(No Model.)

4 Sheets—Sheet 1.

J. E. CAREY.

ELECTRIC CLOCK AND CLOCK SYSTEM.

No. 341,449. Patented May 11, 1886.

Fig. 1.

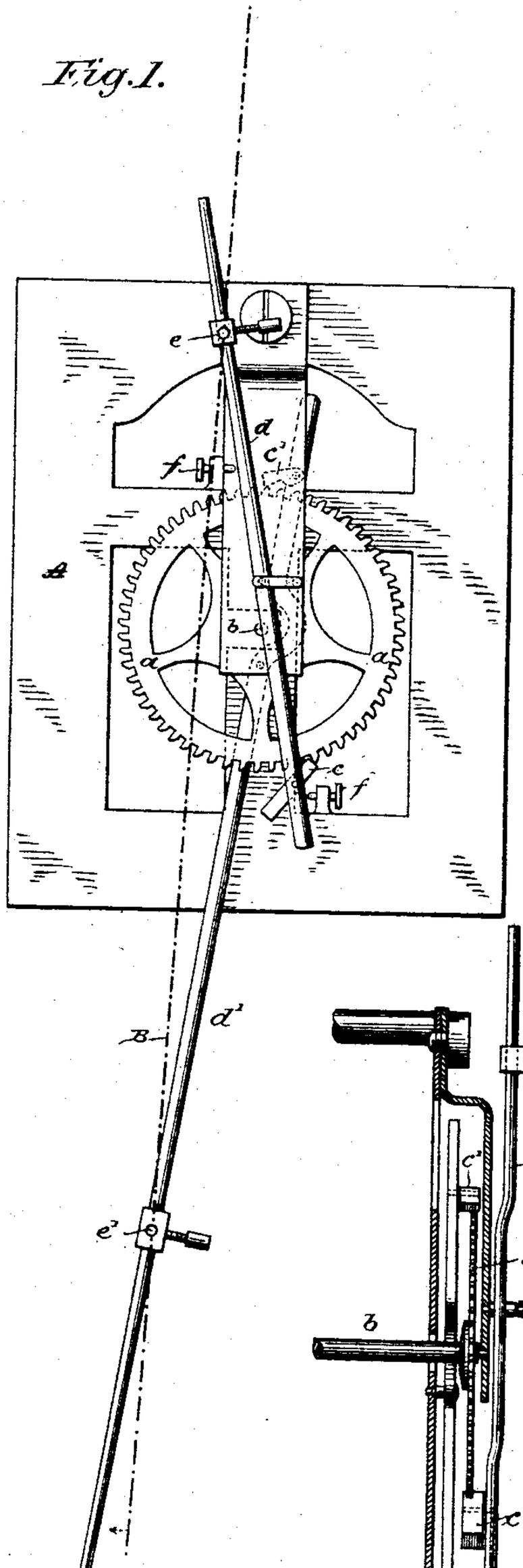

Fig. 2.

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(No Model.) 4 Sheets—Sheet 2.

J. E. CAREY.

ELECTRIC CLOCK AND CLOCK SYSTEM.

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Fig. 3.

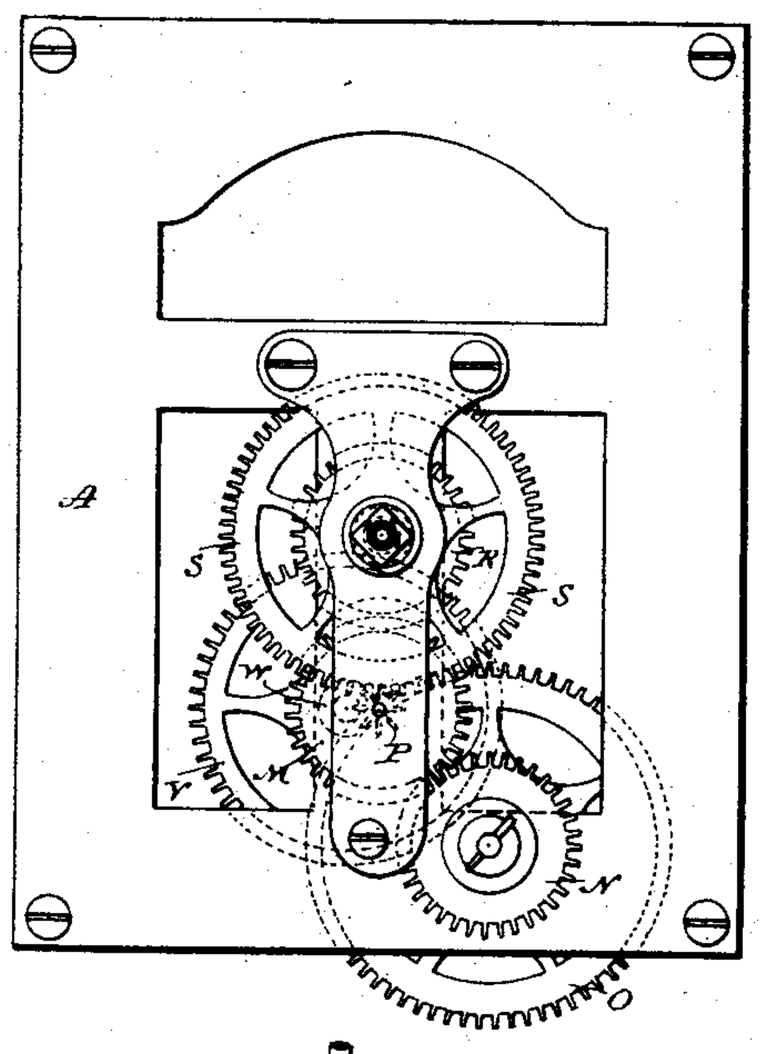


Fig. 4.

