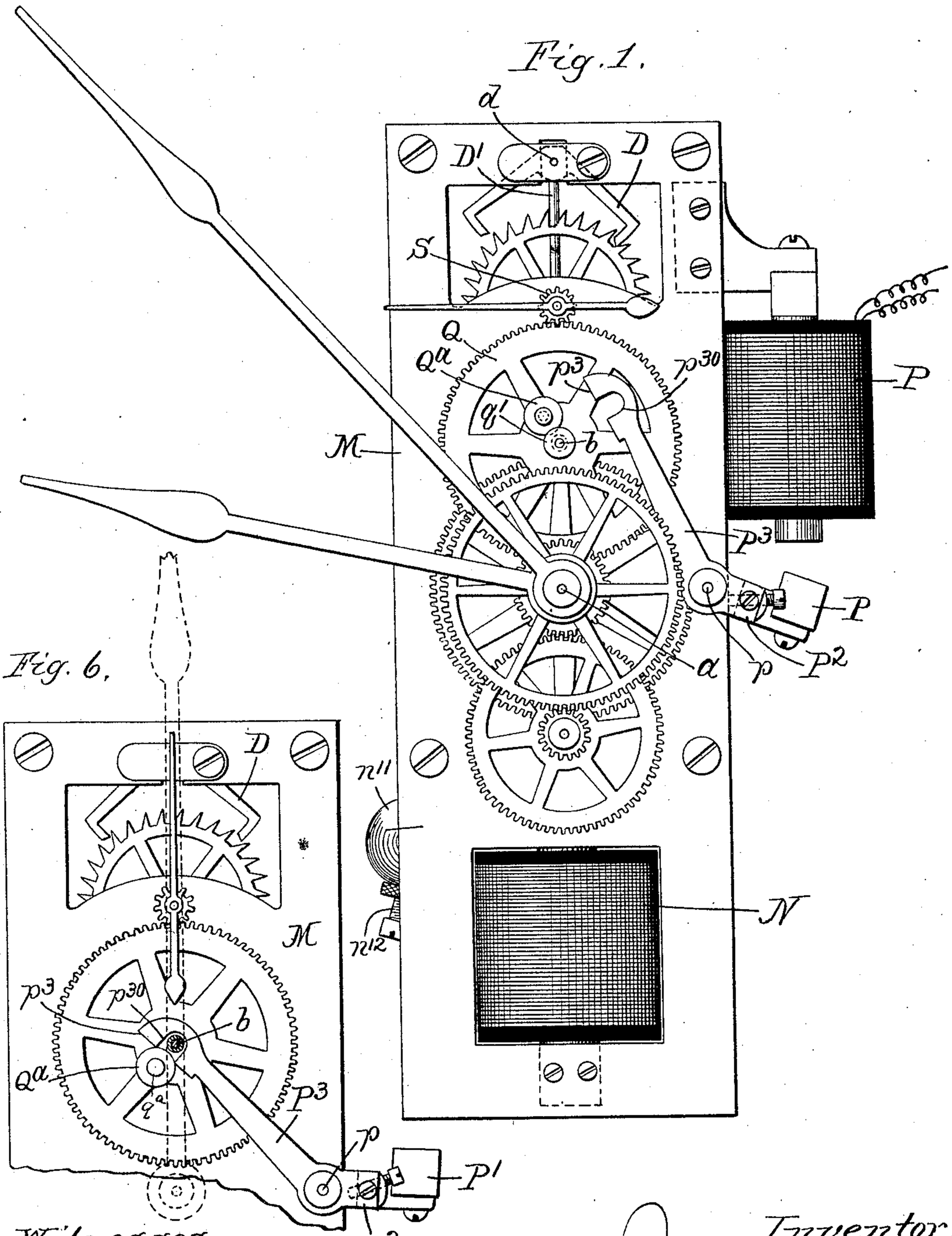
(No Model.) 2 Sheets—Sheet 1.

C. M. CROOK.

ELECTRIC CLOCK.

No. 574,669. Patented Jan. 5, 1897.

Fig. 1.



Witnesses.
E. T. Wray.
Jean Elliott.

Inventor.
Chas. M. Crook
by Burton & Burton
his Attys

(No Model.) 2 Sheets—Sheet 2.

