communication is interrupted the soft iron is no longer a magnet, which releases the alarm, and off it goes. This is done in this way: the wire comes from one pole of the battery into the safe (through a simple contrivance to be described), from there it goes to the alarm-box, a hundred miles away if you please, where it coils about the soft iron magnet, returns back to the safe (through the same apparatus), and back to the opposite pole, and ends its journey.

Suppose the alarm wound up; the magnet, by a simple arrangement, prevents it running down. Now, if this wire be broken at any point in its whole circuit, the soft iron ceases to be a magnet, releases its hold on the alarm, which is sounded. The slightest contact of two metals affords a passage for the fluid; the sharpest knife edge placed upon a disconnected circuit will instantly permit the passage of the fluid through the blade, and so on, to complete the circuit. If within the safe the wire is cut, and the ends left so near together that a little metallic wedge will touch them both when slipped between, the circuit will be again complete, and the alarm be held. If, now, the wedge which opens the circuit is pulled out, the current ceases, the magnet is destroyed, the alarm is released, and says plainly, "somebody 's meddling." Suppose, again, that this wedge were fastened to the door, which, when shut, completed the circuit; if the alarm be wound up, it is held all right; but open the door which pulls out the wedge and clang goes the alarm bell, saying, "some one has opened that safe."

"That's all very nice," says the electrician, who knows all the ins and out of this science; "but I'll show you how easily I can open that safe and not start your alarm. Suppose *a* is your safe, *b* the battery, *c* the alarm box up stairs in your bed-room, *p* the positive pole, and *n* the negative; *m* is my battery which I will take in, and attach the positive pole of mine to the positive of yours *beyond* the safe at *y*, and the negative of mine to yours at *z;* now all that I have done is to make the magnet in the alarm box stronger than before, so that of course the alarm can't go off. Now all I have

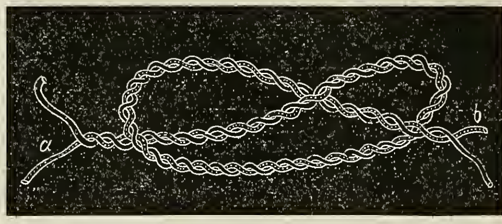


to do is to cut off your wires at *t* and *o*, and your alarm is held by my battery, and the safe at my disposal."

To obviate this possibility, which has hitherto been the great obstacle to the success of all electric alarms, the inventors have devoted their whole energy. Not only have they lavished upon it their own knowledge and ingenuity, but they have, during the whole progress of their studies, had the cordial co-operation of some of the most eminent electricians in the country.

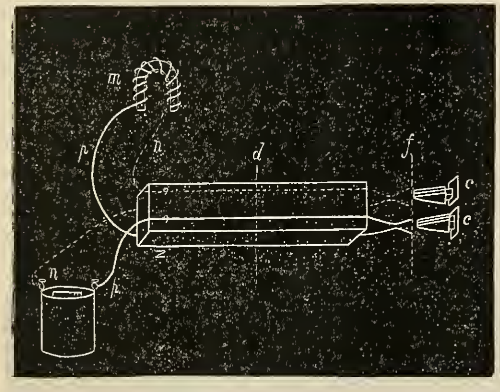
To explain the mode by which they arrived at a successful solution of the difficulty just mentioned, it must be recollected that electricians can easily detect in an insulated or concealed wire, through which a current is passing, the direction in which it is flowing. This is done by the use of a deflecting galvanometer, which is an instrument based upon another immutable electrical law, that a current passing in the neighborhood of a magnetic needle deflects or turns it out of its normal position, and the direction of this deflection depends upon the direction in which the current is passing through the wire. This is easily understood. Suppose that a pocket compass is brought under a wire through which a current is passing, the wire being placed parallel to, and over the needle, the observer standing at its south end; if the current passes from the north to the south through the wire, the compass needle will *always* turn its north end to the right. Now, if the current is reversed through the wire, just the opposite deflection takes place, and the north end of the needle will turn toward the left. This is the rudimental principle upon which the galvanometer is constructed, and they are so exquisitely delicate in indication that the faintest trace of an electric current is instantly shown. This ability to detect and follow the track of the current through the concealed wires of a cable, affords the necessary knowledge to the skilled electrician, honest or dishonest, to substitute another current for the primary one, without disturbance of the normal condition of any apparatus through which it passes.

The two wires of a battery when insulated by being covered with a non-conductor, can be twisted together, without in the least interfering with the transmission of the current. In the twisted knot represented, although the convolu-



tions take any number of turns, the galvanometer will determine, at any point, which is the returning wire, as easily as it can be traced by the dotted line in the figure. If at any place between *a* and *b* metallic contact be made between one wire and the other, the electric current will not pass beyond that point, but will cross over and return to the battery by the other wire.

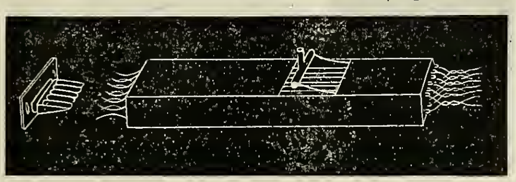
We will now go a step farther and give an idea how the circuit is connected within the safe. Suppose a strip of wood, *z*, which is a non-conductor, be fixed within the shell which covers the safe; the wire *p*, along which the electric current flows, starts from the battery *b*, and is carried along the *upper surface* of the slip of wood, and projects beyond it a little distance, where it is abruptly bent backward and passes *under* the wood, and so on out of the safe, and to the magnet within the alarm box at *m;* after making a sufficient number of turns about that, it returns (as a dotted line *n*), and is secured to the *top* of the strip passing out a little beyond it, and then is sharply bent backward and returns *under* the strip and is connected to the battery at *n*. The outward bound current starting at *p* is traced by the continuous line across the wood and on to the magnet; and the return current by the dotted line back to the battery; the outgoing and returning currents passing through the wires which are fastened side by side on the strip of wood. This circuit, as described, is complete and continuous. Now, suppose at *d* a wire is laid transversely



upon the two wires as they are fastened upon the strip of wood, in metallic contact with both, the instant consequence is, that the current of electricity *will not* go the long circuit through the magnet, but will cross over by that short cut which the transverse affords back to the battery, thus destroying the magnet at *m*. Again, suppose the circuit perfect as at first, and we cut the wires open at the sharp bend *f*, instantly the current is interrupted at that point, and the magnet in the alarm box destroyed, and will remain so until the gap is filled. If the little metallic wedges *c c* are pushed into the openings the continuity is established and the current again flows. Now, if these little wedges are connected to the door of the safe by some non-conductor, and insulated from each other, the consequence is that when the door is shut the current flows and the magnet acts upon the mechanism in the alarm box. Opening the door withdraws the wedges and breaks the circuit, and destroys the magnet. Moreover, between the wood non-conductor and the battery the two wires may be twisted together (if insulated from each other), making the two into one wire, and the same may be done with the two wires between the wood and the magnet, and the results remain the same. Thus far nothing has been shown which makes it at all difficult to "take up" this electric connection between the safe and the alarm. Having gone on step by step to this point, and if understood thus far, it will be easy to show how this can be rendered impossible. One complete independent circuit from the battery, through the safe and alarm back to the battery, has been established, and the wires of it twisted together. Another independent circuit must now be added from the same battery, the wooden block widened sufficiently to fasten to it the wires of the new circuit, which extend to the alarm box; these actuate another electro-magnet, which is entirely isolated from the first, and two more wedges, for connecting the break in this second circuit, are added to the door; this forms a second complete electric connection, perfect in itself, and each acting independently of the other. To make "assurance doubly sure" a third complete circuit and magnet is added, and the wires all secured side by side to the non-conducting block.

It has been said that the positive and negative wire of one of these systems may be twisted together; it could be done so, and the three single wires thus formed be twisted into one cable; but to intermingle the going or returning currents in inextricable confusion, the positive wire of one system is twisted with the negative of the next, and so on, and these three compound strands *braided together*, thus making it totally impossible, upon any principle at present known, to determine to which system any wire that may be experimented upon belongs; so that if the galvanometer indicates at any given point in the braided cable a positive current, it will, of course, belong to some one of the three independent systems; but the experimenter cannot possibly know which, and consequently cannot search out and take up the return current of that system. There is no possible way for him to know but that the return current is of one of the two other systems with which it is interwoven. If he thinks he has *one* of the magnets "spiked," he must then search for the other two; but, as they are all braided in and out, and through and through, he cannot possibly know but that he has not again tapped the same current *at another point*, and that the other two magnets are yet intact. With his best efforts, he can only *guess* that he has them *all* under the operation of his own battery. The only method to ascertain this is to cut the cable bodily, between the safe and his junction. And if he venture to do this the "Pneumatic Safe Protector Co." will hazard a large amount that the alarm will be sounded. From the foregoing explanation it will be seen that a burglar may have free access to the battery, safe, and cable, for any length of time, and the alarm will *surely* be set off, if the slightest damage be done to either.

It now remains to be shown how surely the alarm will be discharged whenever the envelope which surrounds the safe is disturbed. It has been shown how the opening of the door withdraws the little metallic wedges that completed the circuit, and thus discharges the alarm by breaking it within the safe. It must now be shown how the slightest puncture of the shell, by admitting the air, will do the same thing by making a short circuit within the shell, independent of the alarm, and thus discharging it. The going and returning wires from the battery all pass over the surface of the non-conducting strip of wood. This strip, as shown in the cut, is fastened within the air-tight shell



exactly beneath the brass disk previously described; it was also shown that a wire laid across each of these going and returning currents formed a bridge, beyond which the currents would not go, because through it a short road back to the battery was found without going the long circuitous route through the magnets in the alarm box. The whole mystery is solved by knowing that to the disk which is collapsed upward by the pressure of the air, there is attached a little insulated bar of metal, which, when the disk "snaps" down by the entrance of air into the shell, rests across *all* the electric wires, and through it the current returns at once to the battery without going to the magnets, thus discharging the alarm.

These few simple facts embrace the whole thing:

1st. Opening the door breaks the circuit and discharges the alarm by destroying the magnets.

2d. If the cable be cut, the same occurs.

3d. If the air-tight case be ruptured, the magnets are destroyed because a short circuit is formed within the safe, thus destroying the magnets and sounding the alarm.

4th. It is an important fact, that whenever any imperfection exists either in the condition of the battery, or any of the connections between it and the alarm, it gives as instant notice of it as if a burglar was at work.

The apparatus to which this electric system leads, is an ordinary alarm of large size, which gives a blow upon a fifteen-inch gong every twenty seconds, at the same time ringing an incessant alarm upon an eight-inch gong, for an hour after set going. The machine is enclosed in a strong iron box, the door of which is fastened by a combination lock similar to those used upon a burglar-proof safe. The bolt of this lock is so arranged that when the door is *unlocked* (which can only be done by understanding the combination), the alarm is held from running down; but as soon as the bolt is thrown in locking the door, it is then held by the electro-magnets until they are destroyed by some interruption of the current. To render the alarm box invulnerable, the whole is enclosed in a hermetically sealed metallic shell, with a collapsable disk, such as is in that which encloses the safe. This shell has no connection with the electric arrangement, and is so secured to the alarm box that any attempt to remove it sets off the alarm; or, if it is punctured, the collapsed disk as surely discharges it. Nothing can be more effective, and nothing easier to manage, than this fortunate application of abstract science to the necessities of life.

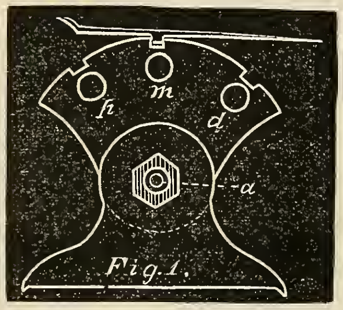
Machine-made Screws.

One of the simplest, but yet exceedingly interesting operations in an American watch factory, is the making of the various screws which are so essential, and which have done away with the use of pins for securing some of the parts in place, as formerly practised in watch making. In fact it may safely be said of many modern watches that there are only two pins in the whole construction, and these secure the ends of the hair-spring in position. "Steady *pins*" is a misnomer, for they are now all steady screws; and even the traditional "joint pin" is almost forgotten.

The first step in making screws is to determine the thread which is best adapted to each particular description of screw, which will depend on the purpose the screw is to subserve. Those upon which the greatest strain is to come, as the plate, cock and case screws, must have a thread so few to the inch that there is no danger of stripping or of being overturned by use. Such as require nice adjustment to position, and that sustain but little strain, will permit and require more threads to the inch, of which character are balance and jewel screws. The usual limit in practice has a range from 100 to 220 to the inch. The beautiful screw cutting machine in the U. S. Factory, and which is exclusively devoted to the producing of taps for use in all the other machines, has a capacity of cutting 400 threads to the inch.

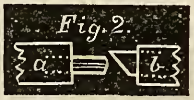
After the size and thread are decided upon, hardened steel gauges for standards are produced, the use of which is rigidly limited to verification.

All taps or dies for use must coincide with this gauge, and as they are in constant use, and must sooner or later deteriorate, the examiners frequently test the products by the standard to insure continued coincidence. The screw-making lathes all have hollow mandrels, and the split chucks through which the steel wire from which the screws are made is passed; it is in lengths of about 12 inches, and of course gauged to suitable size for the intended screw.

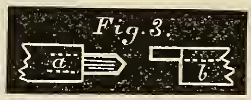


An important adjunct to many of the lathes and machines in the watch factory is a tail stock, swinging at right angles to the line of the lathe about *a*, Fig. 1, as a centre of revolution, carrying arbors or mandrels through *p*, *m*, *d*, parallel to each other and to the lathe bed, each having upon its end the proper cutter or die to perform its own special work in making the screw. The tail stock is indexed by stops which keep *p*, *m*, *d*, in line with the lathe as desired, when the respective cutters are in use. The mandrel of this lathe has, besides the driving pulley, a secondary one, over which a band passes within easy reach of the operator, which is used in giving to the screw blank a reverse motion when running it in the die.

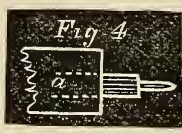
The operations, so tedious to describe, are so rapidly performed by the operators as to keep the observer on the alert to detect which is the beginning and which the end of the completed screw. First the wire is pushed through the jaws of the chuck a little more than enough to complete a screw; the first arbor in the swing tail stock is then brought into line with the lathe, and its cutter points the wire, and at the same time reduces the length, which projects to a fixed amount, so that the screw will be only of the proper length. This cutter is shaped as at

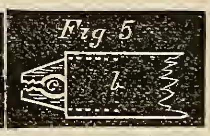


b, Fig. 2, which, on being approached toward *a*, reduces it to a determinate length by a stop upon the cutter bar and points it. On withdrawing this cutter, the next one is swung into place as shown at Fig. 3, and pushed forward to its

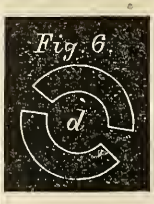


stop, forming the blank upon which the thread is to be run. The next operation is to cut the thread, which is done by swinging the die *b*, Fig. 5, which is fixed upon the third tool carrier into line with *a*, Fig. 4, and pushing it forward, which instantly runs a thread upon the screw blank. This die is somewhat in the





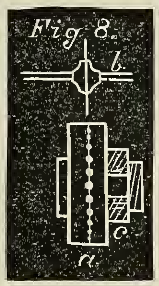
form shown at Fig. 5, a vertical cross section of the same at Fig. 6, showing it cut through radially, which forms two cutting edges that make a thread as perfect as that produced by the original screw cutting engine.



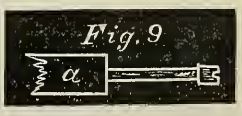
However small the screw may be, these cutting edges take out a clean chip of metal in cutting the thread, not only producing a more nearly perfect screw, but with far less torsion upon the blank than is required by such screw plates or dies as press the threads upon the blank; and in screws of extremely small diameter this is no small consideration in lessening the probabilities of being twisted off in the die. The breaking of screws in the holes in "jam plates"—that is those screw plates which present no cutting edge to the screw blank—is a source of annoyance to many repairers; and the accumulation of screw plates on their hands, with all the desirable sizes of holes plugged up, shows either a lamentable want of care, or a lack of knowledge as to *why* it so often occurs. This accident will seldom occur if the proper diametric size of the blank is first obtained. By reflection it will be seen that the indentation of the screw blank by the interior edge of the die, will raise the adjacent metal to fill the bottom of the thread in the plate; and as a consequence the diameter of the blank must be a mean between the interior diameter of the screw hole, and the exterior of the screw, or the tap that forms the hole. For general purposes, if the interior of the screw hole is measured by the taper slit of Dennison's gauge, and the blank is filed or turned to $\frac{5}{10}$ of a size larger, there will be but little danger of its being twisted off in the hole of the screw plate.