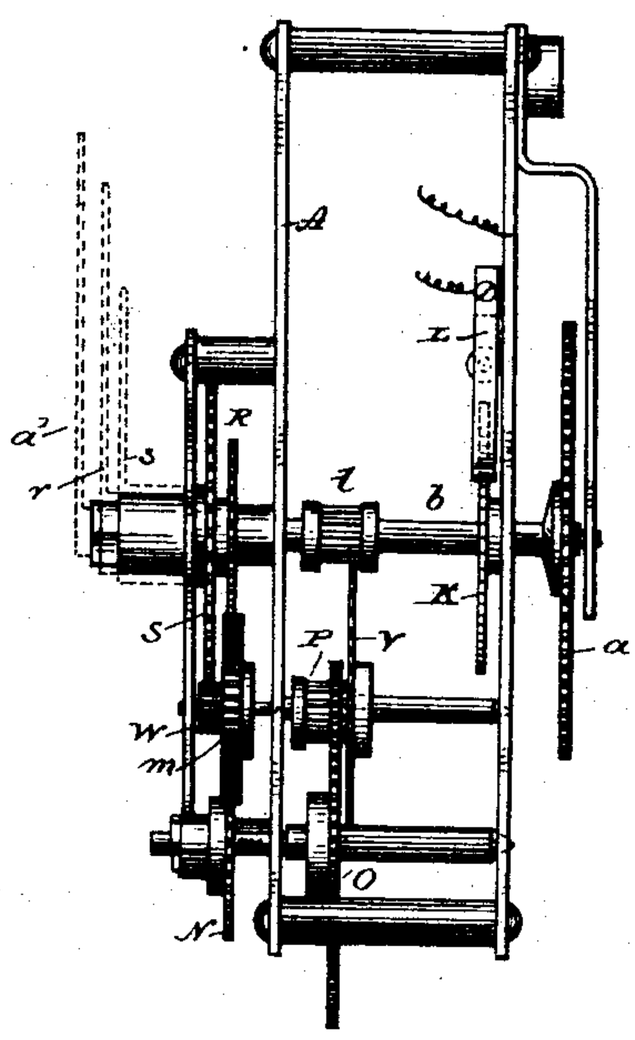


Fig. 5.

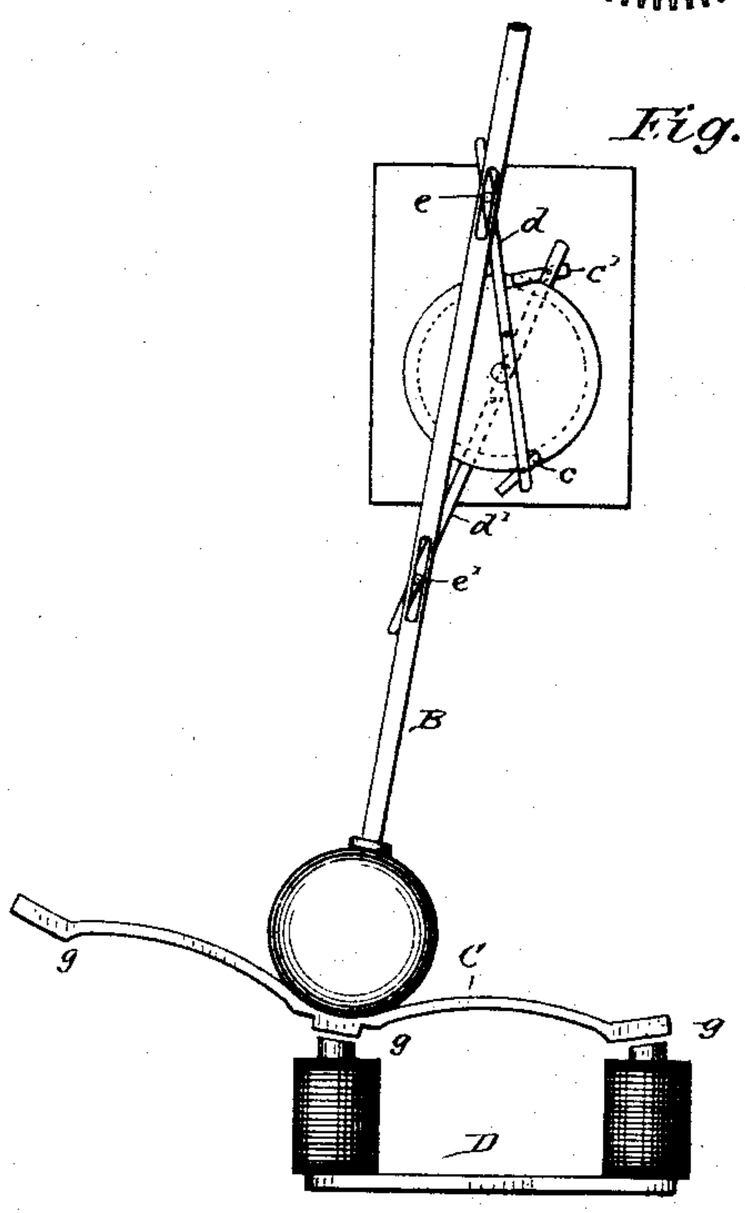


Fig. 8.