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Fig. 5.

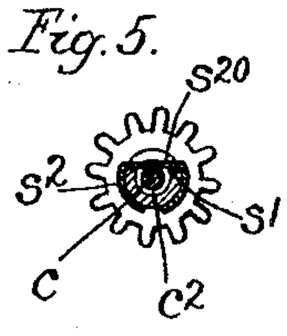


Fig. 4.

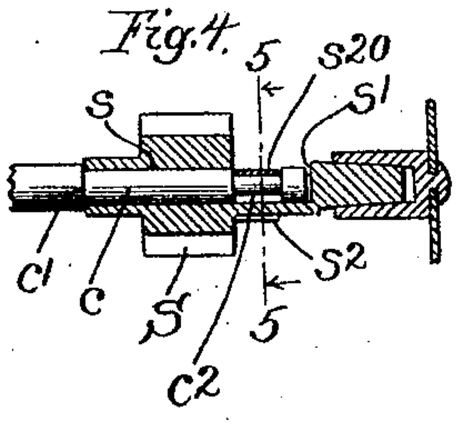


Fig. 2.

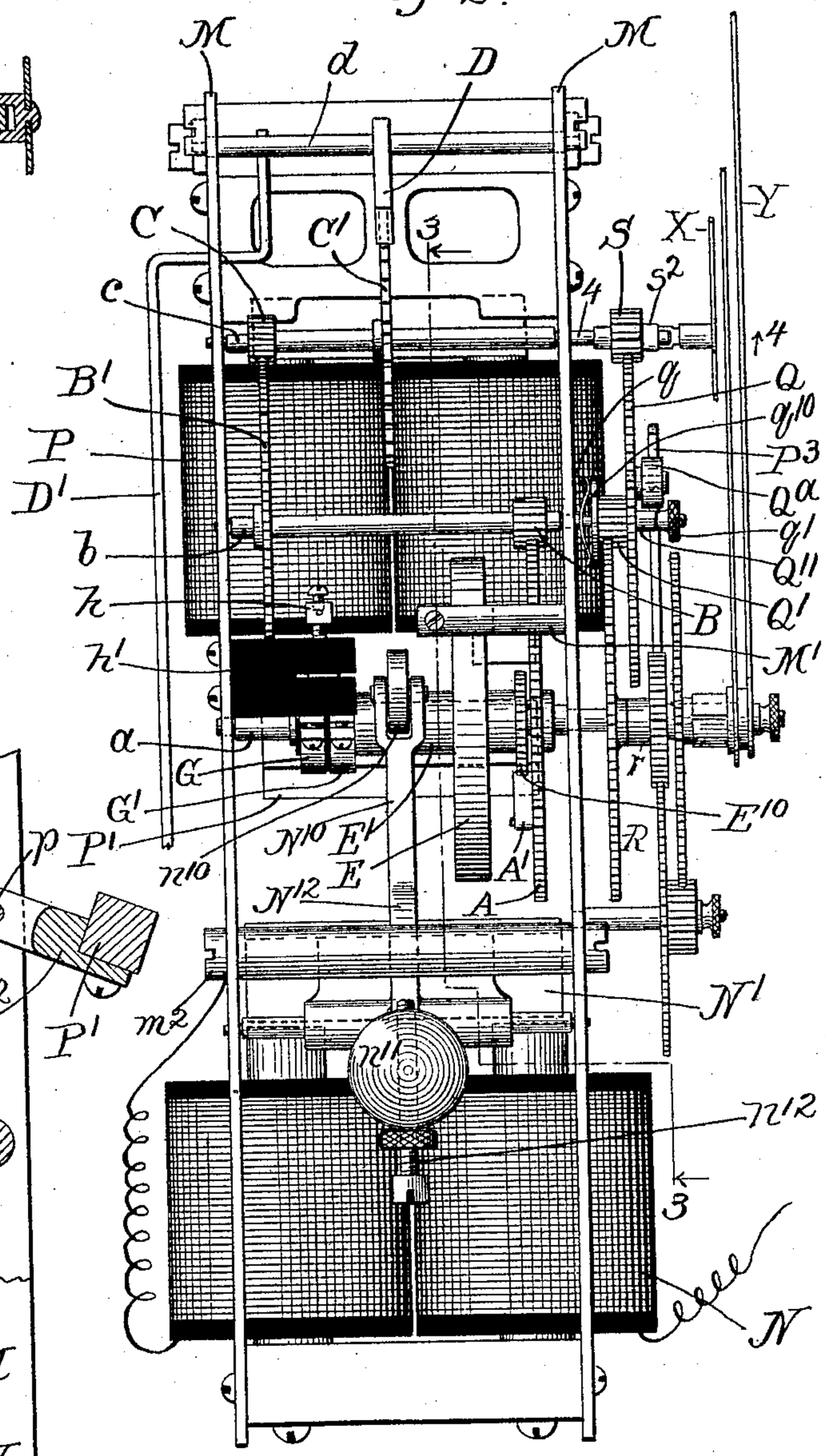
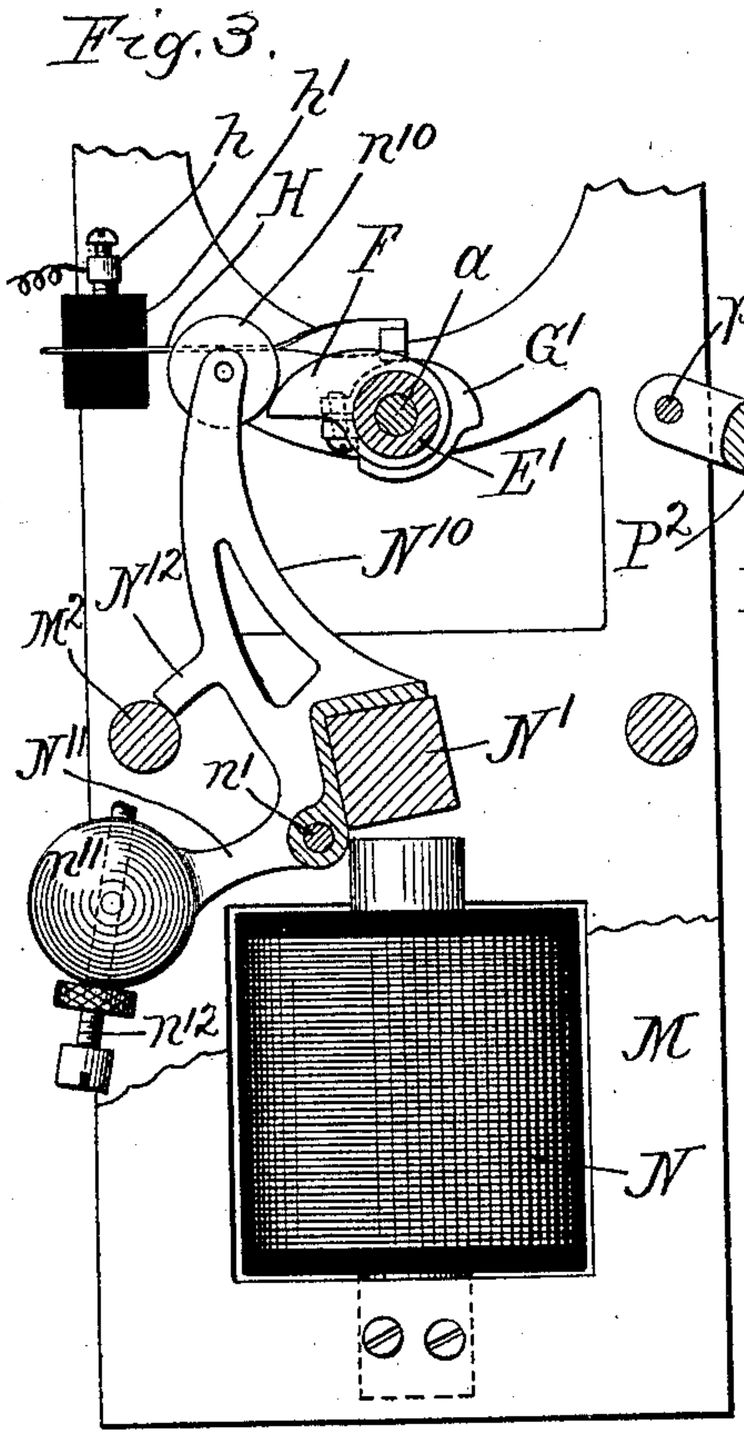


Fig. 3.



