No. 806,332. PATENTED DEC. 5, 1905.

M. FISCHER.

ELECTRIC CLOCK SYSTEM.

APPLICATION FILED JULY 5, 1900.

2 SHEETS—SHEET 1.

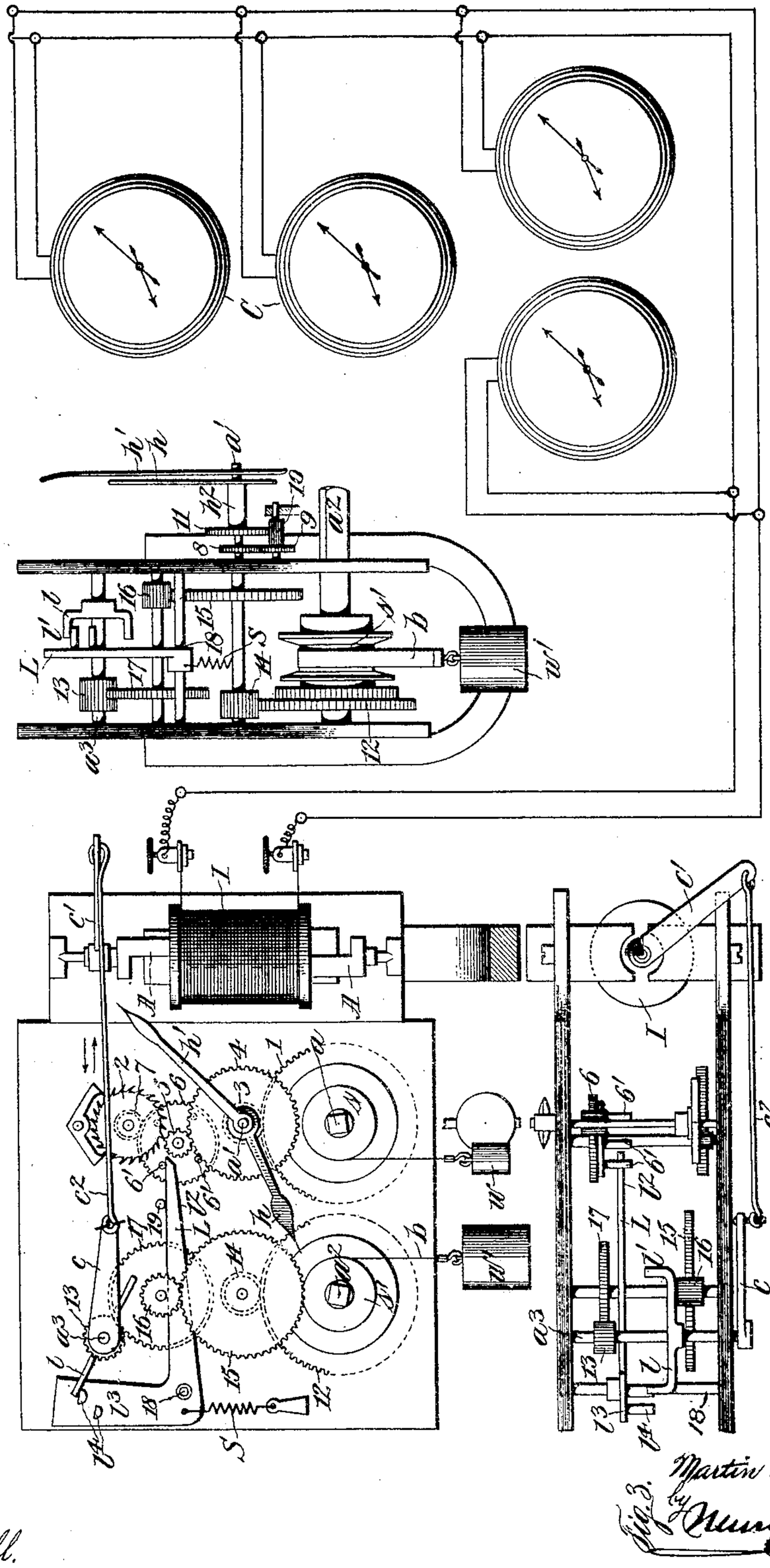

Fig. 2.

Fig. 1.

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Fig. 3.

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2 SHEETS—SHEET 2.

