(No Model.) 2 Sheets—Sheet 1.

E. G. HAMMER.

INDEPENDENT ELECTRIC CLOCK.

No. 444,433. Patented Jan. 13, 1891.

FIG. 1.

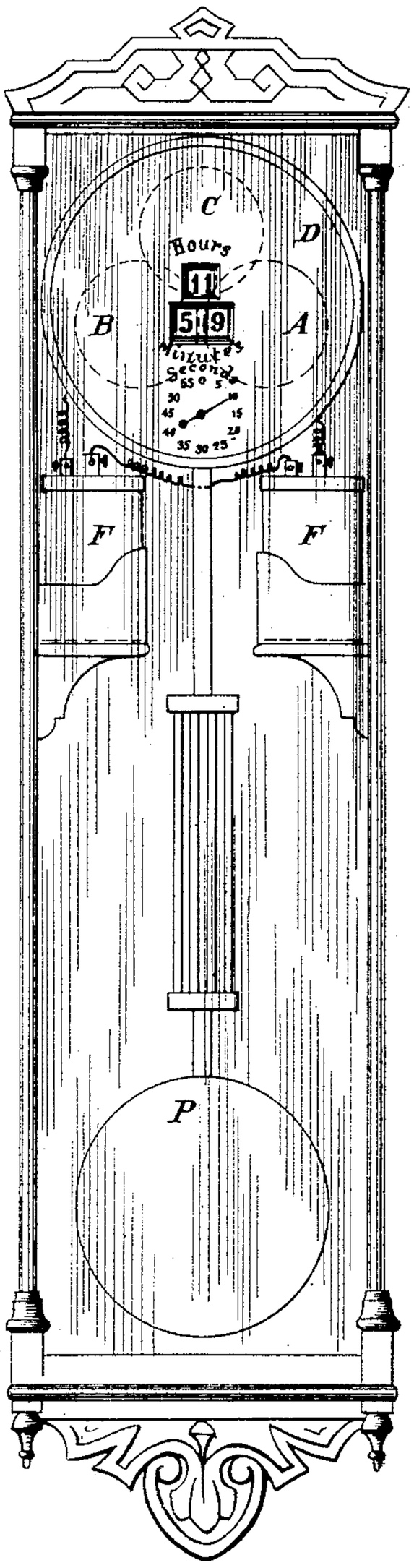


FIG. 3.