Witnesses.
E. T. Wray.
Jean Elliott.

Inventor
Chas. M. Crook
by Burton & Burton
his attys

UNITED STATES PATENT OFFICE.

CHARLES M. CROOK, OF CHICAGO, ILLINOIS, ASSIGNOR TO CHARLES S. BURTON, TRUSTEE, OF SAME PLACE.

ELECTRIC CLOCK.

SPECIFICATION forming part of Letters Patent No. 574,669, dated January 5, 1897.

Application filed December 12, 1895. Serial No. 571,866. (No model.)

To all whom it may concern:

Be it known that I, CHARLES M. CROOK, a citizen of the United States, residing at Chicago, county of Cook, and State of Illinois, have invented certain new and useful Improvements in Electric Clocks, which are fully set forth in the following specification, reference being had to the accompanying drawings, forming a part thereof.

This invention relates to clocks which are operated by springs or weights wound at intervals by the force of an electric current operating through an electromagnet upon a winding device, and which are synchronized periodically by setting devices which are operated by the force of another electromagnet, the circuit through which is closed by the clock-movement at the predetermined time for synchronizing.

In the drawings, Figure 1 is a front elevation. Fig. 2 is a side elevation of the clock-train, including the winding and synchronizing parts. Fig. 3 is a detail section at the line 3 3 on Fig. 2, showing the winding devices and the electromagnet which operates the same. Fig. 4 is a detail section at the line 4 4 on Fig. 2. Fig. 5 is a detail section at the line 5 5 on Fig. 4. Fig. 6 is a detail elevation showing the minute and seconds hands and the synchronizing device in a position occupied at the instant of synchronizing.

M is the frame.

N is the winding-magnet; P, the synchronizing-magnet, both being mounted fixedly with respect to the frame.

The principal train—that is to say, the train from the mainspring to the escapement—comprises the wheels within the case on the shafts *a*, *b*, and *c*, the shaft *a* being that about which the mainspring is coiled, having the main gear-wheel A; the shaft *b* having the pinion B, meshing with and driven by the gear A, and having also the gear B′; the shaft *c* having the pinion C, which meshes with and is driven by the gear B′, and having also the escape-wheel C′.

d is the escapement-staff, carrying the escape-dog D and the pendulum-lever D′.

I have shown the mainspring E held at the outer end by the post M′ and adapted to be wound from the inner end, being therefore secured at the inner end to the winding drum or sleeve E′, which has the ratchet-wheel E^{10} adjacent to the gear-wheel A and adapted to communicate motion thereto through the ratchet-dog A′ in a familiar manner.

My invention does not exclude other familiar forms of communicating power from the spring to the main wheel and thence to the train; but the objection which sometimes exists to this form—that the train is deprived of driving-impulse during the period of winding—is obviated in my structure by the fact that the winding is instantaneous, taking place in less time than required for the passage of one tooth of the escape-wheel—that is, in less than one tick of the clock.

On the sleeve E′ and rigid with it are two parts which do not pertain to an ordinary clock-train, being therefore in some sense distinctive of my present invention—viz., the winding-cam F and the automatic switch, composed of an insulated collar G and an uninsulated collar G′, both rigid with the sleeve E′.

N′ is the armature for the winding-magnet N. It is secured to a lever N^{10}, fulcrumed on the frame by means of a rock-shaft n' and provided at one end remote from the fulcrum and from the armature with an antifriction-roll n^{10}, adapted to bear upon the periphery of the winding-cam F. An arm n^{11} of the lever, projecting approximately at right angles to the main extent of the lever from the pivot n' to the end which has the roll n^{10}, is weighted as seen at n^{11}, the weight tending to hold the armature out of contact with the poles of the magnet and the roll n^{10} away from the shaft *a*. The spur n^{12}, thrown out from the back of the main arm of the lever N^{10}, stops against the frame-post M^2 and thereby limits the movement of the lever in the direction which withdraws the armature from the poles of the magnet. An adjusting-screw n^{12}, set through the arm which has the weight n^{11}, and most conveniently through said weight, projects toward the same post M^2 and collides against it upon the opposite side from that at which the spur N^{12} is stopped and serves to stop the lever in the direction in which it moves when the armature approaches the magnet-poles, said screw being designed to be adjusted so that the armature shall just

barely avoid contact with the magnet-poles, contact being undesirable for reasons well understood.

