(No Model.) 3 Sheets—Sheet 1.

E. G. HAMMER.

ELECTRIC CLOCK.

No. 402,823. Patented May 7, 1889.

FIG. 1.

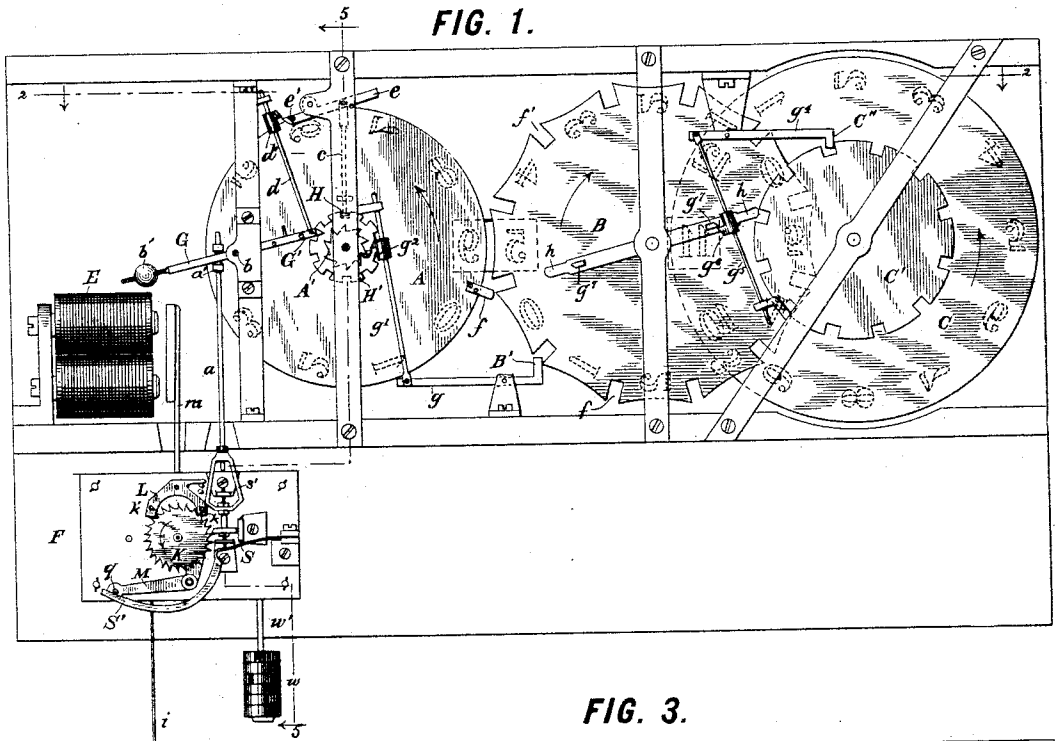


FIG. 3.

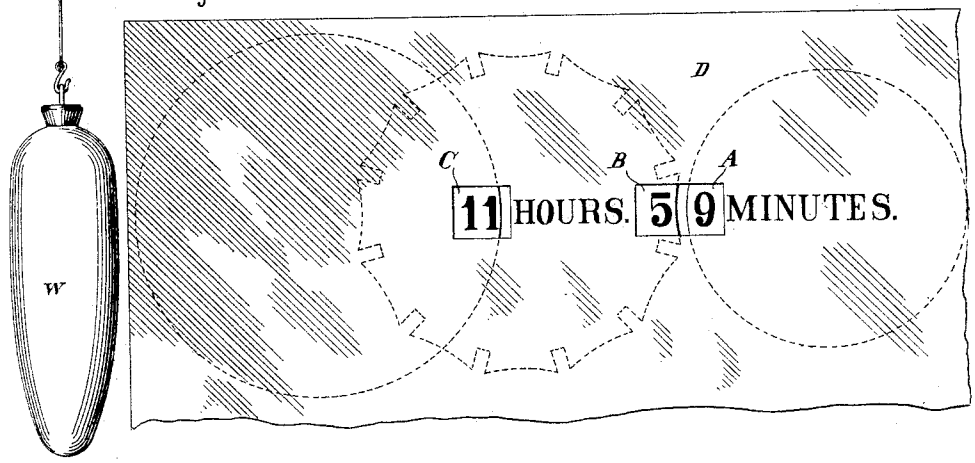
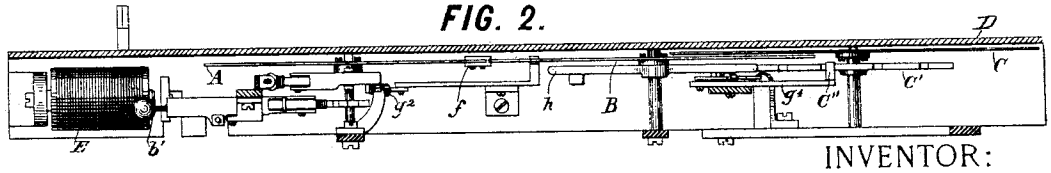


FIG. 2.



