

who may unfortunately be within earshot of that noise. They say about the bell-ringers

“Disturbers of the human race,
Your bells are always ringing.
We wish the ropes were round your necks
And you upon them swinging.”

On the other hand, when we hear

“A chime of good bells,
How many a tale their music tells,
Of youth, and home, and that sweet time
When first we heard their soothing chime.”—MOORE.

ERRATUM.—In the article on “Bells,” in the preceding number of the JOURNAL, the word *treble* is printed *triple*.

ELECTRIC CLOCKS AND TIME TELEGRAPHS.

By LOUIS H. SPELLIER.

[Abstract of a Paper read at the Stated Meeting of the Franklin Institute, May 17, 1882.]

Two years ago I read a paper before the Institute on the subject of “Electro-magnetic Time Telegraphs,” or electric clocks that receive the time telegraphed in certain intervals from a weight or spring clock.

I then stated that “they mainly depend upon the action of one electro-magnet and one armature.” The latter is a piece of iron which is attracted by the poles of the electro-magnet, when the telegraphing clock completes the circuit of a galvanic battery connected with it. As soon as the clock breaks the circuit again, the armature is repelled to its former position by a spring or weight. This movement of the armature turns a wheel which drives time-indicating machinery, and is repeated as often as this machinery requires to indicate the time of the clock, which makes or breaks the electric circuit.

Such instruments work very well, if the action of the armature is needed about once every minute, but if repeated every second or two, then its imperfections become apparent. The movement of the armature is sudden and rapid. With a lightning-like velocity the armature moves toward the magnet, and is checked instantaneously in its rapid progress just at a time when nearest to the magnet and most powerfully

attracted. Naturally the wheel, which receives its impulse directly from the armature, moves with the same rapidity and is checked as suddenly. These sudden checks, offered to the armature and wheel, show their damaging results in a short time, and soon impair the correctness of such instruments.

These clocks, as a rule, soon get out of repair, as may be seen by those in use at the Pennsylvania Railroad Depot in this city. Their noise resembles that of a hammer striking forcibly upon an anvil and it is only surprising that they run as long as they do.

To meet the above-mentioned faults of electric clocks is the purpose of the device of my electro-magnetic escapement, of which I exhibited

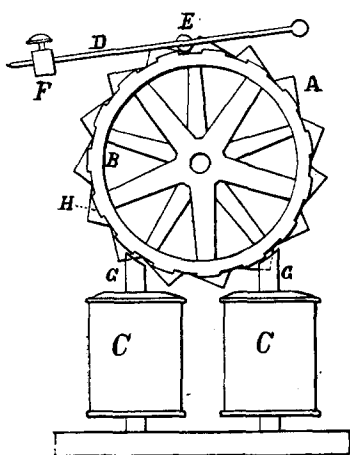


FIG. 1.

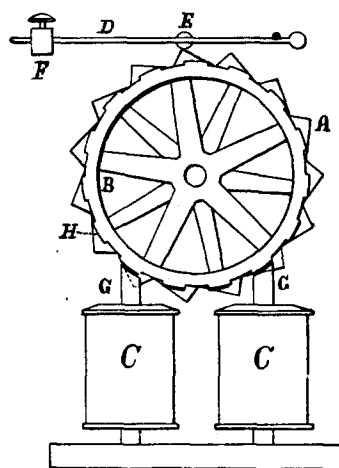


FIG. 2.

here my first model about two years ago, and which is, indeed, the only second system of time telegraphs that is new in its fundamental principle that has been invented in almost half a century.

With the aid of the accompanying cuts, Figs. 1 and 2, which show the principle of my electro-magnetic escapement in its two main positions, I will be able to explain the manner in which I have corrected these evils by the invention of my system. Referring then to Figs. 1 and 2, *G* is the electro-magnet, *B* is an iron wheel that has on its circumference the projections *H*. Those projections are armatures. Fastened to the same axle with this iron wheel is the escape wheel *A*, with the peculiarly shaped cog shown in the drawing. *D* is a lever

with an adjustable weight at *F*, and presses by means of the pulley *E* on its circumference and rests at the bottom of the cog, when the electro-magnet is not charged with magnetism. When in that position, as shown by the drawing to the left, two of the armatures are very near to the poles of the electro-magnet.

