

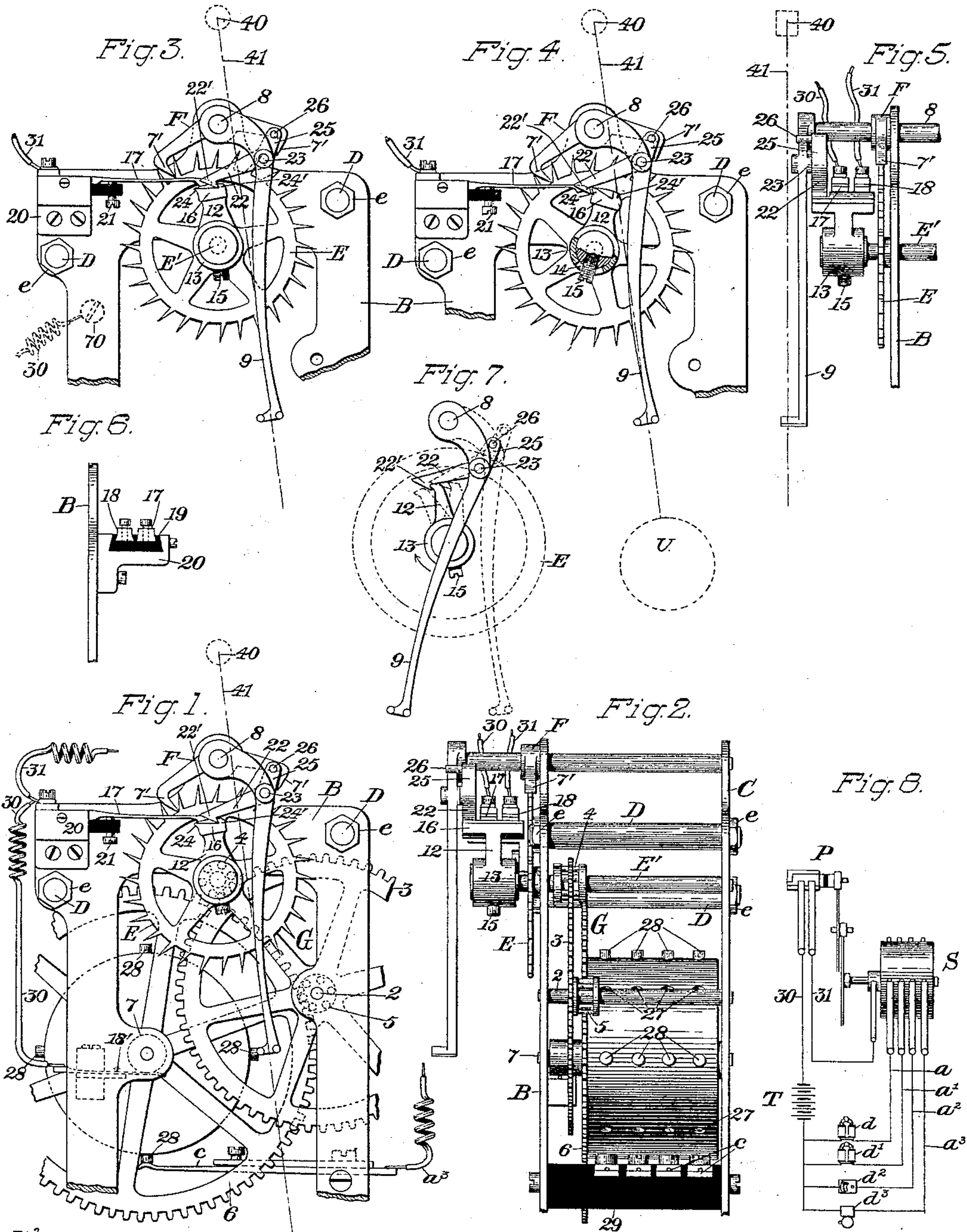
(No Model.)

2 Sheets—Sheet 1.

F. L. GREGORY.
ELECTRIC CLOCK.

No. 525,704.

Patented Sept. 11, 1894.



Witnesses:
John L. Edwards, Jr.
Fred. J. Dole.