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Arthur G. Fraser & Co.

(No Model.) 3 Sheets—Sheet 2.

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FIG. 4.

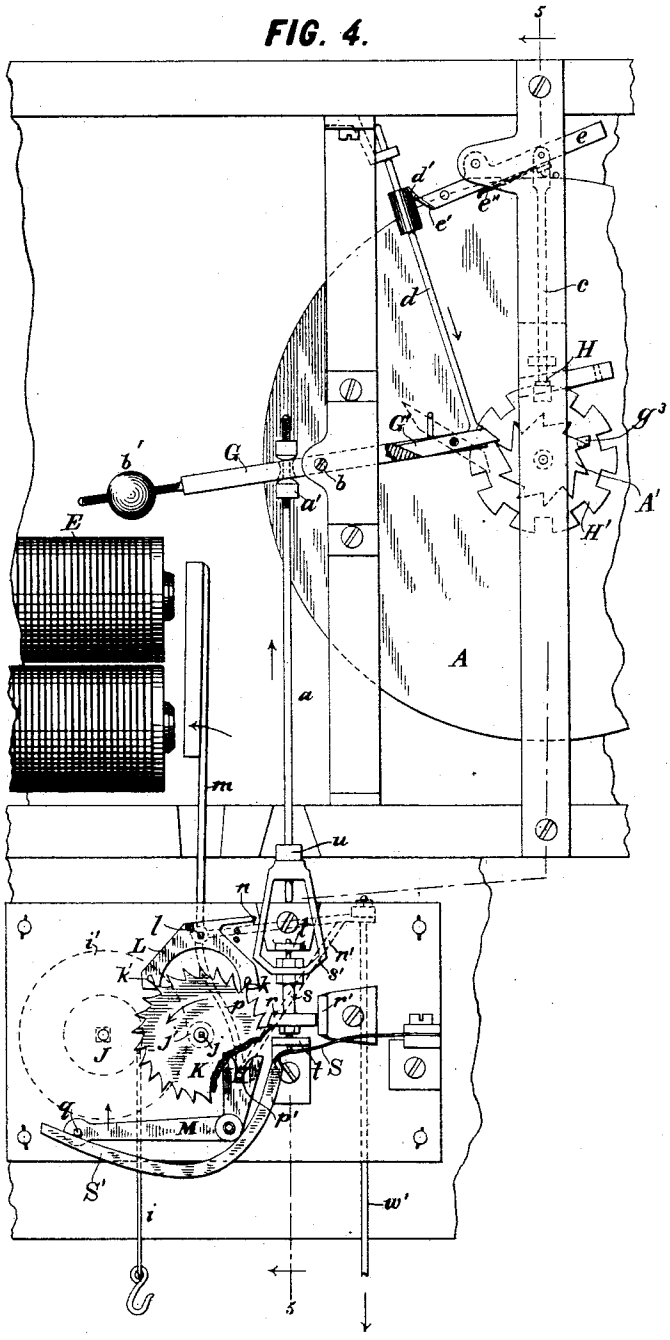

FIG. 5.

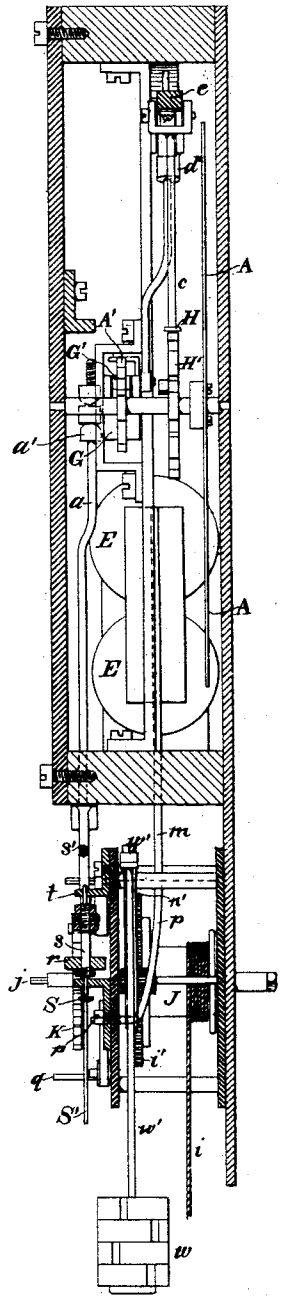

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FIG. 6.