Fig. 4.

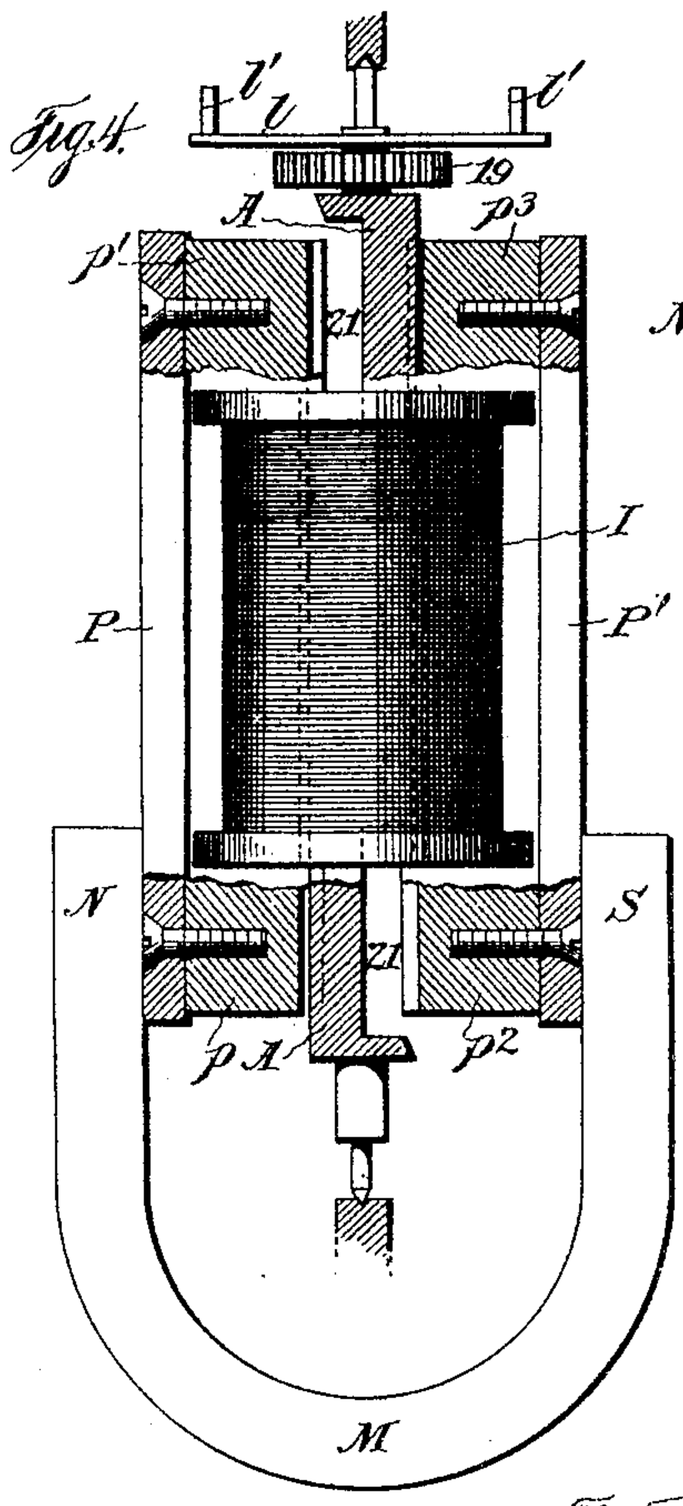


Fig. 7.