The circuit-wire from one pole of the energizing-battery runs to the magnet N and from the magnet to any convenient point for binding it to the frame, as at m^2. From the other pole of the battery the wire runs to the binding-post h, mounted in the insulating-block h' and making permanent contact with the switch-spring H, which it binds rigidly to the insulating-block. The switch-spring H at its end remote from its fastening to the insulating-block bears on the switching device, consisting of the collars G and G', and is thrown from one to the other of said collars as the sleeve is rotated or rocked. The construction of this switching device is substantially that which is shown in my Patent No. 550,822, dated December 3, 1895, and need not be further described here except by saying that the end of the switch-spring travels on the insulated collar while the train is running down, the track and the end of the switch-spring being so formed that the latter slips onto the uninsulated collar when the spring is run down so far as to require winding and runs on the latter collar during the winding process, slipping back onto the insulated collar at the limit of the winding movement. In this part of the clock the features which are concerned in my present invention are the form of the winding-cam F and the relation of the same to the armature and armature-levers and stops for the latter.

Referring to Fig. 3, it will be seen that when the magnet N is energized so as to attract the armature the movement of the armature toward the magnet forces the upper end of the lever N^{10} in toward the shaft a, and the roll n^{10}, bearing upon the periphery of the winding-cam F, causes such movement of the lever to rotate the shaft a through so much of an arc as is contained between the radii which contain the points of contact, respectively, of the roll on the cam at the two limits of such movement, which is designed to be about ninety degrees. The angular movement of the lever itself, which rotates the cam ninety degrees, will be seen in Fig. 3, being substantially the angle of opening between the face of the armature N' and the poles of the magnet N, from comparison of which angles it will appear how much the movement is multiplied by the mechanical connection.

The special purpose of this invention, which is at this point an improvement upon a device for a similar purpose shown in my Patent No. 534,320, dated February 19, 1895, above mentioned, is that by forming and actuating the cam as herein shown I am able to make the power necessary to be applied to the cam for each degree of rotation which it receives in the winding movement correspond precisely with the power developed at each degree of such winding movement by the attraction of the magnet and armature for each other, for it will be understood that the pull upon the armature caused by the attraction of the magnet increases very rapidly as the armature, yielding to that pull, approaches the poles of the magnet, and in order that this increased pull should be utilized the work done through the armature-lever per degree of movement must increase in the same ratio as the pull of the magnet upon the armature increases.

It will be noticed that when the armature commences to move toward the magnet, the "pull" being at its minimum, the leverage obtained by means of the cam is greatest and the amount of pull necessary to produce a given angular movement of the cam is least. It will be noticed, also, that the form of the cam is such that this leverage diminishes rapidly as the lever swings in toward the shaft and rotates the magnet, making the work done per degree of the armature's movement increase with corresponding rapidity. The law governing the increase of the magnet's attraction for the armature being known, the form of the cam F is computed substantially according to the same law, and thereby the maximum effectiveness of a given current energizing the magnet is obtained in the winding of the mainspring. The action being practically instantaneous when the circuit is closed, the roll n^{10} would come to a stop at the innermost point of the cam with a blow upon the latter, and therefore upon the shaft a. This being especially undesirable, I have provided so that the lever is stopped before the roll can give a blow to the shaft. Such stoppage might be effected by contact of the armature with magnet, but for well-known reasons it is desirable that these parts should not come into absolute contact. Hence I employ the stop-screw n^{12}, which collides with the frame-post M^2 and may be adjusted by screwing it through the lever-arm of the armature so as to permit the utmost movement which is permissible, and yet prevent the blow, which is undesired. The stoppage of the lever in the opposite direction, by means of the spur N^{12} against the same post M^2, causes the lever to stand in such position that the roll n^{10} will be in contact with the cam at the time the circuit is closed, and will therefore begin to actuate the cam as soon as it begins to move, not being obliged to travel through an interval and strike the cam, thus wasting power, before commencing to move it.