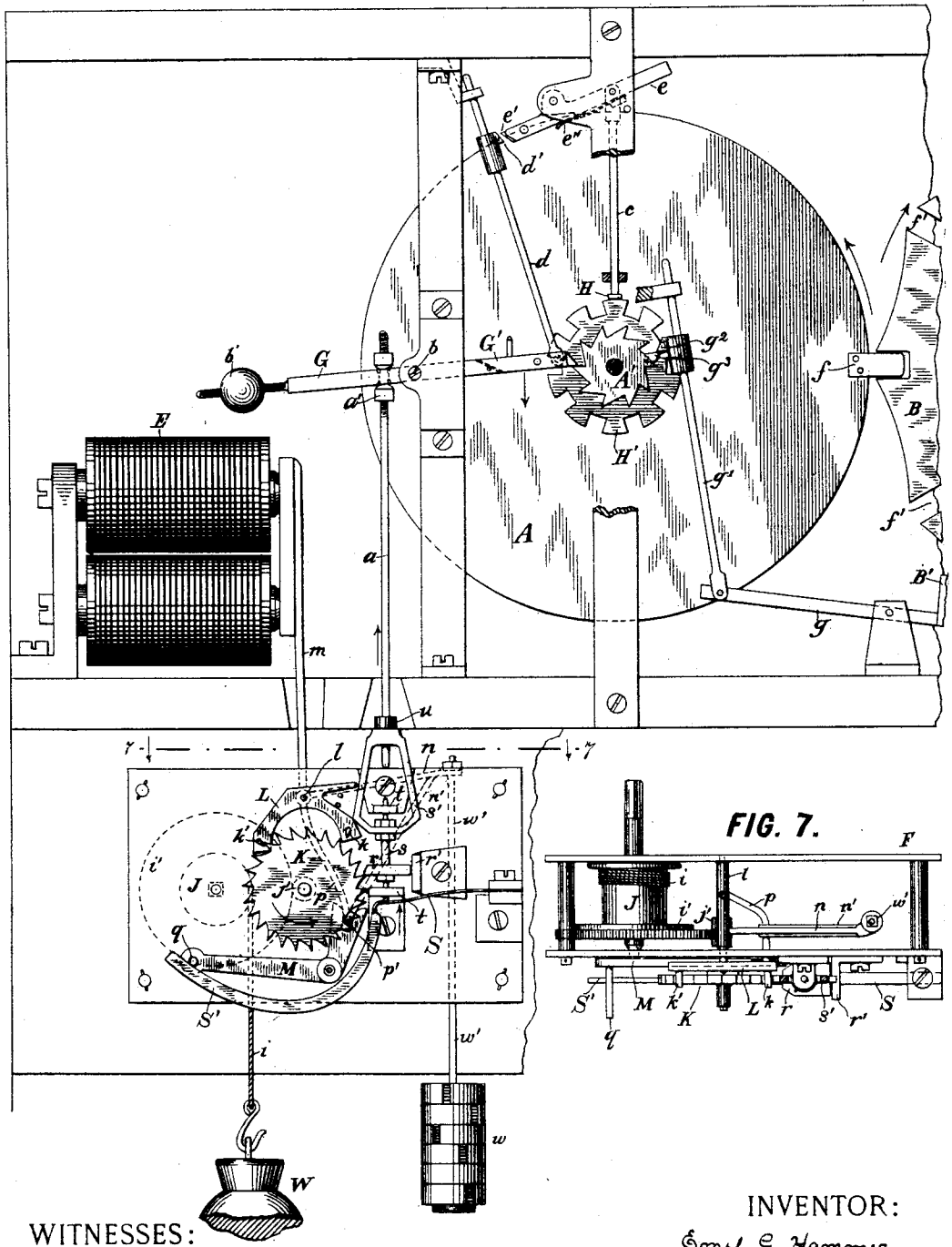

FIG. 7.

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UNITED STATES PATENT OFFICE.

EMIL G. HAMMER, OF BROOKLYN, NEW YORK.

ELECTRIC CLOCK.

SPECIFICATION forming part of Letters Patent No. 402,823, dated May 7, 1889.

