(No Model.)

G. W. MILLARD & J. H. CLARKE.

MEANS FOR REGULATING PENDULUM CLOCKS FROM A DISTANCE.

No. 337,416. Patented Mar. 9, 1886.

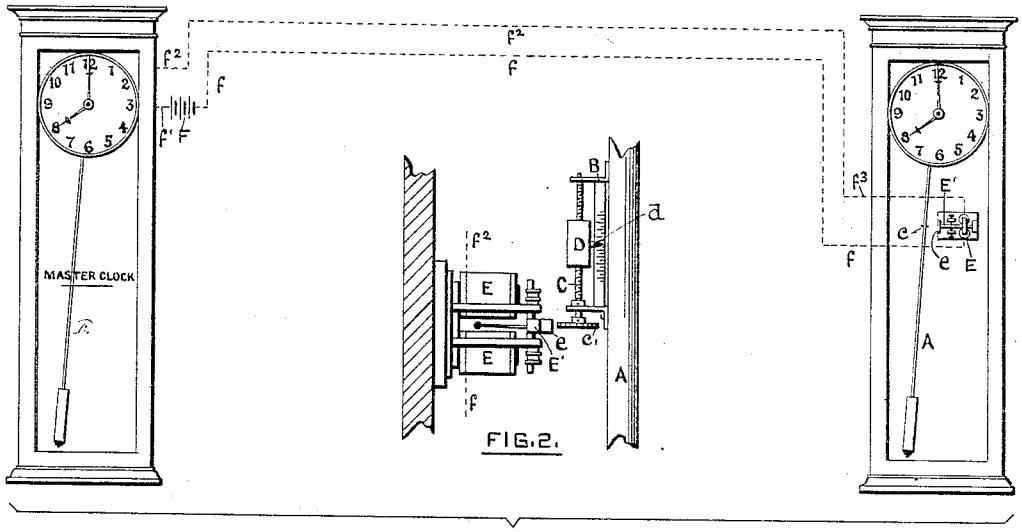

FIG. 1.

FIG. 2.

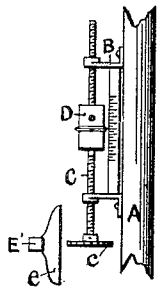

FIG. 5.

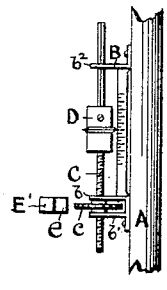

FIG. 6.

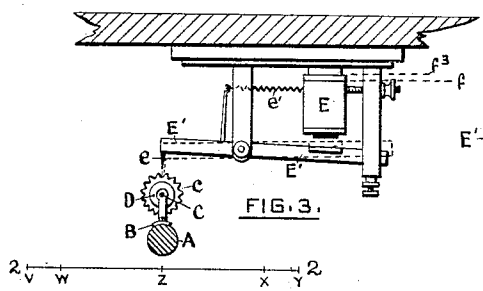

FIG. 3.

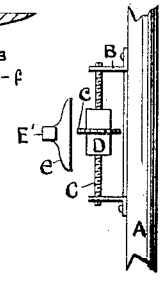

FIG. 7.

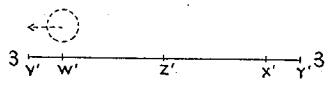

FIG. 4.

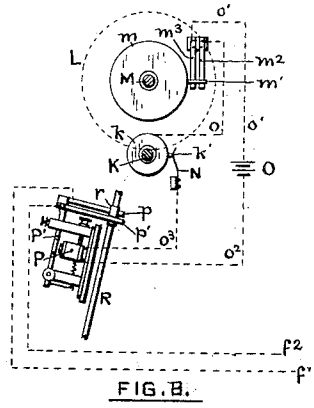

FIG. 8.

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UNITED STATES PATENT OFFICE.

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MEANS FOR REGULATING PENDULUM-CLOCKS FROM A DISTANCE.