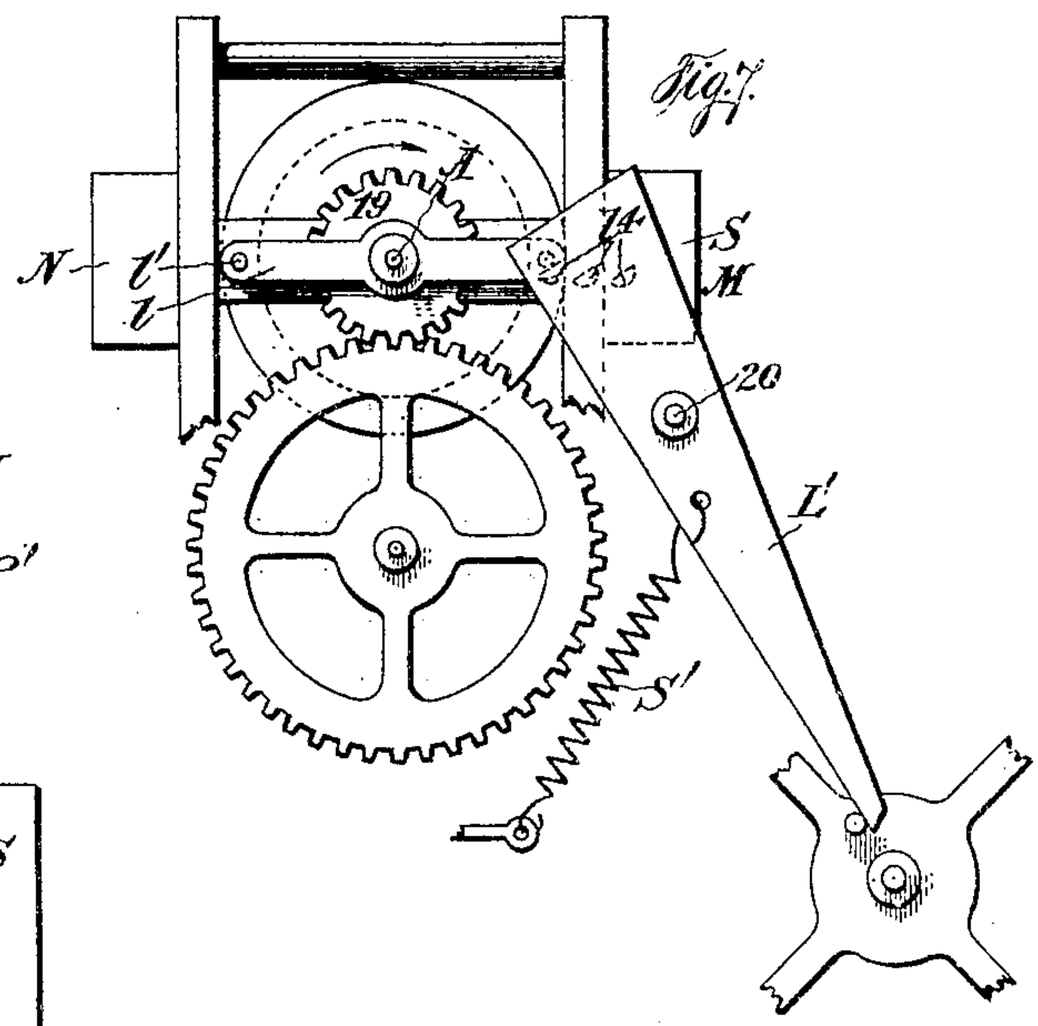


Fig. 6.