Application filed September 11, 1888. Serial No. 285,116. (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 and clock-movements and to analogous mechanisms—such as counters or totalizers—operated by clock-work through the medium of an escapement and controlled by an electro-magnet or other device.

The principal object of my invention is to provide a clock which shall indicate the time by means of revolving dials or disks bearing the figures denoting the hours and minutes instead of by hands turning around the dial. There are three dials, the first moving every minute, the second every ten minutes, and the third every hour. Thus, for instance, if it be eleven o'clock, the dials will show the figures "11.00;" the next minute they will show "11.01;" in ten minutes after eleven they will show "11.10," and at the end of the hour they will show "11.59;" the next minute all three dials will move and show "12.00." This dial apparatus is designed to be connected through the medium of an electric circuit with a standard regulator which acts to close and break the circuit once each minute, (or at other suitable interval of time,) thereby transmitting an electric impulse which excites an electro-magnet and causes it to set in motion the mechanism by which the dials are turned. My improved clock becomes thus a "secondary electric clock," the movement of which is controlled by a "primary electric clock" or regulator. Such primary electric clocks with their circuit-manipulating devices are well known in the art.

The turning of the dials, especially at the end of each hour, when all three are turned together, requires considerable power as compared with the turning of the hands of an ordinary electric clock. In order to provide this power without requiring too powerful an electro-magnet, and consequently too energetic a battery, I provide by my invention a clock-work apparatus to be wound up at intervals, and which is controlled by the electro-magnet through the medium of an escapement. Furthermore, in order to utilize fully the energy of the electro-magnet, I provide for giving the impulse by the joint action of the clock-work mechanism and a spring, which is thrown into action by the electro-magnet.

The impulse by which the disks are turned is transmitted from the escapement-wheel at the instant of its release by the anchor of the escapement to a rod or slide, which in turn moves a lever which engages and turns the disks.

One important object of my improved mechanism is to afford a strong and long stroke to the impelling parts, as thereby the action of the mechanism is rendered positive and unerring.

The dials instead of indicating hours and minutes may indicate units, tens, hundreds, &c., in which case the apparatus becomes a counter or totalizer, and such an apparatus may be operated electrically or by other equivalent means—such as by pneumatic or mechanical action.

In the accompanying drawings, Figure 1 is a rear elevation, on a small scale, of my improved electric clock. Fig. 2 is a horizontal section thereof cut in the plane of the line 2 2 in Fig. 1. Fig. 3 is a front elevation of the face of the clock. Fig. 4 is a fragmentary view, in rear elevation, on a larger scale. Fig. 5 is a vertical transverse section cut in the plane of the lines 5 5 in Figs. 1 and 4. Fig. 6 is a rear elevation on the same scale as Figs. 4 and 5, and Fig. 7 is a plan of the escapement mechanism.

Referring especially to Figs. 1, 2, and 3, let A designate the dial or disk indicating units of minutes, and which, for convenience, I shall call the "minute-dial." Let B designate the dial indicating tens of minutes, and which I shall call the "tens-dial," and let C designate the dial for indicating the hours, which I shall call the "hour-dial." These dials are arranged close behind a front wall or screen, D, which, as shown in Fig. 3, has holes formed in it to expose one of the figures on each of the three dials.

The dial A is driven directly by the clock-work mechanism and drives the dial B at intervals of ten minutes, and the dial B drives the dial C at intervals of one hour. The driving power or energy is derived from a weight,

W, which acts upon the clock-work mechanism F, and from an electro-magnet, E, the armature of which is retracted by a weight, *w*. Each time the magnet E is excited by the passage of an electric current it attracts its armature and releases the escapement of the clock-work mechanism F, whereupon the latter is permitted to advance under the impulse of the weight W, whereby a rod, *a*, is pushed or impelled upwardly. It is through this rod *a* that the motive impulse is transmitted to the dial A. At each impulse the rod *a* is forcibly pressed up and then released and permitted to fall back ready for the next impulse. The rod *a* is connected to a rock-lever, G, which is fulcrumed at *b* to the frame-work of the apparatus. The rod *a* is provided with a shoulder, *a'*, which comes against the under side of the left-hand arm of the lever G, and there is preferably a nut screwed on the rod in order that it may be adjusted in height. Preferably another similar nut is screwed on the rod above the lever. The left-hand arm of the lever is given a tendency to descend, either by making it heavier or, preferably, by providing it with a counter-weight, *b'*, adjustable upon it. The right-hand arm of the lever carries a pawl, G', which is freely pivoted to it, and the left-hand portion of which pawl is heavier than its right-hand portion, so that it normally drops against the lever, as shown in Fig. 4. On the arbor of the disk A is fixed a toothed wheel or ratchet, A', having as many teeth as there are figures on the dial—namely, ten. In the normal position of the lever G the right-hand end or point of the pawl G' is raised above the nearest tooth of this ratchet-wheel. When the upward impulse is transmitted through the rod *a*, the lever G is rocked on its fulcrum and the nose of the pawl G' in descending encounters one of the ratchet-teeth and presses it downward, thereby revolving the dial A one-tenth of a revolution.