At the moment when the electric current passes through the coil *C*, and the poles *G* become magnetized, the two armatures will be attracted and take their position right over the poles of the electro-magnet as shown by the drawing to the right.

The escape wheel *A* fastened to the same axle with *B* has moved with it and lifted up the lever *D*, and has in its movement gone so far as to allow the pulley *E* to glide over the point of the cog and keep its position, shown on the drawing to the right, until the electric circuit is broken again; then the poles *G* become demagnetized, the armatures are no longer attracted, and the wheels *A* and *B* move under the pressure of the pulley until it has reached the bottom of the cog. By this movement the next succeeding two armatures have taken their position shown to the left, again ready to be attracted at the next closing of the electric current. In this manner is produced, by alternately opening and closing the circuit, a step-like movement of *A* and *B*. You will perceive that the object aimed at to avoid violent checks of the armature is completely achieved. Another advantage of no less significance is gained, namely, that it is impossible for the escape-wheel to move without an extra provision, at any given impulse, more than one cog.

Before I show the application of my escapement to time telegraphs I will explain the manner in which I make and break the circuit by means of a weight clock, in order to transmit the time to the electro-magnetic escapement. This current-breaker, Plate I, Fig. 1, I have found to be very effective. *B* is a metal disk fastened to the axle of the escape-wheel of a clock. It has platinum pins vertically upon its face. *C* is another smaller platinum disk fastened to the pin-bearing disk, *b* and *b'* are two springs with platinum terminations. The spring *b* rests on the platinum disk, while *b'* forms the contact with the platinum pins.

When the disk moves with the escape-wheel of the clock it will complete the circuit of the galvanic battery, whenever the spring *b'* comes in contact with one of the pins, and when the spring is removed from the pin, the circuit is broken.

I found this current breaker fully to answer its purpose and to meet

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all the requirements. It prevents by means of friction all accumulation of dust and oxidation and keeps the contact surface bright.

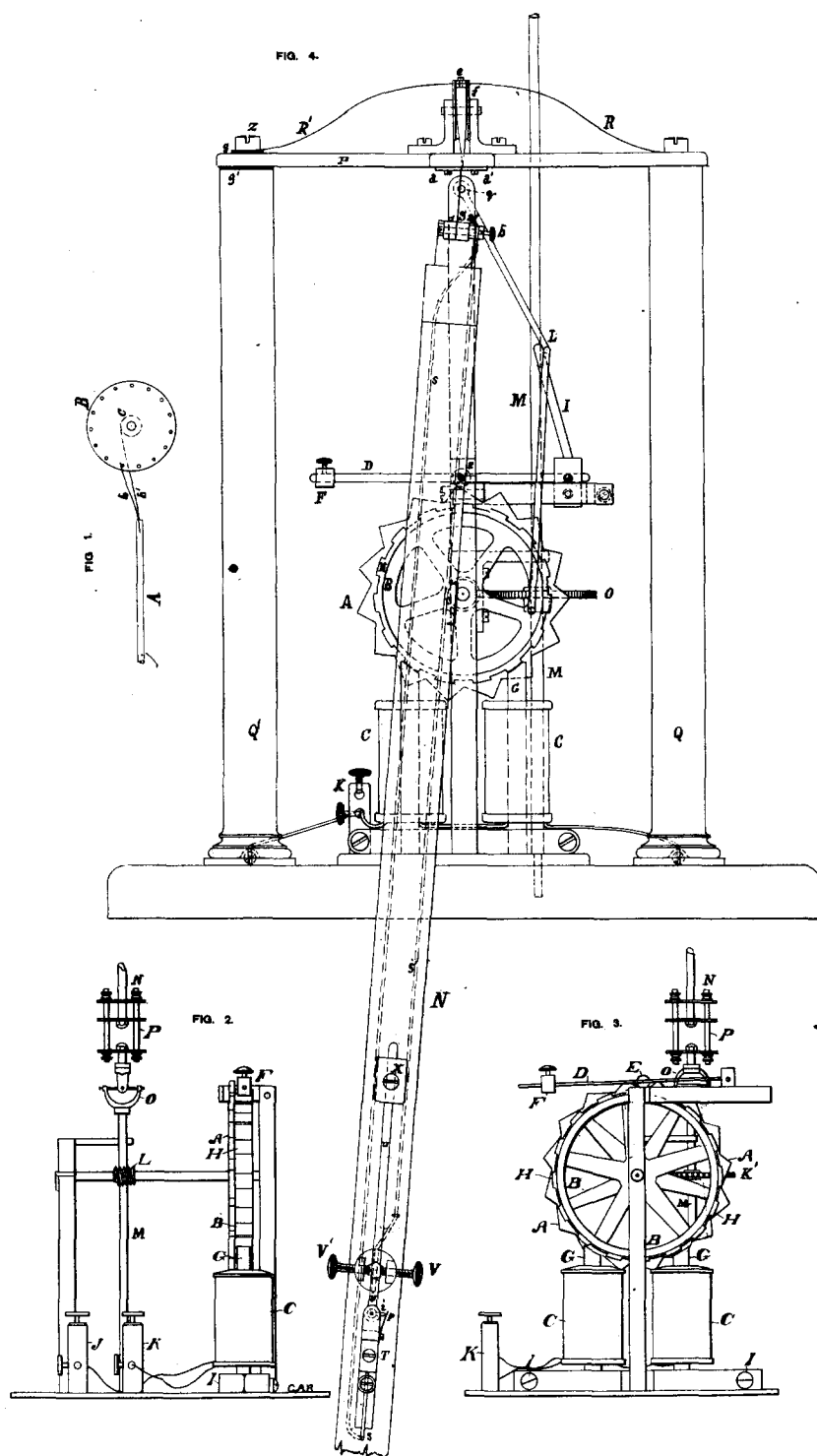
The best clocks for making the contact for time telegraphs are undoubtedly those provided with a gravity escapement invented by Edmund Becket. Clocks with gravity escapements allow an increase in the weight of the clock to such an extent as is needed for a secure metallic connection of this contact-breaker without affecting perceptibly the impulse given to the pendulum.