SPECIFICATION forming part of Letters Patent No. 337,416, dated March 9, 1886.

Application filed November 10, 1884. Serial No. 147,568. (No model.)

To all whom it may concern:

Be it known that we, GEORGE W. MILLARD and JOSEPH H. CLARKE, both of the city and county of Providence, and State of Rhode Island, have invented a new and useful Improvement in Regulating Pendulum-Clocks from a Distance; and we do hereby declare the following specification, taken in connection with the accompanying drawings, forming a part of the same, to be a description thereof.

This invention relates to the regulating of pendulum-clocks at a place distant from the location of the clocks; and it consists in the employment of mechanism located upon the pendulum for raising and lowering the center of oscillation thereof, and means which can be worked from a distance to operate said mechanism, as hereinafter described and claimed.

The invention is applicable to pendulum-clocks or "regulators" in general—such, for instance, as those in which a spring or weight is employed as a motive-power—to that variety for which a galvanic battery or electric current is the power used to secure a continuous vibration of the pendulum, and also to that class in which an electric current and springs are employed to keep the pendulum in motion.

In clocks as ordinarily constructed the center of oscillation of the pendulum may be changed by raising or lowering the "bob" of the pendulum; or it may be accomplished by raising and lowering a supplemental weight upon the pendulum-rod.

In governing and effecting the regulation of a clock or a series of clocks at a place distant from the location of said clock or clocks, we design and prefer to employ a master-clock, which shall automatically govern the regulation of said clock or clocks, although such regulation may be secured by hand, if desired, at such distant place.

As a motive power for operating or bringing into position the means which operate the mechanism for raising and lowering the center of oscillation of the pendulum, we prefer to employ an electric current automatically applied by the master-clock, although a pneumatic or other mechanism automatically brought into action by the master-clock, or even mechanical means (if the clocks to be regulated be not too far distant from the master-clock) may be used.

In the accompanying drawings, Figure 1 shows in elevation a master-clock and a secondary clock, which it is desired shall keep the same time. Fig. 2 represents, on an enlarged scale, a side view of a portion of the pendulum of the secondary clock with a movable supplemental weight thereon, suitable means for raising and lowering said weight, and an electro-magnet to be operated in connection therewith. Fig. 3 shows the pendulum-rod in transverse section, and a top view of said mechanism, together with a line presenting the chord of an arc of the pendulum movement. Fig. 4 shows a line representing the chord of an arc, in which the pendulum of the master-clock swings. Figs. 5, 6, and 7 represent various arrangements of the movable weight and mechanism on the pendulum-rod. Fig. 8 shows an arrangement to be combined with the master-clock for applying the electric current every ten minutes and keeping the circuit closed for half a second.

A is the pendulum of the secondary clock—that is, the clock to be regulated—which vibrates preferably in the same time as that of the master-clock. To the pendulum A is secured a frame, B, Fig. 2, in which a screw, C, is mounted to rotate axially without being itself raised or lowered with relation to said frame, and said screw has a toothed wheel, *c*, secured at one of its ends.

D is the movable supplemental weight, which is threaded upon the screw C, so as to be raised and lowered thereby, and is preferably provided with a finger, *d*, which forks the upright portion of the frame B, so as to prevent the weight from rotating with the screw, and in connection with a scale on said upright portion of the frame B, showing variations in the position of said weight longitudinally of the pendulum.

E is an electro-magnet secured to the case of the secondary clock, the armature-bar E′ of which is furnished with a projecting tooth or plate, *e*. The normal position of this tooth *e* is out of the path of movement of the toothed wheel *c*, so as not to engage the same during

the swinging of the pendulum, and said tooth is retained in such position when the electric current is not flowing by a spring, *e'*.