To insure that the dial A shall not turn too far and shall, when at rest, be held with its figure in the proper position and with the teeth of its ratchet-wheel in proper relation to the pawl G', I provide a locking device. On the arbor of the dial A is fixed a wheel, H', having ten notches. Above this wheel is a vertically-sliding rod, *c*, which terminates in a foot or locking bolt, H, which drops into one or other of the notches of the wheel H', and thereby locks the dial fast. At each movement of the lever G this bolt H is first withdrawn from the notch before the pawl G' reaches the ratchet-tooth, in order that when the pawl strikes the ratchet-tooth the dial shall be free to turn. Before the pawl completes its action on the ratchet-tooth the bolt H is released and drops upon the rim of the wheel H', so that when the dial completes its one-tenth movement the bolt drops into the next notch and locks it again. These movements of the locking-bolt H are communicated to it from the lever G in the following manner: To the lever G is connected a sliding rod, *d*, carrying a tooth, *d'*, which acts upon a pawl, *e'*, on one arm of a rock-lever, *e*, the other arm of which is jointed to the rod *c*, carrying the bolt H. Upon the downward movement of the pawl G' the rod *d* is pulled down and its tooth *d'* pulls down the pawl *e'*, thereby tilting the lever *e* and lifting the rod *c* until the bolt H is lifted clear of the notch. This is the position shown in Fig. 4. At the next instant the pawl G' strikes the ratchet-tooth and before half the movement of the latter is made the tooth *d'* passes beyond the nose of the pawl *e'* and releases the lever *e*, thereby permitting the rod *c* and bolt H to fall, as shown in Fig. 6, which represents the parts at the instant after this bolt has dropped and when the dial has been turned half-way from one figure to the next.

At the completion of the movement of the lever G and when the impetus of the rod *a* ceases the lever drops back under the tension of its weight *b'*. In so doing the pawl G', in passing the ratchet-tooth succeeding the one on which it has just acted, is deflected, as shown in dotted lines in Fig. 4, and simultaneously the upward movement of the tooth *d'* similarly deflects the pawl *e'* against the pressure of a light spring, *e''*.

When the dial A is turning from 9 to 0, it turns the tens-dial B one-tenth of a revolution. This is effected by a tooth, *f*, on the dial A, which enters one of twelve notches *f'* in the dial B, (or there might be six of these notches or any multiple of six, according to the size of the dial.) Normally the dial B is locked by a bolt, B', which enters one of these notches, but which is withdrawn just before the tooth *f* begins to act and is released before the movement of the dial B is completed, so as to be in readiness to drop into the next notch *f'*. This bolt B' is carried on a lever, *g*, the opposite arm of which is jointed to a sliding rod, *g'*, which carries a tooth, g^2, which stands in the path of a tooth, g^3, on the wheel H', (or the tooth g^3 is otherwise connected with the dial A, so as to revolve therewith,) so that when in the revolution of this tooth g^3 it encounters the tooth g^2 the latter is lifted, thereby tilting the lever *g* and withdrawing the bolt B'.

As the tens-dial B carries two consecutive sets of figures, it must be constructed to impart an impulse to the hour-dial C at each half-revolution. To this end it is provided with two teeth, *h h*, which may be constructed as the opposite ends of a diametrical arm fixed on the arbor of the dial B. The hour-dial C is provided with a notched disk, C', fixed on its arbor. Whenever either of the teeth *h* encounters the disk C', it enters one of the notches thereof and turns the disk one-twelfth of a revolution, whereupon it passes out of the notch. The dial C is normally locked by a bolt, C'', which enters one of the notches in this disk. This bolt is withdrawn in similar manner to the bolt B'. It is mounted on a lever, g^4, to the opposite arm of which is

jointed a sliding rod, g^5, carrying a tooth, g^6, which is in the path of two teeth, g^7 g^7, arranged at diametrically-opposite points and revolving with the teeth h.