In running the blank into this cutter, dexterity in the operator is required, for the motions must be reversed; and when the shoulder is reached the operation must cease, otherwise the screw will be twisted off and the threaded part remain in the die. This is all done by the sense of touch; the reverse motion band is seized and brought gently down, at the same moment the die takes the point and the hand which moves the blank by the band *feels* the stop of the die against the shoulder, reverses the direction, which withdraws the screws, and all is done. Should any accident or carelessness twist one off, the arbor that carries the die is withdrawn, and the broken screw slitted through the diametrical opening in the die, and the broken piece removed through the enlargement of the slit at *c*. The sense of touch which is relied upon in this operation, becomes by practice so highly developed that such an accident seldom occurs.

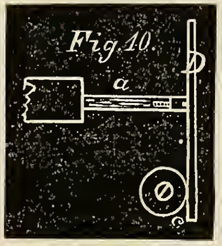
The completed screw must now be cut off. This is done by approaching to it a thin cutting-off tool, drawn forward by hand to a stop which cuts it *nearly* off (Fig. 7). This stage of its progress brings it to another and important adjunct of the screw-making machinery, which is the slitting disk. This is simply two steel disks, *a* (Fig. 8), of perhaps an inch and a half diameter, held together by a screw nut, *c*, and the line of junction of its two surfaces in contact, pierced and tapped with screw-holes as near together as the heads will permit. This chuck, when fitted in the lathe to which it belongs, has a very slow revolving motion, while the rotary slitting saw, *b*, revolves rapidly, making in the head of each screw that passes under it a diametrical slit, and on removal from the lathe, opening the disk allows the screws to fall out. Having the screw completed and nearly cut from the wire, the operative takes the slitting disk, approaches one of the holes in its edge to the screw, which runs in up to its shoulder, and is then instantly twisted off. This is repeated till the holes in the periphery are all filled. A hundred or so of screws (depending on their size) can be made and placed in a disk while another is having the heads slitted.



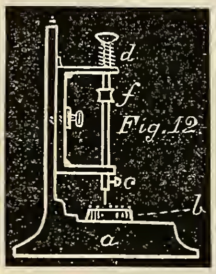
But little attention has thus far been given to the absolute diameter of the heads other than the size of the drawn wire from which they are made. In screws that require to have the head made to fill a recess, such as jewel and cock screws, the size must be identical, which is quickly and accurately done upon a little lathe, which has projecting from its mandrel a hardened and polished point, Fig. 9, with its extreme end tapped for the particular screw which is run into it, and the superfluous metal taken off by a file until the sides of the screw head and the gauge form one line. It is then burnished on the sides and top, flat or round, as the case may be, leaving each screw identical. The points are stoned and burnished by seizing the screw by its head in the jaws of a chuck.



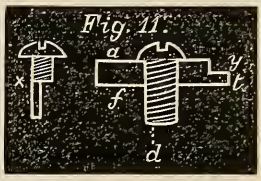
For polishing those that require flat heads there are two modes. The smaller screws are, for this purpose, run into the nose of the chuck *a*, Fig. 10. At a distance of about three inches from it, is an upright hardened steel roller, *b*, its edge, *c*, in line with the surface of the screw-head. Against this roller the flat Arkansas stone, *d*, is firmly held, which insures its being at right angles to the line of the lathe when reposing upon the screw-head; by giving the stone a back and forth motion while the screw is rapidly revolved, a flat head is produced, which is then polished by the similar use of a strip of lignum vitæ, charged with Vienna lime and oil.



Pillar and other screws, with large heads, are done in another manner. Flat steel disks about two inches in diameter are provided, the whole surfaces of which are filled with holes, drilled and tapped for these screws, and into each hole a screw is run. When filled, these disks of screws are held against a revolving lap charged with emery, which reduces all the heads to a uniform level. After being washed clean from the emery and oil, they are glossed on another lap, and taken to a machine to be unscrewed. This is done by a screw-driver run by a band, and is almost a duplicate in miniature of a machinist's upright drill. From the bed, *a*, Fig. 12, a column rises, upon which is a spindle stock carrying the spindle and pulley, *f*, upon the upper end of which is a loose finger collar, a spring, *d*, and below, a set screw, *c*, to fasten the screw-driver into its lower end. The block, *b*, with its contained screws, is placed under the revolving screw-driver, and moved by the operator so that a screw is brought under the driver, which is then pressed down by the finger, and the moment it finds the slit the screw is instantly withdrawn, and another moved under the screw-driver, and so on until all are removed. The rapidity with which this process is performed is surprising.



One of the neatest little arrangements is for producing the little eccentric screws used as banking pins. This is accomplished by a double-faced steel disk, the periphery of one face being concentric with the hole tapped for the screws, and the periphery of the other disk being sufficiently eccentric to the screw hole to bring the line of collimation of the lathe near to one side of the screw. Figure 11 is a section of this disk, the part *t* having the screw hole through its centre; the other half, *y*, having its centre at *d*.



In use, the disk is held in the jaws of the chuck by the circumference of *t*, the surface, *a*, being outward and the screws run in. It is then released, turned over, the periphery of *y* being grasped by the chuck, which brings *d* into the line of collimation, and a cutter is now approached which cuts away the screw into the form *x*. This is a beautiful illustration of simple mechanical manipulation, and is a fair sample of a large class of ingenious adaptations by which watches, as well as a great variety of modern manufactures, are so economically and successfully prosecuted.

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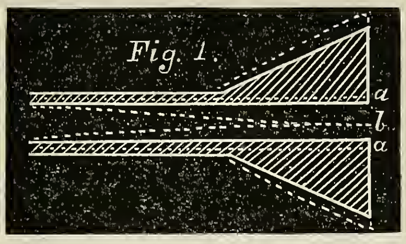
Split Lathe Chucks.

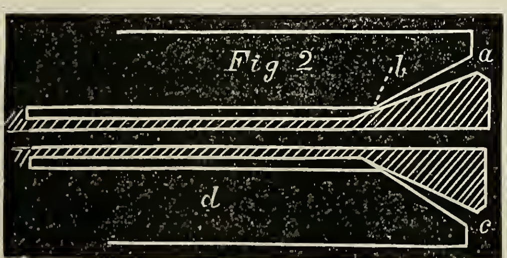
The very general complaint of want of truth in the American spring chuck, must have some foundation in fact, for it is hardly possible that so general an agreement upon one fact could be the result of accident; and certainly so widely separated individuals could not make the charges by collusion. Many have experienced the fault spoken of, namely: that an article turned as correctly as possible, upon being removed and again placed in the jaws of the chuck, is out of truth. Again, if a piece is turned true, and taken out and inverted, and the second part is correctly turned, upon a second inversion, want of truth will be manifest. Some workmen attribute this defect to one, and some to another error in construction; and some believe the *principle* at fault. By giving this matter some little thought, it will be seen that the *principle* is not erroneous; that if the chuck is properly made the results complained of will not be found in it.

Theoretically, the spring chucks are correct only for one size; and the opening and shutting of them to any extent greater than the opening in them as originally constructed, vitiates their correctness; for when distorted, either wider or narrower, the interior of the jaws do not remain parallel, and the article, if parallel itself, is either held by the exterior edge of the jaws or by the rear of the object grasped; in either of which conditions it is liable to be forced out of truth. The cut, Fig. 1, shows by the dotted



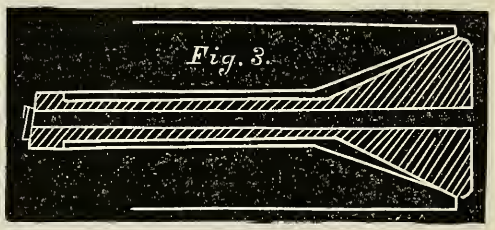
lines *b* the want of parallelism when compressed more than its normal condition; and by inspection it is easy to see that a small object held in the jaws thus closed, will be free at its rear to assume a position out of truth. The same condition of things transpires when the interior surface of the jaws take the position *a a*, and the object is held by its rear end, allowing the same liability for error.

Another source of want of truth is in the original construction of the male and female cones. The relation which the angles bear to each other in some cases is such as to permit distortion when forcibly drawn in upon objects



of some peculiar forms. If the angle of the female cone, Fig. 2, is greater than the male, the pressure comes entirely upon the rear of the chuck cone, leaving the nose of the chuck unsupported at its outer end; and consequently in a measure free to suffer distortion from the line of collimation, because the spring part can be bent by sufficient pressure upon the nose. For example, sufficient lateral pressure applied to the chuck at *c* will force it up into the space *a* until those surfaces come in contact; this is permitted to be done by the thin part of the chuck being bent downward at *d*, the point of contact between the male and female cones at *b* becoming a fulcrum. This error augments as the chuck is drawn in, because the angle of the inner surface of the female cone remains constant, while the angle of the male changes with every change in the aperture of the jaws.

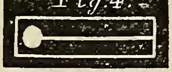
In Fig. 3, the relations of the two cone surfaces are as diverse as in the previous figure, but in the opposite direction, which permits the mouth of the female cone to be in constant contact with the male surface of the chuck; and, as it is more and more drawn in, the surface angles more and more approximate, until



at the moment the jaws close, they coincide; and if the condition of the chuck permitted a farther inward retreat the relation of the two angles would then commence to assume the form represented at Fig. 2.

There can be no doubt but that the proper relation between the male and female is as shown by Fig. 3; for, although the parallelism of the inner surface of the jaws changes equally in each form, the centrality of the articles is better maintained by contact at the outer surface of the chuck, and the chance of distortion by forcible lateral pressure is much lessened, because the fulcrum of the lever is removed to, or near, the outer surface of the jaws, and the thin and weak part of the chuck has almost the whole advantage in the lever thus formed. In most of those chucks which are particularly faulty, it will be usually found that the conditions are as represented at Fig. 2; the remedy for which is, obviously, to alter the form of the angle of the cone to that represented at Fig. 3. Oftener the error charged to the chuck has been the fault of the workmen; the majority of whom, if the article to be held is too large for one, and too small for the other, will force open the small one, and thus make it do; and when the result is unsatisfactory, blame the chuck. It is better to have *one* true one with a good sized opening, and the necessary number of supplementary jaws of steel, Fig. 4, or even good

Fig. 4.



hard brass. These are not difficult to make, and give much more satisfactory results than many of those that come in complete sets. Take the chuck with the largest opening; if not perfectly true, it will be necessary to turn out the hole so as to insure truth and parallelism, leaving a bottom, or light shoulder, to the hole, so that the changeable jaws may go down to, or rest on, a step; next take some of Stubs' steel wire, that *exactly fills* the jaws of the chuck easily, cut off a piece long enough to reach the bottom of the hole, and project a little in front to allow its withdrawal; centre this carefully in the lathe, and drill a hole through of any size desired; near the rear end of this, drill through it a transverse hole of considerable size, then slit this cylinder diametrically down to the transverse hole, and it will form a jaw perfectly parallel in its whole length, and suitable to hold any thing which *fits it*, exactly to the centre, and nothing else should be put in it. These supplementary jaws ought to be provided for every sized article which is required to be held. It is still better to construct these supplemental jaws with three or four transverse holes through the rear part in those that have through them only a very small longitudinal hole. By this means the jaws have a greater elasticity, and more quickly and kindly respond to pressure when the chuck is drawn in upon them; also, by slitting them diametrically in two directions at right angles, more absolute truth can be obtained when they are closed together. It is but a short job to make one of these little jaws in brass, and if one is made for every exigency that requires a new size, a full supply will soon be accumulated, quite sufficient for any occasion. By this simple arrangement positive truth can be relied upon, unless there is some radical error in the construction of the lathe, which must be searched for, found, and corrected.

Jewelry.

Every year, every month, aye, almost every day, wonderful changes are made in the methods of construction in all branches of manufacture. The mechanical modes are almost as changeful as are the forms produced. What to-day may seem quite adequate to the demand, in a month may require radical change. The obvious tendency, in all departments, is to substitute exquisite machines in place of manual labor. The constant causes of irritation between labor and capital, the ceaseless endeavor of the laborer to obtain more, and the employer to pay less, keep the manufacturer constantly on the alert to adopt any means that offers a probable amelioration of this constant unrest. Steam and steel will always be faithful in their service under fixed laws, which are so well known and so immutable, that transgression of them on the part of employers is followed by instantaneous retribution. With the human employee nothing is fixed law—all is mutual compromise; the hours of labor—the amount done—and method of doing it—the compensation demanded—are each and all elements of discord. The infringement on one or several of these mutual compacts does not necessarily "blow up the factory," but creates a thorough "unpleasantness" that may culminate in a "strike," or "lock out," either of which entails greater or less misery on all concerned; the master wishing the man was a machine, and the man wishing the master was a Bank that was *obliged* to honor unlimited drafts for cash. These antagonisms are constantly urging manufacturers to substitute absolute and certain machine labor for unreliable, treacherous, muscle work whenever it is possible to do so.

The jewelry trade is beginning to feel this necessity. Already many branches of the art are worked upon the plan of gauged operations, and articles that once were not supposed capable of this mechanical application, are now better done at half the cost on this plan. For example, onyx sleeve buttons formerly were made by selecting pairs of cut stone agreeing in color and size as near as could be found among the stock of the importer of stones. These were given into the hands of a workman, who proceeded to make the setting for each stone, securing conformity to its size by the file or graver, as occasion demanded. Individual pairs were thus laboriously completed, and, if in good geld, at a cost of fifteen or twenty dollars.

Now the increased demand for the same goods justifies the manufacturer in ordering of a foreign lapidary the samo stones by the gross of pairs, and each stone ground to a gauge in size, and matched in color, and large orders of this kind enable him to get the stones at much less cost; and when received they fit at onco and perfectly the settings which steam, and punches, and dies have made without touch by the hand. The final polish, and the last artistic touch, are given by skilled laber, which is thus relieved of the mechanical drudgery of trade, and produces a completed wholo equally valuable, and better finished, for five or ten dollars. Initial buttens, that formerly consumed time and gold to the value of twenty dollars a pair by the tedious process of the piercing saw and file, are now produced more perfectly, and in any quantity, for less than half the money.

The punch and die never clamor for exactly eight hours of shiftless labor per day, nor for an advance of wages for begrudged service, and the public aro benefited by better goods at far less prices. Of course these mechanical methods are inapplicable to the production of high-class jewelry, where each individual piece is a *chef d' œuvre* of metallurgic fine art; but for the manufacture of that large mass of jewelry merchandise which forms the bulk of the trade, and is known as medium gold goeds, and in which reliable stock is combined with a reasonable amount of skill, the application of machine work has been a success, both to the consumer and producer. The necessary confinement of this application to certain forms, and to articles of general use, where great fluctuations in style are not liable to occur, gives a character of specialty to those goods which have made jobbing houses a necessity. They subserve the same purpose to retail buyers here, that market days do on the continent of Europe, where, at fixed times and places, the widely scattered manufacturers gather the products of their labor to meet purchasers and negotiate sales. Our jobbers do not generally manufacture, but their bazaars contain the products of all the isolated manufacturers of specialties, where the purchaser sees at a glance all there is in the market, and in an hour can inspect and select a stock that he could not possibly do in a week if he was compelled to seek out the location of each maker, and deal directly with him. Not only do these jobbers afford facilities to the retail purchaser, but they are a positive convenience to the producer; for they at once secure him a market for his wares, bringing them to the direct notice of buyers that never would have found his factory unless at an expense of advertising or canvassing that would be fatal to the profits of the enterprise. It also simplifies his transactions, for the jobber will take his productions *en masse* at a single sale, while, if dribbled out to retailers from Maine to Mexico, the vexations and perplexities of overseeing such widely scattered special business would be ruinous to it. Small buyers are prone to imagine that if they can only get access to the makers of goods—can buy of "first hands" as they call it—they obtain great advantages. These ideas are erroneous. In tho first place the manufacturer does not wish to bother with small sales, and for this reason he gives the jobber a discount sufficient to pay him for the risk he takes in distributing the goods over the country, and the risk of bad debts. The retailer only buys by the dozen, the jobber by the gross; consequently the manufacturer prefers to give his products to the jobber at a slightly reduced figure, in consideration of prompt pay and in sums that permit him to re-invest in further production. Tho time lost by retail buyers in running about, from Providence to Newark, to pick up a little stock at "first hands," is penny wisdom and pound foolishness. Only when large quantities of a special article are required will this be found profitable.