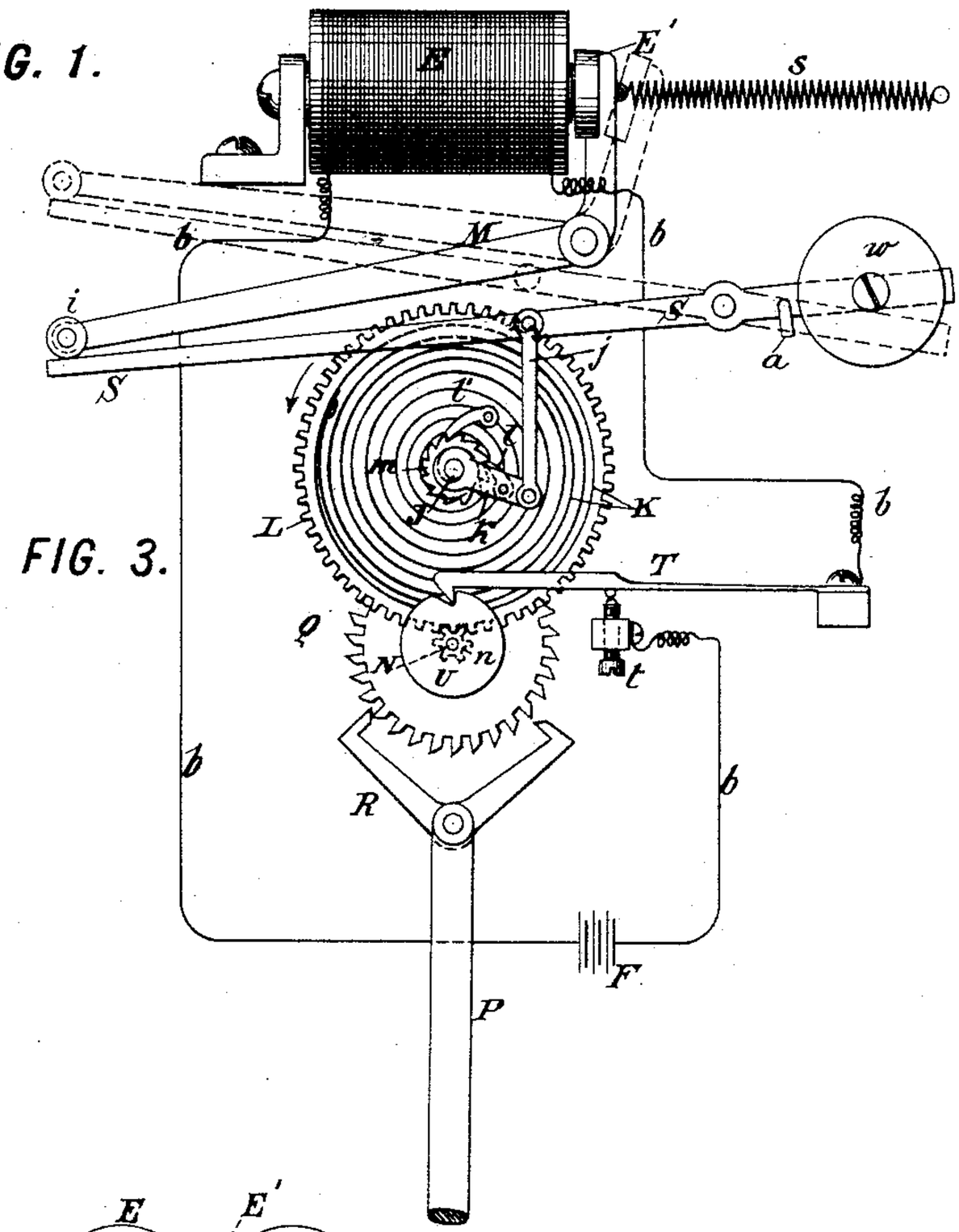
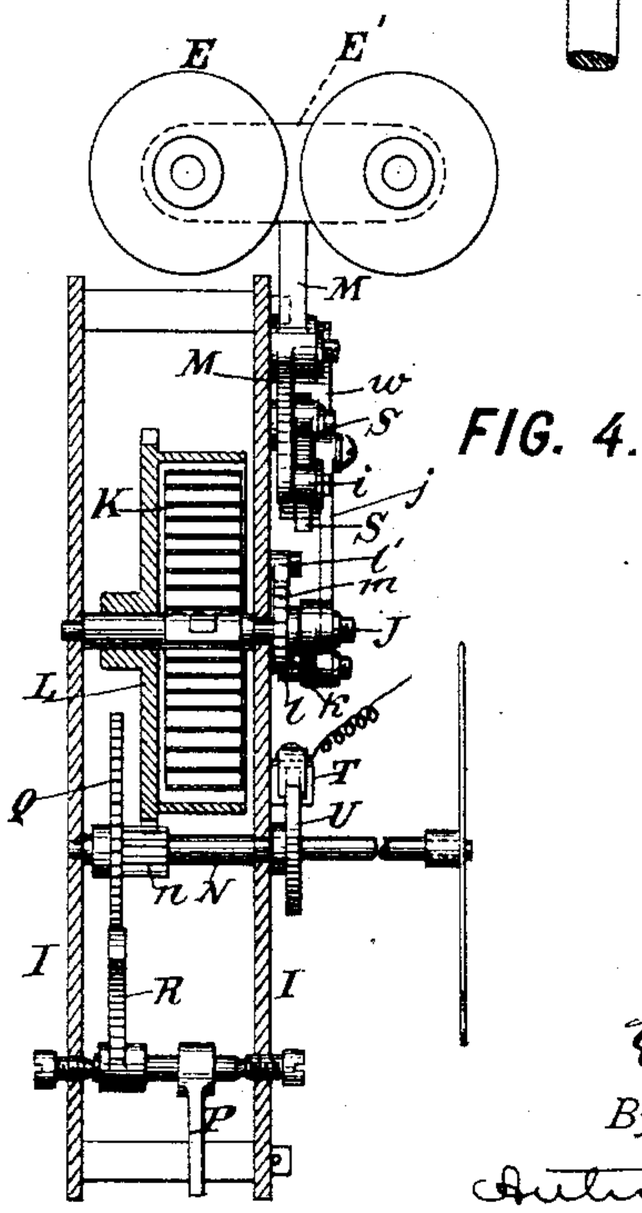