I will now proceed to describe the clock-work mechanism F, through which the upward impulse is imparted to the rod a. The weight W hangs from a cord or chain, i, which winds upon a barrel, J, which is geared through a wheel, i', and pinion j' (or other suitable intermediate gearing) to the arbor j of an escapement-wheel, K. Thus the weight tends to revolve this wheel in the direction of the arrow in Fig. 6. The anchor L of the escapement, which is pivoted on an arbor, l, has two pallets, k and k', which alternately engage the teeth of the escapement-wheel. The armature-lever m, bearing the armature of the electro-magnet E, is fixed to the anchor-arbor l, so that the attraction or retraction of the armature vibrates the anchor. An elbow lever or arm, n, projects from the arbor l, and from its end is suspended the rod w', carrying the retractile weight w. Thus this weight w (which of course might be substituted by a spring) acts to retract the armature. Another arm or lever, p, is fixed to the arbor l and projects downwardly, its end being turned backward and passing through a slot in the rear plate of the movement projects slightly beyond such plate at p', where it engages a notch in one arm of an elbow-lever, M. The other arm of this lever extends to the left and carries a pin, q, which projects rearwardly over a curved arm, S'. Thus as the armature vibrates the levers p and M also vibrate, thereby giving the pin q an up-and-down movement. Preferably the lever-arms n and p are stiffened by a diagonal brace-rod, n'.

Connected to the rod a is an impulse-tooth, r, which is mounted to move vertically, being suitably guided. The apex or working-edge of this tooth is arranged to move tangentially to the escape-wheel K, so that the teeth thereof shall successively take under and lift it, each tooth releasing it and permitting it to drop back in position for the next tooth to act upon it. The impulse-tooth r may be variously mounted and connected, so that when thus moved upwardly by the escape-teeth it shall push up the rod a.

In the construction shown the tooth r consists of a horizontal plate fixed on a vertical staff or spindle, s, the ends of which are prolonged and slide freely in bearing-holes formed in bridges t t above and below. A yoke, s', is connected rigidly to the staff s, and extends upward around the upper bridge t, and its upper end receives the lower part of the rod a, being fastened thereto, if desired, or merely arranged to abut against the shoulder or nut u on this rod. The impulse-tooth r is kept from turning by being formed with a flat side, which works against the face of a bracket, r'. A leaf-spring, S, is fastened at its right-hand end, and its left-hand end comes beneath the bottom end of the staff s and exerts an upward pressure thereagainst. To this end of the spring is securely fixed an arm, S', which extends to and passes beneath the pin q, and is pressed up against it by the tension of the spring S. When the armature is retracted, the tension of the counter-weight w, acting through the levers n p and M, causes the pin q to press the arm S' down, and thereby press down the spring S, so that its free portion is restrained from pressing up the staff s. When, however, the armature is attracted and the pin q consequently lifted, the arm S' and the spring S are permitted to move up, and the spring exerts its upward tension against the staff.

The tendency of the escape-wheel K to revolve is overcome by the anchor L, one of the pallets of which normally engages one of the escape-teeth and holds it stationary until the anchor is vibrated by the electro-magnet. To each back-and-forth vibration of the anchor the escape-wheel is permitted to turn the distance of one tooth. Thus the anchor (unlike ordinary clocks) receives no impulse from the escape-wheel, but acts simply as a check for locking and unlocking it. Its pallets are so constructed and arranged relative to the teeth of the escape-wheel that in its alternate vibrations back and forth the escape-wheel is permitted to make alternately a long and a short stroke. The long stroke is the one which does the work of imparting the upward impulse to the impulse tooth r, while the short stroke is designed solely to afford sufficient clearance to enable the anchor to be retracted to its normal position of rest.

The operation is as follows, assuming the clock to be worked in open circuit: Normally the parts stand as in Fig. 1, the armature being retracted, the spring S pressed down, the impulse-tooth r being dropped directly over one of the escape-teeth, and the escape-wheel being held by the pallet k. When the current passes and the magnet is excited and attracts its armature, at the same time lifting the counter-weight w, its movement is imparted to the anchor L and lever M, tilting the anchor in such direction as to withdraw its pallet k from the escape-teeth and move pallet k' into engagement therewith. Simultaneously the pin q is raised, and before the pallet k releases the escape-wheel the pin q is raised far enough to relieve the arm S' and spring S to a sufficient extent to enable the spring to exert an upward pressure against the staff s, thereby tending to lift the staff against the weight of the staff and its attached parts and the rod a and the counterweighted arm of the lever G; but the tension of the spring is insufficient to quite lift these parts, being preferably sufficient at the instant when the escape-wheel is released by the pallet k to very nearly overcome the weight of these parts, so that upon the release of the escape-wheel its whole power, exerted against the impulse-tooth r, is made effective to impart