Another feature of my improvement relates to the synchronizing devices and the hand-driving train. Heretofore in clocks having a seconds-hand revolving about a different center from the minute-hand one of two methods has been followed. Either the seconds-hand has been mounted upon a shaft of the principal train, usually the escape-wheel shaft, and driven positively by such shaft, and the train from the minute-hand to the hour-hand has been frictionally connected

at one shaft, usually the minute-hand shaft, to the principal train, so that the minute-hand and hour-hand could be set at any time regardless of the running of the principal train, but without the setting of the seconds-hand, or the seconds-hand has also been frictionally connected to its shaft and has been driven in a train with the hour-hand and minute-hand, so that by means of the minute-hand all three of the hands could be set, the connection slipping at both points of frictional engagement—to wit, on the minute-hand shaft and the seconds-hand shaft. A third method, partaking of the elements of both those mentioned, has also been employed, or, when the movement has been adapted for synchronizing, the seconds-hand is provided with frictional connection with its shaft and the minute and hour hand train with a frictional connection at the minute-hand shaft, but the seconds-hand is not driven by the frictionally-connected train which connects the other hands. This construction requires two synchronizing connections, one to set the minute-hand, and thereby the hour-hand, and another to set the seconds-hand. This part of my invention consists in driving all the three hands in one train, that train having a frictional connection with the driving or principal train at an intermediate shaft in the train—that is to say, neither at the minute-hand shaft nor at the seconds-hand shaft—and a third specific feature consists in synchronizing by action upon a wheel in said frictionally-driven train intermediate the minute-hand and the seconds-hand, preferably the wheel on the shaft at which the frictional connection is made.

Another specific feature of my invention consists in utilizing the three shafts of the principal train as shafts of the hand-train and mounting the entire train, from the minute-hand to the seconds-hand, on such three shafts and causing the several wheels in such train to operate in unison with the wheels in the principal or driving train on said shafts, respectively.

In addition to these features I have shown a specific form of synchronizing device which constitutes one feature of my invention, which will be more fully explained hereinafter.

On the shaft *b*, in front of the frame, is the gear-wheel Q and pinion Q′, formed rigidly as a unitary wheel, frictionally carried with the shaft *b* by means of the spring *q*, stopped against the shoulder *b′* on the shaft and acting against the rear disk q^{10} of the pinion Q′, a thumb-screw *q′*, screwed into the forward end of the shaft and bearing against the sleeve-like extension Q^{11} of the hub of the wheel, serving to force the wheel onto the spring, whereby the frictional engagement is obtained. The pinion Q′ drives the gear R, which is loose on the shaft *a*, the hub of this gear being a sleeve *r*, which extends forward and carries the minute-hand Y at its forward end. The wheel Q meshes with the pinion S, which is loose on the forward end of the shaft *c* and which has the forwardly-extended hub S′, which carries the seconds-hand X. The gear-wheel Q is a duplicate as to size and number of teeth of the gear B′. The pinion Q′ is in the same respects a duplicate of the pinion B. The gear-wheel R is likewise a duplicate of the gear-wheel A, and the pinion S is a duplicate of the pinion C. These several wheels in front of the frame therefore have, during the running of the movement, the same speed as the shafts, on which they are nevertheless mounted loosely. With this construction the three hands are maintained in unison after being once so mounted on their respective shafts, and in setting the clocks in the customary manner, by rotating the minute-hand, not only will the hour-hand be rotated in unison, but the seconds-hand also.