There are this month no particular changes that require especial remark for the guidance of distant buyers; in fact, the inauguration of a wide-spread system of commercial travelling has, within the past few years, revolutionized, not only the jewelry trade, but all departments of commodity exchanges. Recent legal decisions, endorsing fully the point raised, that local taxation levied upon commercial travellers, discriminating in favor of local dealers, was a violation of the Constitution, will probably greatly increase the usefulness of a commercial system which is the result of constantly increasing facilities for intercommunication, and which is a greater convenience to buyers than to sellers;

the buyers having the advantage of selection at their own doors, and the opportunity of a critical comparison of prices and qualities of one traveller with those of another, and thus accepting the best; also the endless panorama of goods constantly brought to his notice, keeps him better posted upon styles than he could possibly be by "semi-occasional" visits to centres of trade. He also avoids, or may avoid, accumulating a large quantity of bad stock, by buying often and but little. If the country trade would also add another aphorism to their business mottoes—"to pay often if but little," the jobbers' hearts and ledgers would be lightened. In corroboration of this assertion, one asserted only yesterday that their books showed *open accounts over due* of more than $100,000, aside from notes and acceptances past due. These accounts were scattered all over the country, and a large part of them in small sums. The backwardness of spring trade, in consequence of unseasonable weather, in part excuses this tardiness on the part of debtors, but if each one of them would send on only a few dollars, and often, on account, it would largely benefit both parties by keeping alive that confidence which alone binds together commercial interests. That unfortunate debtor who is in a "tight place," would *never* be crushed to the wall by the creditor who was every few days in receipt of a letter saying: "I enclose you five dollars on account, and will send you another the very moment I can get it." By these *littles* the jobber would be sustained, the confidence in the integrity of the debtor maintained, and the wheels of business roll smoothly along. In addition to which, the consciousness of the debtor that his liabilities were being gradually reduced, and his credit as certainly strengthened, would give him increased energy in the prosecution of his business; while the habit of constantly remitting small sums, would as surely result in the practice of economy in expenditure.

The general prospects for trade are in every particular encouraging, and although collections are slow, the mass of the trade were never in a more safe condition. The absorbing topic among the watch trade here for the past few months has been the "Great Geneva Watch Company," which has, Barnum like, managed to get itself thoroughly advertised by the Court and by the public journals, and has profited rather than been damaged by the injudicious attacks made upon it by respectable houses, who ought to have remembered that such a heap of filthy straw, when lighted, will make only a loathsome stench if let alone, but if kicked about by a timid spectator, lest it "set something afire," springs suddenly into a cheerful blaze. This "great sale" was one of those transactions which depend wholly upon the gullibility of the public for its success. There is, and always will be, it is feared, a goodly percentage of what Lord Dundreary calls "asses," in the community, who will always bite at a hook if covered with red flannel; and the faster they are caught, and the more of them, the better. Legitimate trade everywhere is annoyed by this class, who will not believe what an honest tradesman says, but will swallow the largest humbug, and then, when their throats are excoriated by it, abuse *all* dealers as swindlers. The facts are that the goods were imported by well-known dealers to sell to the trade, but the trade would not buy them; so a "sensationalist," whose operations some of our Western subscribers yet feel the "tingle" of, was called into consultation, and a short incubation hatched out the "Failure of the great Geneva Watch Company." The importers reasonably expected to find plenty of "Toodles" ever on the alert in search of "bargains." Had the affair not been brought into public notice by the attempts of reputable dealers to rescue some of their own goods from such bad company, where the swindlers had placed them as a "leaven to the whole lump," no great harm would have been done. The worthless goods would have realized good prices from parties who are always ready to be cheated, and who could have blamed no one but themselves for believing the silly advertisements of unknown and irresponsible persons. That such humbugs ever seriously damage honest traffic is doubtful. They slowly but surely convince sensible people that if reliable goods are wanted, they must be bought of reliable dealers, who understand their business so well that they cannot be deceived themselves, and are so honest as to have no desire to deceive others. The surest way to kill out such enterprises, wherever started, is to let them alone with rigorous severity.

Ezra Kelley,

Whose name is as familiar to watchmakers all the world over as is that of Morse to telegraphers, called upon us to wish the Journal God-speed. He is a cordial, robust, white-haired gentleman of the old school, and looks likely to outlive another generation of modern effeminates. Originally a clockmaker of the English style, Yankee clock-making wrecked him, as he expressed it, and he took to fishing for porpoises and black-fish, shrewdly judging that it would take a "power of oil" to keep the machine-made clocks all going. A man of thorough integrity as a mechanic, he was equally so in his new vocation, and his success in producing a superior watch oil is due to his indefatigable industry in preparing, with his own hands, and from the most carefully selected stock, the bulk of the oil which has been sold during the past forty years. His personal experiences in the prosecution of this business are full of interest, and he *almost* promised to give the readers of the Journal some facts connected with its development. They would be a valuable contribution to horological literature.

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Friction on Balance Pivots.

Ed. Horological Journal:

I have been watching with considerable attention the progress of the controversy on friction at present going on in the columns of the Journal; and I know that quite a lively interest has been awakened in the minds of many of its readers on this subject. The suggestion made by "B. F. H." to shorten the length of the bearing surfaces of balance pivots, for the purpose of reducing the effects of friction on the circumference of the pivots to an equality with the friction on their ends, when the watch is placed in various positions, is not an original idea, but has been practised by others; consequently he is not to be blamed for the suggestion, if any blame can be attached to it. Substantially the same system of adjusting watches to position is recommended by "Horologist," page 107, second volume of the Journal, and is based upon the supposition that balance pivots and their bearings may be so constructed that the balance will vibrate the same distance precisely, in whatever position the watch may be placed; and these two gentlemen have evidently the same views on the subject of friction, and the laws that govern it.

The idea that friction is not caused by the extent of the bearing surfaces, but by the amount of pressure upon them, is no new discovery; and however impossible it may seem at first sight, it is by no means such a wild doctrine as one at first is apt to suppose, and is the opinion generally held by the best mechanical thinkers. In all large institutes for technical education there are apparatus which prove the doctrine beyond all reasonable doubt; and in the April number I see a description of such apparatus in the "Reminiscences of an Apprentice." The experiments with bricks, mentioned in previous numbers, are imperfect illustrations of laws which may be verified in any workshop where there are two lathes of the same size; the one lathe having the heads resting on V-shaped projections on its bed, and the other having its heads resting on a flat bearing, the whole breadth of the lathe bed. In ordinary every-day use, the head resting on the narrow bearings will generally move easier, because, the bearing surfaces being narrower, dirt is less liable to collect on them than on the broad bed; but if the heads of both lathes be the same weight, and all the bearings thoroughly clean and equal in point of smoothness, the head resting on the broad bearing will be found to move just as easily as the narrow one.

The same laws that govern the example of friction just given, also hold good in the kind of friction produced by the action of pivots. The *friction* on the circumference or the ends of the pivots of a wheel, is proportional to the weight of the wheel and its arbor, and the force of the pressure that bears upon them, and within moderate limits, without regard to the length of the bearings of the pivots, providing the points of contact be in all cases equally smooth and regular; and the *retarding effects* of friction is, in all cases, proportional to the distance the friction is from the centre of motion. It becomes a very difficult matter to practically demonstrate this theory on the pivots of a watch balance, because their reciprocating motion is materially affected by the condition of the balance spring; and to reach the true practical results of long and short bearings on pivots, we must leave the balance spring out of the experiment and test the theory on a train of wheels having a continuous motion. This may be readily effected on a large scale by means of an old Yankee clock. If we turn the pivots of the striking part true and straight, and make the holes smooth and straight, and put the wheels in their places between the frames without the hammer, it will be found that the fly will make a certain number of revolutions in a given time with a weight of a given size; and that these revolutions will not be increased in number by countersinking the holes and making the bearings of the pivots shorter than they were originally. The same experiment may be tried in a more delicate manner by taking an old watch, without the escapement. If a little fly be attached to the scape wheel arbor, and the experiment conducted as above, the results obtained will be found to be the same in both cases; and if the bearings be very short in proportion to the pressure that bears upon them, the revolutions will be positively fewer with the short bearings than with the original ones, because the oil is pressed out, and the surfaces in contact become abraded.

A number of years ago I was constructing a train of wheels that were to have a continuous motion controlled by a conical pendulum. The train of wheels were as accurately made as I could make them, but when the work was completed, and the machine set in motion, the conical pendulum did not revolve in so large an angle as was desired. As the motive power could not be conveniently increased, I concluded to try the experiment of shortening the bearings of the pivots, expecting to get the wheels to move easier, and thereby produce greater force on the conical pendulum and make it revolve in a larger angle. I was particularly careful to have everything clean, and no burr was left anywhere on the pivots or pivot holes; but, to my utter astonishment, the results produced were precisely the reverse of what I had calculated upon; and this circumstance first led me to inquire into those laws that are known to govern friction.

Having given a few examples of the practical effect of friction on long and short bearings on the circumference of a pivot, I will now consider the effects produced by friction in proportion to the distance it is from the centre of motion; and this part of the subject is too plain to require much illustration. If we wish to stop a lathe that is running at a high speed, we can do it more effectively by pressing on the pulley than by using the same amount of pressure on the spindle. If we place a plain watch balance in a pair of truing callipers, and spin the balance round, we can easily stop its motion by applying a little pressure on the circumference; but the same amount of pressure applied against the balance staff would scarcely affect its motion, which shows that, while pressure on a revolving body is comparatively little felt at the centre of motion, its effects are magnified in proportion to the distance it is applied from that centre.

How easy it is for even some of our prominent writers on watch work to overlook some of the most simple laws that govern friction, is exemplified in tbe 103d paragraph of Mr. Grossmann's essay on a mechanically perfect watch. In this paragraph the author discusses the neccessity for using end bearings to certain pivots. He admits the established law in mechanics, that, the pressure being the same, the amount of friction is not altered by the extent of the bearing surfaces; and, referring to the friction on the shoulders of pivots working against the frames, as compared with the friction of the point of the pivot on an end bearing, he remarks that "the resistance to the motion of the cap jewelled pivot can only be easier as the ratio of the difference of the bearing surfaces, and this difference between the surfaces of the pivot end and that of a properly reduced shoulder is a trifling one." Although the superficial surface of the shoulder of the pivot be only a little larger, or even the same size as the point of the pivot, it is a mistake to argue in this instance that the friction is the same in both cases; for, although the surface of the shoulder of the pivot be reduced to its smallest limit, still this surface, being farther away from the centre of motion, retards the revolutions of the wheel to a much greater extent than when the friction is on the point of the pivot, and nearer to the centre of motion, where it is comparatively harmless.

If a wheel be resting on the end of a pivot having a very sharp point, it will move with greater freedom in this condition than in any other position in which it can be placed, because the entire weight of the wheel is pressing near to the centre of motion. If the end of the pivot be rounded, a little extra force will be necessary to move the wheel, because the pressure is a little further from the centre of motion. If the end of the pivot be made perfectly flat, and if it be resting on a bearing also perfectly flat, it will take about two-thirds of the force to move it when in this condition than if it rested on the circumference of the pivots, because the end bearing surfaces being entirely flat, the pressure is distributed over their entire surface; and the friction being thereby distributed from the outside circumference to the centre, its retarding effects have been practically tested in large work to be only two-thirds of the same friction on the outside circumference of the pivots. If the end of the pivot be hollowed out so that only a very thin ring at the outside edge rests on the flat end bearing, the nearest approximation that can be obtained in equalizing the amount of force necessary to move a wheel resting on the circumference and on the end of the pivot, is obtained; because, in both cases, the friction is as nearly at the same distance from the centre of motion as can be reached. The practical application of this plan is, however, attended with various difficulties.

I have already mentioned that the friction on a pivot increases or diminishes according as the pressure upon it is distant from the centre of motion. For this reason a small pivot has less friction, and moves easier than a larger one, simply because the pressure upon it is nearer to the centre of motion than the larger one. "Horologist," and also "B. F. H.," favor the idea that a pivot of a large size has more friction than a smaller one, because the larger one has a larger surface in contact, and consequently it must have more friction; but if there be greater surfaces in contact it is of no practical consequence, for I have already stated how any person can easily prove to their own satisfaction that friction is wholly independent of the extent of the surfaces in contact.

We must not lose sight of these well established laws on the subject of friction when we seek to improve our fine watches and clocks. With all respect for those who have stated differently, I believe it to be a mechanical impossibility to construct the pivots and bearings of a balance so that the balance, without the spring being attached, will make the same number of revolutions, with the same amount of force applied, when placed in various positions; for, while the amount of friction is the same in all positions the balance can be placed in, still the retarding effects of the friction vary as the balance rests on surfaces further or nearer to the centre of motion.

The great difference that exists in the various methods recommended for adjusting watches to position, proves that among a large number of workmen the whole question is treated as a kind of jugglery or legerdemain that cannot be accounted for by natural laws. One class correct the error by introducing another error, and throwing the balance out of poise. Another class of workmen throw the spring out of the centre to create greater pressure and friction on the pivots at particular places; and another class propose to cure or correct all errors of position through the means of the balance pivots and their bearings. I believe the laws that govern all the motions of a watch can be defined and understood, so that we can determine what will be the result of every manipulation previous to putting it into practice. I am of the impression that the great correcting and controlling power in a watch lies nearly wholly in the balance spring; and perhaps the forthcoming Burdett Coutts Prize Essay will diffuse some light on the matter.

N. Y. City. DYNAMICS.

Experiment in Friction.

ED. HOROLOGICAL JOURNAL:

I take the liberty of sending you the result of a little experiment, illustrating one of the many principles of friction. I used the tail-stock of my Swiss universal lathe. The mandrel is steel, 0.35 inch diameter and rubs $2\frac{5}{8}$ inches in length in its brass bearing. The fitting is perfect. In fact, no work could be better. Still it does not bind in any part of the whole bearing, for by elevating or depressing the tail-stock 12° from the horizontal, the weight of the mandrel slides it in or out. I fitted a $1\frac{3}{4}$ inch pulley to the mandrel and passed a silk thread around it; 90 grains attached to the thread would just start the mandrel turning. I then fitted a bearing of Babbit metal, $2\frac{5}{8}$ inches long, to the same mandrel, and cut away the upper half, leaving a close free bearing in the lower section; 60 grains, in this case, would scarcely turn the mandrel. Finally I fitted the same mandrel to two very thin brass holes set 2⅝ inches apart. Upon these bearings, 24 grains turned the mandrel very easily. Comment upon the above facts would be superfluous. The experiment can be easily tried by any watchmaker, with, I venture to say, similar results.

B. F. H.

Sag Harbor.

New Inventions.

Reversible Centre Pinion.—*J. V. Mathivet, Cleveland, O.*—This invention consists of a thin steel disk, riveted on the lower end of a loose pinion, the pinion secured on the smooth arbor of the centre wheel by a collar driven on the arbor above it. The periphery of the steel disk has slight radial cuts, equal in number to the arms of the centre wheel; one adjacent edge of each cut is bent down so as to abut against the edge of the arm, when forced in the direction to carry the watch, but when turned in the opposite direction, the elasticity of the disk allows the bent-down parts, or ratchet teeth, to freely slip over the arms. By this means free rotation is allowed in one direction, and in the other it is rigidly held against the wheel-arms.

Improvement in Jewelry Fastenings.—*Robt. J. Pond, N. Y., assigned to Hodenpyl, Tunnison & Co., N. Y.*—A new snap-lock for use on gold chains, bracelets, amulets, and similar articles of jewelry. It consists in making the snap a spring of one continuous piece, enclosed in a tube with a knob to unlock the same.

Improvement in Ear-Rings.—*L. L. Northup, Olneyville, R. I.*—A lobe attachment by which the ear-ring is more securely fastened.

Electro-Pneumatic Burglar Alarm.—*Duncan & Rowell, Lebanon, N. H.*—Assigned to the Safe Protection Co., N. Y. This invention is for the purpose of giving an efficient alarm whenever an attempt is made to enter the safe to which it is attached. See page 246.