FIG. 4.



WITNESSES:
John Becker
Fred White

INVENTOR:
Emil G. Hammer,
By his Attorneys,
Arthur G. Fraser & Co.

(No Model.) 2 Sheets—Sheet 2.

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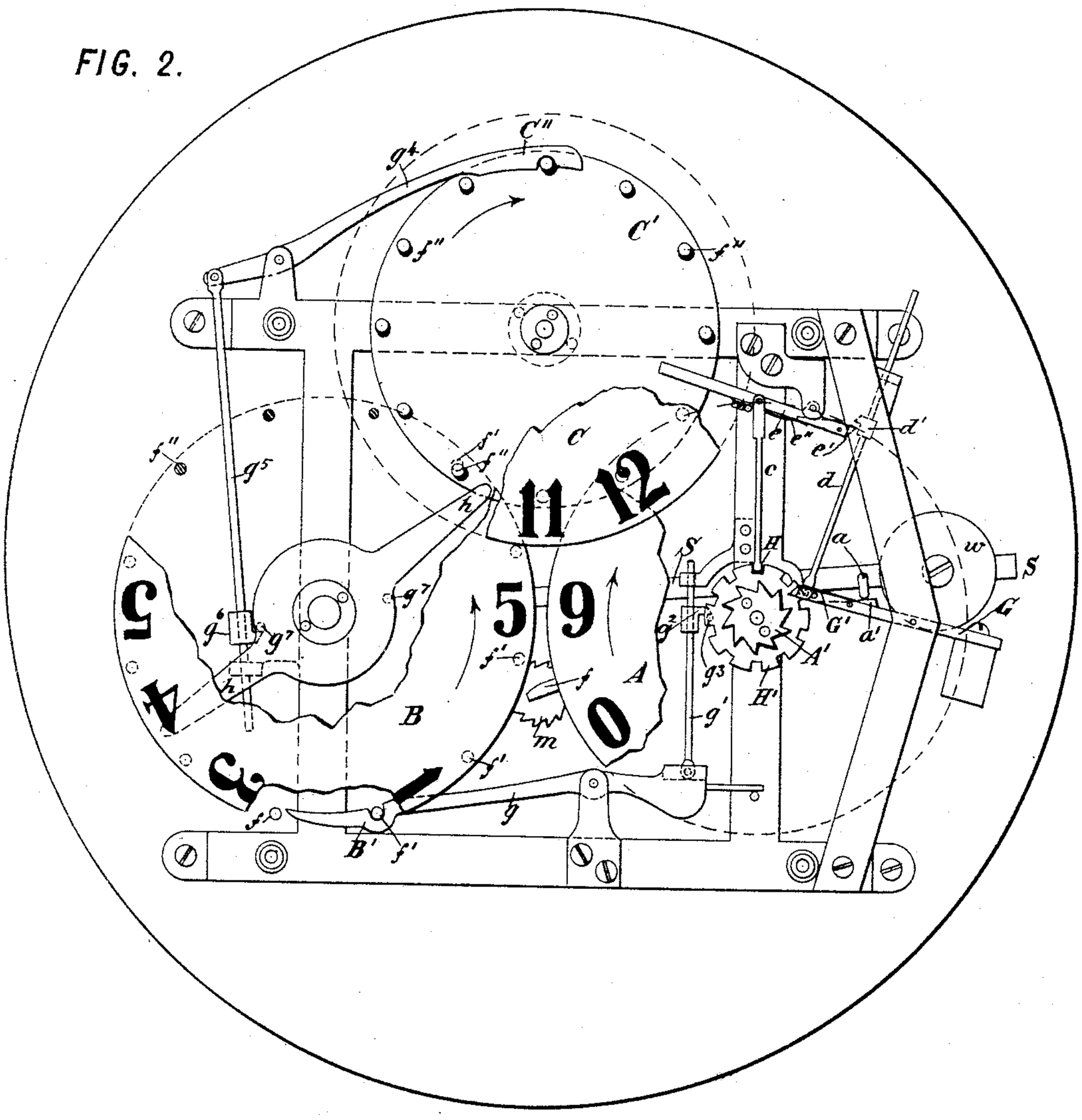
FIG. 2.