Inventor
Fred L. Gregory,
By his Attorney,
F. A. Richards

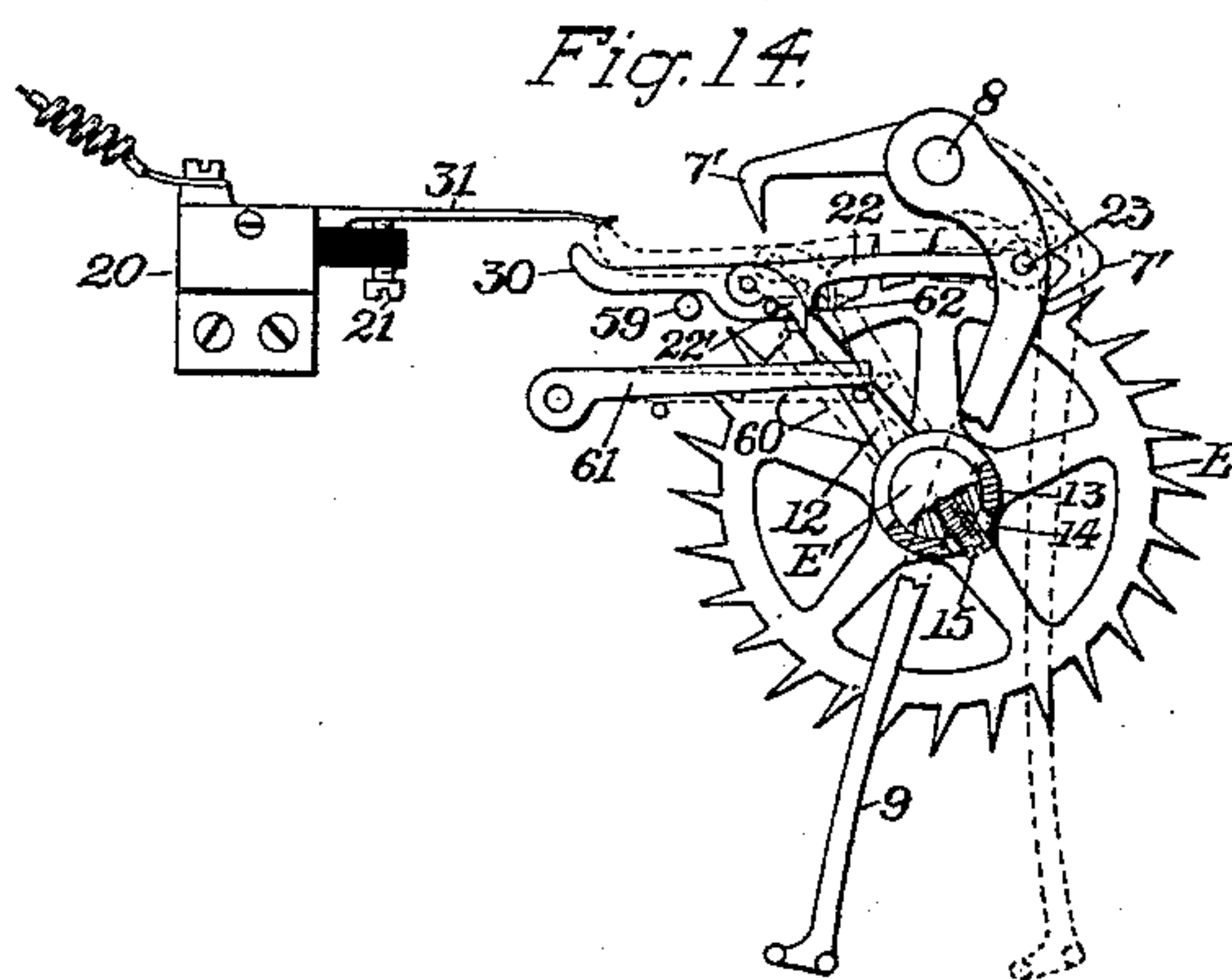
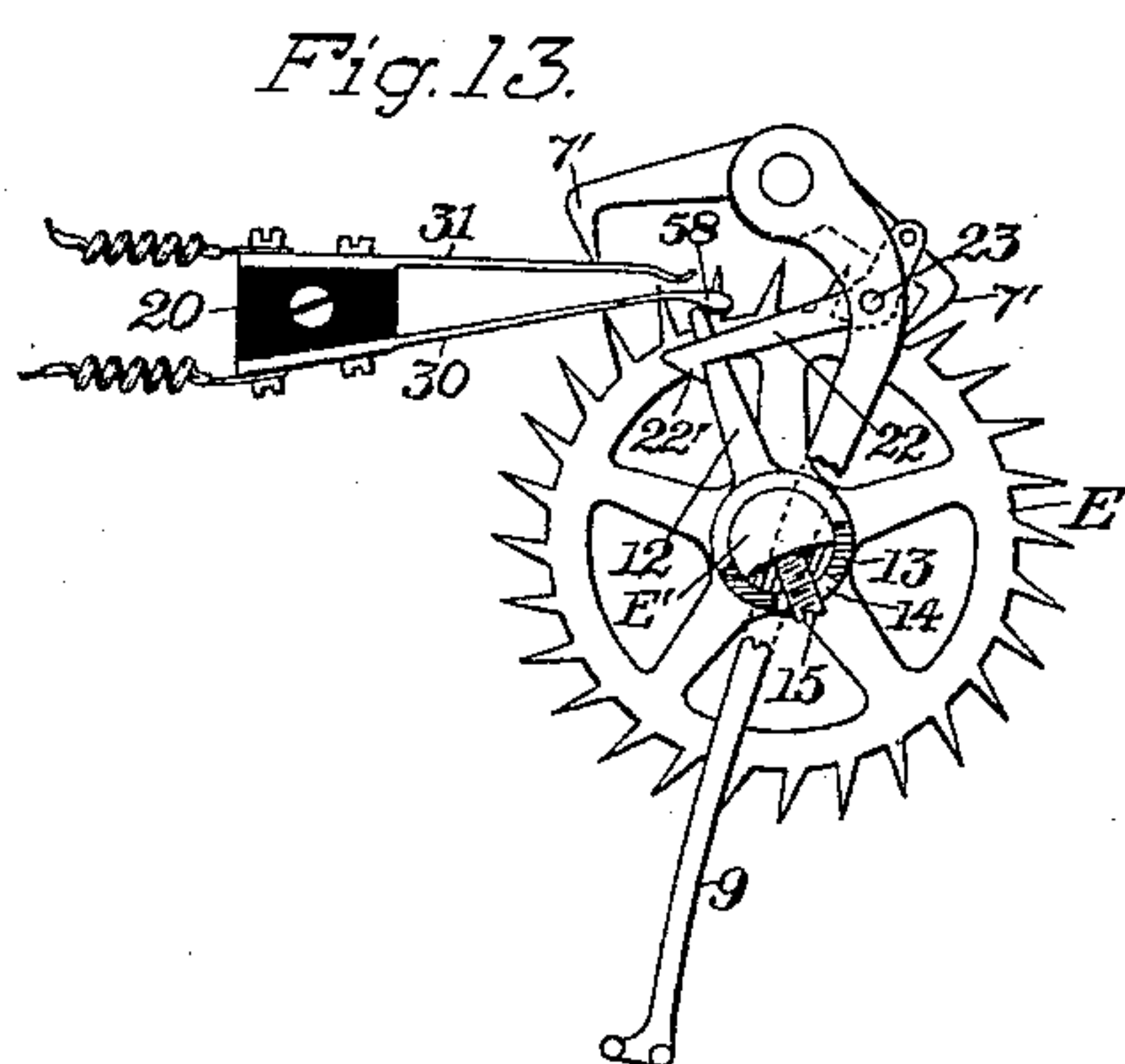
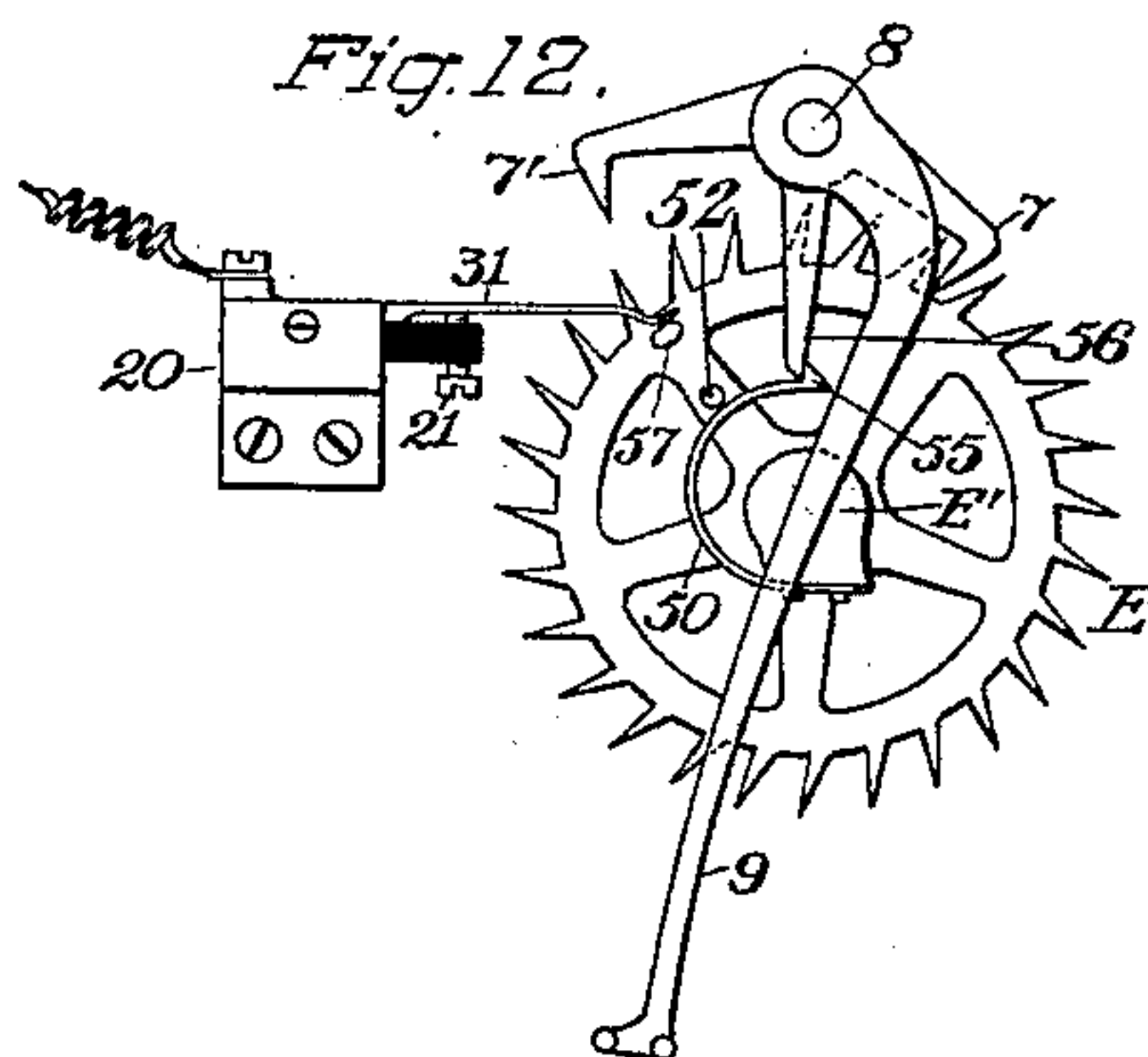