Lathe Chuck.—*A. H. Wagner, Prairie City.*—This is in the form of two jaws closed by a thumb screw, like a pin-vise, and thrown apart by a spiral spring between the jaws and around the screw. To move the jaws out simultaneously, the joint of each jaw is a toothed segment depthing into each other so that the movement of one necessitates a corresponding motion in the other.

Improvement in Main-Spring Adjustment for Watches.—*I. S. Texis & H. B. James, Trenton, N. J.*—It consists in connecting the outer end of the main-spring by means of a link to a stud on the face of the barrel between its centre and periphery, for the purpose of reducing the leverage upon the barrel during the first and second turns of winding. Also a stop for the prevention of over-winding.

Answers to Correspondents.

J. B., *Vincennes, Ind.*—Your question, as to "the superiority of the straight line over the right-angle escapement," cannot be better answered, nor on higher authority, than by quoting Mr. Grossman: "The right angle is the usual plan resorted to in all English, and in the lower grade of Swiss watches. The line from the wheel to the pallet centre makes a right angle, or nearly so, to the line from the centre of the pallet to the balance centre. The Swiss manufacturers make their better qualities of lever watches straight-line escapement. It might appear almost superfluous to state that the performance of the escapement in either of these two arrangements, or in any other angle, is entirely the same, because, as has been previously shown, the two actions of the lever escapement are perfectly independent mechanisms, and their nature cannot be altered by placing them to perform in any respective angularity to each other. Therefore it is quite unjustifiable to consider a straight-line escapement as an indispensable attribute of a first-rate lever watch.

"The escapement at right angles allows a greater economy of space in the watch, and is therefore very appropriate for fusee watches. The straight-line escapement, especially in three-quarter plate watches, makes a better display of the acting parts and visible pallets, by this arrangement. The action, in both cases, is the same, if properly made, and if not, one is as bad as the other. The whole difference lies in the effect on the eye, and it cannot be denied that a well made lever escapement, with visible jewels, is a very good looking thing, although the covered jewels, in point of solidity, are superior, because they can be fixed more firmly; the rough surfaces allowing of more efficient fastening."

It may be said further in favor of the right-angle escapement, that it permits more defects of construction without positively rendering the watch worthless, than the straight line. It is certain that the good or ill performance of a lever escapement depends much upon the correctness of the fork and roller actions, and that these actions, to be practically correct, must be confined within a very narrow range of error, as they involve three important functions of the lever escapement, namely: locking and unlocking, transmission of impulse, and the safety action. Any carelessness in the correct fitting of the pivots and holes of the pallet arbor will more directly affect the condition of the fork and lever actions than in the right-angled escapement. In other words, a side escapement will go when constructed in a manner so careless as to be fatal to the performance of a straight line; and a right-angle escapement, equally well made, is in no respect inferior to it in performance.

T. D. C., *Denver*, *Col.*—We must refer you to previous articles in the Journal for "full directions for soldering." The subject has been treated of in connection with the blow-pipe, metals, metallic alloys, and in various communications from correspondents, etc., but it may serve your purpose if we repeat what has been said elsewhere, that "the operation of soldering is the union of two metallic surfaces by the interposition of another of a little less fusibility." It is essential to keep the adjacent surfaces clean and bright, so that the solder will adhere freely when in a melted condition. For the purpose of protecting these metallic surfaces from the oxidizing influence of the atmosphere, certain fusible substances are applied with the solder, which immediately form a layer on the surface of the metal. These substances (called flux) should also have a reducing action as well as protecting. In practice, it is to secure these essential conditions that the substances commonly used are employed. For soft solder, which is melted without the blow-pipe, resin, turpentine, oil, tallow, powdered sal ammoniac, or a concentrated solution of chloride of zinc. For solders so infusible as to require the use of the blow-pipe, borax, or a melted mixture of borax, potash, and common salt, and in the especial case of iron, pounded glass, are the ordinary fluxes. These substances fulfil, to a greater or less extent, the requisite conditions of soldering, deoxidation, and protection of the metal from the atmosphere. Any substance possessing these two qualifications in the highest degree will, of course, be the best to effect this purpose.

As the result of a great number of experiments, ordinary commercial cyanide of potassium has decided advantages over other substances. It melts very readily, and covers the surfaces with a very efficient protective coating. At the same time, it is known to exert a very strong reducing action, a property which has gained for it many useful applications, both technical and analytical. One of its greatest merits is in its application to such surfaces as cannot readily be perfectly cleaned, and consequently cannot be soldered when the articles will not permit a temperature high enough to reduce the oxidation. It is in this respect that the cyanide, by its energetic action, deoxidizes all rusty particles standing in the way of a perfect union of the parts. The mode of applying cyanide in soldering, is to keep it powdered, ready at hand, in a well stopped bottle, and sprinkle a little over the moistened parts, the same as with powdered borax. In some cases a mixture of borax and cyanide is used, one increasing the reducing power, and the other diminishing the tendency to volatilize. One other consideration of some value is, that there is no tendency to rust, as with some other fluxes.

S. B. E., *Mt. Carrol*, *Ill.*—To poise the balance correctly it should be done in its working condition—roller and hair-spring both in place. Some have even gone so far as to say that in very nice adjudstments even the weight of the hair-spring, *when pinned in its place*, may make a difference in its rate between vertical and horizontal positions, and to obviate it they attempt to give the hair-spring just sufficient *set* to sustain that weight when the watch is in its usual position, stem up. This is a theoretical refinement which the hand is rarely capable of executing. The roller and spring, and collet, as a whole, or each separately, are sensibly ponderable, and consequently whatever want of poise either possesses, has its influence upon a general poise of the balance to which they are attached. The effect of a weight eccentric to the centre of revolution is augmented as its distance from the centre increases; consequently the larger the diameter of the collet and roller, the more care will be required to see that the whole is well poised; and in case the hair-spring collet has considerable diameter, and the cut through it is wide, shifting the hair-spring forward or back *might* alter the poise of the balance slightly. Where such conditions exist, it is well to test the balance as a last thing after the length of spring required for mean time is ascertained.

N. C., *Ala.*—You will find the following an excellent compound for case-hardening, and if the article is small, it will be converted into steel through and through: Take equal parts of Prussiate of potash, common salt, and sal-ammoniac; pulverize thoroughly together in a mortar. In using, heat the article to a dull red and roll it in the compound, when it will become covered with a film. Heat again to a hardening red and plunge into clean water. Some workmen prefer to quench the article in a solution of 4 oz. sal-ammoniac, 2 oz. potash in 1 gallon of water.

G. A. M., *Mass.*—The Fusible Metallic Cement, patented by Barnabas Wood, is an alloy possessing great fusibility, with the requisite tenacity for solder. It consists of the following proportions:

Cadmium	1 or 2 parts.
Lead	2 "
Tin	4 "

Prepared in the usual manner of soft solder, and applied in the same way. It melts at 300°, being 50° or 60° below the melting point of the most fusible mixture of tin and lead.

AMERICAN HOROLOGICAL JOURNAL,

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EQUATION OF TIME TABLE.

GREENWICH MEAN TIME.

For May, 1872.

Day of the Week.	Day of Mon.	Sidereal Time of the Semi-diameter Passing the Meridian.	Equation of Time to be subtracted from Apparent Time.	Diff. for One Hour.	Sidereal Time or Right Ascension of Mean Sun.
		S.	M. S.	S.	H. M. S.
Wednesday	1	66.09	3 6.01	0.302	2 38 52.82
Thursday	2	66.17	3 12.99	0.279	2 42 49.37
Friday	3	66.25	3 19 41	0.255	2 46 45.93
Saturday	4	66.33	3 25.26	0.231	2 50 42.49
Sunday	5	66 41	3 30.54	0.207	2 54 39.04
Monday	6	66.49	3 35.24	0.183	2 58 35.60
Tuesday	7	66.57	3 39 37	0.159	3 2 32.15
Wednesday	8	66.64	3 42 93	0.136	3 6 28.71
Thursday	9	66.74	3 45.93	0.112	3 10 25.26
Friday	10	66.82	3 48 36	0.089	3 14 21.82
Saturday	11	66.90	3 50 22	0.065	3 18 18.38
Sunday	12	66.99	3 51.51	0.042	3 22 14.93
Monday	13	67.07	3 52.25	0.019	3 26 11 49
Tuesday	14	67.15	3 52.43	0.004	3 30 8.05
Wednesday	15	67.23	3 52.05	0.030	3 34 4.60
Thursday	16	67.32	3 51.11	0.051	3 38 1.15
Friday	17	67 40	3 49.64	0.073	3 41 57.71
Saturday	18	67.48	3 47 63	0.095	3 45 54.27
Sunday	19	67.56	3 45.09	0 118	3 49 50.83
Monday	20	67.64	3 42 09	0.140	3 53 47.39
Tuesday	21	67.72	3 38.39	0 162	3 57 43 94
Wednesday	22	67.79	3 34 24	0.183	4 1 40.50
Thursday	23	67.86	3 29.57	0.205	4 5 37.06
Friday	24	67.93	3 24.37	0.228	4 9 33.61
Saturday	25	68 00	3 18 67	0 249	4 13 30.17
Sunday	26	68.07	3 12 46	0 270	4 17 26.73
Monday	27	68.15	3 5 76	0.290	4 21 23.28
Tuesday	28	68 21	2 58 58	0.310	4 25 19.84
Wednesday	29	68.27	2 50.93	0.329	4 29 16.40
Thursday	30	68.33	2 42.82	0 348	4 33 12.96
Friday	31	68 39	2 34.25	0.366	4 37 9.51

Mean time of the Semidiameter passing may be found by sub tracting 0.18s. from the sidereal time.

The Semidiameter for mean noon may be assumed the same as that for apparent noon.

PHASES OF THE MOON.

		D.	H.	M.
☻	New Moon	7	1	18.9
☽	First Quarter	15	4	5.4
☺	Full Moon	22	11	8.6
☾	Last Quarter	29	2	12 9

		D.	H.
☾	Perigee	12	12 2
☾	Apogee	24	10.8

Latitude of Harvard Observatory .... 42° 22′ 48″.1

	H.	M.	S.
Long. Harvard Observatory	4	44	29.05
New York City Hall	4	56	0.15
Savannah Exchange	5	24	20.572
Hudson, Ohio	5	25	43.20
Cincinnati Observatory	5	37	58.062
Point Conception	8	1	42.64

	D.	APPARENT R. ASCENSION. H. M. S.	APPARENT DECLINATION. ° ′ ″	MERID. PASSAGE. H. M.
Venus	1	1 20 18.88	+6 48 16.4	22 42.0
Jupiter	1	7 40 7.67	+21 59 26.4	5 0.6
Saturn	1	19 31 47.57	—21 28 26.4	16 50.1

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CONTENTS.

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Close of the Third Volume.

The present number completes the third volume of the American Horological Journal. That it has fulfilled the promises made at its commencement, is shown by the letters of approval and encouragement daily received from old and new subscribers. These commendations from wide-awake practical men all over the country prove the existence of a general desire for a trade paper of the character it has endeavored to maintain.

We have been nobly sustained thus far by valuable contributions and communications, from both practical and theoretical mechanicians of the highest order, and here take occasion to acknowledge the indebtedness; and also to say that there are thousands of others whose experience in various departments of the art, if contributed to the Journal, would be highly appreciated, not alone by us, but by all who have learned to look to it as a source of supply for valuable information.

The success attendant upon the reduction of the price of the present volume has fully realized the expectations of the publisher, and gives reasonable assurance that the subscription list for the fourth volume will be largely increased over the present number, thus multiplying the number of readers, and affording advertisers a vehicle for reaching the largest possible number of the trade, and bringing to the notice of distant buyers the location and business of reliable jobbers whose names would otherwise never have been known to them.

Since the advent of the American Horological Journal there have sprung up several other papers of a kindred class, although none have ventured upon assuming both the scientific and practical character which it has maintained from the first. They each subserve the purposes of their originators, and help to foster the very general interest which seems to have been awakened among the trade on horological subjects. The introduction of machinery in the manufacture of watches has greatly stimulated the inventive faculty of the trade ; the general acceptance of the fact that this class of fine work can be performed mechanically, has incited a general train of thought toward improvement in tools, and the invention of new ones for performing operations which formerly depended on dexterity.

Scarcely a week passes that does not bring to notice some new tool or machine, developed by the advanced condition of the trade, which shows clearly that progress has been made, and that methods and means heretofore thought good enough, are rapidly yielding to these advancements. For this public sentiment the American Horological Journal claims a large share of credit, as being the pioneer in this direction; it also hopes, in the "good time coming," to be fully up with, if not ahead of, trade progress, and to maintain the high position it now holds among Horologists.

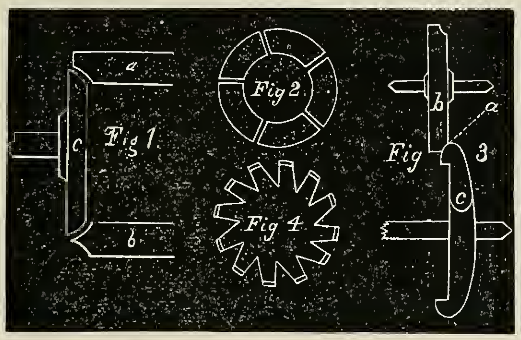
Wheel Cutting.

From the earliest period of mechanical constructions, to the present time, constantly increasing attention and careful study has been bestowed upon the proper forms of wheel teeth to transmit motive force with the least possible loss to the point where it is to be used or expended. Latterly this question has claimed a large share of theoretical investigation, and the highest mathematical talent has given theorems to practical men from which they can construct suitable curves for wheel teeth for any specific purpose desired. Arguments and demonstrations relating to this subject have occupied a good share of space in the Journal since its commencement, and it is hoped with profit to those whose opportunities for theoretical instruction in principles of construction have been limited. These disscussions cannot fail to give them hints as to the reasons why there are such diversified results from trains apparently identical, and show them also the necessity of a careful examination of depthings, and the proportions between the size of wheels and pinions. A diffusion of knowledge in these respects will be almost sure to save many movements from the hard usage they formerly received from persons who were searching blindly for unknown difficulties.

In giving, from time to time, an idea of the processes in modern watch factories, the limited space and a want of elaborate drawings will permit scarcely more than a simple announcement of the principles upon which the operations are performed. To attempt a full explanation of any one of the beautiful machines employed in making the simplest part of a watch movement, so that it could be comprehended by one who has not seen their operation, would require at least a whole number of the Journal. The sketches given must not be supposed an attempt at giving a view of the machines themselves (which would be down right slander upon them), but only an illustration of the *principles* upon which they work. It is but an act of justice here to express the many obligations we are under to the subordinates as well as the principals of the United States Watch Factory, at Marion, for the unwearied courtesy with which they have cheerfully answered the thousand and one questions in regard to the operations in their various departments. Although details differ in the different factories, the principles involved in the mechanical construction are almost identical. As in every other branch of competitive industry, each claims superiority in various respects, and the decision upon these claims must rest with the public upon trial of the various productions.

In the formation of wheels and pinions, the proportions their diameters bear to each other, and the number of teeth and spaces into which each respectively are divided, must determine the peculiar form which it is desired to give the acting face of each tooth. On a large scale, no difficulty is experienced in drawing the proper epicycloidal curve; the difficult problem is to transfer this large curve to the small tooth of the wheel and pinion. The principle involved in this transfer is the same as in those lathes used for turning irregular forms, where, by a change of proportions in the acting parts, a small shoe last can be made the exact duplicate in form of the large model which governs the motion of the cutting tool. On this principle a small grinding lap is made with an epicycloidal edge or corner, which is a miniature copy of the large drawing, and each sized wheel must have a hardened steel outlined form made suitable for the curve of that particular wheel tooth. These forms determine the shape of each grinding lap, and each lap gives definite shape to the tool that cuts the spaces between the teeth.