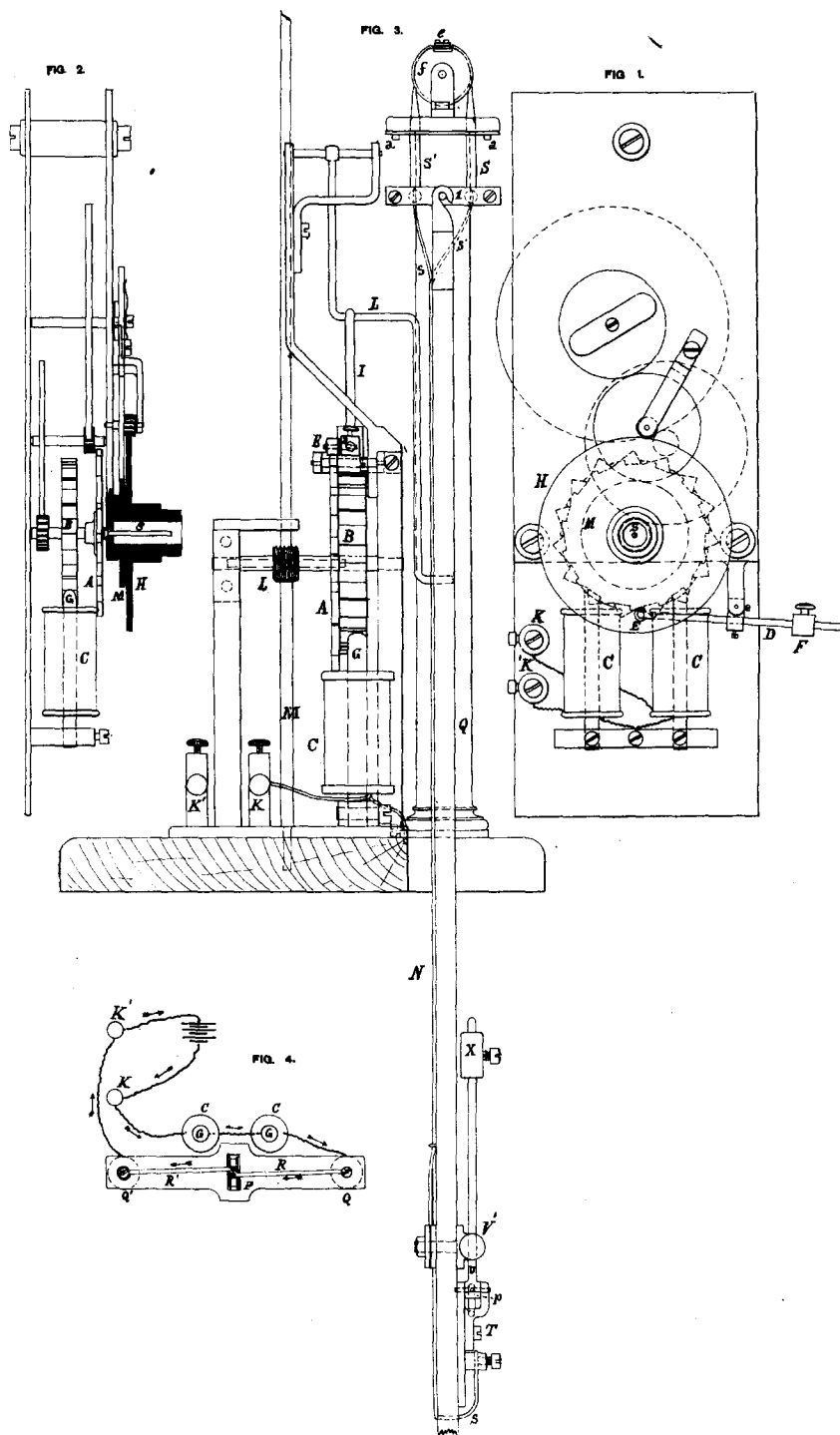
I will now show the construction of my time telegraphs for two different purposes; one kind is intended for different apartments of any building, and the other for public clocks only.