WITNESSES:
John Becker
Fred White

INVENTOR:
Emil G. Hammer,
By his Attorneys,
Arthur G. Fraser & Co.

UNITED STATES PATENT OFFICE.

EMIL G. HAMMER, OF BROOKLYN, NEW YORK.

INDEPENDENT ELECTRIC CLOCK.

SPECIFICATION forming part of Letters Patent No. 444,433, dated January 13, 1891.

Application filed May 24, 1890. Serial No. 353,011. (No model.)

To all whom it may concern:

Be it known that I, EMIL G. HAMMER, a citizen of the United States, residing in Brooklyn, in the county of Kings and State of New York, have invented certain new and useful Improvements in Electric Clocks, of which the following is a specification.

This invention relates to electric clocks, or those which are driven or wound by means of electric energy.

The improved clock provided by my invention measures time through the action of any suitable escapement, which is driven by a spring that is wound at intervals through the action of an electro-magnet. The excitation of this magnet is determined by a circuit-closer which closes the circuit once each minute or at other predetermined intervals of time, and is operated by the escapement. The action of the magnet not only rewinds the escapement-spring, but performs the mechanical work incident to the advancing of the hands or other indicating devices of the clock upon the dial to denote the time. The time-indicating devices just referred to may consist of revolving dials or disks bearing the figures indicating hours and minutes, as described in my patent, No. 402,823, dated May 7, 1889.

Figure 1 of the accompanying drawings is a front elevation of my improved clock on a small scale. Fig. 2 is a front elevation of the dial mechanism thereof, partly broken away to show the parts in the rear. Fig. 3 is a front elevation of the driving and time-marking mechanism of the clock, the dial mechanism being removed and the frame-work omitted. Fig. 4 is a side elevation of the mechanism shown in Fig. 3, but including also the supporting frame-work thereof.

My improved clock will ordinarily be inclosed in an upright casing, as shown in Fig. 1. In this figure the front of this casing is removed disclosing the pendulum P and battery-cells F F. In place of the usual clock-dial there is a circular disk or screen D, having near its middle three openings, through the upper one of which is exposed the number indicating hours, while through the two lower openings of which are exposed the numbers indicating minutes. These numbers are marked on three dials A, B, and C, (shown in dotted lines in Fig. 1 and in full in Fig. 2, except that in the latter figure they are largely broken away to show the parts behind them.) The dial A is numbered from 0 to 9, and is turned one-tenth of a revolution at the end of each minute. The dial B indicates tens of minutes, and is numbered from zero (blank) to 5, being turned from one number to the next by the dial A, while the latter is turning from 9 to 0. The hours-dial C is numbered from 1 to 12, and is turned one-twelfth of a revolution by the dial B each time that the latter turns from 5 to blank. The mechanism thus described I will call the "time-indicating devices." It takes the place of the minute and hour hands in an ordinary clock and their connecting-gears, and so far as my present invention is concerned it might be substituted thereby, if preferred. I have not thought it necessary to show this substitution, because it is thoroughly well understood, being embodied in almost every clock in use.