Figure 1 will illustrate the principle of action, but of course gives no idea of the complicated arrangements which are necessary in order to produce a cutter positively free from striæ, and with a perfect cutting edge. *c* is a revolving soft steel lap, the corner of which is a duplicate of the adopted curve, and charged with diamond dust; *a*, the piece of hardened steel which is to be ground into a cutter, is made to approach the lap in a positive position, which grinds in it a female curve coincident with the male of the lap; *b* is the same piece transferred to the opposite side of the lap, which forms the other half. The proper under-cut to give clearance to the cutter is determined by the position in which it is brought to the lap in reference to the circle of revolution. This cutting tool, which has required so much philosophical study and mechanical skill to produce, seems an insignificant little bit of steel to make such a fuss about; but really it requires more thorough knowledge to produce it, than many persons, who buy and sell watches, think is required to construct the entire machinery of a watch factory. The cutter is secured in, and projects from, the side of a small mandrel, which is rapidly revolved, and under it slide the blanks to be cut. These wheel blanks are punched, and the arms crossed out by means too well known to need description. The mandrel upon which the blanks are strung for cutting is peculiar, being a hollow arbor, very firm and massive, except the part upon which the blanks are placed, which is turned down to the size of the *interior* diameter of the web of the wheel; and to allow the blanks to slip on, this hollow tube is cut by five longitudinal slits, each wide enough to permit the arm of the wheel

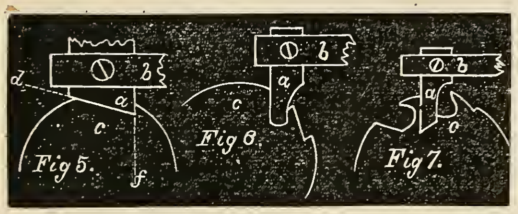


blank to pass into it. Fig. 2 shows an end view of this mandrel, and fifty or a hundred blanks, as the case may be, are slipped into, or upon this, forming, when secured in place, a solid stack. As will be seen, there is not the slightest opportunity for them to slip or become misplaced when being cut, as they are centred by the inside circle of the web, and held by the arms resting in the slits. Upon the opposite end of this mandrel is now fastened the dividing disk, which is of steel, about four inches in diameter, with divisions corresponding to the number of teeth required in the wheel, cut sharply across its edge, and into which a stop fits, keeping the arbor and its contained stack of blanks rigidly in position upon the sliding bed, which travels longitudinally under the revolving fly cutters. After the teeth are cut, the circumference of their points have whatever circular truth the revolution of the mandrel gives them, and the utmost care is taken that this shall be a perfect circle. They are then centred for drilling and opening the hole for the pinion or arbor by this outside periphery. Going barrels are centred for cutting by a small hole through their centre, which is afterward opened to the required size for the arbor in the same manner as the others.

Pinion cutters, unlike wheel cutters, are circular, and are slit radially, to give cutting faces. The turning tool which is used to make them, has its form produced in the same manner as the grinding lap for the single cutters. Fig. 3 is a diametric section; a notch *c* being cut into the periphery, allows it to be perpetually sharpened so as always to preserve the perfect epicycloidal foım as a cutting edge; *b* is a steel disk, which is to be given the proper form for a pinion cutter. If, while rapidly revolving on its own arbor, the cutting edge *a* is brought up to it, one side will be cut away to correspond with the shape of the cutter; now change the position, and bring the other face of the disk to the cutting tool, and there will be produced a male form which exactly fills the space between two leaves of a pinion. Being now notched to give cutting faces and clearance, the pinion cutter is ready for use. Various mechanical appliances are resorted to for producing eccentric motions in all stages of the process of grinding, in order to prevent the possible coincidence of lines or scratches that might give to the cutting edges other than a perfect line. These preparations of tools involve an amount of labor and skill unappreciated by those who only see the productions. All the wheels, with the exception of the escape wheel, are cut by the same processes by simply changing the cutters and the division plates to their respective shapes and numbers.

The escape wheel cutting engine is one of the most carefully constructed machines in the watch factory. Five fly-cutters are carried by five separate spindles, supported horizontally, and arranged around the circumference of a drum or cylinder, which has also a revolution on its own axis, with stops which fix it in place when any one of the cutters is in working position. By a mechanical arrangement, only the cutter revolves which is in the position for the wheel blanks to be slid under it—the others remaining idle until, by revolving the head that carries them, they are brought to a cutting position.

The stack of wheel blanks is placed upon one end of a split arbor, similar to that for other wheels, with the division plate upon the other end. There are three steel cutters for roughing out, and two sapphire cutters for finishing. The first cut is made by a steel cutter, in the shape represented at *a*, Fig. 5; *b* is the mandrel in which the cutter is secured; *c*, the wheel blank; the line *d* being the impulse plane of the tooth, and *f* the rear of the tooth. Fig. 6 shows the form of the second cut, which gives the under cut of the club, and the rear curved back. Fig.



7 gives the form of the third cut, which completes the tooth, giving the proper angle to the impulse and repose planes. For giving the final finish to these two planes, sapphire cutters are used, ground with the greatest care to the calculated angles, leaving the surfaces exquisitely finished.

The wheel is now complete, except centring and opening the hole for the pinion. This, of course, is an operation of the greatest delicacy, as the least want of truth in this respect would be fatal to correct action in the escapement. The centring is done by putting the wheel in a little lathe for this especial purpose, the split chuck which grasps the wheel by its periphery being centred with the utmost care, and its truth ascertained by careful trial with a tester. This is a little instrument so constructed as to magnify any slight eccentricity to a visible quantity. It usually consists of a small metal sphere which has run through its centre a steel wire, one end projecting only a short distance beyond the surface of the ball, and the other end extending from it to the distance of from six to twelve inches, as the intended delicacy requires. This ball is hung in a ring, with gimbals, like a mariner's compass, and the whole supported upon an upright column, adjustable to height by a set screw. This arrangement allows the sphere a free motion in any direction, and a very small amount given to the short end of the wire index is magnified by the long end in proportion to their respective lengths. To test the truth of the chuck, a disk of brass, the size of the escape wheel, is turned perfectly true, and placed in the jaws. It is then centred by the point of the graver, and the short end of the tester index adjusted to this centre dot; and if, on rotating the lathe, no motion is detected in the long end, it is assumed to be true. The disk is now released and moved a quarter or a half about, and tried again. If it shows eccentricity by the long end of the index describing a small circle, the chuck is not true, and the workman puts a new bush in the jaws of it and turns it up again, and repeats the trials until its perfect truth is established. The escape wheel may now be trusted to this chuck, with a reasonable certainty that the hole drilled through the centre will be absolutely concentric with the outer points of the teeth.

The utmost care is required in grinding the single cutters to proper angle for forming the escape wheel teeth. This is done after they are hardened, and upon laps charged with diamond dust, the same as the sapphire cutters are ground. The manner of fixing the stones in the cutting tool may suggest a convenient way of making hand turning tools for the watch repairer's use that will be less expensive than the diamond ones on sale, besides the satisfaction each workman feels in the conscious ability to provide them for himself. The sapphire is only second in hardness to the diamond, and as the stone is much cheaper, especially those which are too light color to be of commercial value as an ornament, it is economical to use it for these mechanical purposes, although they are not so hard and not so durable. It is first cut into strips of length and thickness suitable to form the desired tool; a hole is then drilled in the piece of soft steel intended to carry it, and the sapphire slipped in; small wedges of brass are then made and pushed in, and of such shapes as will fit the stone on one side and the steel on the other. When carefully secured in this way, the whole is filled with soft solder, thus making an easy and yet firm support for the stone. Grinding this tool into shape requires some consideration; the stone itself should only be required to furnish the hard cutting edge, so arranging the shape that this cutting edge shall be *supported* by a backing of steel, that will sustain the requisite pressure—for if the sapphire itself is depended on for strength as well as hardness, it will probably give way and so disappoint the expectations of the workman. It is well to recollect that in the use of stone-cutting tools the stone subserves the same purpose that the *hardened* edge or point of a steel tool does, and no mechanic is so ignorant as not to know he must let down the hardness of all such tools, except at the cutting edge, if he would give strength to the tool. The reason why the sapphire finishing cutter gives such an exquisite polish to the brass wheel is, that it simply transfers its own polish to the metal over which it passes. Were this fact oftener remembered by workmen in preparing various tools for use, a more satisfactory result would often be attained, and with far less labor than is often bestowed upon work. A moment's consideration shows this: a file will give only a surface similar to its own; a hone leaves the face of a tool sharpened upon it covered with grooves which are a transfer of its own coarseness, and the tool transfers these grooves to the cut surface; therefore a tool so fine-grained and hard as to be capable of receiving a *perfect polish*, will transfer that polish to whatever cut it makes.

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Gold-Pen Making.

This industry has had its birth and rapid growth up to its present immense stature within the memory of every middle-aged man, and a prejudice in favor of the quill—the result of its use for centuries—has been rapidly overcome. Professors of penmanship, lawyers, copyists, divines, editors, all cried out that nothing could supplant the quill, but it is now not only ignored, but degraded to a vulgar toothpick. A history of the brief but rapid growth of this manufacture would be of interest, but is foreign to the present purpose. Were this article for a daily paper it would probably read thus: "At the invitation of Messrs. Edward Todd & Co., the enterprising and eminent gold pen manufacturers, we visited their extensive establishment at the corner of First and North Eleventh streets Brooklyn, where we found a crowd of thrifty, intelligent mechanics plying their vocation in a spacious room, well lighted on three sides, the view unobstructed by post or pillar, and filled to repletion with whirling wheels, clanging punches, glowing gas flames, and all the sights and sounds that go to make up the *tout ensemble* of a great factory."

The Horological Journal endeavors to instruct, not amuse; to furnish such descriptions of processes in the finer branches of mechanic art as artisans are always interested in, and in such language as one mechanic would use to make himself fully understood by another. Its readers are widely scattered through the length and breadth of the country, many of them so remote from centres of fine mechanical operations as to be deprived of the satisfaction of witnessing these interesting operations, and yet, are ever eager to know the precise means by which the articles are produced, which they are often called upon to reconstruct.

Reputable makers of gold pens rarely use more than two qualities of stock, 12 and 16 carat. The alloy is prepared with the greatest care, and from absolutely pure metal, which is rendered necessary from the fact that so very much depends upon having a uniform elasticity to the gold. In making ornamental gold goods, color is the first requisite, and quality a secondary consideration; but where elasticity is of vital importance, no pains must be spared to insure that the pens shall always be identical in that respect. If one melt of gold was highly elastic, and the pens made from it were eminent in that respect, and another melt was materially deficient in that quality, such a manufacturer could not, and would not, be relied upon; hence the necessity for great precision in this respect.

The operations of melting and rolling the gold into a ribbon $\frac{1}{32}$ of an inch thick need no description; its width must be just sufficient to allow two rows of blanks to be cut from it with the least possible waste. These blanks are then run under a little milling tool, or burr cutter, which mills out a recess across the point of the blank in which to lay a minute bit of iridium, which is the famous "diamond point" of the gold pen. This metal, which derives its name from the fact that its solutions give all the prismatic colors, is comparatively rare, and was of no commercial or mechanical value until adopted for this purpose. It mostly comes from the platinum ores in Russia, where it occurs in small grains. Its lustre is similar to that of bright steel, and its hardness exceeds that of hardened steel, although samples differ in this respect. It is the most refractory of metals, not being fusible by the oxy-hydrogen blow-pipe, and is not oxidizable. Its market value varies with the supply and demand, and has occasionally reached a price as high as $175.00 per oz.

A dozen or so of these pen blanks are laid upon the flat surface of a piece of charcoal, and the notch in the point moistened with a solution of borax, the selected bit of iridium laid in, and the point of gold melted by a gas flame with the blow-pipe, which fixes it permanently. This is an operation requiring great delicacy of manipulation; for, if the heat is continued an instant too long, the form of the gold is destroyed, or, if too little, the iridium is not firmly attached to the gold. No solder is used by reliable pen makers, the "sweating" process being the one now universally adopted. The good or bad qualities of gold pens depend so eminently upon the quality of the stock and the manner of securing the point upon them, that dealers in them ought, in justice to themselves and honorable manufacturers, to fully explain to their customers the reason why inferior pens are worthless. The mode of manufacture fully shows these reasons; for, if low quality of gold is used, it not only lacks elasticity, but its fusing point is so low that solder of a still lower quality must be used to secure adhesion between the iridium and the gold. All workers in gold know that, in soldering, the most complete union exists between two dissimilar metals when they are both heated as near to the melting point as possible, and the greater the difference in the fusibility the more difficult it becomes to form perfect union. When solder is introduced, only a moderate degree of heat is admissible, and the iridium is not sufficiently heated to "take" the solder thoroughly; the pen, when completed and in the hands of the user, fails to be satisfactory for want of elasticity, or, if that is not objected to, the points are sure to come off upon the slightest provocation; a fall upon the floor, an accidental touch upon the inkstand, or even a few months' use in many of the chemical inks now in market, so weakens the union between the metals that, as customers sometimes say, "they come right off as I was writing on smooth paper, and when I hadn't done nothing to them." The remedy is to sell the pens of reputable dealers, and convince buyers that cheap pens must, from the necessities of the case, be bad pens.

After the point has been melted on, it is taken by the grinder, and faced upon both sides, and the end squared upon a thick copper lap charged with emery and oil, and is then taken to the rolls, which are like jewellers' rolls, except that upon the under one a recess is cut deep enough to receive the point and protect it from the pressure which comes upon the gold. The amount of rolling which the blank receives determines the stiffness of the completed pens, which are graded in this respect as "stiff," "medium," and "soft." Attached to the edge of the mill is a graduated scale, and each blank is rolled until its *length* reaches the grade mark upon this scale. Rolls will not give the metal such elasticity as it acquires from hammering, consequently each blank is hammered till its elasticity is such as to permit the nib to be bent almost back upon itself, and again return to its former position. The hammering and rolling have given a rough outline to the pen, which must be perfected by a cutting die which gives it the proper form. A screw press next stamps on it the trade mark, and it goes to another screw press to be "raised." The raising press has, in addition to the usual vertical die and matrix, a horizontal bed, carrying dies on opposite sides of the matrix, which are made to approach it simultaneously by a right and left hand screw, so that when the blank is placed over the matrix, and the upright die drives it down, by turning a hand wheel the horizontal dies are brought forcibly against the partially turned edges of the pen blank and complete the rounding up, giving it the well known commercial form.

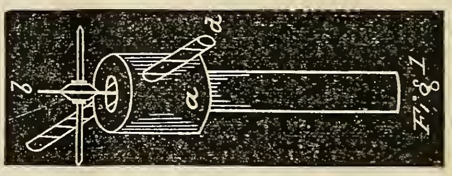
The iridium point is next slitted by a very thin, soft copper disk, about three inches in diameter, and not thicker than thick writing paper. This is held in shape and position on the revolving mandrel by brass disks of a little less diameter, held firmly together upon it by a nut run upon the mandrel. The edge of the copper is charged with emery and oil, and the pen point brought centrally upon it by being secured in a swing frame in the rear of the wheel. After the point is slit, a thin circular saw instantly slits the gold the required distance. This last operation shows upon what slight circumstances or conditions the practical results of an operation depend for their success or failure. For instance, a valuable lot of pens would be spoiled if so trifling a thing as sawing this slit was improperly done. It is well known that a crack in thick plate glass can be stopped from farther progress by drilling at its extremity a round hole. The same principle is involved in preventing the slit in the pen from progressing indefinitely under use. To do this, the saw cut must end exactly perpendicular to the two surfaces of the pen, which prevents the pen from cracking farther up, and becoming spoiled.

Slitting the pen of course removes more or less of the metal, depending on the thickness of the cutters, and the two edges must be brought together again, which the workman does by drawing the outer edges of the nib by hammering them on a stake. This is about the extent to which machinery can be applied in the construction of the pen. It now comes into the hands of the grinder, and skilled labor commences; for however well all these primary operations may be performed, unless the form of the point is correct, the pen is comparatively valueless. The first operation by the grinder is to form the inside surfaces of the slit exactly flat. The philosophy of the pen's action must be thoroughly understood, or all possible grinding will not produce a good pen. By hammering the edges of the nib the points have been thrown together with more or less force, but the proper amount should be just enough to keep them in easy contact; too much so presses them together that the ink will not freely flow, and also if one leg of the nib gets slightly above or below the other, they will instantly cross each other with a snap. The object of having the inside edges of the slit square and flat is to prevent them from easily slipping by and crossing, but if the surfaces are rounded they can with difficulty be kept against each other. This flatness is obtained by running a thin copper disk between them, with the *sides* charged with emery and oil. Dexterity in this manipulation is the only means of success. The sides, edges and end are then ground upon the broad faced copper wheel, as the experience of the operator and his judgment suggest. The skill required for this operation may be judged of by the fact that, although there are thousands of pens made in New York, there are not to be found a dozen first class grinders. The pen, during this process, is critically examined from time to time with a glass, and tried on paper to detect any defect in the points, and again and again ground and tried, until satisfactory. It then goes to the polisher, who, with rotten stone and rouge upon properly shaped buff-wheels, gives the final finish, and it then has the inside of the nib stoned to a gray as far as the pen dips in the ink. There is a reason for graying the inside of the pen aside from mercantile appearance; for, when a perfectly polished pen is dipped in ink, the tendency is for it to slip off, or aggregate into isolated masses, and it will not readily spread all over a polished surface, and in consequence the flow is uneven; but by the slight roughening of the surface this difficulty is remedied. Finally, the pen comes again to the grinder, and the points are examined to see if they have received any damage during the polishing, and to receive the final touches upon his grinding wheel.