Of the first-mentioned clock I have six in operation here in our lecture-room, and their construction is shown in Figs. 1 and 2, Plate II. This is the clock with a centre or sweeping second-hand, of which I possess but one specimen. The figures show a front and side view of it, and it will at once be recognized that *GC* is the electro-magnet, *A* the escape-wheel, and *B* the iron wheel with its projecting armatures. *D* is the pressing lever with its pulley *E*, and *F* the adjustable weight.

It is unnecessary to explain the action of the escapement again, nor to explain the purpose of every wheel, but I will merely state that *H* is the wheel that carries the hour hand, *M* the minute hand, and *S*, the extended pivot of the escape-wheel axle, is to receive the second-hand.

The electric current acts in these clocks once in every *four* seconds, and if the duration of the current is that of two seconds, the second-hand will execute the movements of a clock provided with a two second-beating pendulum. If, however, the circuit is closed once in four seconds for a time just long enough to allow the attracted armatures to take their proper position over the poles of the magnet, for which a fraction of a second is fully sufficient, it is evident that a great saving of electrical force is gained, and the battery employed will need a less frequent attention. The duration of the current can be easily regulated by adjusting the contact spring *b'* of the current-breaker. If the spring is set more or less deeply into the circle of the contact-pins, a contact of longer or shorter duration between spring and pins will be effected accordingly. The escape-wheel has a diameter of two and three-eighths inches, while that of the armatures has a diameter of two and one-eighth inches. The dial of the clock has a diameter of two feet. It can be made, however, two feet and a half





without overtaxing the small escapement with more work than it can perform.

I have been running two of these clocks with one callaud. To make it secure, however, one callaud should be used for each clock. The clocks run very easily and lightly. I direct attention on this point to the clock with centre second-hand here in operation. In order to perceive its beat, it is necessary to bring the ear close to it, when a muffled pulsating sound will be perceived. In this respect my time telegraphs are in striking contrast with those of the old system.

While the latter are the most noisy clocks ever made, mine will prove to be the most noiseless of any clocks invented for their size, the pneumatic clocks, perhaps, excepted,—an advantage very desirable in hospitals, where the very tick of a clock in a sick room will annoy the nervous patient.

I have made the escape-wheels of hard rubber or vulcanized fibre, which makes them very light and easily movable.