From one of the coils of the electro-magnet E a wire, *f*, Fig. 1, extends to a galvanic battery, F, and from said battery a wire, *f'*, extends to and is connected with any suitable mechanism for closing the electric circuit, which mechanism is intended to be attached to the master-clock, and to be automatically operated by said clock, so as to apply an electric current for a short space of time to the magnet E and close its armature, thereby bringing the tooth *e* on the armature-bar E' into the path of movement of the toothed wheel *c*, so that said tooth may engage said wheel and turn it in one of two directions, if the secondary clock be faster or slower than the master-clock within certain limits, as will be hereinafter explained. From said circuit-closing mechanism the wire f^2 may extend to join the wire f^3, connected with the remaining coil of the magnet E, thereby forming a "metallic circuit," (or both of said wires may be "grounded,") if but one secondary clock is to be regulated; or said wires may form part of a circuit in which are located the electro-magnets of other secondary clocks of a series, if more than one clock is to be regulated, in a manner well understood by electricians.

The secondary clock having first been regulated in any preferred manner to keep, as nearly as possible, correct time, or the time of the master-clock, the secondary clock is set to the time of the master-clock, and the pendulum of the former is set swinging substantially synchronously with that of the latter. The magnet E is then connected electrically with the circuit-closing mechanism of the master-clock.

The pendulums of the two clocks shown in the drawings are supposed to beat seconds of time; and the lines 2 2, Fig. 3, and 3 3, Fig. 4, represent chords of arcs in which such pendulums swing. The time-distance on said lines between the points V W V' W' and X Y X' Y', respectively, is one-fourth of a second, and the time-distance between the points W Z W' Z' and X Z X' Z', respectively, is also one-quarter of a second. The tooth *e* of the armature-bar E' is located opposite to the point Z, as shown in Fig. 3.

It is designed that the electric current be applied to the magnet E once in, say, ten minutes, and that the electric circuit shall remain closed for half a second. Various arrangements may be employed for accomplishing this, one of which is shown in Fig. 8. In said figure K denotes the scape-wheel arbor of the master-clock, which arbor has a pinion meshing into a gear-wheel, L, (shown by dotted circle,) on the arbor M. The arbor K makes one revolution in a minute, and the arbor M revolves once in, say, ten minutes. The arbor K is provided with a disk, *k*, fixed thereto and insulated therefrom, and having a spur, *k'*, which spur for two seconds during the revolution of the disk *k* is in contact with a spring, N. The arbor M is furnished with a disk, *m*, fixed thereto and insulated therefrom, and having a spur, *m'*, which spur for several seconds during the revolution of the disk *m* is in contact with two springs, m^2 m^3, electrically insulated from each other. The disk *k* and spring m^2 are electrically connected by a wire, *o*, or other suitable means, and the spring m^3 is connected by a wire, *o'*, to a local battery, O. This battery and the spring N are respectively connected by wires o^2 o^3 to an electro-magnet, P, the armature-bar P' of which bears two very flexible springs, *p p'*, insulated from each other. These springs are respectively connected to the wires f' f^2, Fig. 1. The springs *p p'* are separated laterally, so as to allow the pendulum-rod R, Fig. 8, of the master-clock to swing between and in contact with them, and said pendulum-rod is provided with a metallic ring or ferrule, *r*, to electrically connect said springs when they are brought into the path of movement of the rod.