Messrs. Edward Todd & Co. also make a rubber pen which for many purposes subserves an excellent purpose. It is in the form known as a barrel pen. A short account of its mode of production will give an excellent idea of its capabilities. In the first place the nib of a gold pen, in blank, is cut out, and the iridium "sweated" on. This nib has three holes punched through it above where the slit will come, which gives the rubber firm hold upon them. These nibs are given to the Rubber Company, and they, by a process of their own, entirely enclose them in the body of the rubber tubing when in a plastic state. The rubber is then vulcanized (hardened) and the tubes returned to the pen factory, where they are turned and filed away until the enclosed gold point is found. It is then slitted, ground, polished, etc., with the same care as the all-gold pens, forming a cheap, strong, coarse writing pen, well adapted to many commercial purposes.

Pen and pencil case making are particularly interesting to the mechanic, as involving some very notable properties of metals. At various times, and in connection with quite diverse operations, the action of metals under pressure has been spoken of, and their ability to flow under such circumstances illustrated. In describing the process of case making this property will be especially noticeable, for most of the parts, and in fact nearly the whole mechanism of a pen or pencil case is made of hollow tubing of brass for the "movements," and gold, silver, and plated tubing for the outside or "shell." The first operation in producing a hollow tube is to bend up into a rude cylinder a strip of plate of the width necessary for the intended diameter of tube, and any desired length. This rough tube, usually of about 18 inches in length, is then passed through a draw plate, which rounds it up and brings the edges in close contact, and along the seam are laid pieces of solder and ground borax, which is heated by the air blast gas blowpipe until they flow. Before giving a description of the process of drawing these tubes, it will be best to describe some of the appliances for doing it. Of course the drawing is all done by power. The draw bench or frame has an endless chain constantly running between its bars, over a pulley, at each end. This chain is put together like the chain of a watch, the open spaces between the links permitting a turned down hook upon the drawing jaws to drop into them and be carried along irresistibly. The first thing is to provide a great variety of steel rods, drawn down to the various sizes which are required for the interior diameter of the tubes. These rods are as hard as drawing can make them, and are not only of different sizes, but of various shapes, and each having a plate with corresponding holes. Their use is this: the soldered tube is slipped over one of these steel wire forms, its end a little diminished so as to enter the first hole in the plate; the draw tongs seize this end, the hook is dropped into a link of the endless chain, and the tube and its contained steel rod travel through the hole together. The first draw does but little more than perfect the shape, and straighten and fit the tube to the steel core. The next draw shows plainly the effect of compression, for the tube is so tightly drawn upon the core as to require powerful burnishing to loosen it sufficiently to allow it to be withdrawn. In drawing gold tubes, the steel cores are lubricated with beeswax, or wax and tallow, not only to facilitate their withdrawal, but also to allow them to flow easier; for, during this process, all the metal in front of the plate must move forward, or slide upon the core, because it is crowded forward by the compression between the hole in the plate and the inside rod. This flow of metal is admirably shown by watching the end of the tube travel along the steel core, under the pressure of a draw. An eighteen-inch gold or silver tube is, in a few moments, elongated to five or six feet in length. After the final size, both interior and exterior, is obtained, it must be slipped off the steel rod. Burnishing is not now admissible to loosen it, for the lines left by the burnish would be ruinous to the finished tube; consequently, it must be drawn off as it was drawn on, that is, by a plate. Instead of using the same steel draw-plate, a brass one is now substituted, and in this operation the steel core must perfectly fit the hole, the end of the tube upon it butting against the surface of the plate, while the steel rod is drawn through both it and the hole. The object of using the brass draw-plate is, that the steel wire cores may not be injured, which might be if they came in contact with the hard steel draw-plate. On the contrary, if they do touch the inside of the brass hole, the hole itself suffers change, rather than the passing rod. These drawn tubes do not come from the plate perfectly straight, but are more or less curved, and must be straightened by hand. None of the modes of straightening solid wire can be adopted; the hand and eye of the workman are alone relied upon for this purpose.

The brass tubes for the movements of pencil-cases and pen-holders, which slide out by either a straight push or by a twist or turn of one part upon another, are cut up into lengths suitable for the various purposes designed, and the well-known interior curved slits through their length are cut by a very ingenious though simple device; for true mechanical ingenuity will produce the desired result by the simplest possible means, and not by the most complex, as popularly supposed. Cutting these screw slits is done by a circular milling tool, or saw (*b*, Fig. 1), running in a lathe. Beneath this cutter is



a socket, *a*, fixed by a set screw into the column which supports the hand-rest, with a hole drilled transversely through the head, just below the upper surface, and of such size as to permit the tube, *d*, to pass easily through. The top of this socket is concaved out till it intersects the transverse hole, so that when brought up under the circular mill, the cutter will descend a little into the transverse hole. The operation is at once seen to be, that, if a tube is pushed through this hole when it and the plane of the cutter coincide, a straight slit will be cut; and if the socket is set so that the hole through it forms an angle with the cutter plane, it will be found that the tube will not go straight through, but must be twisted or screwed through, forming an inclined slit. By this simple arrangement any pitch can be given by changing the angular position between the tube and cutter, and either right or left hand slits formed with great ease and rapidity.

After the silver and gold tubing is cut into proper lengths, it is taken to the ruling machine, where all the beautiful geometric line work seen upon pen cases is done. Only a general idea of the operation of this machine can be given without detailed drawings. Its principal parts consist of a travelling bed, similar to that of a small planer, and an arm or bar at right angles to this bed, and a little above it, which holds the cutting tool or graver. This tool bar has given to it a vibratory motion, depending in extent upon the amount of eccentricity which is given to a revolving point which actuates it. The blank tube to be ornamented is slipped on a metal arbor which carries on its end an index plate, by which the blank is automatically revolved one division at each journey of the bed, which carries the blank back and forth. As it passes under the vibrating pointed cutter a waved line is produced the whole length of the blank; at the next journey, the blank having been revolved one division, a line parallel to the first is made. Any forms differing from these straight waved lines must be determined, as on the engine turning lathe, by pattern disks or wheels, the periphery of which is shaped in conformity with the figure intended to be produced upon the blank. These disks determine the position of the waved lines made by the vibrating cutter, and consequently the figures can be as numerous as the different disks, which make a complete revolution in the same time that the blank makes a revolution upon its own axis. This style of ornament is more largely used than hand chasing, because cheaper. Beautiful effects are produced by hand work, by engraving and chasing; but the most elegant by a combination of all three together.

Vulcanized rubber is also largely used for pen, pencil and tooth-pick cases; the Rubber Company furnish them in blanks, already turned and polished. The machine which ornaments these is simple, and yet similar to that for ruling the gold and silver cases. There is this difference, that the line upon the rubber cannot be *cut;* it is made by a round point which simply indents the surface; a cut line would be ragged and dead, the burnished line is clean and bright. The blank is rotated one notch at each journey under the marker the same as in the other machine, but the point, instead of vibrating from side to side, has an up and down motion, and if no pattern was used the line drawn by it would be a straight line, but by placing upon the bed which carries the blank a notched strip, these notches will, as they travel under the arm that carries the point, alternately lift it off and let it down upon the blank. This produces a dotted line instead of a continuous one, but the dots would be alike upon each line and give no variety. To remedy this an ingenious device is resorted to, giving an endless variety of figures. A steel screw of very coarse thread, rounded and smooth, so that a point can slip over each thread, is substituted for the notched rack. This screw has a division plate upon one end, so that, as it is carried under the arm, it makes a series of short lines on the blank; now by revolving the screw one notch, of course the next line of dots do not coincide with the first, but are moved from them by so much as the screw thread has been changed by its partial revolution. A considerable revolution of the screw changes materially the relative position of these dots, and so by this simple means of revolving the screw backward or forward, an infinity of changes of patterns may be produced.

The points for leads in pencils are drawn hollow from German silver. Turning and cutting the screws both male and female, spinning the noses to various shapes of the different sized pen-holders from the straight tubing, and the innumerable operations of fitting together the various parts, demand the use of many small tools and machines, an inspection of which shows the positive necessity for the constant constructive services of an ingenious and skilful mechanic in this as well as in every manufacturing establishment. Much depends upon the machines, more upon the men, and most upon the machinist. All honor to the skilled mechanic, for, without him writers would yet be dependent on the Eagle or the Goose.

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Reminiscences of An Apprentice.

TRADE SECRETS.

The violence of the storm on the friction question had abated in our shop; "Our Maister" had relapsed into silence, and the subject was never mentioned except privately between "Our journeyman" and myself. I had become a convert to the doctrine that friction was independent of the extent of the surfaces in contact, and instead of seeing so many obstacles in the way of believing in it, all that appeared to be obstacles before, seemed now to be positive proofs of the soundness of my new belief. "Our journeyman" endeavored to show me the error of my ways, and the danger of embracing any of these new-fangled notions one learns from books, or from Professors, or from any of those whirligig things that we had seen at the academy, and which he maintained had nothing whatever to do with watches or clocks, and was of no use to *us* that had to make them. I thought that the experiments at the academy had taught me a great deal about making pivots; that now I knew the reason why pivots were made in various ways in order to acomplish certain results; but before that I had made the pivots as I was told, without fully understanding why they were so made.

"Our journeyman" got a little mad, and told me that I did not know what I was talking about; that in making the pivots it was in the shoulders where the secret lay, and when once these philosopher fellows could tell us how to polish a shoulder flat, then he would think they knew something. "That's what beats them, though," said he, "and they know it too, and try all they can to get the different ways of doing it out of workmen that do know it. Why," he continued, "when I was in London a lot of them scientific coves, and some men in the trade that didn't know anything, got up a school that they called a Horo—— something Enstetution; and to have heard them talk you would have thought that they were going to make fortunes for us all right away; but we were not so green as they thought, and soon saw that it was only to get the secrets of the trade out of us workmen that they wanted, so that the lecturing fellows would have something to talk about and put in their journal. The master that I worked with warned me about them, and said, says he, 'them fellows are poor tools, they are no good, they are all regular duffers; I know them all right through, they want to spoil the trade and take the bread and butter out of the workmen's mouths; have nothing to do with them, or their Enstetutes, or their journals,' and so I didn't, and I won't either. Somebody sends me a Journal but I don't read it, you see that I don't, but I see you and the 'Maister,' who never were in London, both read it through and through, yet you never saw anything in it that would teach you to make the shoulders of pivots flat. That licks all the Enstetute fellows; getting the shoulders flat is the great secret in making pivots."

The first opportunity I got I asked "Our Maister" if perfectly flat shoulders on pivots made the clocks or watches go better than when they were a little rounded. He said that it only displayed good workmanship; and that a class of workmen, and he noticed that "Our journeyman" was among the number, had a most mischievous custom of judging the quality of a pivot entirely by the flatness of the shoulder it had, and made the pivot itself secondary in importance to its shoulder. That a skilful workman turned his pivots to the right shape and size smooth enough to be polished off the turning tool, without using a file, while a few rubs with a polisher took the graver marks out, and a few more rubs with finer polishing stuff glossed it. A good workman, in polishing pivots, used the polishers as little as possible, and if they were flat and square he could scarcely avoid making the pivots flat and square on the shoulders also. "Our Maister" continued to explain that he was not opposed to the shoulders of pivots being a little rounded if they were true, because, when the shoulder rubbed against the frame or cock, the bearing was nearer the centre of motion than when it was perfectly flat. I could understand the philosophy of his remarks at once, but "Our journeyman" sat and listened to every thing in meek silence, evidently reflecting on a favorite saying of his, that good work could not be appreciated outside of London.

I was cleaning some common silver watch-cases one morning. One of the cases belonged to a watch that had been on board of a ship newly arrived from the West Indies with a cargo of sugar. This case was very black and dirty, and I went to work to clean it with a brush and chalk and water, the same as I cleaned ordinary silver cases. I brushed hard and used a good deal of chalk, but still the black would not come off, and I do not doubt in the least but that I was making a good deal of dust, and the most of it was either going on "Our journeyman's" work, or, what was far worse, it was settling on his hair or on the lapel of his new blue coat, and he did not like it, because on all occasions he sat at his bench in the window, fully prepared to make a favorable impression on any susceptible maiden that might incidentally glance in at the window when passing. "Our Maister" was out at the time, so he commenced to scold me about making so much dust; but I got saucy and told him that I did not care how much dust I made if I could only get the black off the watch-case. He told me that neither the "Maister" nor I knew how to clean a dirty case; that he could clean the dirtiest case he ever saw in a few minutes better than I could do in half a day. "What, with chalk?" says I. "No; without any chalk," says he. "Well, then you must use rouge, the same as I do on gold cases;" but he said that he did not use rouge either, or any kind of polishing paste,—that he did it by a chemical secret that he learned when he was in London. "Well, then clean this case," I says to him, "and there will be no more dust." But, oh, no! he could not do that, because it would expose the secret. So I brushed away, and made as much dust as ever I possibly could, and taunted him that he had no secret at all—that it was only some more of his London blowing. At length the clouds of dust became so great that he got up, threatening to give me a beating if I would not stop, and indeed he was so very angry that I thought he was going to beat me in reality, not only for the injury that I had done to his hair and his coat, but also for any consequential damages that might arise from any of his lady friends seeing him in that dusty condition. I was not afraid of him beating me, however, because I was nearly as big as he was, and I continued to teaze him about his secret, till at length he promised to come up to our house in the evening and tell me, and I was to provide a private room, and some hot water and sawdust for the experiment.

In the evening I got a room ready for "Our journeyman's" arrival, and also some small pieces of very dirty silver to clean, and some hot water and several basins, but I could not get any sawdust, so I went to make some. On pulling a piece of wood out of a pile I got a splinter in my finger which I could not get out easily, but proceeded to make the sawdust that was to be used for the secret. "Our journeyman" arrived at the appointed time, and I had everything in readiness for him. He shut the door and locked it, covered up the key-hole, and pulled down the window curtain; and, after binding me to the strictest secrecy, commenced to unfold the mystery. He took a small piece of a white substance, that looked like fine chalk, and put it in the water; and, during the time it was dissolving, told me that at one time only one man in London knew this secret, but that once he thought he was going to die, and he told the secret to his wife. He did not die at that time, and the wife told it to another woman that she could depend upon to keep the secret, who told it to her husband, and the husband, for a consideration, told it to "Our journeyman," who was now going to tell it to me. After the substance had dissolved in the water, he put an old dirty silver coin into it, and in a very short time it became clean and bright. He then rinsed it in the hot water and dried it in the sawdust, and handed it to me with all the airs of a juggler, and all the satisfaction of a chemist who had made a great discovery after years of laborious research. I was perfectly delighted, and asked him to tell me what it was that he put in the water; and he told me that it was cyanide. "Cyanide of what?" I asked. "*Cyanide of what?*" says he, "Why, it is just *cyanide.*" I remarked that I had been reading a book on chemistry lately, and I saw that there were various kinds of cyanides—that there were cyanides of various substances, just as there were oxides of different substances; but this allusion to what I had seen in books did not please "Our journeyman" at all. He treated it with scorn, and told me if he thought that I was going to begin with any of that kind of nonsense, he would not have come up; and he continued to insist that what he had put in the water was cyanide, the real, pure, genuine cyanide, and nothing else.