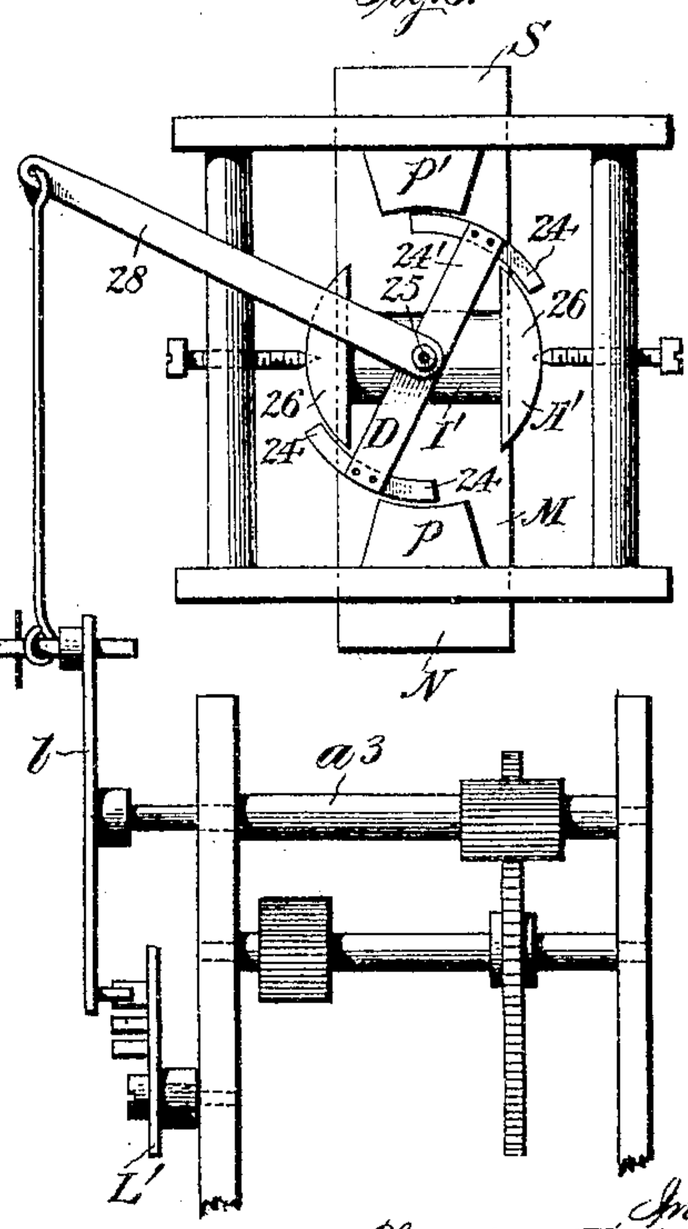
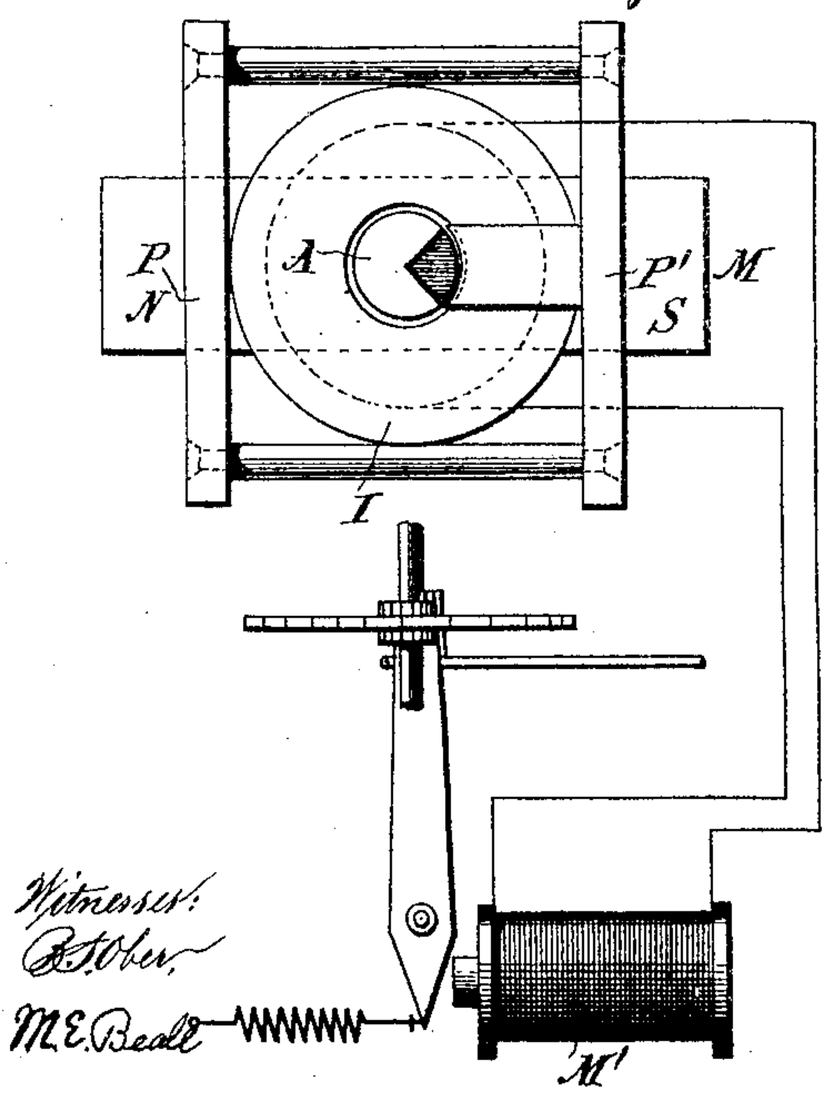


Fig. 5.