The fact that second-beating time telegraphs have been of such a self-destructive nature has driven them almost entirely out of use. In some of the principal cities of Europe electrical clocks are quite common, but the mode of moving the hands once in a minute is generally adopted. This is the case, for example, with the very perfectly arranged series of clocks in the city of Geneva, built at the expense of the city government, and constructed by the eminent electrician, Dr. Hipp. There the time is telegraphed every minute to the watch and clock makers of the city from the astronomical observatory.

The necessity, therefore, of moving the hands once in a minute instead of every second (in order to avoid the early destruction of the mechanism) is avoided by the invention of my escapement, since it moves as lightly as the escapement of any weight or spring clock, and I think with its application a successful future is secured for the time telegraph. If time telegraphs are once made a success, then their advantages are too apparent to need much demonstration. Good time-pieces are exceedingly costly. The city of Paris, which adopted the mode of setting ordinary spring or weight clocks throughout the city through the medium of electricity, has paid for the thirteen clocks employed to do that work from \$450 to \$500 each.

Institutions that desire correct time in every room of their buildings,

may have it wherever it is desired at a comparatively small expense with one good clock and the use of a well-working time telegraph.

But there is still another field open in which a successful time telegraph can be of great service to the public in general; I mean its application to public clocks of any dimensions. "It has become a problem of great perplexity to this day with the most ingenious minds of the horological world to construct clocks which will overcome the effects of wind and storm beating against the exposed clock dials of public clocks, forcing the hands in one or other direction; and here I think it is that the time telegraph has its future. A good and well-regulated clock, kept at a place of no great change of temperature, will show but very little variation in time. If such a clock controls a time telegraph adapted for tower and other public clocks, it will show the time with only such slight variation as will hardly be noticed by the public."

I have constructed time telegraphs for this purpose and I think with full success. Not very long ago one of our daily papers stated that the reason why they had not an electric clock in the tower of the new building of the Pennsylvania Railroad depot was, that they could not get an electro-magnet strong enough to move the hands! There are plenty of electro-magnets strong enough to do it, but they had no electric clocks of such construction as to answer the purpose.

I have here a time telegraph constructed for the purpose of indicating time on public clocks. It is not large enough to fill a good size pocket, and yet almost sufficient to do the very work. They could not find an electro-magnet powerful enough, and yet the electro-magnet of this instrument I have here is rather small. The diameter of its iron core is but five-sixteenths of an inch, and the escape-wheel belonging to it is only three inches and a quarter in diameter. It is only necessary to add one-third to its size in order to make it of sufficient strength to do the work required of the clock in the tower of the Pennsylvania Railroad depot. A time telegraph for public purposes is here in operation and may be examined after the meeting. Its construction is shown in Plate I, Figs. 2 and 3.

The escapement will be readily recognized, and but very few words will be needed to explain its operation. Fig. 2 shows a side and Fig. 3 a front view. The side view will show that escape-wheel *A* and that of the armature are closely fitted together. The axle has a screw at *L* that moves the wheel *K* on the upright standing axle *M* forming

with *K* an endless screw ; if we now connect the axle *M* with the shaft *N* leading to the dial works of a clock dial you will readily understand that all that is now necessary is to make and break the electric circuit connected with the time telegraph and the electric battery as often as is needed for the proper movement of the clock hands.

I have now shown the application of my electro-magnetic escapement on time telegraphs, and I will close that subject by reading to you the opinion given in a report of the Committee on Science and the Arts of this Institute, to whom my escapement was referred for examination. On the merits of the escapement the report reads as follows :

“The principal object we think worthy of commendation is the very ingenious escapement which entirely avoids any sudden jar (for there is no impact) and works smoothly and noiselessly and practically with the least possible friction.

“Believing that the time is not far distant when it will be necessary to transmit time from a standard clock to different points in a large city, or in hotels, factories or dwelling houses, there are no means by which it can be done as cheaply, quickly and accurately as by electricity, and there is no device that promises to do it so well, that we have yet seen, as Spellier’s Electro-magnetic Time Telegraph. As we think Spellier’s invention such a great step in advance that it merits the warm approval and commendation of the Franklin Institute, we recommend that he be awarded the Elliot Cresson Gold Medal ;”—and I hope the result of my efforts has vindicated their anticipations.