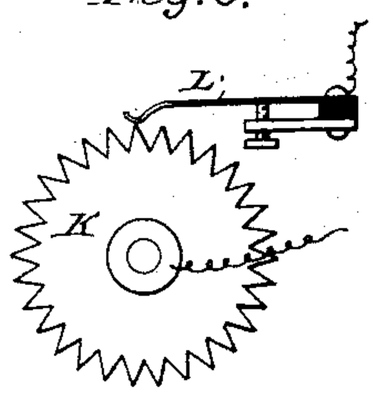
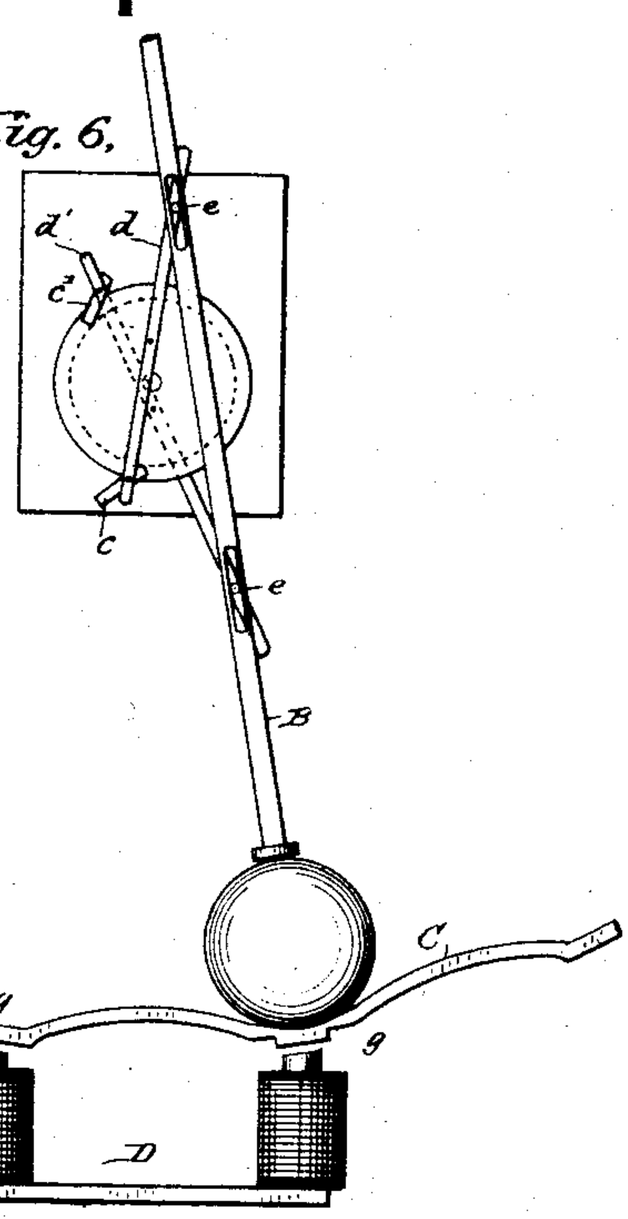


Fig. 6.



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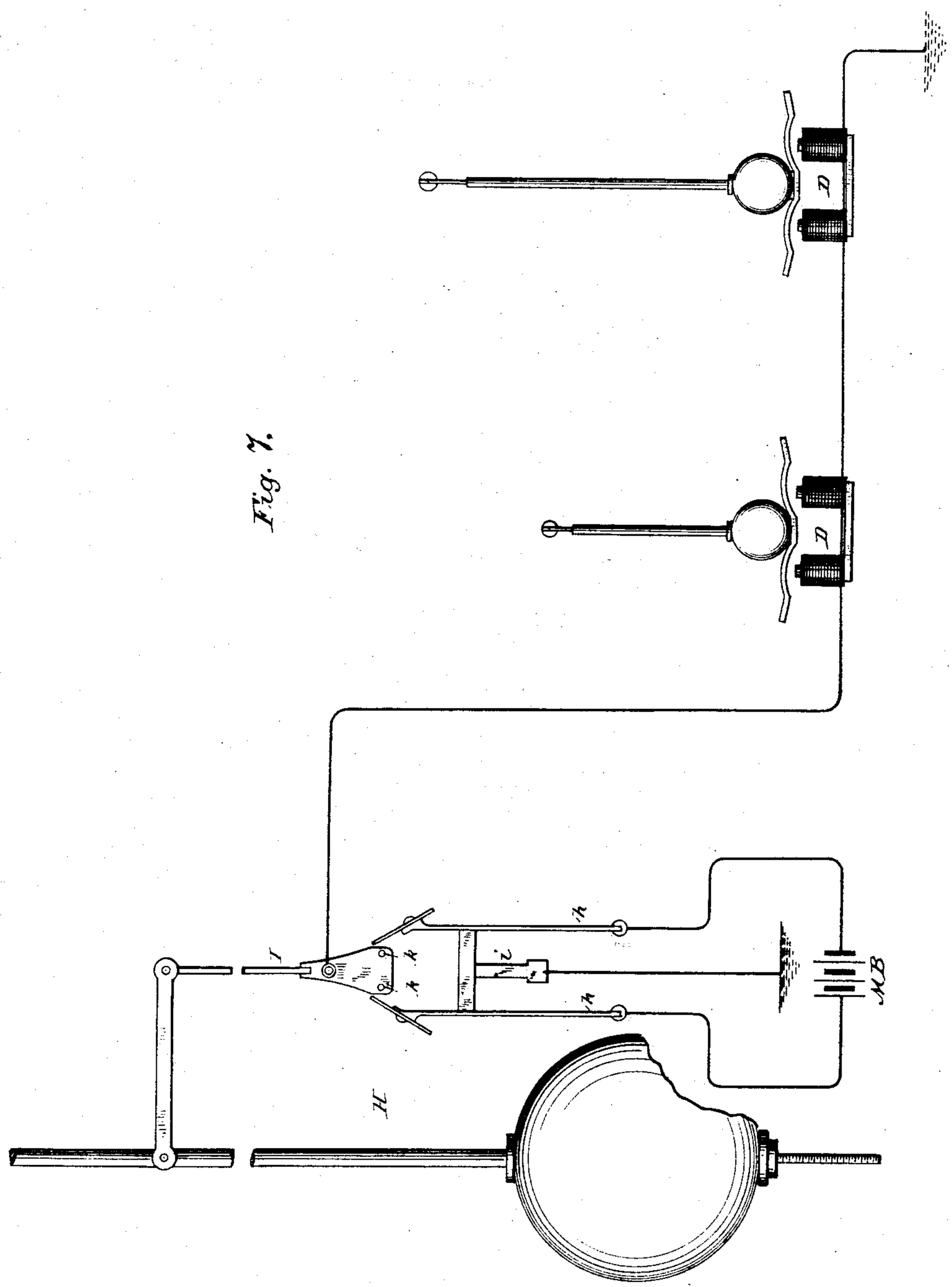
ELECTRIC CLOCK AND CLOCK SYSTEM.