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UNITED STATES PATENT OFFICE.

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ELECTRIC CLOCK SYSTEM.

No. 806,332. Specification of Letters Patent. Patented Dec. 5, 1905.

Application filed July 5, 1900. Serial No. 22,582.

To all whom it may concern:

Be it known that I, MARTIN FISCHER, a resident of Zurich, Republic of Switzerland, have invented a certain new and useful Improvement in Systems of Electric Master-Clocks without Batteries, of which the following is a specification.

My invention has relation to signaling systems operated by electric impulses generated by the signal-controlling apparatus, and more particularly to a system of time distribution wherein a number of secondary clocks are actuated by a central or master clock.

In the systems of time-indicators hitherto proposed a battery or equivalent constant source of electricity has been employed for supplying the necessary current to operate a number of time-indicators, the transmission of current being controlled by contacts operated to open and close the circuit at predetermined intervals of time through the medium of a revoluble element of a time train of gearing or through the medium of a vibrating element of a time-indicator, as the pendulum. It is, however, well known that a battery cannot be relied upon, because its efficiency is variable from causes well understood, while the use of contacts is also objectionable owing to the difficulty of maintaining their efficiency. To avoid these difficulties, it has also been proposed to substitute a simple form of electric generator, comprising an armature-coil arranged to rotate in the field of a permanent magnet and having a periodical rotation imparted thereto in one and the same direction through mechanism actuated or controlled by a revoluble element of a time train of gearing. The armatures of this class of generators, having a sufficient number of ampere-turns to produce current of requisite strength to operate the secondary clocks, are found in practice to be of too great weight and size, however, to be capable of regular and accurate operation by the master-clock, which, it will be understood, is called upon to give to the armature a quick positive rotation of uniform extent for each period of time, and further disadvantages and obstacles to the success of systems of this type have been due partly to the difficulty of maintaining efficient electrical contact between commutator rings and brushes without producing such friction as would preclude their easy relative movement and also partly to the fact that the receiving apparatus of the secondary clocks have not been adapted to the peculiarities of the momentary current impulse furnished by the mechanical generator.

These and other disadvantages are intended to be obviated by the present invention, which has for its object the provision of a circuit in the form of a permanent closed conducting-loop involving no movable parts or electrical contacts, combined with a compact and easily-actuated means for impressing adequate current upon such circuit or loop for actuating the indicators or secondary clocks. With this object in view I have constructed a circuit involving a generator in which the usual armature-coil and field are both stationary, and the mechanical power is utilized only to control the direction of the field with relation to the coil, and I have found that this may be accomplished by means of a simple conductor of magnetic lines of force, such as a soft-iron bar, so located between the poles of a permanent field-magnet that reversal of its position will produce a reversal of polarity or change in the direction of the lines of force passing through the coil, and this device may be of such small mass and swing through such small distances that it will not accumulate objectionable momentum, which fact renders it especially adapted for being quickly and positively moved by means of a low-power motor and light connecting-gearing. The magnetic field existing between the poles of the permanent magnet and the magnetic conductor, however, is so intense as to require more power than is practicable to be derived from the time-train gearing, and for this reason I prefer to make use of a separate train and motor for generating the current; but by my improvement the latter may be of substantially the same size and power as the time-train motor.

The stationary coil, which is subject to the change of field referred to, is connected by its terminals permanently to the line conductors which lead to all the secondary clocks, and the latter are especially adapted to the current impulse produced by each change of field by being provided with a power-accumulator, as a spring, whereby the initial energy of the current impulse in their electromagnets is stored until the current reaches a maximum, whereupon the accumulated power may be said to be added to the maximum power for

overcoming the inertia of the receiving or indicating apparatus. The construction of the secondary clock, however, I have fully described in a divisional application, Serial No. 69,607, filed July 24, 1901, and make no claim to the same herein.

The present invention also involves other features of construction and operation, all of which will be hereinafter fully described, and more particularly pointed out in the accompanying claims.