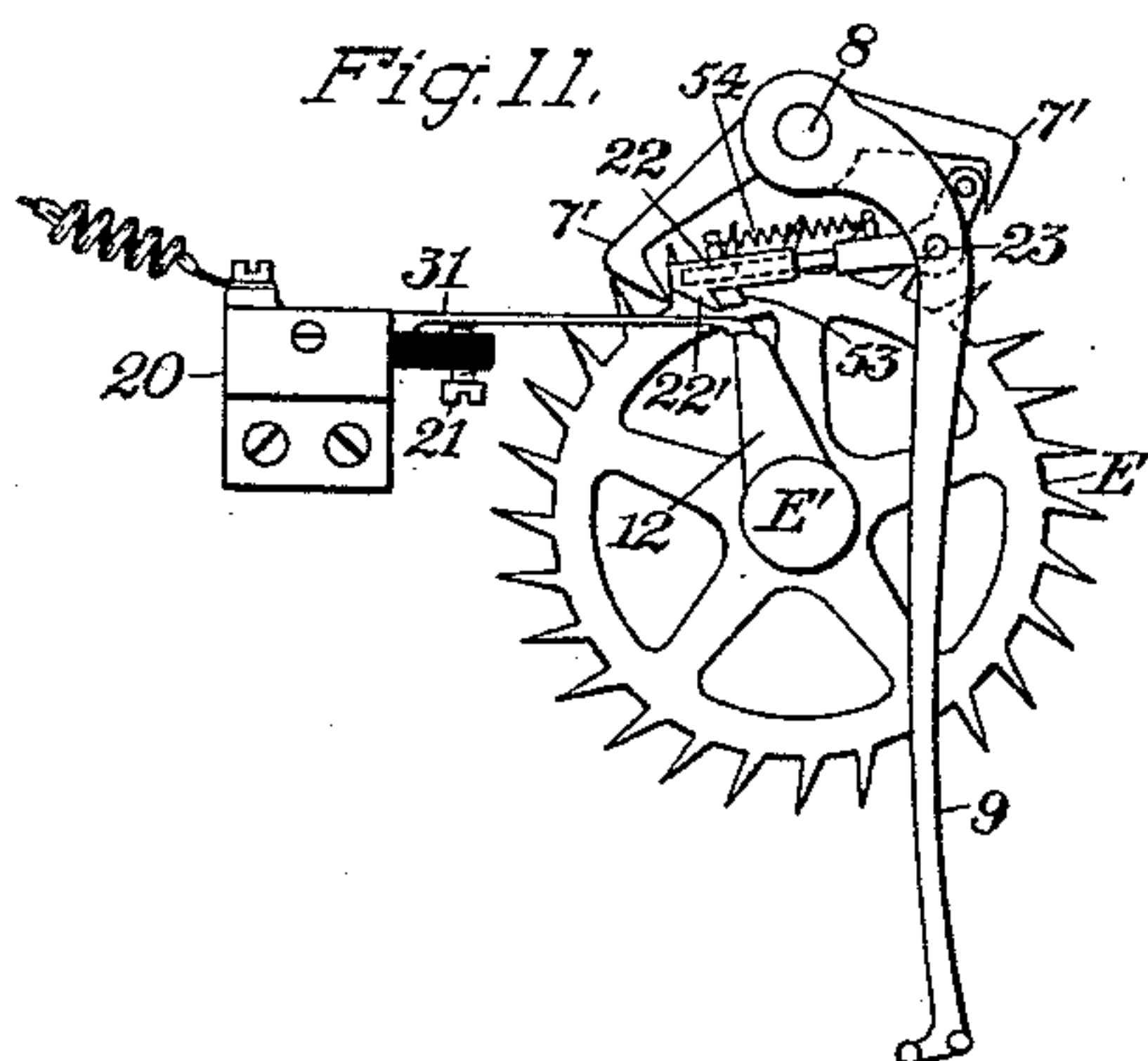
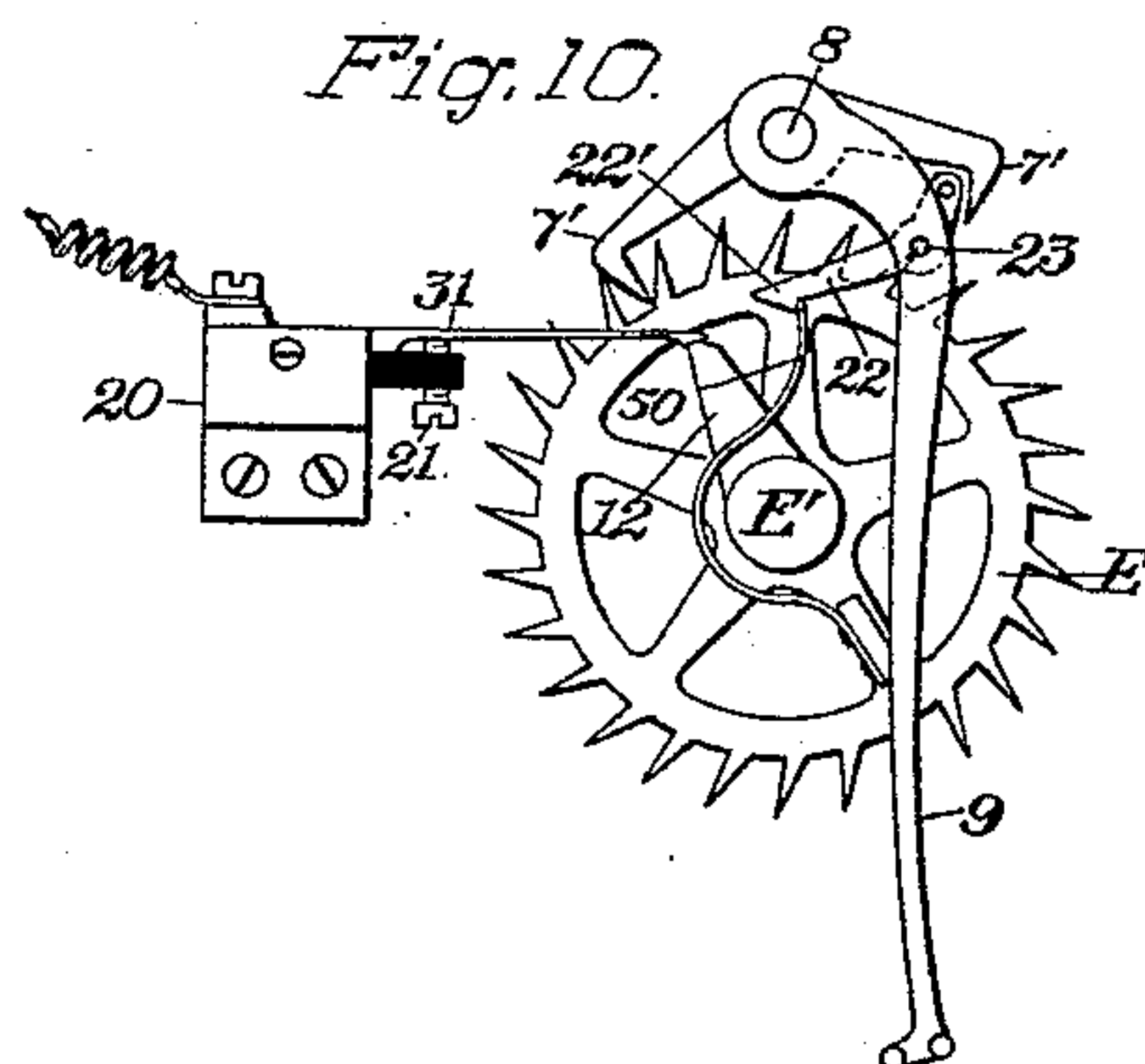
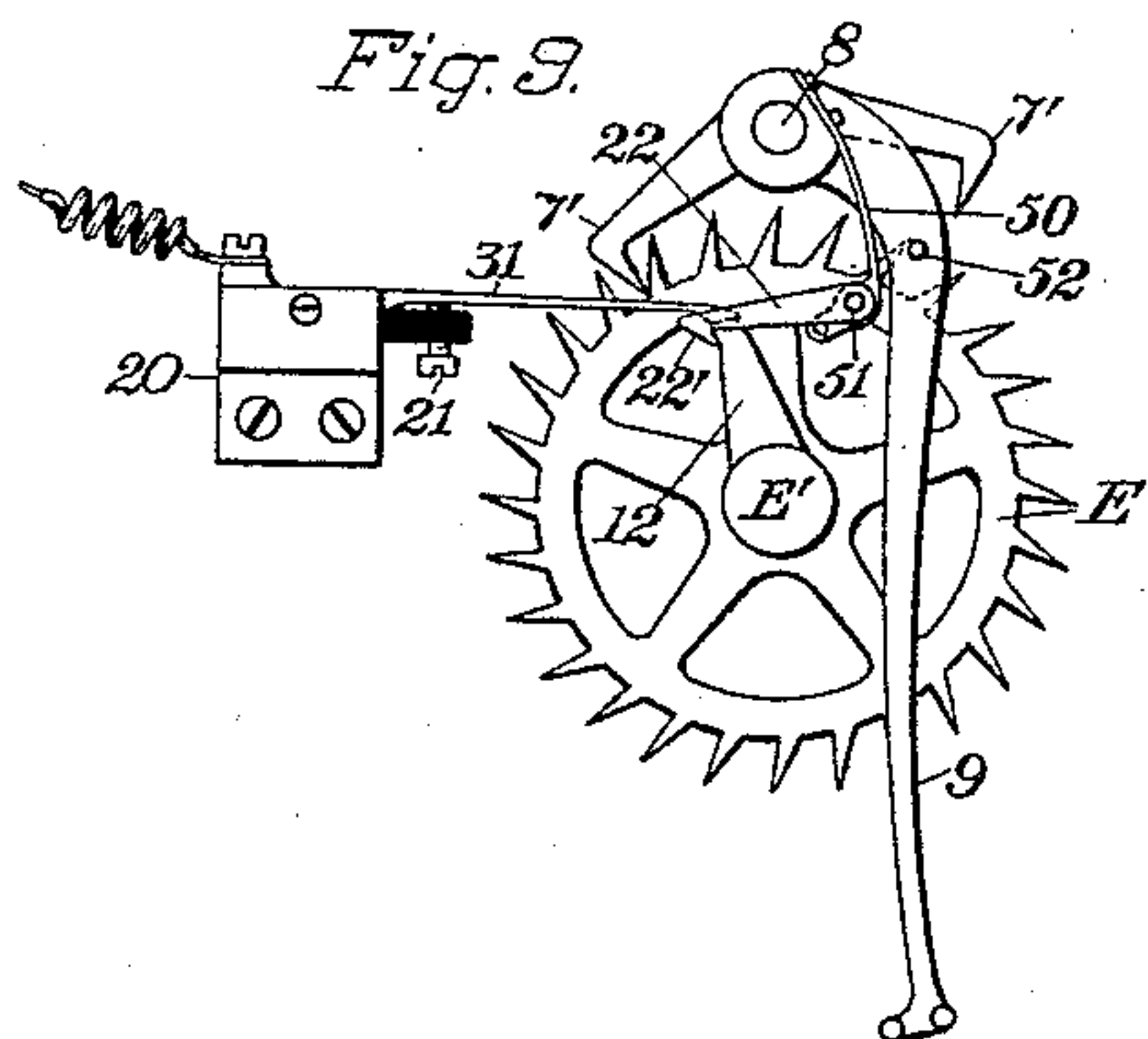
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2 Sheets—Sheet 2.