I now come to a subject of less general interest, but of not less importance, that of real electric clocks, where the moving power of the whole mechanism is electro-magnetism only. I called such clocks in my paper two years ago more of a scientific curiosity than a useful invention ; and yet some of the most prominent philosophers and mechanicians have devoted their time and genius to their construction to make them correct time-pieces. The first who constructed such clocks was Bain, about 45 years ago. At present the clocks of Dr. Hipp seem to take the lead, but although he claims great accuracy for them, they seem not to sustain the claim in every instance. One small specimen of his clocks is exhibited in the window of Mr. Thomas Shaw, Ridge avenue, above Ninth street, of our city. In principle I think it to be a step backwards, as it is but a modified and improved clock of the Bain type.

There are three main difficulties in the way of making electric pendulum clocks a success.

They are, first, the variation of the strength of the electric current of galvanic batteries ; second, the danger that the current-breaker will not make a sufficiently secure contact for the passage of the electric current, since the contact is made by the pendulum, which has not in all cases sufficient surplus of power to make a secure contact ; and, third, the obstruction which the current-breaker offers to the pendulum in its oscillations. Therefore, electric clocks can only be a success when the above-mentioned difficulties are avoided. I think I have met the difficulties successfully by a clock exhibited here to-night, presently to be explained.

I shall first explain the current-breaker of my clock, and to show how far it differs from those employed up to this day I will introduce this explanation by a brief description of the current-breaker now in use at the astronomical observatory in Paris.

There the pendulum of the clock has two side-extending metal arms. Each of these arms is provided with three screws with platinum terminations. Three levers, separately movable, but in metallic connection, corresponding to the screws, will be either in contact with, or removed from the screws as the pendulum moves to and fro. The levers and the arms are inserted into the circuit of a galvanic battery and an opening and closing of the same, corresponding to the oscillations of the pendulum, will be effected. That the pendulum meets with a comparatively great obstruction in its movement by such a current-breaker cannot well be disputed, and yet the contact cannot be formed with a great deal of force to make it as secure as desired, since the levers have to be very light so that they will not obstruct the pendulum too much in its movements.

I now will show how I effect with a new device of a current-breaker a secure and firm contact, and yet at the same time allow the pendulum to follow the course of its oscillations without meeting with any obstruction. Plate I, Fig. 4, shows a front view of my electric clock, and Plate II, Fig. 3, a side view, in which *N* is the pendulum and *T*, *V* and *V'* its current-breaker. You see an upright standing lever, *U*, with a weight *X* on the top. Near its fulcrum are two screws *V* *V'*, against the one or the other the lever will rest, if the pendulum is out of its vertical position to one side or the other. Two electric wires, *s s'*, coming down the pendulum rod are in metallic connection with

the two suspension-springs $S S'$; both springs are fastened together at e' by an insulated substance, and each of these suspension-springs is again connected with its corresponding spring $R R'$. Now let the poles of the galvanic battery be connected with the springs $R R'$, and set the pendulum oscillating. If the pendulum has its present position, the lever U rests against the screw V , and forms a metallic contact with the screw. The screw is connected with one of the wires coming down the pendulum rod from one of the suspension-springs, and the lever is again connected with the other wire coming from the other suspension-spring, so that the electric current can pass through the contact made by the lever U and the screw V . If the pendulum has its position on the opposite side, the lever will bear against the screw V' . This screw has an insulating substance upon its termination that keeps the circuit broken. Thus, by the movements of the pendulum to and fro the lever U will bear against one or the other screw and make and break the electric circuit. The fall of the lever from one to the other screw is so small that it needs very careful watching to perceive it. The contact formed proves to be secure. It is made with a great deal of force, since it is formed very near the fulcrum of the lever. You will observe that this simple contrivance of my current-breaker removes two of the principal difficulties which electric clocks have to combat with. It now remains to show how I made the impulse given to the pendulum for its movements independent of the strength of the electric current acting upon the electro-magnet of the clock. The springs $R R'$ are connected with the electro-magnet and inserted into the circuit of the galvanic battery. You see in the drawing fastened to the axle of the lever D that moves the escape-wheel, an arm I . Against this arm rests the lever L with its fulcrum at q . The extension of this lever touches the pendulum, while resting on the arm I , when the pendulum hangs in its vertical position.