For the purpose of synchronizing—that is, setting the clock periodically in agreement with any controlling chronometer with which its synchronizing devices are electrically connected—I provide the wheel Q with an abutment in the form of a roll Q^a, mounted on the stud q^a, the roll being greater in diameter than the tubular hub Q^{11} of the wheel Q, and on the shaft *p*, suitably supported on the frame, I mount the lever P^2 P^3, whose arm P^2 carries the armature P′ for the magnet P, while the arm P^3, extending in front of the wheel Q and past the shaft of said wheel, is adapted to strike the abutment Q^a. The edge or face p^3 of the lever-arm P^3 toward the abutment is straight, and its direction is substantially radial with respect to the shaft *p*. If this face or edge p^3 were uninterrupted throughout the entire extent which could encounter the abutment, it would tend, when it encountered the abutment on the side of the shaft *b* toward said lever-arm at any position except in a radius of the shaft *b* at right angles to said edge p^3, to rotate the wheel Q one way or the other, according to the position of said roll one side or the other of the radius at right angles to the edge. By this means the wheel Q might be rotated any distance less than ninety degrees if at the instant of synchronizing the abutment was anywhere except at the one point indicated on the side of the shaft *b* toward the lever-arm P^3. If, however, the abutment happened to be anywhere in the other half of its circuit, the lever P^3 would not act upon it and the clock would not be synchronized. In order, therefore, to adapt the lever-arm P^3 to rotate the wheel Q whichever side of the shaft the abutment may stand at the instant of synchronizing, I make the notch p^{30} in the lever-arm P^3, interrupting the face or edge p^3 and adapting the lever to stride the hub of the wheel Q, so that the edge p^3 at both sides of the notch may extend past the shaft *b* when the lever is rocked, and may encounter the abutment Q^a and rotate the wheel Q when said abutment is on the farther side of the shaft, as well as when it is on the proximate side. A special advantage is obtained by this

notch in addition to the fact that the lever is adapted to reach past the shaft, which may be understood by observing that if the wheel were on the extreme end of its shaft, the shaft not projecting past it and therefore not being in the way of the lever, the straight edge p^3, if not interrupted, would tend, by pressing against the abutment Q^a, to rotate the wheel Q to a point at which the contact of the edge p^3 on the abutment should be in a line through the axis of the wheel Q at right angles to the edge p^3, but as the abutment approaches such point, the angle between its direction of movement and the line of pressure exerted by the lever approaching a right angle, it would seldom be brought to rest exactly at the theoretical point indicated, for if the stroke were slow it would stop short of it, and if it were rapid the momentum of the wheel would carry the abutment beyond that point, and it would come back to it only with the slow movement due to the continuing pressure of the lever, so that rarely, if ever, would it rest at the exact point desired. When, however, a notch is made in the edge p^3, the corners of the notch being at some little distance from the point where the roll would be tangent to the edge p^3 if the latter were uninterrupted, the roll runs off the edge into the notch some time before the angle of pressure becomes disadvantageous, and the roll lodges in the notch in contact with both its corners, this position being invariably attained whenever the lever is actuated. It becomes immaterial, therefore, whether the corners of the notch are exactly equidistant from the theoretic point at which the abutment would rest upon the edge if the notch were not made, but the intention of the structure is preferably to make the notch symmetrical with respect to the radius of the shaft *b*, which is at right angles to the edge p^3 when the latter is at the limit of its forward stroke upon the abutment. When the hands are originally mounted, they will be set together at the synchronizing-point, say twelve o'clock, with a roll Q^a in the position on the side of the shaft *b* opposite the lever P^3, to which it would be forced by the stroke of that lever. At such position, therefore, it should stand at the next synchronizing period, twelve o'clock of the next day. If the movement has been fast or slow to an extent less than necessary to cause the abutment at twelve o'clock to stand on the side toward the lever P^3, and so nearly in a line at right angles with the face of the lever that the latter will not force it back by its synchronizing stroke, the stroke of the lever will steer the abutment to the proper point opposite the shaft from the lever, thereby setting the three hands at twelve o'clock and in perfect unison. As illustrated, the lever, by its stroke upon the abutment, will rotate the latter from any point outside of an arc of about sixty degrees on the side toward the lever. It is capable, therefore, of rotating the wheel Q through one hundred and fifty degrees either way to the synchronizing-point. As the train is constructed, one hundred and fifty degrees movement of this wheel corresponds to three minutes running time of the train. The device, therefore, is adapted to make a maximum correction of three minutes either way—that is, for loss or gain.

Obviously the train may be constructed so that the correction may reach any desired amount within necessary limits.

It will be understood that the synchronizing-circuit is closed by a suitable circuit-closing device in the clock-train. This is not shown in the drawings. Any well-known device for that purpose may be employed.