The divulging of this secret to me had the desired effect of again raising "Our journeyman" in my estimation to the very highest pinnacle; and when I bade him good-night at the gate, I melted down, and told him how sorry I was that I had ever made fun of his London secrets; and could you believe me he was magnanimous enough to forgive me for all, and said that what he had shown me was nothing to what he did know, and that he would tell me something more if I would not tell it to the "Maister." I promised I would not tell anybody, and so we parted mutually happy. Now, for the first time in my life, I was in possession of a genuine trade secret, and one all the way from London, too; and I thought of the pleasure I would have in crowing over the other watchmaker's apprentice in our town; and I went up stairs and wrote down all the details of the experiment in a book lest I would forget anything. By this time my finger pained me from the effect of the splinter, and I took a pair of tweezers and pulled it out; the finger began to bleed, and I went to the basin and washed it with the secret water. How nice and pleasant the water feels, I thought, and so slippery, too; I never felt anything like it before, and was delighted with everything, and went to bed that night with the same kind of feeling that, as I suppose, one has after being initiated into the first degrees of Odd Fellowship or Free Masonry.

Next morning I had a sore finger, and during the day it got worse and worse, and in the afternoon it was so bad that I had to stop work. "Our Maister" said that my finger was well enough yesterday, and inquired what I had been doing. I told him that I had got a splinter of wood into it. He looked at the finger and said I must have been handling some poisonous substance, and finally I told him that after taking the splinter out I had bathed the finger in a secret kind of water that "Our journeyman" had shown me last night, that was used for cleaning silver. "Oh," says he, "that is clear enough; you have poisoned your finger with the cyanide of potassium;" but I told him no; it was not potassium, it was a secret preparation that came from London. "Secret," exclaimed "our Maister," "I have used the cyanide of potassium for cleaning silver when it was very dirty, for the past ten years, and I did not know it was a secret before. If I had thought in time I would not have allowed you to wear out brushes on that black watch-case yesterday; everything is secret to two fools like you, that don't know what you are doing or working with; go home and get that finger poulticed or else the doctor will soon have to cut it off."

I went home, and in the evening my father thought it advisable to take me to the doctor, and we told him I had a sore finger; that I had been cleaning very dirty silver by a secret London process. The doctor shook his head, and said: "Cyanide of potassium is a bad thing to get on to any part where the skin is broken, or if you inhale its fumes into your lungs." After my finger was dressed he brought out a little piece and dissolved it in water and then cleaned some dirty silver coins he had in his pocket, the same as "Our journeyman" did. I put my hand in the water, and it had exactly the same kind of slippery feeling as the water he used, so of course I had to believe that it was the cyanide of potassium, for I could not contradict the doctor, especially when he had said the same thing as "Our Maister." However, I asked him why he knew that it was the cyanide of potassium that "Our journeyman" and I had been using. The doctor, who was also a chemist, told me that a solution of the cyanide of potassium was commonly used by silversmiths, etc., for cleaning silver; and after I told him we had been cleaning silver, he concluded that the cyanide of potassium had poisoned my finger in a place where the skin had been broken. As he appeared to know considerable about the subject, I asked him if there was anything else that he knew would accomplish the same results. The doctor readily consented to tell me all that he knew on the subject, and went on to explain that for large heavy articles that were very dirty, a solution of the cyanide of potassium was very serviceable, and was probably as good a solution as could be got, but in small and very delicate articles it had to be used with caution, for in the use of cyanide of potassium solution there was considerable waste of silver, because it was by dissolving off the dirty silver that the effect was obtained. A strong solution of hyposulphite of soda, the same as is used by photographers, is perhaps the safest wash for delicate articles, as it will in no way attack the metallic silver, but only the films of chloride, etc., on its surface.

The first time I saw "Our journeyman" after this, I said that his secret was all humbug; that it was no secret at all; that the "Maister" knew all about it, and so did the doctor; but I could not convince him that I had not betrayed the secret to them both. His feelings were deeply wounded at the result of this misplaced confidence in me, and he declared that he never would tell me another secret again. I told him that I could tell him one now, and it was about cleaning silver too. That the hyposulphite of soda was a very good thing for that purpose. "Soda! says he, sneeringly, "soda clean silver; well that is a good joke. I know better than to believe in any of that kind of nonsense, for neither plain soda nor hyposulphite of soda, nor any of these other high fancy drinks the druggist sells, are worth a pin for cleaning silver. If you would listen more to what I tell you," continued he, "and take less notice of the nonsense that you read in books, or what you hear professors or doctors say about the trade, I would soon make a man of you." Now, at this period of life, I was trying very hard to be a man, as was plainly evident by the eagerness which I displayed to be able at the end of the week to take a seat in the village barber's chair, and have that artist catch me by the nose, and perform the usual interesting operation connected with his business, but I could not take "Our journeyman's" advice. All my life I have had a partiality for books, especially those relating to our trade, and that partiality has extended to all sorts of philosophical and chemical "whirligigs" the same as I had seen at the academy, which, in addition to being a source of amusement in hours of leisure, has also been a means of imparting information to me I could never have obtained otherwise.

It is not the design of Horological Institutes or Journals to betray any person's secrets. Their mission is simply to help us to fully comprehend that which is secret and mysterious. The hard-working student laughs at petty trade secrets, and despises all that peculiar or special kind of knowledge that belongs to one individual, or to one family, and which must not be told to any outside of the family. There is no business or profession that requires a greater amount of philosophical, mechanical, and chemical skill, than the construction and improvement of Horological instruments; and no one engaged in the business at the present day can afford to do without all the information that he can possibly obtain on these subjects. The British Horological Institute and Horological Journal since its foundation, has sown the seeds of improvements, or it may be a regeneration of the art, the influence of which is already felt in all the English speaking countries of the world. As regards our own Journal, I feel that I make no extravagant assertion when I state, that the contributors to its pages, instead of losing any knowledge to their own disadvantage by the information imparted in their communications, have, on the contrary, in many instances been made wiser by the manner in which some of the subjects have been discussed; and the bread which they cast on the waters has already returned to themselves fourfold.

Premiums Awarded by the Neuchatel Observatory, 1870.

At the competitive trial of watches and chronometers for prizes offered by Government at the Neuchatel Observatory for 1870, five prizes in all were distributed. The first prize, of 150 francs, was awarded to C. H. Grosclaude, of Fleurie, for a marine chronometer which satisfied the required conditions. This instrument showed an astonishing degree of regularity. For the two months it was run at the Observatory its rate of variation from one day to another was not more than 0.12s., and the difference between extreme of daily rate was only 1.75s. Under increased temperature it showed a loss of 0.13s. for each degree, rates which would not be discreditable to an Astronomical clock.

To Messrs. Borel & Courvoisier, of Neuchatel, was awarded a prize of 125 francs for a pocket watch with lever escapement. This watch showed wonderful regularity of rate, only varying 0.17s. from one day to another. Its variation for position only amounted to 0.59s., and for every degree of temperature 0.12s., the greatest difference of daily rate for a month being only 1.70s. Such rates are creditable, not only to the makers, but to the lever escapement, which has heretofore been supposed incapable of such results. Messrs. Borel & Courvoisier also submitted a number of other watches which showed remarkable perfection.

The Workingmen's Association of Locle were awarded the third prize, of 100 francs. They have already acquired considerable reputation for the Astronomical Clocks which they have furnished to the Neuchatel and Zurich Observatories. This watch had a mean daily variation of only 0.21s.; the difference for temperature and position was a trifle greater than the others, but the difference of extreme daily rates was but 1.50s., being less than either of the others.

M. Paul Mathey-Doret, Locle, was awarded a prize of 75 francs, for a pocket chronometer whose mean daily rate was only 0.24s., its average for temperature and isochronism being even more nearly perfect than either of the preceding, losing, by change of position, only 0.23s., and for each degree of temperature 0.06s.; the extreme of daily rate being only 1s. in a month.

For the prize of 50 francs, the contest between the pocket chronometers of U. Nardin, Borel & Courvoisier, and H. Grandjean & Co., was very close, each having the same mean daily rate of 0.27s. In this case the regulations assigned the first position to the chronometer which exhibits the least difference between the extreme rates, which was No. 3772, of M. Nardin, Locle. It appears upon consideration of the observations for the year 1870, as shown in the Directors' report, that there is not a marked difference between the four principal escapements; still the Lever in the Observatory trials leads the others.

The flat spiral, with Phillips' terminal curve, is at the head of the list in perfection of performance. The performance of 147 watches without the fusee show a mean variation of 0.54s., and 20 with the fusee a mean variation of 0.56s. M. Saunier, in the *Revue Chronometrique*, cautions horologists against drawing erroneous conclusions as to the relative value of the various escapements from these Observatory trials. He intimates that the length of time they are under examination is not sufficient to fully establish their quality. Instruments that give excellent results in the Observatory have often, in use, proved deceptive. The vicissitudes incident to active use for a considerable length of time, are absolutely necessary conditions to determine, with any degree of certainty, the relative intrinsic merits of the various escapements; such as prove best under the quiet routine of Observatory trial, may, under the rough usage of active life, prove to be otherwise. And he strongly recommends premiums for those marine chronometers that show the best rates at sea, rather than in the Observatory.

Friction.

Ed. Horological Journal:

I was in hopes to have been able to present to the readers of the present number the results of a series of experiments upon friction, but the time has passed so rapidly, and other and more important business has claimed my attention so much as to prevent their completion, and forces me to reserve this pleasure for some future opportunity; but I would beg leave to offer a few remarks in reply to the article of B. F. H., in the March number, "Friction *vs.* Bricks." He thinks "my experiment with the bricks proves too much;" if we are at liberty to interpret this as *more than he was willing to admit*, I think he is correct; but, however his obstinacy may blind him as to the real truth of the matter at issue, it proved just enough to show that his ideas of a certain characteristic of friction are false. He confesses to be ashamed of the thought of trying such an experiment, but he ought to be rather ashamed of exhibiting so much lack of perseverance as not to endeavor to overcome the difficulty in finding bricks with plane surfaces; a true willingness and desire to "get at the rights of the matter," should have suggested to him that bricks can be ground flat, if they are not so already. Much more might be said as to his style of reasoning on the results, but I would spare his feelings and save my time by simply stating, that, although the bricks I used were perfectly flat and square—having been made by a steam brick machine just outside of our city, and for which great merit is claimed as to the perfection of its work—I repeated the experiment with ground bricks.

The reason why my first experiments gave irregular results was due to my using a rather rough and thin pine board, which bent a little more under the pressure of all the bricks on the edge of one, than when they were distributed on their flat side over a greater area of the board. As my object was only to prove that increase of surfaces in contact does not *increase* the friction, I thought the result answered very well, for it did prove that. It is true the experiment is a rough one, and from this it becomes difficult to measure accurately the amount of friction as to its proportionality to the pressure; but I have nevertheless been able to obtain better results, of which the following is approximately a true record, after repeating the experiment under various circumstances and conditions. I ground the bricks myself on a large, smooth, and perfectly flat slab of marble, and after washing them and the slab, and drying them in the sun, I tested them on that same slab of marble and in the same way as in my previous experiment. When testing them on the edge of one brick the coefficient of friction appeared to be:

For 1 brick..............................0.75
" 2 " 0.75
" 3 " 0.76
" 4 " 0.775

When side by side on their broad sides:

For 1 brick..............................0.75
" 2 " 0.75
" 3 " 0.76
" 4 " 0.75

These results are the mean of many repetitions of the same experiment, which are as near as I believe it is possible to observe them, and although not perfect, yet I hope they will prove just enough for B. F. H. I would ask pardon for so doing, but I am inclined to doubt his honesty when he says that " he regards authorities in mechanics, etc., as entitled to the greatest consideration." I am thus inclined on the ground of another statement of his, in the November number, where, in reply to Dynamics, as touching the principle of friction proportional to pressure, independent of the extent of the rubbing surfaces, he says: " There is no work on philosophy within my reach that makes the assertion quoted, and *I would not believe it if there was, for I know better, etc.*" This is not the language of a man of experience and close observation, nor even of a willing student, but plainly shows the attitude taken by B. F. H. in the matter, and will also excuse me with the readers of the JOURNAL for calling upon witnesses to my first experiment with the bricks. I protest that I have not overlooked nor "ignored" any of the authorities worth noticing which he referred to in previous articles; nor have I contradicted my own, as I will presently be able to show. The quotation from my article, page 134, will be made clearer by supplying one word, when it would then read: " varying with the speed and (QUALITY) of the surfaces in contact;" but in place of this, B. F. H. seems to supply the word " *extent*," which, though just wrong, is well in keeping with his manner of reading the opinions of others. The expression, as also the one quoted from my February article, is taken from the authorities which, in the same article, I recommended him to consult, and with which he is evidently as yet not familiar.

His endeavors to contradict the well-known principle of friction in question, by the quotation from Mr. Grossmann, is a signal failure, because that gentleman elsewhere in the Essay asserts the truth of it. Taking this into consideration, the intelligent reader would hardly use the expression as B. F. H. did, but rather seek to interpret it in harmony with known laws and the author's own tenets; and if we distinguish between friction as the resulting constant to the pressure, or friction as a unit, and friction in the aggregate, there should be no difficulty in doing so. There is a certain amount of friction at the axles of a locomotive, whether at rest or in motion, which is a constant to the pressure upon them, but the difference between this friction and the friction that will result when the locomotive will have been running over a track of 100 miles, is just the difference which we should make in this instance; this latter friction would be more properly called *the work of friction*. The reference to the Essay on the Pendulum, will admit of the same remarks.

In the next instance B. F. H. says that "it is hardly necessary to pursue the subject farther in relation to pivots and their bearings, for it is the *universal* practice to make the bearings convex," etc. Now I wonder whether he was aware of that fact when he discovered that recipé for isochronous pivots, as given in the

August number of the JOURNAL; and when he made the "experiment on those few watches," might it not be possible that he cut off a portion of the pivots which never touched the bearings at all? It would be useless to notice all the quotations he makes, in particular, many of which have little or no bearing on the subject. As far as their value goes, the intelligent reader will not misunderstand them. I wish simply to defend myself and principles, and in this behalf I would say to B. F. H. that I do not consider him ill-mannered for quoting myself against myself, but I feel sorry to see that he has all this time labored under a misunderstanding of the passage in question, and am at the same time glad to be afforded an opportunity for correcting this mistake in his mind. I refer to the passage quoted by him from the article on "The Chronometer Escapement," p. 28, vol. ii. Now we know that friction does vary as the pressure, *i. e.*, when the pressure is greater, friction is also greater; and when the pressure is less, it will be less also; but the pressure of a train wheel is least at its greatest radius, consequently the friction will be least also; therefore, "to effect a good *draw*, and create the least friction, the *point* of the tooth only must be in contact with the surface of the jewel." He quotes an expression from Holtzapfel, stating that "the more acute the angle of a screw thread is made, the greater is the surface friction, *because the extent of surface is increased*." This cannot be true, for it can be shown that the more acute the angle of a screw thread is, the less surface is exposed, for the screw thread is an inclined plane; but the surface of an incline is greatest when the angle of inclination is also greatest, and least when the angle is most acute. It is true that the power of a screw is greater when the angle of the screw thread is more acute; but this is not because there is greater friction, nor because there is more surface in contact, but because the pressure acts more perpendicularly against the face of the thread, as may easily be proved by applying the parallelogram of forces to the base of the thread. It is also stated that "the durability is increased by the enlargement of the bearing surfaces;" but he has just stated that friction is increased by increasing the extent of surfaces in contact, hence it would follow that the greater the friction, the more durable the thread; and B. F. H. thinks he could show that there is no inconsistency in this teaching? I am inclined to think that when he will be able to distinguish between things that differ, his confidence in himself to do so will vanish. Any one who is acquainted with the mode of fastening the American lathe to the bench, will not need any comment on the passage quoted from page 48, vol. i., but I should think B. F. H. does need it; for because it is said, "the bearing base being so great," he at once thinks of "*greater surface*," whereas the fact of its greater stability is due to the bearing being so far from the centre of motion of the base.

He now returns to the supposed pivots of his Newark watch. He had before admitted that under the supposed conditions the pivots would bind in the holes, which he attributes to the increase of surfaces in contact; but I have proved to him that this does not necessarily follow, by showing him that the same effect can be produced with very small surfaces in contact in the way of inserting a wedge; but, far from apprehending the point of the argument, he thinks a new light has dawned upon the subject by the introduction of the theory of the wedge, and challenges me to contradict that "the power of the wedge consists only in its surface friction," which, I presume, he means by the italics. I suppose he is familiar with the theory of the wedge, as taught in our mechanical philosophies. The power of a wedge is, indeed, due to the surface friction, as friction is everywhere the result of contact of surfaces; but he wells know that just in the case of the wedge, perhaps, more than in any other mechanical power, the equilibrium of the system most obviously requires that the friction be constantly proportional to the pressure; for, were it not so, no wedge could be driven; and it might be dangerous for a man to attempt it. But we know that the pressure on a wedge is proportional to the force with which it is driven, independent of the size of the wedge; or, which is the same thing, the magnitude of the surfaces in contact, and hence the friction must be so also.