The indicating devices shown are of the same essential construction as the dial mechanism in my said patent, No. 402,823, the parts of which are designated with the same letters of reference that are applied to them or the corresponding parts in the accompanying drawings. The only difference is in the arrangement of the disks, the hour-disk C being now placed above the minute-disks A B instead of alongside of them, as formerly. There are also some minute changes in the form and construction of some of the intercommunicating parts, which, however, are immaterial. It is thus seen that this dial mechanism for indicating the hours and minutes by the display of numbers forms no novel part of my present invention, and is not essential thereto.

Omitting for the present a description of the detailed construction of this dial mechanism, I will proceed to describe the time-measuring and motive mechanism of the clock wherein resides my present invention.

Referring to Fig. 3, an electro-magnet E, connected in a circuit *b* with a battery F, constitutes the motive device through which the entire clock is driven. The armature E′ of this magnet is mounted on an elbow-lever M, having a prolonged lateral arm, on the end of which is carried an anti-friction roller *i*, which

bears on the long arm of a lever S, the opposite arm of which carries a counter-weight *w*. This counter-weight may constitute the retractile device for moving the armature away from the magnet when the latter is demagnetized; or a separate retractile spring *s* may be provided, as shown. Each time that the circuit is closed the magnet attracts its armature and throws down the long arms of the levers M and S, lifting the counter-weight *w*. The lever S is connected through a rod *j* with a vibrating arm *k*, carrying a pawl *l*, which engages the teeth of a ratchet-wheel *m*, which is kept from turning backward by a stop-pawl *l'*, which is pivoted, Fig. 4, to one of the plates I of the supporting-frame. The ratchet-wheel *m* is fixed on the front portion of an arbor J, which extends thence rearwardly, and is fastened to the inner end of a coiled spring K, which I will call the "escapement-spring." The outer end of this spring is fastened directly or indirectly to a gear-wheel *l*, preferably by inclosing the spring in a drum in the usual manner, fastening its end to the wall of the drum, and forming gear-teeth upon the periphery of the drum. In such case the drum turns loosely on the arbor J, being turned solely by the tension of the coiled spring K, which reacts against the arbor J, to which its inner end is fastened. The gear L, to which is thus imparted a tendency to turn in the direction of the arrow in Fig. 3, meshes with a pinion *n*, as shown in dotted lines in Fig. 3, and also in Fig. 4. This pinion is fixed on a seconds-arbor N, on which also is fixed an escape-wheel Q, with which engages an anchor R, the vibrations of which are controlled by a pendulum P, connected to it in any manner known in the art. With a pendulum beating seconds the escape-wheel Q will have thirty teeth and will be released a half-tooth to each semi-vibration of the pendulum, so that the seconds-arbor N will make one-sixtieth of a revolution. The front end of this arbor passes through the dial D, and carries on its end a seconds-hand, as shown in Fig. 1, which revolves over a series of graduations marked on the dial D, in any manner customary with the seconds-hands of clocks. If a shorter pendulum be used, the escape-wheel will have a greater number of teeth than thirty; or it may be on a separate arbor from the seconds-arbor and be geared down thereto, as is commonly done in the designing of clocks.

The electro-magnet E requires in the construction shown to be energized once each minute, although other intervals of time might be selected. To do this it is necessary to introduce in the circuit *b* some suitable form of circuit-closer which shall be operated at intervals of one minute. Such a circuit-closer is shown at T in Fig. 3. It consists of a vibratable arm which when dropped falls by its own weight against a contact-screw *t*, the screw and arm being connected to opposite terminals of the circuit, so that when they are in contact the circuit is closed. This circuit-closer is most conveniently operated by the seconds-arbor N, which makes a complete revolution each minute. To operate it, a disk U is fixed on this arbor, being notched at one side, and the arm T is formed with a tooth which rests on the rim of this disk, and at the end of each minute drops into this notch, thereby bringing the arm T onto the screw *t*. This closes the circuit, excites the magnet, and throws down the long arms of the levers N and S, thereby causing the pawl *l* to move down over one tooth of the ratchet-wheel *m*. After a suitable interval of time– say one or two seconds—the turning of the disk U lifts the arm T and breaks the circuit, whereupon the armature is retracted and the lever S tilted by its weight *w* to the position shown in dotted lines, thus pulling up the link *j* and arm *k* and causing the pawl *l* to advance the ratchet-wheel *m* the distance of one tooth. The consequent turning of the arbor J winds up the spring K to the corresponding extent.