In order to facilitate the work of cleaning and repairs, I make the pinion S, which is loose on the shaft *c*, as explained, so that it may be retained on the shaft and readily removable therefrom without the necessity of extending the shaft through the long hub of the pinion, which it is necessary to provide in order that it may carry the seconds-hand at its forward end. A device for this purpose is shown in Figs. 4 and 5. The pinion and its hub is drilled at the center from the rear side, as seen at *s*, the shaft *c* being turned down to a size which makes it loose in the pinion at this point. At a point which would be forward of the pinion when the latter is in place, and stopped at its rear end against the shoulder *c'* of the shaft, I make a peripheral annular groove c^2 in the shaft, and at a corresponding point in the hub of the pinion S, forward of the latter, I cut through into the interior aperture of the hub at *s*, and on the outside of the hub at this point I place a spring-clasp s^2, which is held in place by its ends clasping the hub, as seen in Fig. 5, a straight portion s^{20} of the clasp between the ends lodging in the aperture *s'* of the hub and in the annular groove c^2 of the shaft, and by its engagement with the shaft in said annular groove and with the hub in said notch it retains the pinion longitudinally on the shaft, while permitting it to rotate freely, the straight portion s^{20} of the clasp traveling around in the annular groove c^2 during such rotation of the pinion. A repairer will use a pin or other delicately-pointed instrument to spring the clasp up out of the annular groove and will then withdraw the pinion longitudinally from the shaft when he desires to dismantle the movement for any purpose requiring the separation of the front and rear plates of the frame.

I claim—

1. In a chronometer, in combination with the winding shaft, drum or barrel, the cam thereon; the electromagnet and its armature, and the lever which carries the latter having an abutment adapted to operate against the cam; the lever having an arm adapted to be stopped by collision with the frame in the movement caused by the attraction of the magnet for the armature, one of said colliding parts having an adjustment-screw by

which the collision may tend, with respect to the approach of the armature to the magnet-poles and of the abutment to the end of the cam-track, whereby the armature may be prevented from contact with the poles, and the abutment prevented from giving a blow to the cam: substantially as set forth.

2. In a chronometer, having a seconds-hand rotating about a different center from the minute-hand, in combination with the principal train, a train connecting the three hands, said train having frictional connection only with the principal train, such connection being at a wheel in said train intermediate between the minute and seconds hands.

3. In a chronometer, in combination with the principal train, a train connecting the seconds-hand, minute-hand and hour-hand, such train being connected to the principal train frictionally, and not positively, the wheels of such train which extend from the minute-hand to the seconds-hand being mounted on the shafts of the principal train, and having the speeds of such shafts respectively, the frictional connection being made at an intermediate shaft of the principal train and corresponding intermediate wheel of the hands-train.

4. In a chronometer, in combination with the principal train, a train frictionally connected with the principal train and connecting the seconds-hand, minute-hand and hour-hand, a wheel in said train intermediate between the seconds-hand and minute-hand, being provided with a synchronizing device, and an electromagnet and its armature provided with a lever-arm adapted to operate upon such synchronizing device.

5. In a chronometer, in combination with the principal train, a train frictionally connected with such principal train, and extending between the seconds-hand, minute-hand and hour-hand, such frictional connection being made at a wheel intermediate in the train between the minute-hand and the seconds-hand, and a synchronizing-lever adapted to operate upon such intermediate wheel.

6. In a chronometer, in combination with the principal train having the escapement-wheel staff extending forwardly through the frame; a train in front of the frame comprising a pinion mounted on the forwardly-protruding staff of the escapement-wheel; the hub of said pinion having an aperture and the staff having an annular groove in a position corresponding to said aperture; and a spring-clasp exterior to the hub having a portion which lodges in the aperture and extends into the annular groove of the shaft, whereby the pinion is longitudinally stopped on the shaft and detachably disengaging the clasp: substantially as set forth.

In testimony whereof I have hereunto set my hand, in the presence of two witnesses, at Chicago, Illinois, this 7th day of December, 1895.

CHAS. M. CROOK.

Witnesses:
CHAS. S. BURTON,
JEAN ELLIOTT.