Now if the pendulum is moved to the left, as it is shown in Plate I, the lever of the current-breaker will bear against the screw V , and close the circuit. The armatures nearest to the magnet are attracted, and the lever D that moves the escape-wheel is raised, and with it the arm I is moved, which in turn raises the lever L ; there it remains until the pendulum has taken its position to the right. Then the lever of the current-breaker drops against the insulated screw V' , and the circuit is broken, then the lever D suddenly drops down, moving the escape-wheel, while the lever L drops against the pendulum and the

pressure of its weight gives the pendulum the impulse for its oscillations. This action of the mechanism is repeated as the pendulum swings to and fro. If we now consider that the lever is always lifted up to the same height, and its weight is not subjected to any changes, the power, acting upon the pendulum to keep up its oscillations, must be the same at every impulse given, without regard to the attracting force of the electro-magnet. It will be seen that this electric clock makes a firm contact for the electric current to pass; and that it does not obstruct the pendulum in the course of its movements, and also that it makes the movements of the pendulum independent of the strength of the galvanic current. This, I think, embraces all the elements necessary for a true time-piece.

Some few words are in place regarding some details of the clock, to make the entire mechanism understood.

Two hard rubber plates, g and g' are essential to insulate the metal plate P from the screw Z and the post Q , to prevent the current from going directly through the plate P from Q to Q' , in which case the current would escape the passage through the current-breaker, and the circuit would be continuously closed.

To avoid the passage of the current through the holes in which the pivots of the lever U move, a spring, p , is fastened to the support of the lever, pressing against a platinum pin, i , at the axle of the lever.

The pendulum suspension of this clock is made according to the principle of my suspension as described in the JOURNAL OF THE FRANKLIN INSTITUTE for July, 1880, to which I must refer for its object and detailed construction. Here it is necessary to state that the pulley f , over which the suspension-springs S S' are laid, is of hard rubber, to keep the springs insulated. 1 and 2 are two bars, also of hard rubber, which support the pendulum, and between which the two ends of the suspension-springs are fastened. The plates a and a' are of the same material and are used to hold the suspension-springs in their proper positions.

The clock, shown in the plates, has an escapement of the same dimensions as the time telegraph for public clocks already described, and is otherwise like it in all its details. It is the first one built, and mainly made to establish its principle. I had attached to it four dials, three feet in diameter, with a battery of three callauds. They can, of course, be made of very small dimensions, and will then require but little battery power to keep them going.

The course of the electric current is indicated by the arrows on the ground plan, Fig. 4, seen below the side view in Plate II.

Now, a few words in conclusion, of the utility of the electric clocks, before I close. They will hardly ever come into general use, and always be a costly novelty for those who desire to have them. If we, however, succeed in constructing correct electric time-pieces, they may become of great value in astronomical observations. The astronomer, while making his observations, listens to the beats of his pendulum clock. The beats of an electric clock are louder and more perceptible than weight clocks, and therefore, more desirable, if correct. But that is not all. We know that the density of the atmosphere is subject to constant changes. The resistance of the pendulum, therefore, through the air will vary with its density, and so disturb, although slightly, the regularity of its movements. This can be avoided with electric clocks by closing them in hermetically closed glass cases with greatly rarified air, and, indeed, a great many clocks exhibited at the last Paris Exposition were provided with this precaution. Among others, those of Dr. Hipp were most numerously represented, but since the barometrical error of pendulum clocks is so slight, and the oscillations of the pendulum on Hipp's clocks not only are greatly obstructed by his manner of forming the contact (although admirably ingenious), but still more by the fact that his pendulum works in reversed order (moving the clock train), it is hard to see how the removal of the slight barometrical error will compensate for the faults his clocks are subject to; unless it is taken as a suggestion for a more perfect clock for the future. There is certainly plenty of reasons for the doubtful reception these clocks have received at the hands of some of our prominent philosophers, and of which Dr. Hipp so greatly complains.*

The perfection of electric clocks, however, should receive its full share of attention and encouragement, for the service they may render at astronomical observatories, for reasons already stated. But such work should not be expected from the enterprise of individuals. It properly belongs to the government, which should always furnish the standards for the use of all the people.

* See *Electrotechnische Zeitschrift*: Berlin, 1881, page 102.