It is designed that the electric current be applied to the magnet E of the secondary clock at a time when the pendulum of the master-clock is at a point in its arc of movement indicated by the point W' on the chord 3 3, Fig. 4, and is swinging toward the point V', as indicated by the dotted circle and arrow. The springs m^2 m^3, Fig. 8, are arranged with relation to the revolving spur *m'* so that the latter will engage said springs one or more seconds before the electric current is to be applied to the magnet E, and will remain in engagement for a few seconds after said current is applied. The spring N is arranged with relation to the revolving spur *k'* so that the said spur will engage said spring a second before the current is to be applied to the magnet E, and will remain in engagement therewith two seconds. The engagement of the spur *m'* with the springs m^2 m^3 and the spur *k'* with the spring N closes the circuit from the battery O through the magnet P, and causes the armature thereof to be drawn down, and the springs *p p'* to be brought into the path of movement of the pendulum-rod R, the ring *r* on said rod coming in contact with said springs at the time when the pendulum is in the position indicated in Fig. 4, and remaining in contact therewith during the time it is swinging from W' to V' and from V' to W'—that is, for half a second. Before the pendulum R of the master-clock again returns to the point W' the spur *k'* has passed out of engagement with the spring N, and the springs *p p'* have been retracted out of the path of movement of the pendulum-rod by the rearward movement of the armature-bar P', and the circuit through the battery O and magnet P will not be closed again for ten minutes—that is, until the spur *m'* again engages the springs m^2 m^3.

With great care the current may be applied to the magnet E for regulating purposes by

hand mechanism—that is, by the use of an ordinary telegraph-key connected to the wires f' f^2, Fig. 1—as will be readily understood.

The application of the electric current to the magnet E closes its armature, and brings the tooth *e* into the path of movement of the wheel *c*, where the tooth is held for half a second. So long as the secondary clock is less than one-fourth of a second slower than the master-clock the wheel *c* will not be engaged by the tooth *e*, for the said wheel will be between the points Z and W, and will be moving toward the latter point. When, however, the secondary clock gets more than one-quarter of a second slow, the wheel *c* will be engaged by the tooth *e* as said wheel moves to the left toward the point Z, and the wheel will be turned toward the right, thereby raising the weight D on the pendulum A, and elevating the center of oscillation of the latter, and causing said pendulum to increase its rate of movement. So long as the pendulum A remains sufficiently slower than that of the master-clock to bring the wheel *c* into engagement with the tooth *e*, said wheel will be turned from time to time until the pendulum A is less than one-fourth of a second slow.

If the pendulum A be less than one-fourth of a second fast of the master-clock, the wheel *c* will not be disturbed by the tooth *e*, because the latter is withdrawn from the path of movement of said wheel at the end of a half-second, calculated from the position of the pendulum of the master-clock, as shown by the dotted circle and arrow in Fig. 4. If, however, the pendulum A be more than one-fourth of a second fast, then it will be between the points V W, and be swinging toward the right, and the wheel *c* will be engaged by the tooth *e* before the latter is withdrawn, thereby turning the wheel toward the left and lowering the weight D on the pendulum A, which operation lowers the center of oscillation and decreases the rate of movement of the pendulum. So long as the pendulum A is sufficiently faster than that of the master-clock to bring the wheel *c* into engagement with the tooth *e*, said wheel will be turned from time to time until the pendulum A is less than one-fourth of a second fast. From the foregoing it will be understood that the secondary clock will be kept within a fraction of a second of the master-clock at all times.

In place of mounting the weight D loosely on the screw C, as shown in Fig. 2, the said weight may be secured to the screw so as to turn therewith, as shown in Fig. 5, and said screw be threaded into the frame B, so that it will be raised and lowered relatively to the frame when the toothed wheel *c* is turned. If desired, also, the toothed wheel *c* may be threaded upon the screw C like a nut, and turn between arms $b\,b'$ of the frame B, as shown in Fig. 6, the weight D being secured to the screw, and the upper portion of the latter being made polygonal, so as to slide through the upper arm, b^2, of the frame B without rotating. The arrangement shown in Fig. 7 may also be adopted, the screw C being rigidly secured to the frame B, the weight D threaded upon the screw, and the toothed wheel *c* secured to the weight. The tooth *e* is made long enough to engage said wheel in any of its vertical positions.

If the bob of the pendulum of the secondary clock be light enough, it may be raised bodily by threading the equivalent of the wheel *c* as a nut on the pendulum-rod, which rod would then be the equivalent of the screw C, and by placing the magnet E so that the tooth *e* will engage said wheel and operate it, as hereinbefore described, as will be readily understood.