F. L. GREGORY.
ELECTRIC CLOCK.

No. 525,704.

Patented Sept. 11, 1894.



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UNITED STATES PATENT OFFICE.

FRED L. GREGORY, OF CHICAGO, ILLINOIS.

ELECTRIC CLOCK.

SPECIFICATION forming part of Letters Patent No. 525,704, dated September 11, 1894.

Application filed January 30, 1894. Serial No. 498,523. (No model.)

To all whom it may concern:

Be it known that I, FRED L. GREGORY, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Time-Circuit Mechanisms, of which the following is a specification.

This invention relates to time-circuit mechanisms; the object of the invention being, primarily, to provide a simple and effective mechanism for making and breaking electrical circuits at regular or predetermined intervals, and especially in connection with clocks; and whereby, owing to the construction and organization thereof it may be practically employed in connection with a time-movement or other driving-mechanism of light power, and at the same time be capable of controlling an electrical current of relatively great potential, thereby making it capable of employment with an ordinary clock-movement or chronometer for making and breaking an electrical current of sufficient potential to actuate the mechanism of a tower-clock, or to operate a series of electrically-actuated appliances either independently or simultaneously.

In electro-mechanical apparatus of the foregoing class, it has been usual to employ a circuit-closer of the "wheel" or rotary type geared to or carried by a time-train or clock-movement actuated by a spring or other motor; and inasmuch as a rubbing-contact under pressure between the circuit-closer and electrical-terminal is necessary to insure the best practical results in circuits of high potential, and owing to the excessive resistant-force exerted by the terminals (usually springs) in counter-action to the movement of the circuit-closer and its actuating mechanism, a relatively powerful motor or actuator for the circuit-closer has heretofore been required, capable of exerting a power very greatly in excess of that necessary for actuating the time-train alone.

One of the principal objects of my present invention is to provide a circuit-making apparatus in which the circuit shall be closed or completed by a rubbing-contact under pressure so as to maintain the contact-points or surfaces bright and in proper working condition, and at the same time provide effective

means whereby the circuit-closer will, during the contact period, be actuated to carry it under and past the electrical terminal or terminals with great force, and independently of the power (for the movement) of the time-train to which it is connected. In this way I overcome the resistance to the motive-power apparatus due to the said rubbing-contact or pressure which takes place in apparatus of this class of ordinary construction, and I thereby enable the circuit-closer to be practically used in connection with time-mechanisms of relatively small power. By the term "time-train," as the same is used herein, is meant a suitable escapement or timing-device, combined with means for driving the same. Said timing-device or escapement will generally consist in an escapement-wheel, a usual form of which is herein designated by E; and the means for driving said timing-device or escapement-wheel will ordinarily consist of shafts and toothed wheels, as herein-after more fully described.

Heretofore and generally in clocks, the reciprocatory member, whether this be a balance-wheel as in watches and marine clocks, or whether it be a pendulum as in ordinary clocks, has been driven by the time-train through the escapement-wheel; the function of said reciprocatory member having been to time the mechanism by holding back the escapement and time-train. Hence I herein refer to said pendulum, or other equivalent device therefor, as a "reciprocatory member."

According to my present invention, the escapement-wheel or its shaft, or some other part of the time-train of the clock-mechanism, carries a contact-maker which, in one part of its movement, comes into position for contacting with, or for effecting a contact with, an electrical terminal, for completing the circuit and thereby performing such work as may in any particular case be required thereof, such, for instance, as actuating a secondary clock. Said contact-maker being carried as set forth by the time-train, will ordinarily, when it meets the electrical terminal, especially if this be arranged for a rubbing contact, cause relatively considerable resistance to the continuing movement of the time-train. For overcoming this resistance, and also for permitting the use of a firmer rub-

bing contact between the contact-maker and the electrical terminal, I provide a power-connection between the described reciprocatory member, (which, as stated, will usually be the pendulum of a clock,) and the contact-maker or its carrier, so that, during the contact for completing the electrical circuit, power will be supplied by said reciprocatory member and transmitted backwardly therefrom to the contact-maker or its carrier for overcoming said resistance and thereby insuring the proper operation of the mechanism. Said power-connection may be arranged in several ways to transmit power from the pendulum or other reciprocatory member directly to the contact-maker, or to the contact-maker indirectly through its carrier or through one of the wheels of the time-train, said wheel being usually the escapement-wheel, as herein shown. Preferably, the power-connection will be made effective through a yielding or slightly independent movement of the contact-maker upon its carrier, or by means of a spring constituting a part of the power-connection or arranged in connection therewith. The latter arrangement is capable of several modifications, which, however, do not essentially change the mode of operation of the same. Some of these modifications are shown, respectively, in Figures 9, 10, 11, 12, 13 and 14, and will hereinafter be described in detail.

In the drawings accompanying and forming a part of this specification, Fig. 1 is a front elevation of a multi-circuit making and breaking mechanism constructed in accordance with my invention, said mechanism embodying, as herein shown, a primary and a secondary circuit-closer and being adapted for energizing the conductors of a series of electrical appliances either separately and successively, or simultaneously, a portion only of the frame and driving mechanism being shown. Fig. 2 is a side elevation of the mechanism looking toward the left-hand in Fig. 1. Fig. 3 is a front elevation of a portion of the mechanism shown in Fig. 1, said figure showing only the primary circuit-closer, which circuit-closer is herein shown of the form of a bearing-arm carried by the shaft of the escapement-wheel (such as is used in ordinary clock-mechanisms) and as in contact with the terminals of the electrical circuit. Fig. 4 is a view similar to Fig. 3 showing the circuit-closer as having been thrown forward by the auxiliary actuating device out of contact with the electrical terminals. Fig. 5 is a side view of the mechanism shown in Fig. 4, looking toward the left-hand in said figure. Fig. 6 is an end view of a portion of the frame showing the manner of attaching the electrical terminals thereto. Fig. 7 is a diagrammatic view of a portion of the mechanism showing various successive positions of the circuit-closer and auxiliary actuator in full and dotted lines. Fig. 8 is a diagrammatic view illustrative of the application of my im-

provement to a system embodying a series of electrically-controlled appliances in a circuit. Figs. 9 to 14 inclusively, are modified forms of contact-making devices embodying my improvements.

Similar characters designate like parts in all the figures.

The time-train drives the reciprocatory-member regularly and constantly by power carried forward thereto through the escapement, while said member connects back and at determined intervals applies power to said train for making the required forcible contact for closing the electrical circuit.