Time permits me to notice only one or two more points, though the subject is too full of interest to be slighted. One is: he is telling us that he "has been trying to show all along that he has adjusted watches to position;"

but he has been doing so on false principles; and he seems to be well acquainted with that rule of logic, "*if the premises are false, the conclusion is false also.*" The terms "more or less flat," will *just do* for my theory, and if he had any experience in adjusting to position, he would know that; for the surfaces of the pivots on the sides and on the ends, as well as those of the jewel holes and end stones, are not always equally smooth and polished. On a high polish, the friction will be less than on a rough surface; and, moreover, the balance staff does not always stand perpendicular to the plane of the end stones, which circumstances all tend to make the friction more variable, as might be inferred from what has been repeatedly stated in previous articles. Indeed I very seldom need to make a perfect flat on the pivot, and yet I succeed in producing the same arcs of vibration. This could not be due to more surface in contact, for I sometimes find that, when the pivots are not both exactly of the same size, the arcs of vibration are even more diminished when running on the smaller flat.

THEO. GRIBI.

Wilmington, Del.

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An Improved Mechanism for Winding and Setting Watches.

Watches which dispense entirely with a key for winding and setting purposes, certainly present instruments for measuring time theoretically perfect within themselves. It is evident that if a mechanism could be so adjusted as to attain both these ends, to wit, that of imparting the movement to the works, and having the power of regulating the exact position of the hands, besides doing away with that extra part, the key, the chances of disturbance within the watch itself, from the introduction of dust, from opening it, would be entirely overcome.

The introduction of stem-winders in the United States is by no means recent; and good as they were, there was still something left to be desired.

The great trouble in stem-winders and setters was of a double character. Firstly, within the small compass allotted to the general movement, a serious complication of parts was necessary, increasing very much the cost of the watch; and, secondly, what is quite as important, they were found to be uncertain, and unable to resist any rough movement. Manufacturers found it easy enough to wind up the watch, by a crown on the pendant, but the difficulty to be overcome was in making such a gear as would do the work of hand-setting.

Heretofore, the change from winding to setting has usually been accomplished by shifting the gears. The trouble was, in this delicate mechanism, that no device could be hit on which would bring the gears completely opposite, and they would frequently lock. The tooth of one wheel would come directly opposite the tooth of another; then the only method of relieving them was by exerting an unusual amount of force on the crown, which extra force invariably resulted in causing the hands to jump.

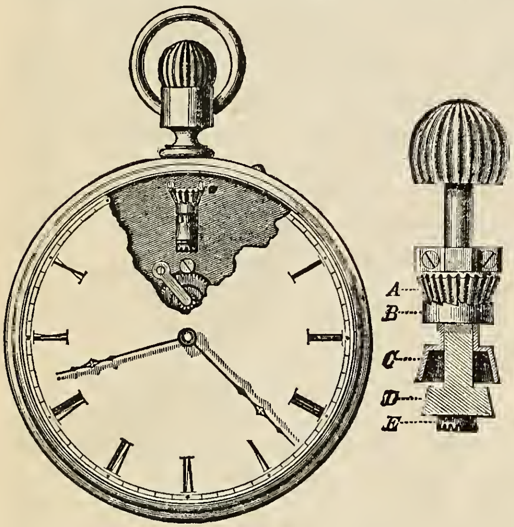
The best Swiss manufacturers have for a long time been endeavoring to overcome this obstacle. They use a train of several small wheels, with a certain amount of extra room between the teeth, so as to take up any waste motion, in order that, instead of the hands moving suddenly in setting by the extra force applied, such excess of power would be distributed over the various wheels, and the jar thus diminished.

This method, ingenious as it may seem, led to no good results. Very often all the waste motion in the train of wheels would be of no avail, and the hand-jumping would continue.

The American Watch Company of Waltham, by applying to this winding and setting movement the well-known principle of the *friction clutch*, have overcome every difficulty, and are now producing watches perfect in this respect. The friction-clutch, as is understood by mechanicians, unlike a gear, can be closed at any moment, always finds its proper place, imparts instantly transmitted motion, and has been much employed for power-lathes, to prevent clashing.

The first engraving represents a watch with a portion of its dial removed, in order to show this new winding and setting apparatus. Here the clutch is *closed*, and the watch ready for *setting*.

The smaller cut gives an enlarged drawing of the shape and position of the various parts, the clutch being *open* and the watch ready for *winding.* A is a bevel-gear, connecting with a contrite-wheel on the upper plate, which acts directly with the barrel. In the drawing the friction-clutch is shown *open*, being its position for *winding.* The ratchet B is so arranged as to be in connection, by means of a spring, with the corresponding teeth of the gear A. When pres-



sure is brought on the spring, the ratchet B becomes released, and is no longer in connection, from a change in its position, with the bevel-gear A. The mechanism is then in proper adjustment for hand-setting, the two parts of the friction-clutch C and D being closed. C is a steel cup, so made as to fit exactly over the solid piece D, thus, when closed, making a fixed connection between the crown and the cannon pinion by means of the connecting wheel E.

The signal advantages gained by this ingenious method are that the parts are no longer complex, and are of fewer parts by one-half than those of foreign watches, consequently a notable reduction of friction is the result, giving greater ease in winding and setting; and, less power being required, greater durability, and freedom from risk of breaking, is imparted to the whole movement.

Whether the parts be used from winding to setting, or back again to winding, the position of the hands is never altered. Watchmakers can readily appreciate the excellence of this new winding and setting device, when they find that that constant source of annoyance, the sudden jumping of hands, sometimes requiring them to regulate a watch over and over again, is entirely done away with by the new stem-winder and setter of the American Watch Company of Waltham.—*The Watchmaker's, Jeweler's, and Silversmith's Journal.*

Compensation Pendulums.

Ed. Horological Journal:

With your permission I should like to inquire of some of your numerous correspondents how the mercurial pendulum can be so compensated as to be practically accurate for all the varying conditions of temperature; or, in other words, how a correction applied at one extremity can compensate for an error produced at the other end by an exposure to a different degree of heat. It has seemed to me that for an accurate compensation, either the corrections must be applied opposite the error, or the ball and rod must be exposed to the same identical temperature. May not this peculiar construction of the mercurial pendulum account for some of the eccentricities of its performance? Let us look a little more carefully to the conditions under which the pendulum has to perform. Take, for instance, a very low-studded room, and a seconds pendulum, the length of which is some 40 odd inches, and the top of the rod with spring must of necessity come very near the overhead ceiling, exposing the upper part of the rod, with its accompanying spring, to a much higher degree of heat than the lower or compensating part. Take the same clock and place it in a very high-studded room, and for the length of the pendulum, the temperature would be nearly uniform. Now, it seems to me, for the clock to have the same steady rate in the first condition that it would have in the second, is simply an impossibility; that for the same even performance the pendulum should be compensated for the place in which it is going to stand while running, seems to be not only reasonable but necessary.

Fairbanks.

Weymouth, Mass.

[If our correspondent had given in his communication the results of any experiments he has made of the difference in temperature between the top and bottom of rooms with high and low ceilings, also the difference in temperature between the upper and lower extremities of pendulums—suspended at ordinary heights in both classes of rooms,—it would have furnished valuable data toward a solution of the problem he proposes; and it would also have been a valuable contribution to the stock of facts necessary to be known when speculating upon the possible cause of these perturbations of the pendulum. If "FAIRBANKS" has made any experiments of this character, or if he is in a situation to do so, and would contribute the results to the JOURNAL, it would be esteemed a favor.]

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Answers to Correspondents.

D. & S., *Fall River, Mass.*—Engraving door plates is a peculiar branch of the engraver's art, and consequently requires peculiar treatment, depending also upon the kind of plates, for there are two kinds, one of which is electro-plate on hard or soft metal, and the other close-plate—that is, the silver soldered on to hard metal. In engraving the brass plates, the outline of the lettering is first boldly cut by the graver, cutting completely through into the brass; the bodies of the letters are then cut away to considerable depth, and this is done, not by gravers, but by small cold chisels and hammer. By this means the brass is chipped out, and the more rough and ragged the bottoms of the letters are left the better, for it holds with greater tenacity the wax with which they are filled. In the soft metal plates (which are far inferior), this cutting away by the chisel is not admissible, and the usual way is to outline, and fill in the body with lining or any fancy filling desired, and the cuts filled in with black sealing-wax. This filling in can be done in two (or more) ways. One is by heating the plate sufficient to melt the wax, which is then rubbed into the cuts and left to cool. The surplus, which will more or less cover also the surface of the plate, is then dissolved away by wiping with alcohol and a cloth. This process is, of course, somewhat tedious, but no other is so safe, where the plating is thin. Those which are close-plated may be filled in the same manner before the plate is polished, and then the wax stoned off with the grain end of a piece of charcoal and water, and the surface finished with rotten-stone and oil and glossed, or the black wax may be broken up in grains and filled into the engraving, and melted by heating the plate until it flows, and the superfluous wax dissolved away by alcohol as before directed. These operations, like those in every other art, must be practised to acquire the necessary skill—no verbal or written instruction can supply the place of practice in art.

W. P. S., *Denver, Col.*—The easiest and most ready way to "fix up" the worn-out holes in the pendant, when they have become so worn as to permit the bow to slide through, is to broach the worn hole out round, and fit through it a piece of hollow brass wire, such as is sold by most of the material dealers; or, if none such is at hand, and not easily procured, it may be well to draw some hollow wire to keep on hand for the purpose. This is very easily done, if you have a draw-plate, by cutting from brass plate a strip a little more than three times the diameter of the hole it is to fill, and as long as is desired. After having bent this strip up, by the plyers and hammer, into a rough resemblance to a tube, partially sharpen one end so it will easily enter the hole in the draw-plate. Hard solder into this sharpened end a short piece of wire, allowing it to project far enough to be seized by the plyers for drawing; this, at the same time, anneals the brass so that it is easily drawn through the plate, perfectly smooth and round.

If the pendant has no push-pin through it, the hollow wire may be run *through* the holes in both sides of the pendant, and a little soft solder applied, which flows in on heating it, thus soldering the tube firmly in; after which, saw off the superfluous tube, and finish up flush with the pendant; then countersink the holes so as to receive the bow nicely when it is snapped in, put the screw through, and the job is as good as new. If there is a liability that the "bush" thus put in will show, it may be done in the same way by silver tubing. Should the pendant have a push-pin passing through it, two separate bushes must be soldered in, one on each side, and it will be prudent to allow considerable solder to flow in around each to give the requisite strength.

M. M. S., *Charleston.*—You can decide for a certainty, whether the article you bought as elephant ivory is so or not, for it is distinguishable from bone by a peculiar rhombohedral net-work which a transverse section of it shows. Many suppose that the tusk of the elephant is the only true ivory, but such is not the case, for the hippopotamus, wild boar, and horn of the narwhal, in fact the tusk of the sea horse, are no way inferior, and for some purposes superior to elephant tusk. It sometimes attains a length of ten feet, and its material is susceptible of a higher polish than any other ivory. It is easily dyed, and on this principle is founded the test for distinguishing it from the vegetable ivory, from which so many small articles are manufactured and sold as real ivory. If concentrated sulphuric acid is applied to the vegetable imitation it will at first turn pink, then a splendid red, and finally almost purple, an effect which it will not produce on animal ivory.

H. E. P., *Minnesota.*—The most convenient way for you to ascertain the quality of gold alloys, is by test needles, fully described in vol. ii., page 251. You can also detect oroide, Milton gold, and all that class of fine brass, or bronze, by the use of a solution of the common bi-chloride of copper, which, if applied to gold, or gilt, or plated goods, produces no effect, but upon the compositions mentioned it gives a brown stain.

A Series of Alphabets, Designed as a Text-Book for Engravers and Painters of Letters. By Archibald McLees. New York: Ivison, Blakeman, Taylor & Co., 138 & 140 Grand street.

This work will supply a want long felt by unprofessional engravers. No thoroughly artistic text-book of this character has ever before been properly brought to their notice, but this series, embracing, as it does, all the various kinds of lettering that can be desired, needs but to be seen to be appreciated.

The American Watchmaker's, Jeweller's, and Silversmith's Journal. New York: Shaw & Co., 41 Park Row.

This new claimant for trade favor makes its appearance in a very attractive costume. Its numbers, thus far, show excellent promise of special attention to the æsthetic branch of these kindred arts. It makes no distinctive claim as a practical instructor, but as an exponent of correct taste in styles it bids fair to take a rank second to none. It must succeed if interesting matter, elegant diction, and the highest style of typographic art can command success.

EQUATION OF TIME TABLE.

GREENWICH MEAN TIME.

For June, 1872.

Day of the Week.	Day of Mon.	Sidereal Time of the Semi-diameter Passing the Meridian.	Equation of Time to be subtracted from / added to Apparent Time.	Diff. for One Hour.	Sidereal Time or Right Ascension of Mean Sun.
		S.	M. S.	S.	H. M. S.
Saturday	1	68.44	2 25 26	0.383	4 41 6.07
Sunday	2	68.50	2 15.8[illegible]	0.400	4 45 2.63
Monday	3	68.55	2 6 08	0.416	4 48 59.19
Tuesday	4	68.60	1 55.93	0.431	4 52 55.75
Wednesday	5	68.64	1 45.41	0.445	4 56 52.30
Thursday	6	68.69	1 34.55	0.457	5 0 48.86
Friday	7	68.73	1 23.41	0 470	5 4 45.42
Saturday	8	68 77	1 12.00	0.481	5 8 41.98
Sunday	9	68.80	1 0.34	0.491	5 12 38.54
Monday	10	68.83	0 48.43	0.500	5 16 35.09
Tuesday	11	68.86	0 36.32	0.508	5 20 31.65
Wednesday	12	68.89	0 24 05	0.516	5 24 28.21
Thursday	13	68.91	0 11 62	0.522	5 28 24.77
Friday	14	68.93	0 0.94	0.526	5 32 21.33
Saturday	15	68.95	0 13.61	0.530	5 36 17.88
Sunday	16	68.96	0 26.37	0.534	5 40 14.44
Monday	17	68.97	0 39.21	0.537	5 44 11.00
Tuesday	18	68 97	0 52.10	0.538	5 48 7.56
Wednesday	19	68.97	1 5 00	0 538	5 52 4.12
Thursday	20	68.97	1 17.91	0.538	5 56 0 68
Friday	21	68 97	1 30 80	0.538	5 59 57.24
Saturday	22	68.97	1 43.68	0.536	6 3 53.81
Sunday	23	68.96	1 56 48	0.533	6 7 50.35
Monday	24	68 95	2 9 22	0.530	6 11 46.91
Tuesday	25	68.93	2 21 86	0 525	6 15 43.47
Wednesday	26	68.91	2 34.40	0 520	6 19 40.03
Thursday	27	68 89	2 46 81	0.514	6 23 36.58
Friday	28	68.88	2 59.06	0.507	6 27 33.14
Saturday	29	68.85	3 11 13	0.499	6 31 29.70
Sunday	30	68 81	3 23.00	0.490	6 35 26.26

Mean time of the Semidiameter passing may be found by subtracting 0.19s. from the sidereal time.

The Semidiameter for mean noon may be assumed the same as that for apparent noon.

PHASES OF THE MOON.

		D. H. M.
●	New Moon	5 15 23.5
☽	First Quarter	13 19 19 1
☺	Full Moon	20 18 58.0
☾	Last Quarter	27 9 27.6

		D. H
☾	Apogee	9 3 4
☾	Perigee	21 16.2

Latitude of Harvard Observatory .... 42° 22′ 48″.1

		H. M. S.
Long.	Harvard Observatory	4 44 29.05
	New York City Hall	4 56 0.15
	Savannah Exchange	5 24 20.572
	Hudson, Ohio	5 25 43.20
	Cincinnati Observatory	5 37 58.062
	Point Conception	8 1 42.64

	D.	APPARENT R. ASCENSION. H. M. S.	APPARENT DECLINATION. ° ′ ″	MERID. PASSAGE. H. M.
Venus	1	3 47 56.96	+19 9 45.6	23 7.9
Jupiter	1	8 0 52.93	+21 5 38.7	3 19.4
Saturn	1	19 28 22.35	−21 37 38.1	14 44.7