Referring to the accompanying drawings, which form a part of this specification, Figure 1 is a face elevation illustrating the armature-actuating train of gearing and so much of the time train of gearing as will be necessary to a full understanding of my invention, together with suitable let-off devices controlled by said time-train, also showing an electric circuit including a number of controlled clocks. Fig. 2 is an end elevation of the armature-actuating train and part of the time train of gearing; and Fig. 3 is a plan view of Fig. 1, showing the current-generator, the mechanism for operating its magnetic pole-changer, the let-off devices, and those parts of the train of gearing which operate the pole-changer, together with those parts of the time train of gearing which control the said let-off devices. Fig. 4 is a vertical sectional view of the current-generator in which the pole-changer is adapted for rotation according to the modification shown in Fig. 7, and Fig. 5 is a top plan view of Fig. 4 with the actuating-gearing removed and showing a simple form of receiving instrument provided for each subsidiary clock. Fig. 6 is a plan view of a modified construction of the generator, also showing means for oscillating the pole-changer thereof; and Fig. 7 is a plan view showing means for imparting to the generator-armature periodical angular movements in one and the same direction.

Referring first to Figs. 1, 2, and 3, I have shown part of a time train of gearing operated by a weight w, winding on a drum or spool s on winding-arbor a, which also carries the master-wheel 1, a pawl-and-ratchet connection being provided between the spool and master-wheel in the usual manner. The master-wheel 1 is geared to the escapement-wheel 2 through the medium of suitable intermediate proportional gearing 3, 4, 5, 6, and 7, a' indicating the minute-hand arbor, h^2, Fig. 2, the hour-hand sleeve, h h' the hour and minute hands, and 8, 9, 10, and 11 the usual reducing-gearing that moves said hour-hand sleeve. The train of gearing which actuates the pole-changer A consists, as shown, of a master-wheel 12, driven by weight w', attached to a band or ribbon b of steel, winding on a spool s', (see also Fig. 2,) the usual ratchet-and-pawl connection between spool and master-wheel being also provided, and in practice, with a view to economy of space and durability, I preferably use such a band for the weight w of the time-train. The master-wheel 12 is geared to a pinion 13 on an arbor a^3 by suitable intermediate proportional gearing 14, 15, 16, and 17. The arbor a^3 has secured thereto a radial or crank arm c, connected by a rod c^2 to a radial or crank arm c' on a sleeve secured to and insulated from the field-pole changer A of the current-generator, and on said arbor a^3 is furthermore secured one of the elements of a let-off device—namely, the arrester l—in the form of two arms radially disposed on a hub and having a pallet l' at their ends. One of the wheels of the time train of gearing—as, for instance, the wheel 6—is provided with a number of pins 6′, and L indicates the other element of the let-off device in the form of a bell-crank lever fulcrumed at 18, whose longer arm l^2 projects into the path of the pins 6′ on wheel 6, while its shorter arm l^3 carries two stop-lugs l^4, the said lever L being held in a normal position, Fig. 1, against a stop-pin 19 by a spring S.

It will be readily seen that when a pin 6′ depresses the arm l^2 of let-off lever L the pallet l' of the arrester l, engaged by the right-hand lug l^4 on arm l^3 of said lever L, will slip off said lug to be caught by the left-hand lug. As the lever-arm l^2 is further depressed and about to be released by the pin 6′ the arrester l is also released from the left-hand lug l^4, thus releasing the armature-actuating train of gearing. The spring S immediately returns lever L to its normal position, so that the arrester l will be enabled to make one-half of a revolution only, when it will again be caught by the right-hand lug l^4 on lever L. It will be observed that the movements of the crank-arm c impart intermittent half rotations to the field-pole changer A in opposite directions; but it will be understood that I do not limit myself to mechanism imparting to the pole-changer angular movements of one hundred and eighty degrees, alternating in direction—*i. e.*, oscillating movements—as the object I have in view is also attained by imparting to the armature periodic angular movements of one hundred and eighty degrees, more or less, in one and the same direction. Thus, as shown in Figs. 4 and 7, the field-pole changer A can be geared to one of the gear-wheels of the generator-actuating train of gearing—for instance, the last wheel of said train—the pole-changer carrying a pinion 19 in gear with said last wheel, the latter and pinion being suitably proportioned. In this case the part A also carries the arrester l, whose pins l' lie in the path of the stop-lug l^4 on a straight let-off lever L′, fulcrumed intermediate its ends at 20, the longer arm of said lever projecting into the path of pins 6′ on one of the wheels of the time-train, S′ indicating the retracting-spring which holds lever L′ in the normal position (shown in Fig. 7) against a stop, (not

shown,) and in this arrangement I have shown the shorter arm of the let-off lever provided with three stop-lugs l^4. The object of this is to provide a means for setting the hands of the controlled clocks forward independently of the time train of gearing of the controlling or master clock and to guard against the release of the armature train of gearing for a longer period of time than required for the arrester l to make one-half of a revolution.