The proportions of the respective parts are such that by the action of the pawl and ratchet the spring K is wound up at each excitation of the magnet as much as it has run down, by the rotation of the gear L in turning the pinion *n* and seconds-arbor one revolution. Thus at the end of each minute the spring is wound up as much as it has run down during such minute, so that it is restored to its original tension. In the particular instance shown in the drawings the ratchet-wheel *m* has ten teeth, so that the arbor J is turned each time one tenth of a revolution, and during the ensuing minute the gear L advances equally one-tenth of a revolution in turning the pinion *n* one revolution, the gear L having sixty teeth and the pinion *n* six teeth. Any suitable proportions may, however, be adopted, and any additional gear-wheels may be interposed, as may be desired. I have shown one of the simplest constructions embodying my invention. The winding up of the spring K is effected directly by the tension of the counter-weight *w* when this counter-weight is released by the retraction of the armature, so that the tension applied to the ratchet and pawl is always uniform and independent of the strength of the battery, so that no possible derangement can result from the varying energy with which the magnet may be excited at different times. The mechanism may be simplified by causing the magnet to act directly upon the lever S and arranging the latter so that the work should be done by the attractive movement of the armature; but for the reason stated and certain mechanical reasons I prefer the construction shown.

By the construction of the magnetic winding apparatus with an armature-lever M, with its long arm bearing on the long arm of a counterweighted lever S, and the latter connected to a swinging arm *k*, carrying the pawl, a long sweep is secured and the pawl enabled to pro-

pel the ratchet far enough at each vibration to wind up the spring sufficiently, so that only a single gear and pinion is required to communicate movement to the seconds-arbor, and the latter is propelled for an entire revolution before the spring requires rewinding. Otherwise it would be necessary to close the circuit oftener than once a minute or to interpose more wheels to gear up sufficiently to the seconds-arbor.

I will now explain how the dial mechanism shown in Fig. 2 is driven. The lever S carries an arm or finger *a*, which upon the release of the armature and the return of the lever by the action of the counter-weight moves down against the bearing-face *a'* on a lever G, thereby tilting this lever and causing a pawl G', which it carries, to strike one of the teeth of a ratchet-wheel A', fixed to the spindle of the disk A and turn the latter one-tenth of a revolution. Before turning it, however, the lever G acts through a rod *d*, tooth *d'*, pawl *e'*, lever *e*, and rod *c*, to lift a lock H out of one of the notches in a locking-disk H', thereby freeing the disk A, and before its movement is completed the lock H is released and falls back on the disk H', dropping into the next notch at the termination of the movement. At the completion of an entire revolution of the disk A—that is to say, while it is turning from 9 to 0—an arm *f*, which it carries, encounters a pin or projection *f''*, fixed to and projecting rearwardly from the disk B and turns the latter one space, so as to cause it to display the next higher number. First, however, the disk B is unlocked by releasing a lock B', having a notch which engages one of the pins *f'* thereof. This lock B' is carried on a lever *g*, which is tilted by the action of a pin g^3, carried by the disk H' on a tooth g^2, connected through a rod *g'* with the lever G. As the disk B turns from 5 to blank (or zero) an arm *h*, which it carries, strikes a pin *f''* on a disk C', fixed on the arbor of the disk C and turns the latter one-twelfth of a revolution. First, however, the disk C is unlocked by withdrawing a lock C'', which engages one of the pins *f''* thereof. This lock C'' is mounted on a lever g^4, which is tilted by a pin g^7, carried with the disk B, acting on a tooth g^6 on a rod g^5, connected to this lever.