No. 341,449. Patented May 11, 1886.



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4 Sheets—Sheet 4.

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ELECTRIC CLOCK AND CLOCK SYSTEM.

No. 341,449. Patented May 11, 1886.

Fig. 9.

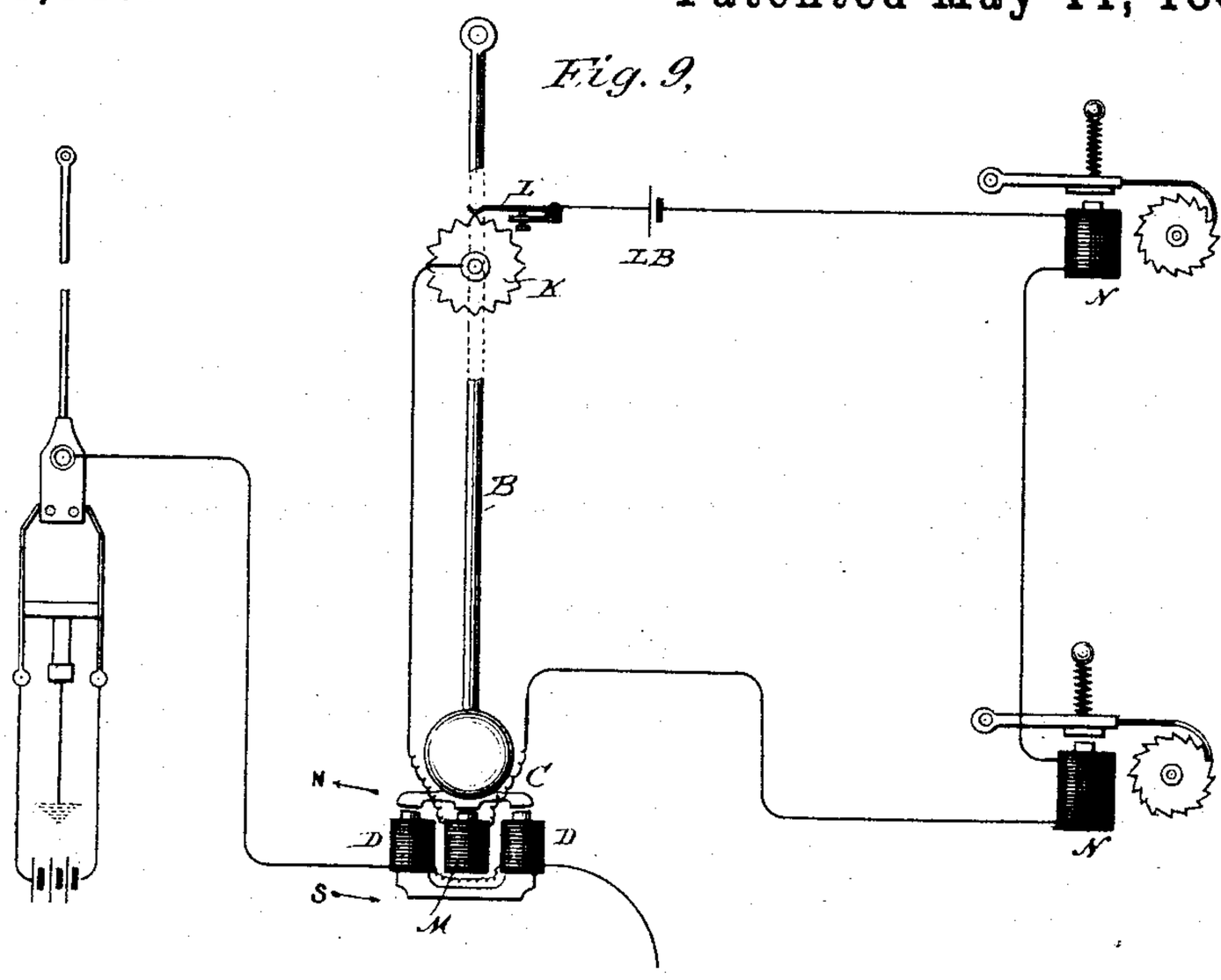
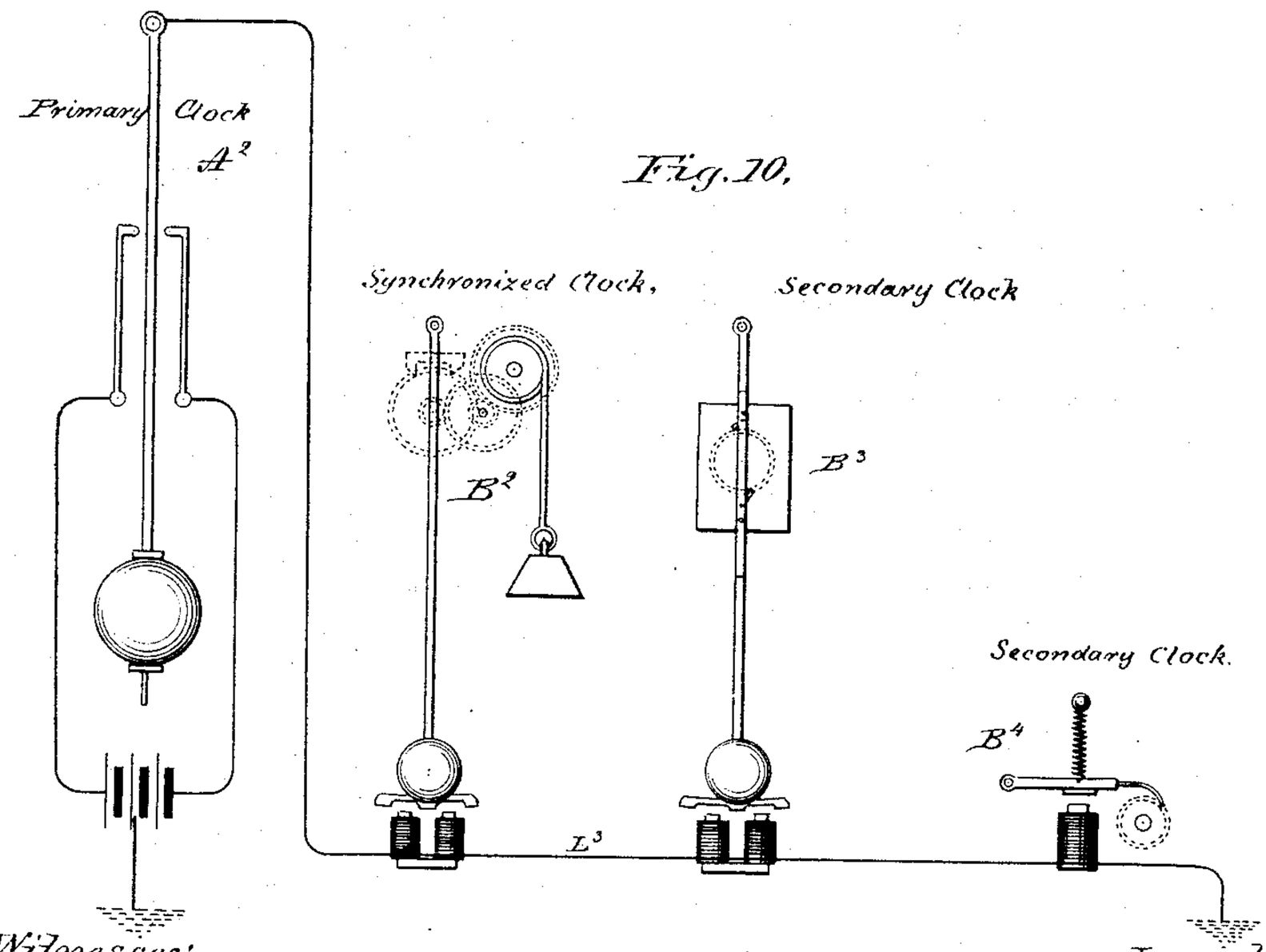