The organization required for effecting the result hereinbefore described will ordinarily involve the use, in connection with the contact-maker or its carrier, or in connection with any reciprocatory member, of a yielding element or one adapted to have a slight movement relatively to the principal part with which the same is carried. In Figs. 1, 2, 3, 4, 5, 6, and 7, said yielding or adjustment movement is effected by making the contact-maker 12 to have a slight turning movement independently of its carrier-shaft E'. In Fig. 9 another specific arrangement is adopted, whereby the circuit closer actuator or thrust-member 22, this being in the form of a hooked pawl, is carried by a spring, 50, attached to the reciprocatory member 9. Another arrangement is shown in Fig. 12 in which said circuit-closer actuator 22 engages with a spring-arm, 50, on the escapement-shaft, the contact-maker being, in this case, a pin, 52, fixed in the escapement-wheel at one side of said spring-arm.

The operation of each of the several forms of the device here described is substantially the same in a general way. At the moment the contact is made, the power for effecting the same, and for forcibly carrying the contact-point or device against and along the contact-face of the electrical terminal, is furnished directly by, and is brought back from the reciprocatory member which as before stated, may be the pendulum, so that said occasional work of making the contact is performed by power stored in said member, thereby avoiding any overloading of the escapement-wheel, which is ordinarily driven with only a small power.

To provide for the requirements in a system of this class comprising a series of electrical appliances (such as electrically actuated clocks) wherein it is desired to synchronize the movements of the entire series thereof by means of a primary actuator or master time-piece, and also to provide for the requirements in a system comprising a series of electrical appliances in which it is desired to separately actuate each appliance of the series at predetermined intervals, or to simultaneously actuate two or more of said appliances, I have shown in the drawings in Figs. 1, 2, and 8, one form of circuit-controlling apparatus capable of simultaneously or

independently and successively making-and-breaking the electrical-circuits in a series of appliances; and in Figs. 3, 4, and 5 have shown another and simplified form of circuit-closing mechanism which may be used with a system in which it is desired to synchronize the movements of the series of appliances therein at regular or predetermined intervals.

In the drawings the operative parts of the mechanism are shown carried by the framework having the front plate, B, and back-plate, C, these plates being connected by pillars or bolts, D, and nuts, *e*, after the usual manner of constructing clock-frames. The usual clock-train, this not being necessary to an understanding of my present improvement is not fully shown herein, although for convenience in illustrating the application of my present improvements in connection with the parts of said clock-mechanism, I have shown in the drawings an escapement-wheel, E, mounted in the usual manner upon an escapement-shaft, E', journaled at its ends in the front and back plates of the frame, also an escapement-anchor, F, the pallets, 7', of which engage the teeth of said wheel E, and a portion of the driving-mechanism, designated in a general way by G, which as will be hereinafter described, is in operative connection with the escapement-wheel E. This driving-mechanism is herein shown as consisting of a shaft, 2, journaled in the frame and carrying a gear-wheel, 3, in mesh with a pinion, 4, upon the escapement shaft E', and a pinion, 5, carried by said shaft 2 and meshing with a spur-wheel, 6, mounted upon the shaft, 7, which shaft is also journaled in said frame. In some cases, the escapement shown in the drawings, may be replaced by a rotary reciprocating wheel and shaft as employed in some clock-mechanism, and commonly designated a balance-wheel. The pendulum, U, and escapement or balance-wheel, or some suitable escapement therefor, constitute a reciprocatory timing-device which co-acts with one of the wheels of the driving-train for limiting the forward movement of the same after the ordinary mode of operation of escapements in time-pieces.

In the drawings I have shown the circuit-maker-and-breaker (or the "circuit-closer" as it will be hereinafter designated) as carried upon the escapement-shaft E' so as to travel in a circuit and have a limited amount of movement independently of the carrier or shaft by which the same is supported. This circuit-closer may, if desired, be mounted upon a "carrier" independent of the escapement-shaft and be operatively connected with some wheel of the time-train. Its movement independent of the supporting shaft or carrier may be provided for by mounting the arm loosely on the carrier and providing a stop for limiting the extent of its free movement as shown most clearly in Fig. 4 of the drawings, or this may be accomplished by making the circuit-closer in the form of a

spring-arm, or by mounting the same on a hub or shorter arm by means of a pivot, stop or spring, or other like device.

To obtain the best practical results, it is desirable that my improvement be applied to a timing mechanism embodying a "reciprocatory member;" by which term is to be understood some part moving back and forth, as for instance, a lever, slide or a crank. A simple form of timing-mechanism embodying the described reciprocatory member, is shown in Figs. 3, 4 and 5. The escapement-shaft E' carries the escapement-wheel E, which wheel engages the pallets 7' of an escapement-anchor, F, fixed to a shaft, 8, journaled in the frame and actuated by the usual escapement-lever or reciprocatory member, 9, secured to one end of said shaft, which member is connected with and regulated in its reciprocation by the upper end of the pendulum, U. This construction and organization of escapement-mechanism or timing-device may, obviously, be varied as circumstances may require.

One form of the electrical system, shown most clearly in the diagram, Fig. 8, may comprise the two main electrical-terminals, 30, 31, contiguous to the primary circuit-closer; a series of electrical conductors, *a*, *a'*, *a*², *a*³, having electrical terminals at one end contiguous to the secondary circuit-closer; a primary battery T, connected to energize the entire circuit; a primary circuit-closer, designated in a general way by P; a secondary or multiple circuit-closer designated by S; and a series of electrical appliances, as *d*, *d'*, *d*², *d*³, in electrical connection with the conductors *a*, *a'*, *a*², *a*³, respectively. These electrical appliances may, if desired, have different functions, as, for instance, one or more of said appliances may constitute electrical motors for actuating clocks, striking mechanism, fire-alarm signals, &c., while others may constitute electrical annunciators, signal-bells, electric-meters, or other appliances; this system, as hereinafter more fully described, permitting the energizing of the said appliances either separately and successively, or simultaneously.

The primary circuit-closer which as before stated is mounted upon the shaft E', will, in the preferred form thereof shown in Fig. 7, consist of the bearing-arm, 12, having the tubular hub, 13, slotted at one side as shown at 14, and movably secured to said shaft by means of the screw-threaded stop-pin, 15, projected through said slot and connected with the shaft E'. This circuit-closer, in connection with the timing-mechanism, is so constructed and organized that it will, during the movement of the shaft E' in the direction of the arrow, be carried in a circuit with a relatively slow movement until its contact-end or bearing-face, 16, comes into contact with the ends of the two brushes 17 and 18 which project into the path of movement of said circuit-closer and to which the terminals 30 and 31 of the electrical circuit are con-

nected, as shown most clearly in Figs. 1, 3, 4
 and 5. The moment the circuit-closer arrives
 at the "contact" position in its traveling cir-
 cuit, it will be engaged and forcibly carried
 5 forward with a relatively fast movement in-
 dependently of the movement of the carrier
 or shaft upon which it is mounted under and
 past the contact-brushes by an auxiliary
 closer-actuating device, as will be hereinafter
 10 more fully described. The brushes 17 and 18
 are shown secured at their outer ends by
 means of screws to the insulating-block, 19,
 supported in a bracket, 20, secured to the
 frame of the apparatus and will usually be
 15 in the nature of "spring-arms" which will
 bear at their ends with considerable stress
 upon the circuit-closer when the same is
 brought into contact therewith, the stress of
 such brushes being regulated by any suitable
 20 device, such for instance, as a regulating
 screw, 21, shown in Figs. 1, 3 and 4. As a
 means for actuating this primary circuit-
 closer for forcibly carrying the same past the
 ends of the terminal brushes independent of
 25 the movement of the carrier upon which it is
 mounted, I have provided a closer-actuating
 device, or as will be hereinafter termed cir-
 cuit-closer actuator or closer actuator, which
 in the preferred form thereof herein shown,
 30 consists of an actuating-arm, 22, carried at
 one end by the reciprocatory member of the
 timing-device, it being herein shown as piv-
 otally connected at 23 to the reciprocatory
 member 9. This circuit closer-actuator has,
 35 at the free end thereof, a detent-catch, 22',
 adapted, when the same is moved backward
 by one movement of the reciprocatory mem-
 ber 9 (or toward the left hand as shown in Fig.
 7) to extend over and engage the circuit-
 40 closer, and upon the reverse movement of
 said member be retracted drawing the circuit-
 closer forcibly forward against, under and
 past the terminal-brushes 17 and 18, as will be
 clearly understood by reference to Fig. 7 of the
 45 drawings. This action of the closer-actuator
 will take place periodically, the length of time
 between actions being governed by the regula-
 tion of the timing-mechanism. In some cases
 it is desirable that the duration of "contact"
 50 should be very small or "momentary." This
 will necessitate the making and breaking of
 the circuit with rapidity, while in other cases
 it is desirable that the contact shall be of more
 or less duration or "prolonged." As a means
 55 for accomplishing this end, I have shown in
 Figs. 1 and 7 two slightly varying forms of
 circuit-closers. In the form of circuit-closer
 shown in Fig. 1, the contact-end thereof at
 one side of its bearing-face 16 is in the nature
 60 of a ratchet-segment, it having a multiplicity
 of projections or teeth adapted to be success-
 ively engaged by the detent-catch of the cir-
 cuit-closer-actuator on successive strokes
 thereof, while in the form shown in Fig. 7,
 65 the circuit-closer at its bearing-end is in the
 form of a one-tooth ratchet. In the drawings
 I have shown the bearing-face of the circuit-