motion to the dial mechanism. The lifting of the pin *q* continues after the release of the escape-wheel, so that as the spring S is further relieved of restraint it is enabled to press upwardly with greater force upon the staff *s*, so that it follows the latter in its upward movement and continues to oppose its tension to the weight of the parts, and even serves to add to the driving impulse imparted through the rod *a*. The motion of the escape-wheel is limited by the striking of one of its teeth against the pallet *k'*, whereupon the parts come to rest, the tooth engaging the impulse-tooth *r* having just before the end of the movement passed beneath it and freed it, so that it may drop back. Its falling back is, however, resisted by the spring S; but at the next instant the current is broken and the electro-magnet releases its armature, whereupon the latter is retracted by the weight *w*, which also presses down the pin *q*, and thereby depresses the arm S' and spring S, so that the latter no longer obstructs the descent of the staff *s* and its superimposed parts.

It will be observed that the upward impulse derived from the spring S is due to power stored up therein through the medium of the weight *w*, which is manipulated by the electro-magnet, so that this power is derived ultimately from the magnet, whereas the power exerted against the impulse-tooth by the escape-wheel is derived from the weight W or other motive power of the clock-work. The combination of the two effects is the most economical and advantageous.

I find that the action of the spring S is made more effective by providing it with a long arm, S', acted on by the pin *q* or other bearing part deriving motion from the electro-magnet than if the pin were to act directly upon the spring or upon a shorter arm.

I arrange the escape-wheel K in the same position in which in an ordinary electric clock the center wheel which bears the hands is placed.

In case the magnet is operated on a closed circuit no essential change need be made in the mechanism, and the operation will be substantially the same, the only difference being that the position of rest of the parts will be that assumed when the armature is attracted. It may, however, be advantageous to arrange the magnet on the opposite side of the armature, in order to attract the armature, toward the right to adjust the weight *w*, so that it will not serve to press down the spring S; but the tension of the spring S will sustain the counter-weight and hold the staff raised. The attraction of the magnet, however, will serve to lower the counter-weight and compress the spring, thereby holding the parts in the same position between the electric impulses as with the precise construction shown.

My invention is not limited to the precise details of mechanism shown, as these may obviously be greatly modified without departing from the essential features introduced by my invention.

I claim as my invention the following defined improvements applicable to electric clocks and other clocks and analogous mechanisms—such as counters or totalizers—substantially as hereinbefore specified, namely:

1. In a clock-work mechanism, the combination, with an escape-wheel, its motor, and a vibrating anchor for controlling its movement, of an impulse-tooth (distinct from said anchor) mounted to move tangentially, or approximately so, to said escape-wheel and to be displaced and released by the successive teeth thereof in their passage, whereby successive impulses are communicated to said impulse-tooth from said escape-wheel.

2. In a clock-work mechanism, the combination, with an escape-wheel, a motor imparting to said wheel a tendency to revolve, a vibrating anchor having pallets alternately engaging with the escape-teeth and serving as a stop to check the rotation of the escape-wheel, and an electro-magnet or equivalent controlling device for vibrating said anchor and thereby determining the movements of the escape-wheel, of an impulse-tooth mounted to move tangentially, or approximately so, to said escape-wheel, and to be displaced and released by the successive teeth thereof in their passage, whereby successive impulses are communicated to said impulse-tooth from said escape-wheel.

3. In a clock-work mechanism, the combination, with an escape-wheel, its motor, and a vibrating anchor for controlling its movement, of a sliding staff and an impulse-tooth carried thereby and arranged to be successively engaged and lifted by the teeth of said escape-wheel.

4. In a clock-work mechanism, the combination, with an escape-wheel, its motor, and a vibrating anchor for controlling its movement, of a sliding staff, an impulse-tooth carried thereby and arranged to be successively engaged and lifted by the teeth of said escape-wheel, and a push-rod arranged to receive the motion of said staff.

5. In a clock-work mechanism, the combination, with an escape-wheel, its motor, and a vibrating anchor for controlling its movement, of a sliding staff, an impulse-tooth carried thereby, and consisting of a plate having a flat side and a parallel guiding-face engaging said flat side for preventing the rotative displacement of the impulse-tooth.

6. In a clock-work mechanism, the combination, with an escape-wheel, its motor, and a vibrating anchor for controlling its movement, of an impulse-tooth arranged to be displaced successively by the teeth of said escape-wheel, and a spring arranged to exert a tension against said impulse-tooth in the direction of the impulse or displacement effected by the escape-wheel.