Fig. 10.



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Inventor:
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By his Attorney: H. C. Townsend

UNITED STATES PATENT OFFICE.

JULIAN E. CAREY, OF NEW YORK, N. Y., ASSIGNOR TO THE ELECTRIC TIME COMPANY.

ELECTRIC CLOCK AND CLOCK SYSTEM.

SPECIFICATION forming part of Letters Patent No. 341,449, dated May 11, 1886.

Application filed June 16, 1884. Renewed February 15, 1886. Serial No. 192,055. (No model.)

To all whom it may concern:

Be it known that I, JULIAN E. CAREY, a citizen of the United States, and a resident of New York, in the county of New York and State of New York, have invented certain new and useful Improvements in Electric Clocks, of which the following is a specification.

The object of my invention is to improve the construction, simplify the action, and increase the efficiency and certainty of operation of electric clocks and electric-clock systems; and to these ends it consists in certain details of construction, combinations of elements, and peculiarities of arrangement and operation, that will be specified more particularly in the claims at the end of this specification.

My invention consists, primarily, in an electric clock whose pendulum is propelled solely through the agency of electricity, has a free or uninterrupted swing, and is not subjected at any portion of its vibration or swing to abrupt changes in the mechanical opposition to its swing.

My invention consists, further, in the combination, with such a pendulum, of a dial or indicating train actuated solely by such electrically-propelled pendulum and mechanically connected therewith through propelling devices that are in engagement during the whole or major part of the vibration of the pendulum.

The pendulum of my improved electric clock is a freely-swinging pendulum, in that no mechanical interruption or impulse is applied to it during its swing, as is the case with those clocks in which the pendulum controls through an escapement, a spring-driven train, or an impulse is given to the pendulum near the completion of each oscillation by a spring or weight controlled by an electro-magnet, and as is the case with those in which a catch or detent is employed for detaining the pendulum at the end of its swing, so as to compel it to begin a new oscillation at the proper time. As at the same time the propelling action of the pendulum is distributed through its swing, the pendulum is better able to maintain its natural rate of vibration, and is in less danger of losing its beat.

In the accompanying drawings, Figure 1 is an elevation of one form of an improved mechanism devised by me for enabling an electrically propelled pendulum to actuate a time or indicating train in such way as not to interfere with the free movement of the pendulum at its natural rate, and not to interpose sudden or abrupt changes of mechanical resistance to the pendulum's swing. Fig. 2 is a side elevation and partial section of the mechanism shown in Fig. 1. Fig. 3 is an elevation of the indicating or time train. Fig. 4 is a side view thereof. Fig. 5 is an elevation of the pendulum, showing it at one extreme of vibration and as connected to the propelling devices of Fig. 1. Fig. 6 shows the same pendulum at its opposite extreme of vibration. Fig. 7 is a diagram showing two of my improved clocks connected in the same electric circuit with a primary or controlling electric clock. Fig. 8 is a detail of construction of the mechanism shown in Fig. 4. Figs. 9 and 10 are diagrams illustrating circuits and connections of apparatus that will be described further on.