closer in the nature of an arc concentric to
 the axis of said circuit-closer and of sufficient
 width to extend across and contact with the
 70 two terminal-brushes arranged side by side.
 It will be obvious, however, that the bearing-
 face of said circuit-closer might be of less
 width and adapted for contact with but a sin-
 gle terminal-brush.

In the operation of the device shown in
 Fig. 1, wherein the circuit-closer is in the na-
 ture of a ratchet having a series of teeth, the
 circuit is maintained by the contact-arc 16 at
 the outer end of said closer during more than
 80 one entire double-stroke of the reciprocatory
 member of the timing-mechanism, the suc-
 cessive reciprocatory movements of said mem-
 ber causing the circuit-closer-actuator to pe-
 riodically engage the successive teeth of said
 85 closer and to periodically retract or draw for-
 ward said closer a distance equal to the dis-
 tance between successive teeth, which dis-
 tance will coincide with the length of throw
 of said actuator; thus maintaining a closed
 90 circuit for a greater or less period of time ac-
 cording to the rapidity of movement of the
 reciprocatory member of the timing-mech-
 anism.

The operation of the mechanism shown in
 Fig. 7 is similar to the operation of the mech-
 anism just described, the only difference be-
 ing that the contact-end of the closer being
 of relatively less length than that shown in
 Fig. 1, and having but one tooth, is drawn
 100 into and out of contact with the terminal-
 brushes by one movement of the reciproca-
 tory member, as will be understood by refer-
 ence to said figure, in which the closer is
 shown in successive positions by dotted and
 105 solid lines.

It is not desired to limit this invention to
 the exact construction of circuit-closer and
 closer-actuator shown in the drawings, as, for
 instance, the contact-end of the circuit-closer
 110 might be in the nature of a ratchet-segment
 having a series of fine teeth closely arranged,
 and the closer-actuator might be constructed
 so that its throw could be increased or de-
 creased to draw forward the actuator a greater
 115 or less distance at each reciprocation of the
 reciprocatory member 9; also the "ratchet-
 and-pawl" arrangement shown may be re-
 placed by the equally well-known friction-
 pawl intermittent wheel-feed apparatus.

The circuit-closer actuator 22, as before de-
 scribed, to the escapement-lever 9 has an
 arm, 25, provided with a stop, 26, adapted to
 bear against the face of the escapement-lever
 to retain said arm 22 in operative position to
 125 engage the circuit-closer during the oscillat-
 ing movement of said lever. It will be seen,
 by reference to the drawings, that the circuit-
 closer actuator by reason of its connection
 with the escapement-lever, acts as a powerful
 130 lever to draw the circuit-closer under and out
 of contact with the brushes 17 and 18 by
 transmitting directly to the closer the force
 of the swinging and relatively heavy pendu-

lum U, this being pivoted at about the point 40, and carried by a rod represented by the dotted line 41.

By reason of the construction and organization of elements in an electric-circuit making-and-breaking mechanism as described, it becomes practicable to secure a relatively high-pressure between the contacting-point of the brushes 17 and 18 and the circuit-closer P for completing the electrical circuit, and without interruption or material resistance to the operation of the clock-train; and also permits the use of a relatively small and delicate clock-mechanism for making-and-breaking circuits transmitting electrical currents of high potential; so that, in practice, a relatively small clock-mechanism, when provided with my improvements, may be used for making and breaking electrical currents of sufficient potential to operate relatively large mechanisms, such as the hands and shafts of tower-clocks, striking-mechanism for fire-alarms, and for winding clocks at a distance, and for like purposes.

In Figs. 1 and 2, I have shown a combination of mechanism in which the circuit-closer connected with the reciprocatory member of the clock-mechanism, as before described, cooperates with the secondary circuit-closer mechanism carrying a series of contact-arms or circuit-closers and constructed and organized for making-and-breaking a series of circuits tributary to the main circuit, and whereby one or more of said tributary circuits may be closed at each closure of the main circuit or after a multiplicity of said closures. As a means for accomplishing this end I have provided a series of tributary circuit-closers movably mounted upon a revoluble carrier S, which carrier in the form herein shown is in the nature of a wheel or drum revolubly supported upon a shaft 7, journaled in the frame and carrying a spur-wheel 6 in mesh with the pinion 5 of the clock-train mechanism. This wheel is in electrical connection with the terminal 30 of the main circuit through the medium of the brush 18' connected with the terminal 30 and bearing against the shaft 7. The tributary-circuit-closers are herein shown as pins, 28, removably secured in sockets, 27, formed in the carrier S, said carrier having a sufficient number of sockets formed therein to provide for the adjustment of the circuit-closers. These circuit-closers are so disposed with relation to the carrier as to contact with the end of the tributary circuit terminals (herein shown as brushes c) as will be understood by reference to the drawings. These brushes or terminals just referred to will usually be secured to an insulating block 29 as shown in Fig. 2 by means of suitable screws.

In practice, the contact members or tributary-circuit closers will be so arranged around the periphery of the carrier S, and said carrier will be so timed in its movements with relation to the movement of the main or

primary circuit-closer as to bring the circuit-closers into contact with the proper terminal brushes of the tributary-circuits at the required time for actuating the appliances in said circuits, which closures of the tributary or secondary circuits may be arranged for taking place at each closure of the main circuit, or only after a multiplicity of closures of said circuit, as may be desired, which will be thoroughly comprehended by reference to Figs. 2 and 8 of the drawings.

By the construction and organization of mechanism as herein described, I am enabled to provide for the operation of certain of the electrical appliances in the circuit simultaneously with each closing contact of the primary circuit-closer with the terminals of the main circuit, and also for the operation of other of the electrical appliances in the circuit at varying intervals, or after a multiplicity of closures of the main circuit. This will be understood by reference to Figs. 1, 2, and 8 of the drawings, in which a, a', a^2, a^3 designate the tributary-circuits and d, d', d^2, d^3 , the apparatus located in said circuits to be operated by said mechanism.

By means of the organization of mechanism hereinbefore described, the closer, or contact-maker, is carried forward in its course with a relatively slow movement, and in one portion of its movement is engaged by a device in connection with the reciprocatory member and which advances the contact-maker with a relatively rapid movement into contact with the electrical terminal or terminals; and by means of said organization in which the electrical circuit comprises two circuit-closers, these closers are periodically actuated to close the one more frequently than the other, whereby the electrical circuit will be completed or closed only after a multiplicity of closures of the more frequently actuated closer.

It will be understood that instead of having the two terminals 30 and 31 projected into the path of movement of the circuit-closer, if desired, (as it may be in some cases) one only of said terminals may be employed, and the circuit-closer may be connected with or may constitute the other terminal. In this case the circuit-closers will be brought into the circuit, which may be done by connecting one of the line-wires to the frame of the mechanism, as indicated by dotted lines at 70, Fig. 3.

In the modifications shown in Figs. 9, 10 and 11, and hereinbefore referred to, the circuit closer or contact maker will be in the form of an arm 12 and preferably fixed to the shaft E' of the time-train mechanism.