The intervals at which the pole-changer is reversed may of course be varied; but I have found periods of one minute to be quite satisfactory.

The setting of the secondary clocks may be readily effected by a cord attached to the shorter arm of lever L′, a pull on which rotates said lever against the stress of its spring S′, and by providing a suitable stop limiting the rotation of the lever.

I will now describe the construction of the current-generator, referring more particularly to Figs. 4 and 5, it being understood that the pole-changer A (shown in Fig. 4) may be operated by the gearing of Figs. 1 to 3, if desired, and that the generator may be used for other purposes than the distribution of time.

M indicates the permanent magnet, P P′ soft-iron plates secured to its poles N S, respectively, and p p' p^2 p^3 pole-shoes having concave faces secured to the upper and lower proximate ends of said plates. The pairs of pole-shoes p p' and p^2 p^3 represent, respectively, divided poles of the magnet M. A indicates a soft-iron core or field-pole changer, which is preferably cylindrical, as shown in the figure referred to, (or may be polygonal in cross-section—*i. e.*, in the form of a flat bar,) and is mounted on suitable end journals to rotate on its longest axis between the pole-shoes, the faces of the latter being cylindrical in contour and of slightly greater diameter than that of the core, so that the latter may rotate close to the shoes, but out of contact with them. The core A is recessed or cut away at diametrically opposite points where it extends between the pole-shoes, as shown at 21, the relative arrangement of the core and pole-shoes being such that the magnetic lines of force will traverse through the length of the core in opposite directions as the latter is rotated through angular distances of one hundred and eighty degrees. Thus in the position indicated in Fig. 4 the lines of force pass from the N pole of the permanent magnet M through pole-shoe p, through the core A from the bottom to the top, and from thence through the pole-shoe p^3 to the S pole of the magnet. Upon reversing the position of the core A the lines from the N pole will pass through the pole-shoe p', through the core A in a direction reverse to that just mentioned, to pole-shoe p^2 and the S pole of the permanent magnet. The stationary induction-coil I is located in the magnetic circuit between the two plates P P′, surrounding the core A, in such position as to be in the path of the magnetic lines, so that upon a change of the field in the core A a current is produced in the winding thereof. The terminals of the coil are permanently secured to the conductors leading to the secondary clocks, as indicated by Figs. 1 and 5, and the current produced in the coil may traverse these to the electromagnets M′, Fig. 5, of the secondary clocks to operate them in the manner already referred to and as particularly described in my copending application mentioned above.

The advantages of a generator of electricity constructed as above described are manifold. The coil being stationary may have any desired number of ampere-turns, and its terminals may be readily attached to the line conductors without the use of commutator rings and brushes or other objectionable contacting surfaces.

The alternate change of polarity of the iron cylinder A may be effected in various ways, either by arranging the cylinder so as to have motion with respect to the coil or by the use of an auxiliary device for changing the direction of the lines of force through it. It is not essential that the core be rotatable, as indicated, as it may obviously also be mounted to swing transversely, so as to alternately bridge diametrically opposite pole-shoes, as shown in Fig. 6. In either case, however, the movement required is very light as compared with the weight of the coil, and a correspondingly low power is therefore sufficient to operate it in such manner as to effect the required change of polarity of the field with great rapidity.

It will be obvious to the electrician that if an additional induction-coil should be located around each of the soft-iron plates P P′ currents will also be generated in them and that these may be properly connected with the main induction-coil I so as to augment the current thereof.