7. In a clock-work mechanism, the combi-

nation, with an escape-wheel, its motor, its restraining-anchor, and a controlling device for vibrating said anchor, of an impulse-tooth acted on by the escape-teeth, a spring arranged to exert a tension against said impulse-tooth in the direction of the impulse imparted to it by the escape-wheel, and a movable pin or shoulder connected to and moving coincidently with said anchor and arranged to press against said spring and thereby reduce its effective tension when the escape-wheel is inactive and to release the spring at the instant when the escape-wheel imparts its impulse to said impulse-tooth.

8. In a clock-work mechanism, the combination, with an escape-wheel, its motor, its restraining-anchor, and a controlling device for vibrating the anchor, of an impulse-tooth acted on by the escape-teeth, a spring arranged to exert a tension against said impulse-tooth in the direction of the impulse, an arm forming an extension of said spring, and a movable pin or shoulder connected to and moving coincidently with said anchor and arranged to press against said arm and reduce the tension of the spring when the escape-wheel is inactive and to release the spring at the instant when the escape-wheel imparts its impulse.

9. In a clock-work mechanism, the combination, with an escape-wheel, its motor, its restraining-anchor, and a controlling device for vibrating said anchor, of an impulse-tooth acted on by the escape-teeth, a spring arranged to exert a tension against the impulse-tooth in the direction of the impulse, and a movable pin or shoulder connected to and moving coincidently with said anchor, and arranged to press against said spring and reduce its effective tension when the escape-wheel is inactive, and to release said spring upon the releasing vibration of the anchor and to partially release the spring before the release of the escape-wheel, whereby the spring commences to exert its effective tension before the impulse is given.

10. In a clock-work mechanism, the combination, with an escape-wheel, its motor, its restraining-anchor, and an impulse-tooth acted on by the escape-wheel, of a spring arranged to exert a tension against the impulse-tooth in the direction of the impulse, a retractile weight connected to said spring and acting to reduce its effective tension, and an electro-magnet or equivalent controlling device connected to said anchor and adapted when operated to vibrate the latter, and thereby release the escape-wheel, and to relieve the tension of said weight upon said spring, and thereby enable the spring to exert its tension upon the impulse-tooth at the time of the impulse.

11. The combination, with an escape-wheel, its motor, its restraining-anchor, an impulse-tooth acted on by the escape-wheel, and a spring arranged to exert a tension against the impulse-tooth in the direction of the impulse, of an electro-magnet, a retracting-weight acting against said magnet upon said anchor, a movable pin or shoulder arranged to act upon said spring and connected to said retractile weight, whereby it communicates the tension of said weight to said spring in opposition to the tension of the latter, and a connection between the magnet and said spring, whereby upon the action of the magnet the pin is retracted from said spring.

12. The combination, with an escape-wheel, its motor, its restraining-anchor, and an impulse-tooth acted on by the escape-wheel, of a spring, S, and its arm S′, a pin or shoulder, *q*, a retractile weight arranged to press down said pin or shoulder against the tension of said spring, and an electro-magnet with its armature connected to said anchor, pin, and weight.

13. The combination, with a dial, of a ratchet-wheel connected thereto, an actuating-pawl mounted to reciprocate against the teeth of said wheel, and a lock entering notches and adapted to hold said dial stationary, with a mechanism for withdrawing said lock during the actuating-stroke of said pawl, consisting of a coacting tooth and pawl, the one connected to said actuating-pawl and the other to said lock and arranged so that the tooth shall displace and pass and release said pawl during the actuating-stroke.

14. The combination, with a dial, of a ratchet-wheel, A′, a lever, G, a pawl, G′, for acting on said ratchet-wheel, a locking-bolt, H, entering notches connected with said dial, a rock-lever, *e*, connected to said bolt, and a tooth, *d*′, connected to said lever G and adapted during the actuating movement to displace said lever *e* and thereby withdraw said bolt, and subsequently to release said lever *e* and thereby leave the bolt free to enter the succeeding notch.

15. The combination of a unit-dial, a clock-work mechanism for imparting a step-by-step rotation thereto, a second dial for indicating higher numbers, a tooth carried by the first dial and adapted to enter notches in and thereby to turn the second dial, and a lock adapted to hold said second dial stationary with a tooth carried by the first dial and a tooth connected to said lock and adapted to be displaced by said dial-tooth to release said lock.

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

EMIL G. HAMMER.

Witnesses:
GEORGE H. FRASER,
JOHN BECKER.