Although, as hereinbefore described, the electric current is applied to the magnet E when the pendulum of the master-clock is in that position of its arc of movement indicated by the point W′ on the chord 3 3, and is swinging as shown by the dotted arrow, yet the current may be applied when the pendulum of the master-clock is at the point X′ and swinging toward Y′. In such case the screw C should be provided with a left-hand thread. The current may also be applied at other points in the chord of the arc of movement of the master-clock pendulum, it only being necessary properly to locate the tooth *e* longitudinally of the chord 2 2, and to arrange the time during which said tooth shall remain in the path of movement of the wheel *c*.

If a series of clocks are to be regulated, the pendulum-rod of each is provided with a movable weight, a screw, and a toothed wheel, as hereinbefore described, and each clock is furnished with a magnet to operate a movable tooth, *e*. The magnets are connected to each other in a series, and the first and last of the series are electrically connected with a master-clock. When the electric current is applied by the master-clock, all the teeth *e* will be moved by the magnets into the paths of movement of the toothed wheels on the pendulum-rods, and all the clocks will be regulated as hereinbefore explained.

What we claim and desire to secure by Letters Patent, is—

1. The combination, with a pendulum of a clock, of suitable means, substantially as described, whereby its center of oscillation may be raised and lowered, suitable mechanism, substantially as described, for working the said means, and suitable means, substantially as described, for operating the said mechanism from a distance, whereby the pendulum may be made to take a gaining or a losing rate relatively to its prior performance, substantially as set forth.

2. The combination, with a clock to be regulated, of means, substantially as described, located upon the pendulum, whereby its center of oscillation may be raised and lowered, an electro-magnet, and a tooth, *e*, normally held out of position to engage the said means on the pendulum, and adapted to be moved by

said magnet into a position to engage the said means, as described, and a master-clock provided with suitable circuit-closing mechanism, as described, electrically connected with said magnet, whereby the tooth *e* may be brought into a position to operate the said means on the pendulum for changing its center of oscillation, substantially as set forth.

3. The combination, with a clock to be regulated, of a weight, D, screw C, and toothed wheel *c*, located upon the pendulum thereof, an electro-magnet having a tooth, *e*, on its armature-bar, which tooth is normally held out of position to engage the wheel *c*, and a master-clock provided with suitable circuit-closing mechanism, as described, electrically connected with said magnet and operated by said master-clock, whereby the tooth *e* can be brought into the path of movement of the wheel *c* at predetermined times, and be held in such position for a definite time, substantially as and for the purposes specified.

4. The combination, with the pendulum-rod A, of a weight, D, screw C, and toothed wheel *c*, a lever or bar having a tooth, *e*, which tooth is arranged, as described, so as to be brought into the path of movement of the wheel *c*, and suitable means, as described, for holding said tooth out of the path of movement of said wheel, substantially as set forth.

5. The combination, with a clock-pendulum, of a supplemental weight swinging therewith and adapted to be raised and lowered thereon, and suitable means, substantially as described, for raising and lowering the said weight, whereby the center of oscillation of the pendulum may be changed while the pendulum is in motion, substantially as set forth.

6. The combination, with a pendulum, of suitable means, substantially as described, whereby its center of oscillation may be raised and lowered, and suitable mechanism, substantially as described, normally held out of position to effect a change in the center of oscillation of the pendulum, and adapted, as described, to be moved into a position to cause such change, substantially as set forth.

7. In a system for regulating clocks, an electric circuit, a master-clock in said circuit, mechanism operated by the master-clock to close said circuit at predetermined intervals, one or more secondary clocks, also in said circuit, provided with mechanism actuated by changes in said circuit, whereby the center of oscillation of the pendulum of said secondary clock or clocks is raised or lowered, all substantially as described.

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Witnesses:
EDSON SALISBURY JONES,
HENRY J. STAPELTON.