In the modification shown in Fig. 9, the circuit-closer acutator 22 is pivotally supported at 51, upon a carrier-spring, 50, that is fixed to the reciprocatory member 9 of the time-train. In the form herein shown the spring 50 is secured at its upper end to one side of the reciprocatory member, and the circuit-

closer actuator 22 is pivotally secured to the opposite lower end of said spring. In practice, the closer-actuator may be held up into operative position for engagement with the contact-maker by means of a suitable pin or like device carried by the spring 50, a stop-pin, 52, being also provided in connection with the reciprocatory member to limit the forward or retractive movement of the closer-actuator 22. The general operation of the device just described is similar to that described in connection with the device shown in Fig. 1, with the following exceptions: The contact-maker travels in its circuit with, and has no movement independent of, the shaft or carrier, upon which it is supported, and the spring 50 acts to transmit power back to the time-train to assist in drawing forward the contact-maker upon the forward movement of the reciprocatory-member to which it is secured.

Another modification is illustrated in Fig. 10, in which the circuit-closer actuator is shown pivotally supported at 23 on the reciprocatory member 9, it being similar in construction to the closer-actuator 22 shown in Fig. 1. In this form of the apparatus the closer-actuator 22 has its hooked end 22' in position for engaging the working-end of a spring 50, which in this instance is secured at its opposite end to the escapement-wheel E at one side of the shaft thereof, preferably opposite the circuit-closer 12. In this case power is transmitted directly back to the time-train by the closer-actuator and the spring, upon the forward movement of the reciprocatory member 9.

A further modification is illustrated in Fig. 11, in which the circuit-closer actuator 22 is connected directly to the reciprocatory member 9 in the same manner as shown in the preceding figure, it being supported in position for engagement with a catch 53 upon the escapement-wheel E of the time-train. According to this modification, the required yielding connection is formed in the circuit-closer actuator 22 itself, by making this connection in two parts normally held together by a spring, 54, through which spring power is transmitted to one of the parts of said actuator to assist in drawing forward the said wheel E for bringing the circuit-closer or contact-member into contact with the electrical terminal, upon the forward movement of the reciprocatory member 9 to which one part of said thrust member is connected.

Another modification is illustrated in Fig. 12, in which the circuit-closer is in the nature of a spring 50 secured to the escapement-wheel of the time-train, which actuator has at one end thereof a hook-shaped catch, 55, located in position and adapted for engagement with a fixed catch, 56, carried by the reciprocatory-member 9 of the time-piece. In this instance the circuit-closer is in the nature of a pin or projection, 57, formed upon or secured to said wheel. The operation of

this device is similar to that described in connection with Fig. 10.

The general operation of the several modifications just described is substantially the same as the operation of the preferred form of the improvement described in connection with Figs. 1, 2, 3, 4, 5 and 7. In each case the circuit-closer is carried by the time-train in close proximity to, or into "touch-contact" with, the electrical terminal or terminals for completing the circuit, and at the same time the catch or lock-part carried by the circuit-closer or its carrier comes into position for engagement with the circuit-closer actuator of the reciprocatory timing-piece, so that on the following stroke of said timing-piece, said actuator operates to exert power (either directly or indirectly, as hereinbefore described) upon the circuit-closer or its carrier for effecting the required rubbing-contact for completing the electrical circuit, and for overcoming the resistance which said contact would otherwise impose upon the time-train of the clock-mechanism.

The contact-maker or circuit-closer is preferably carried, as hereinbefore described, directly on the time-train shaft, and also preferably constitutes a connection between two terminals as set forth. But in some cases said contact-maker may consist only of a thrust-arm or device for operating one of the terminals; and this arrangement may also be modified in several ways within the scope and limits of my invention. In Fig. 13 is shown one said arrangement, wherein the arm or contact-maker 12 which is mounted for a limited free movement on the shaft E', forms a thrust-member for lifting the terminal 30 into contact with the other terminal 31. This operation is effected as follows: In this instance the thrust-member or contact-maker 12 having been carried by the time-train into close proximity to the terminal 30, the swing of the reciprocatory member 9 carries the hook 22' of the circuit-closer actuator 22 over and into engagement with said arm 12 (the contact-maker) so that on the return stroke of said member 9, said arm is forcibly carried forward under the terminal-cam, 58, of the terminal 30, thereby lifting this terminal into contact with the opposite terminal 31 and completing the electrical circuit. The contact-making arm 12 being in this case a part of the time-train, it will be seen how power is transmitted back from the timing-piece to said train through the connection 22 during the contact-period.

In some cases, the operative electrical terminal may be carried by or supported upon the circuit maker, as illustrated in Fig. 14; and this arrangement is understood to be within the meaning of the broad claims which I have made in this application. According to this modification of my invention, the operative terminal 30 is carried on the connection 22 which is pivoted at 23 to the reciprocatory member 9. In this instance the member 22

constitutes the "circuit-closer," and the member 12 constitutes "the circuit-closer actuator," but for convenience in describing this modification I will refer to the member 22 as the "power-connection" and the member 12 as the "thrust-arm." During the time between the successive contact-periods, the projecting end of the power-connection is supported by a pin or stop, 59. When the forward movement of the time-train mechanism carries the thrust-arm 12 into close proximity to the power-connection 22, as illustrated by dotted lines in Fig. 14, on the backward stroke (toward the left-hand) of the timing-piece, the pawl or hook 22' of the power-connection passes over and engages with the thrust-arm 12 so that on the forward stroke (toward the right-hand) of the reciprocatory member said thrust-arm is forcibly carried forward and upward, thereby lifting the power-connection 22 and carrying the operative terminal 30 into forcible contact with the fixed terminal 31, and thereby completing the electrical circuit. This operation carries the thrust-arm under a detent-pawl, 61, for preventing retraction of the same, so that on the next backward movement of the power-connection said arm passes off from the face, 62, of the power-connection 22, which then drops out of contact with said fixed electrical terminal, after which the mechanism runs on as before until the thrust-arm is again brought into position for engaging with the catch or pawl of the power-connection.

Having thus described my invention, I claim—

1. The combination with an electrical terminal and the reciprocatory member, of time-train mechanism driving the reciprocatory member and comprising a contact-maker carried by said mechanism, and a contact-maker-actuator adapted and in position for transmitting power from the reciprocatory member back to the time-train mechanism during the contact period.

2. In a circuit-making and -breaking mechanism, the combination with an electrical terminal, of a time-train, a reciprocatory member actuated by the time-train, a contact-maker carried by the time-train for contacting with the electrical terminal, and a contact-maker-actuator adapted and in position for transmitting power backwardly from said member to the contact-maker of the time-train, for performing the work of making the contact, substantially as described.

3. The combination with an electrical terminal and a reciprocatory member, of a contact-maker, means for carrying forward the contact-maker in its course with a relatively slow movement, and a contact-maker-actuator in operative connection with said reciprocatory member for engaging the contact-maker in one portion of its movement and advancing the same with a relatively rapid movement, substantially as described.

4. The combination with an electrical termi-

nal, and with a time-mechanism having a reciprocatory member, of a contact-maker, means for carrying forward the contact-maker in its course with a relatively slow movement, and means in operative connection with said reciprocatory member for engaging the contact-maker in one portion of its movement and advancing the same with a relatively rapid movement into contact with said terminal, substantially as described.

5. In an electrical circuit-making and -breaking mechanism, the combination with a suitable driving mechanism, of a circuit-closer adapted for movement in a given course or path, one or more electrical terminals projected into said path, and means for periodically engaging and forcibly carrying the circuit-closer in one portion of said path into and out of contact with the terminal or terminals, substantially as described.

6. In a circuit-making and -breaking mechanism, in combination, a circuit-closer-carrier, a circuit-closer supported so as to have a limited amount of movement independent of the carrier, means for intermittently moving the circuit-closer in its path with a relatively slow movement, one or more electrical terminals projected into the path of the circuit-closer, and means for periodically engaging and forcibly carrying the circuit-closer into and out from contact with the terminals independently of the movement of the carrier, substantially as described and for the purpose set forth.

7. In a circuit-making and -breaking apparatus, in combination, the reciprocatory member, one or more electrical-terminals, the circuit-closer intermediate to said terminal or terminals and the reciprocatory-member, and a closer-actuator connected with said member and in position to engage and draw the circuit-closer out of contact with the electrical terminals, substantially as described and for the purpose set forth.

8. In a circuit-making and -breaking apparatus, in combination, a circuit-closer-carrier, a circuit-closer supported to be capable of a limited amount of movement independently of its carrier and adapted for traveling in a circuit, an electrical terminal projected into the path of movement of the circuit-closer, and a circuit-closer-actuator connected with a reciprocatory-member and adapted for engaging the closer when this reaches a predetermined point in its circuit and then forcibly carrying the circuit-closer under and past the electrical terminals independently of the movement of said carrier, substantially as described.