A indicates the frame in which the dial or indicating-train of the clock is mounted, while *a* indicates a toothed or ratchet wheel rotated by means of the oscillating pendulum, and mounted on a shaft, *b*, through which movement is communicated to the train of wheels, to be presently described. The wheel *a* is a seconds or half-seconds wheel, as may be desired, this being determined by the length and rate of oscillation of the pendulum. The shaft *b* carries a seconds or half-seconds pointer, *a'*.

Mounted in any suitable manner on the frame A, or other suitable support, are two levers, *d d'*, that are adapted to swing freely, and that carry, respectively, the pawls *c c'*, which latter are propelling or actuating pawls adapted to engage with and turn the wheel *a* as the levers *d d'* swing to and fro with the propelling electrically-actuated pendulum. The levers *d d'* are operated by the pendulum B, Figs. 5 and 6, through the adjustable arms *e e'*, which take into slots in the pendulum-rod, and are adjustable upon the levers for the purpose of determining the extent of movement of the wheel *a* at each swing of the pendulum. The pawls *c c'* are loosely pivoted pawls, kept in engagement with the wheel by their own

weight. This arrangement is employed in order that the movement of the levers and pendulum may be obstructed as little as possible. The pawls *c c'* are placed respectively above and below the pivots of the lever by which they are supported, and are applied in such way that while the pendulum swings in one direction the wheel *a* will move forward under the action of the pawl *c*, the pawl *c'* during such action moving backward over the teeth of the wheel to a new position of engagement, while on the reverse movement the latter pawl, *c'*, will propel the wheel *a* forward, the pawl *c* at the same time moving backward to a new position. As will be seen, the propelling-pendulum is practically connected to the indicating-train throughout its swing, and no sudden or abrupt changes of mechanical opposition to its swing are encountered. Moreover, the pendulum is less liable to lose its beat than are those which are obliged to do all of the work required of them in moving the train at or near the end of the swing where the pendulum has lost most of its momentum, and where, therefore, a very slight opposition may bring it to a stop. Where an electrically-operated pendulum is made to do its work of moving an indicating-train throughout its swing, and the greater portion of the work is done at the intermediate portions of its swing, between the extremes of vibration, less liability to derangement will be experienced. This is one of the leading features of my invention, and I wish it to be understood that I do not limit myself to the particular mechanical devices shown, the essence of the invention consisting in keeping a freely-swinging electrically-operated pendulum in mechanical connection with its propelled train throughout the whole or greater portion of its swing, instead of compelling the work to be done at an extreme of vibration or at a portion only of the vibration, thus subjecting the pendulum to abrupt changes of resistance, impairing its freedom of swing, and deranging its capacity to maintain its natural rate of vibration.

Stops (indicated at *f f*) may be applied to the levers to prevent overmovement of the pawls. When these are used, the levers should be springy or elastic, so as not to interpose a rigid check to the movement of the pendulum in case the latter should move so far as to bring the levers against the stops. The yielding or flexible resistance afforded by the spring-arms in the mechanical connection between the pendulum and its driven wheel also possesses this advantage during normal operation or swing of the same—to wit, that it permits the pendulum to be more responsive to the magnetic attraction brought to bear periodically upon it at each swing for the purpose of keeping it in vibration.

The dial or time-indicating train is of any ordinary or desired construction for indicating hours and minutes, and is connected with the arbor *b*.

R *r* indicate, respectively, the minute wheel and hand driven by the gear-train consisting of wheels *m* N, wheel O on the shaft with N, pinion and wheel *p* V, and pinion *t* on the arbor *b*. The hour-wheel gears with the pinion *w* on the same arbor with the wheel *m*.

Any other desired arrangement of wheels and pinions might be used for giving the desired relative movements to the hour and minute wheels from the wheel propelled by the electrically-operated and freely-swinging pendulum.

The pendulum B is electrically actuated through the intervention of suitable electro-magnets, suitably placed to give an impulse to the pendulum either at every whole or half oscillation, or after a number of oscillations, as may be desired.

The electro-magnets (one or more) are employed, not for the purpose of interposing a mechanical stop to the pendulum, nor for the purpose of controlling any mechanical impulse device. They are suitably placed or arranged to permit the pendulum to swing freely, subject, however, to the magnetic pull of the electro-magnet, which is exerted upon the pendulum, and is timed by any suitable controlling device, so as to assist the vibration.

I do not wish to be understood as claiming an electrically-operated pendulum *per se*, but do claim the same in the combinations hereinafter specified, as well as the special arrangements of actuating or impelling magnets hereinafter described. The circuit-controlling device whereby the impulses are given to the pendulum may obviously be a primary clock or other device independent of the pendulum to which the impulses are applied, or it may be a device actuated or controlled by said electrically-operated pendulum. In the latter case, however, it is independent of the pendulum itself—that is, the pendulum does not itself act directly on the circuit closer and controller—so that the necessity for carrying any electrical connections to or through the pendulum is avoided, as well as the danger of causing the pendulum to lose its beat, which might ensue if it were subjected to the abrupt mechanical opposition attendant upon operating a circuit closer or breaker at some portion of its swing. To make such a circuit closer or controller independent of the pendulum in the sense just stated, and to therefore secure for the pendulum the greater freedom and uniformity of vibration and mechanical opposition, I propose to operate the circuit-closer from some portion of the train driven by the freely-swinging pendulum, as will be presently described. The impelling magnet and armature for the pendulum I prefer to arrange in the manner shown in Figs. 5, 6, and 7, where D indicates a fixed horseshoe or bibranched electro-magnet fixed beneath the pendulum, and C an armature carried by the pendulum. The armature might be fixed while the magnet moved; but this is not desirable, as it would in-