I do not limit my invention to the construction of generator shown and described, as this may be variously modified without departing from the principle upon which its construction is based. For instance, as shown in Fig. 6, the core A′ and coil I′ may both be stationary and a pole-changer D arranged to oscillate in the magnetic field of the permanent magnet M. The pole-changer D may consist of two segmental shoes 24, of magnetic material, secured to a bar 24′ of non-magnetic material, mounted on an arbor 25, arranged perpendicular to and midway of the longitudinal axis of the armature and coil I′, said shoes forming in a measure shiftable magnet-poles. To the arbor 25 is secured a crank-arm 28, connected to crank-arm on the driving-shaft of the armature-actuating train of gearing, as hereinbefore described, or, as

shown in said Fig. 6, to a pin 29 on the arrester *l* on arbor a^3 of the armature-actuating train, said arrester controlled by the let-off lever L′, the arrangement being such as to impart to the pole-changer angular movements in opposite directions, the core A′ having heads 26 in the form of segments of cylinders, the diameter of the circle of which is but a trifle less than the diameter of circle of the inner faces of the segmental shoes 24 of the pole-changer, the same relation existing between the outer faces of the latter and the inner faces of the pole-shoes *p p′* of the magnet M. Oscillation of the pole-changer D obviously produces a change in the direction of field in the core A′. By the provision of suitable mechanism whereby the field-pole changer D is caused to slowly recede from the magnetic poles and then to suddenly move back to its normal position the armature is first depolarized and its polarity suddenly restored, whereby direct currents are also generated in the induction-coil. Further modifications of the generator will be apparent from what has already been described. For example, with some forms of the actuated or receiving instruments a direct-current impulse is preferable, and this may obviously be secured by removing from the generator shown in the drawings an upper and a lower oppsite pole-shoe, in which case one of the plates P P′ will also be unnecessary and each current impulse will be of one direction.

It will be obvious to an expert that a plurality of current-generators such as described may be made use of by connecting the stationary coils thereof together and effecting the changes of polarity of the armatures synchronously or successively or alternately, the synchronous changes, however, being preferred, as the pole-changers A may then be mounted on a common shaft.

It will be observed that the combination of flat steel band and binding-drum presents several important points of advantage over weight winding means hitherto employed; but as this combination is clearly capable of use in other relations I regard the same as an independent invention, for which I reserve the right to make claims in a subsequent application.

Having thus described my invention, what I claim as new therein, and desire to secure by Letters Patent, is—

1. A system of time-distribution, comprising a permanent magnet arranged to form an open magnetic circuit, a stationary induction-coil in the field of said magnet, a soft-iron bar movable relatively to the magnetic poles and coil to close said circuit through the coil, and a permanently-closed metallic electric circuit free from moving elements and including the coil and translating devices for and adapted to operate secondary clocks; in combination with a master-clock and means controlled thereby to periodically impart proper movements to the aforesaid bar, for the purposes set forth.

2. A system of time-distribution, comprising a permanent magnet arranged to form an open magnetic circuit, a stationary induction-coil in the field of said magnet, a soft-iron core movable in said coil relatively to the magnetic poles to close the magnetic circuit through the core, and a permanently-closed metallic electric circuit free from moving elements including the coil and translating devices for and adapted to operate secondary clocks; in combination with a master-clock, a normally inoperative motor connected to the soft-iron bar to impart proper movements thereto, and means controlled by the master-clock to periodically cause said motor to become momentarily operative, for the purposes set forth.

3. A system of time-distribution, comprising a permanent magnet arranged to form an open magnetic circuit, a stationary induction-coil in the field of said magnet, a soft-iron bar, having motion relatively to the coil and magnetic poles, to close the magnetic circuit through the coil in opposite directions alternately to generate electric currents of opposite directions in the coil, and a permanently-closed metallic electric circuit free from moving elements including said coil and translating devices adapted to be operated by said currents and adapted to operate secondary clocks, for the purpose set forth.

4. In a system of time-distribution, a permanent magnet, an induction-coil between two pairs of unlike poles of said magnet, a soft-iron bar extending through the coil and movable between said pairs of poles and so shaped as to reverse the direction of flow of the magnetic flux through the bar at each successive movement thereof; a permanently-closed metallic electric circuit free from moving parts and of which the induction-coil forms a part, and electromagnets for operating secondary clocks, the induction-coils of which likewise form part of said electric circuit; in combination with a normally inoperative train of gearing connected to the aforesaid soft-iron bar to impart proper movement thereto, a master time train of gearing, and means controlled thereby to periodically cause the motor-train to become momentarily operative, for the purpose set forth.

In testimony whereof I have hereunto set my hand in presence of two witnesses.

MARTIN FISCHER.

Witnesses:
A. LIEBERKNECHT,
TH. FLONSEN.