9. In a circuit-making and -breaking apparatus, in combination, a suitable timing mechanism embodying a reciprocatory member, a circuit-closer connected with said mechanism so as to have a uniform intermittent movement in the arc of a circle, an electrical terminal projected into the path of movement of said circuit-closer, a circuit-closer-actuator

intermediate to the reciprocatory member of the timing-mechanism and circuit-closer, and means for reciprocating said actuator to periodically engage the circuit-closer and draw the same out of contact with the electrical terminal, substantially as described.

10. The herein-described circuit-making and -breaking mechanism, comprising, essentially, a circuit-closer-carrier, a circuit-closer supported on said carrier so as to have a limited amount of movement independent thereof, an electrical-terminal projected into the path of movement of said circuit-closer and adapted to bear thereon, means for intermittently bringing the circuit-closer into bearing contact with the electrical terminal at predetermined intervals, and means for forcibly moving said circuit-closer independent of its carrier under and out of contact with the electrical terminals, substantially as described and for the purpose set forth.

11. The herein described circuit-making and -breaking mechanism, comprising, essentially, driving and timing-mechanism, a circuit-closer operatively connected therewith so as to have a circuit-movement, one or more electrical terminals projected into the path of movement of the circuit-closer, a reciprocatory member connected with and actuated by the timing-mechanism, a circuit-closer-actuator carried by said reciprocatory member and adapted for engagement with the circuit-closer in one movement of the said member, and to retract said circuit-closer on the reverse movement of said member to make and break the circuit, substantially as described and for the purpose set forth.

12. In an electro-mechanical apparatus of the class specified, in combination, an electrical circuit having electrical terminals, a circuit-closer supported upon a carrier adjacent to said electrical terminals, means for imparting a relatively slow movement to the circuit-closer to bring the same periodically into engagement with the electrical terminal or terminals, a closer-actuator supported in position for engagement with the closer and adapted for forcibly drawing the same against the electrical terminals with a relatively fast movement, and means for imparting a reciprocatory movement to and for timing the movement of the circuit-closer-actuator, substantially as described and for the purpose set forth.

13. In a circuit-making and -breaking mechanism, the combination with the driving and timing mechanism, and with the electrical terminal or terminals, of a circuit-closer supported for circuit-movement adjacent to the electrical terminals and having on its contact-end a multiplicity of teeth or catches and means connected with the timing-mechanism and in position to engage the teeth or catches of the circuit-closer one at a time to periodically draw said circuit-closer step by step into and out from engagement with the terminals,

substantially as described and for the purpose set forth.

14. In a circuit-making-and-breaking mechanism embodying a driving and timing mechanism, and one or more electrical terminals, the combination of a circuit-closer in operative connection with the driving-mechanism, and having a bearing-face and a series of detent catches, a reciprocatory member in operative connection with the timing-mechanism, and a circuit-closer-actuator connected with said reciprocatory member and adapted to engage successive catches of and retract said circuit-closer with an intermittent movement, to make, continue and break the circuit, substantially as described and for the purpose specified.

15. The combination with the driving mechanism and electrical terminals, of a circuit-closer consisting of a toothed-segment having a smooth contact-portion concentric to the axis thereof, a reciprocatory member in connection with the driving-mechanism, and a circuit-closer-actuator carried by said reciprocatory member and having a detent-catch in position for engagement with the teeth of the circuit-closer, whereby said circuit-closer upon movement of the member and closer-actuator, may be brought into and out from contact at predetermined intervals with the electrical terminals, substantially as described.

16. In a circuit-making and -breaking apparatus embodying the driving mechanism and one or more electrical terminals, the combination therewith of a ratchet-segment supported for rotary movement and having a bearing-face adapted for being brought periodically into contact with the electrical terminals, a timing-mechanism in connection with the driving-mechanism, a reciprocatory member in connection with the timing-mechanism, and a circuit-closer-actuator pivotally supported on the reciprocatory member in position to engage and retract the circuit-closer from its "contact" position upon the movement of the said reciprocatory member, and having a stop to limit its movement, substantially as described and for the purpose set forth.

17. In a circuit-making and -breaking apparatus, the combination with the driving-mechanism and an electrical terminal or terminals, of a circuit-maker mounted upon a rotating carrier so as to have a limited amount of movement independent of said carrier, a stop connected with said carrier for limiting the independent movement of the circuit-maker, a reciprocatory member, and a circuit-maker-actuator connected with said reciprocatory member and in position for periodically engaging and drawing said circuit-maker out of contact with the terminal or terminals, substantially as described and for the purpose set forth.

18. In a mechanism of the class specified,

the combination with the reciprocatory member of the timing-mechanism, of a closer-actuator carried by said member, an electrical terminal, a closer-carrier in operative connection with the reciprocatory-member, and a circuit-closer carried by said carrier, whereby on the closer being brought into proximity to the electric terminal, the closer is actuated by said closer-actuator to make, continue, and break the circuit, substantially as described and for the purpose specified.

19. The combination with a reciprocatory member, of a circuit-closer-actuator, a circuit-closer-carrier, a circuit-closer on said carrier and adapted for limited movement independently thereof, and an electrical terminal in the path of the closer, substantially as described.

20. In an electrical system of the class specified, the combination with an electrical circuit comprising a series of tributary-conductors, of a primary circuit-closer contiguous to the two main terminals of the circuit, and adapted for intermittently making and breaking the circuit, a secondary circuit-closer provided with a series of contact members adapted to be brought successively into engagement with the terminals of a series of conductors, driving-mechanism therefor in operative connection with the primary circuit-closer, and means for actuating the primary and secondary circuit-closers at varying speeds whereby the series of conductors in the system may be energized simultaneously or independently and successively, substantially as described.

21. In a time-circuit apparatus, the combination with an electrical circuit comprising two circuit-closers, of means for periodically actuating the closers to close the one more frequently than the other, whereby the circuit will be entirely closed only after a multiplicity of closures of the more frequently actuated closer, substantially as described.

22. In a time-circuit apparatus, the combination with an electrical circuit comprising a primary and a secondary circuit-closer, of closer-actuating means for closing the primary closer at relatively short periods, and means adapted and operating for closing the secondary closer at relatively long periods each coinciding in duration with a multiplicity of the relatively short periods, whereby the circuit will be entirely closed only on that closure of the primary circuit which is coincident with the end of said longer period, substantially as described.

23. In a time-circuit system, in combination, a main circuit, a series of tributary-circuits, a primary circuit-closer adapted for closing the main circuit, and a series of tributary-circuit closers, (one for each tributary circuit) adapted for closing said tributary circuits, means for actuating the main circuit-closer and tributary-circuit-closers whereby one or more of the tributary-circuits may be closed simultaneously with each closure of the main circuit, or after a multiplicity of closures of said main circuit, and means for independently regulating and timing the closures of the tributary circuits, substantially as described.

24. In a mechanism of the class specified, the combination with a carrier, of an arm thereon, electrical terminals, a reciprocator, and an actuator-device adapted for engaging the arm when this reaches a predetermined position to make a contact between the terminals by power from the reciprocator, said arm and actuator being one of them in connection with or constituting one of the terminals, substantially as described.

25. In a mechanism of the class specified, in combination, a normally open electrical circuit having terminals, a carrier intermediate to said terminals, an arm on said carrier in electrical connection with or constituting one of said terminals and adapted for being brought into contact with the other of said terminals, means for moving said arm in a circuit with a relatively slow movement, an actuator-device adapted for engaging the arm when this reaches a predetermined position in its circuit, and means for retracting the actuator with a relatively rapid movement, to make a contact between the terminals by power, substantially as described.

26. The combination with an electric terminal or terminals and with the reciprocatory member of a timing-device, of a contact-maker located in position and adapted for being brought periodically into contact with said terminal or terminals to complete the circuit, and a resilient member intermediate to the terminal and reciprocatory member and adapted for making a yielding connection between the contact-maker and reciprocatory member, substantially as described and for the purpose set forth.

27. In a time-circuit apparatus, in combination, the reciprocatory member of the timing device, the electrical terminal or terminals, the contact-maker, and a spring-controlled contact-maker-actuator intermediate to and adapted for operatively connecting said contact-maker and reciprocatory member, substantially as described.

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Witnesses:

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