volve the carrying of an electric circuit through the pendulum-supports—a thing which it it is desirable to avoid. The armature C is formed with the three portions *g*, arranged to swing close to the poles of the magnet and intermediate connecting portions of iron that are formed so as not to come within the attractive influence of the magnet-poles, but to yet constitute a magnetic-connection between the extreme portions *g* and the intermediate portion *g*, so that either extreme piece *g* and the middle piece may serve as a true magnetic keeper or armature for the electro-magnet D. The magnet D is arranged so as to be capable of exerting a pull on the armature as the pendulum nears each extreme of vibration in obvious manner, and to thus keep the pendulum in oscillation. The coils of the electro-magnet D are in the circuit governed by the circuit-controller, whether the latter be actuated by a separate or primary clock or whether the circuit-controller be in the same clock with the pendulum on which the magnet acts, so as to make a self-propelled electric clock.

By arranging the magnet D as shown, and with its poles on a line parallel with the plane of vibration of the pendulum, I am enabled to considerably reduce the electric resistance on a line containing a number of clocks, since, as will be obvious, I not only secure from the magnet all the advantages of magnetic pull between a horseshoe magnet and its armature, but the magnet whenever energized is effective upon the pendulum. Where separate magnets (either horseshoe or single) are set at both ends of the arc of vibration, as is sometimes done, and are both placed in the same circuit, both must be energized at each electric impulse; but that one only which is on the side of the arc of vibration to which the pendulum is swinging is of use, the one at the opposite end opposing useless resistance.

By my arrangement of the horseshoe-magnet I get all the advantages, with half of the line-resistance, that is present when two horseshoe-magnets with their poles on a line transverse to the plane of vibration and at opposite ends of the arc of vibration are employed.

The arrangement of the attracting-poles in a line coinciding with the plane of vibration presents an additional advantage, in that wobbling or vibration of the pendulum about its axis in a plane transverse to the plane of vibration is not only avoided, but corrected.

Hitherto when two or more magnet-poles have been arranged to attract the armature on the pendulum at the same time they have been placed so that the line joining their poles is transverse to the plane of vibration or else to one side thereof. The result of this is that, through want of perfect adjustment of the magnet or false movement of the pendulum, one portion of the armature may be attracted before the other, and the wobbling movement described may be primarily produced or increased. By arranging the attracting-poles of the magnet or magnets in a line coinciding with the plane of vibration this difficulty is avoided.

A primary clock that may be used with the electrically-propelled clock herein described is shown in Fig. 7, where I have indicated two electrically-propelled clocks upon the same circuit, one of which has a pendulum vibrating twice as fast as that of the other. H indicates the primary or controlling electric clock, which is adapted to send seconds electric impulses of alternating or reversed polarity, by a pole-changing arrangement, such as indicated. M B indicates the main battery, having its opposite poles connected, respectively, with the springs *h h*. The latter press normally against an intermediate conducting-stop, *i*, connected to ground, and are alternately withdrawn from contact with said stop, at or near the extremes of vibration of the pendulum, by means of the pins *k k* on an auxiliary pendulum or lever, I, operated by the main pendulum. The lever I is connected to the line and the electro-magnets D D. The effect of the pins *k k* is obviously to connect first one pole and then the other pole of the battery M B to line, leaving in each case the opposite pole connected to earth. When the clock is to be a self-propelled clock, in whole or in part, the circuit-controller may consist of the device shown in Figs. 4 and 8, where K indicates a spur or toothed wheel mounted on the arbor *b*, and L a circuit-closing spring arranged to make contact with the teeth successively and for an instant only during a forward movement of the wheel *a* under the action of the propelling pendulum. The spring is mounted on a suitable insulating-block secured to the frame, and the poles of the circuit containing the battery and impelling-magnets are connected, respectively, to the spring and to the frame and wheel K in any usual or desired manner. The spring is adjusted so that at the completion of a vibration of the pendulum it shall be out of contact with the wheel, but that the closure of circuit shall occur just before the swing is completed, and while portions *g g* of the armature are approaching the poles of the magnet D. If the circuit-closer were used only as the primary controller for other clocks on a circuit separate from that of the magnet for the clock by which it is operated, it would obviously be immaterial at what portion of the swing of the pendulum the circuit were completed, provided it were properly adjusted to be out of contact with the wheel at the extreme of the pendulum's vibration.

In Fig. 9 I have illustrated an improved arrangement in which my improved clock is a self-propelled electric clock synchronized by means of magnet D in a circuit from a controlling or primary clock, and is itself the controlling or primary clock for one or more secondary clocks of any usual or desired construction. The magnet M is placed in suitable proximity to the armature of the pendu-

lum, to act upon the two extreme armatures or portions of armature *g g* alternately at or near the extreme of vibration, and to give impulses thereto which shall assist in keeping said pendulum in vibration. The electro-magnet M is in a circuit with a battery, L B, and circuit-controller K, operated by the mechanism of the clock in any desired manner. In the same circuit are any desired number of secondary clocks of any usual or desired construction. The electro-magnets for such clocks are indicated at N, and the vibratory armature-levers of said magnets carry impelling-pawls that operate a ratchet-wheel connected with an indicating-train. This form of secondary clock is well known in the art and need not be now fully described. Other constructions of secondary clock might be used in its place. The electro-magnet D serves to keep the pendulum's vibration synchronous with those of the primary or controlling clock governing the main circuit. The poles of said magnet act alternately on the central portion, *g*, of the armature. An interruption or break of the main-line circuit, such as would interfere with the transmission of the electric impulses through the electro-magnet D, acting on the pendulum, though continued for considerable periods, will not under this plan affect the going of the secondary clocks in the local circuit, since the controlling-clock for the latter is, by virtue of electro-magnet M and circuit-controller therefor, a self-propelled electric clock. The arrangement also presents the advantage that one battery serves for the self-propelled clock and the secondary clocks controlled by it.