If a more minute and detailed description and illustration of the working parts of this dial mechanism is desired it will be found in my said patent, No. 402,823.

If it be desired that the clock shall be run by the energy of a spring wound manually instead of by electric energy applied through the automatic winding of a spring, a spring-motor may be provided, as shown in my said patent, and released once a minute or at other predetermined intervals of time by the magnet E in the same manner as shown in my said patent, the impulse resulting from the release of the motor being imparted to the lever S of my present construction, just as in my said patent it is imparted to the lever G thereof. In such case the action of the escapement device in measuring time will determine the intervals at which the circuit-closer shall act, and thereby excite the magnet, and the latter will have no other work to do than to release the spring-motor. For all ordinary purposes, however, I prefer to rely wholly on electric power for driving the clock, as it much simplifies the mechanism and obviates all necessity for winding.

By my improved construction of clock the time-measuring mechanism is reduced to the utmost simplicity, consisting only of the escapement, its impelling-spring, and their connecting gear and pinion. The liability of derangement is consequently reduced to the minimum, so that with proper workmanship the clock should run for years without attention. Of course the accuracy of the clock will depend upon the nice adjustment of the pendulum. So long as the mechanism remains in order the clock will continue to run as long as the battery supplies the necessary energy. By reason of the very frequent rewinding of the spring K it is kept always at uniform tension, so that the impulse of the escapement on the pendulum is unvarying. The energy required to be transmitted through the spring is reduced to the minimum, so that a light spring may be used. The electro-magnet at each operation thus stores up the power required for driving the time-measuring mechanism by which it is governed, and also exerts the power necessary to drive the time-indicating mechanism. The time-measuring mechanism is thus entirely relieved of the work of driving the time-indicating mechanism, so that the clock is rendered a very accurate time-keeper. This subdivision of the work is especially desirable in a clock wherein the time-indicating device consists of a combination of dials, since the driving of such device requires different amounts of power at different times, requiring the least power when only the disk A is being driven, requiring greater power when the disks A and B turn simultaneously, and still greater power at intervals of an hour when the disks A, B, and C turn all together. It will of course be understood that a balance-wheel may be substituted for the pendulum as an equivalent means for governing the escapement.

I claim as my invention the following defined novel features, substantially as hereinbefore specified, namely:

1. In a clock, the combination of an escapement, a spring for driving the escape-wheel thereof, a ratchet and pawl for winding up the spring at intervals, a time-indicating device, and an electro-magnet for actuating the pawl and indicating device.

2. In a clock, the combination of an escapement, a spring for driving the escape-wheel thereof, a ratchet and pawl for winding up the spring at intervals, a time-indicating de-

vice, an electro-magnet for actuating the pawl and indicating device, and a circuit-closer operated through the escapement for controlling the excitation of the electro-magnet, whereby the sole work of the escapement-spring is to drive the escapement and circuit-closer, and the heavier work of driving the indicating device is performed directly by the electro-magnet.

3. In a clock, the combination of an electro-magnet E, a lever M, to which the armature thereof is connected, a counterweighted lever S, the long arm of which is engaged by the long arm of the lever M, a vibrating arm *k*, connected thereto, a pawl *l*, carried by said arm, a ratchet-wheel *m*, an escapement, and a spring for driving the escape-wheel thereof, connected to said ratchet-wheel, to be wound by the action of the ratchet and pawl.

4. In a clock, the combination of numbered dials for indicating hours and minutes, and their driving mechanism, with an electro-magnet, a counterweighted lever S, actuated thereby and having an arm *a* for imparting motion to the dial mechanism, a time-measuring device, a spring for driving it, means connected with said lever for winding up the spring by the vibrations thereof, and a circuit-closer operated by the time-measuring device for controlling the excitation of the electro-magnet.

In witness whereof I have hereunto signed my name in the presence of two subscribing witnesses.

EMIL G. HAMMER.

Witnesses:

GEORGE H. FRASER,

CHARLES K. FRASER.