I do not wish to be understood as limiting myself to the forms of magnet and armature herein shown in the various figures of drawings, since other forms might be used for giving the impulse to the freely-swinging pendulum without departing from the spirit of the invention.

In the diagram, Fig. 10, I have shown an electric clock or time system devised by me, and that I sometimes employ in practice. At A^2, I have indicated a primary or controlling clock, that may be of any desired construction, adapted to periodically make, break, or alter an electric circuit, and to produce in the general circuit L^3 impulses or changes, either reversed, interrupted, or of constant polarity, as may be desired. B^2 indicates a normally-operated clock—that is, one whose mechanism is actuated by a weight or spring, as are ordinary clocks. There may be one or more such clocks on the circuit. It is synchronized by means of an electro-magnet in the line-circuit L^3 and an armature or armatures on the pendulum, the arrangement of magnet and armature being preferably that hereinbefore described, although I do not limit myself to this particular arrangement. At B^3, I have indicated on the same circuit a secondary clock, electrically operated or kept in action by the impulses on the electric circuit L^3. The clock is supposed to have an electrically-operated pendulum—such, by preference, as is hereinbefore described—and the oscillations of said pendulum serve to communicate movement to a train, as already described. Modifications may be made in the form of this clock; but in any case its pendulum should be electrically operated or kept in vibration, and the train should derive its movement from such pendulum. One or more such clocks may be placed in the circuit. At B^4 is indicated a secondary clock of the ordinary form, in which the vibrations of an ordinary armature for an electro-magnet impart a step-by-step movement to a train of wheels through an actuating-pawl. The magnet is in the circuit L^3. There may be one or more such clocks on the circuit.

By the term "freely-swinging pendulum" I mean one which meets with no sudden interruption to its free vibration, such as is experienced by the pendulum of clocks in which the pendulum at some portion of its swing is made to impinge upon or operate a circuit breaker or closer, or in which the impulse is given by the sudden impact or action of a spring or a weight made to impinge upon the pendulum. In these claims, therefore, in which I claim a freely-swinging pendulum as an element, I mean to exclude those clocks in which, as just explained, the pendulum meets with a sudden interruption to its free pendulous motion, either by impact upon some device or by receiving a sudden blow or impulse, as from a spring or weight.

What I claim as my invention is—

1. The combination, with an indicating-train, of a propelling-pendulum, an electro magnet or magnets arranged to give an impulse to said pendulum by direct magnetic influence, so as not to interrupt the free or continuous swing of the same, and a continuously-maintained intermediate mechanical connection between the pendulum and train from or near one extreme of vibration to or near the other, whereby said pendulum may act directly as the propelling agent, and at the same time the work required in actuating the train may constitute a uniform mechanical opposition to the pendulum during its swing.

2. The combination, in an electric clock, of an actuated dial or indicating train and a freely-swinging pendulum having a continuous propelling mechanical connection with said train during the vibration of the pendulum from or near one extreme to or near the other, and an electro magnet or magnets giving to said pendulum impulses by direct magnetic influence.

3. The combination, with a freely-swinging pendulum kept in action by direct magnetic influence, so as not to interfere with its natural swing, of a dial or indicating train and a propelling device constantly engaged with the train during the swing or vibration of the pendulum from or near one extreme to or near the other, and moving in continuous connection with said pendulum.

4. The combination, with a freely-swinging and electrically-propelled pendulum having uniform or invariable mechanical opposition through its whole period of oscillation or swing, of an electro magnet or magnets for keeping the same in action by directly-operating magnetic impulses, and a dial or indicating train mechanically connected with said pendulum and propelled thereby, as and for the purpose described.

5. The combination, in an electric clock, of a movement propelled by the vibrations of a freely-swinging pendulum having uniform or invariable mechanical opposition to its swing, as described, an impelling electro-magnet and armature, one upon the pendulum and the other upon a separate support and arranged in suitable relations to permit a free swing of the pendulum, and a circuit-controller for said magnet independent of the pendulum, as described.

6. A clock mechanism with a time-train and vibrating pendulum for propelling the same, in combination with a magnet or magnets acting on the pendulum without interrupting its free swing and an intermediate transmitting or propelling mechanism between the pendulum and dial-train and in substantially constant engagement from or near one extreme of vibration to or near the other, for the purpose described.

7. The combination, with the indicating-train, of a toothed wheel, a freely-swinging magnetically-actuated pendulum, and an impelling-pawl turning the wheel by the direct action of the pendulum in its vibration from or near one extreme to or near the other extreme.

8. An electrically-operated clock with a time-train and a pendulum operating on said time-train through a complete vibration, in combination with means for actuating said pendulum by the force of a vitalized electro-magnet upon an armature, said magnet and armature being carried one on the pendulum and the other upon the frame or case.

9. In an electrically-actuated clock, the combination of a magnetically-impelled pendulum, an actuating circuit and circuit-controller, operated independently of the pendulum, a toothed wheel and dial-train, and a swinging arm acting on said wheel and oscillating with the pendulum from or near one extreme to or near the other.

10. The combination, with a freely-swinging and magnetically-impelled pendulum having uniform or invariable mechanical opposition through its whole period of oscillation or swing, of a toothed wheel, two levers continuously connected to and oscillating with said pendulum, and two actuating-pawls pivoted respectively on the levers and acting alternately to propel the wheel.

11. The combination, with the dial or indicating train, of the toothed wheel, the two levers and impelling-pawls, each of the latter being freely pivoted and arranged, as described, to alternately actuate the wheel, and a continuous connection between said levers and the pendulum, as and for the purpose described.

12. The combination, in an electric clock, of a dial or indicating train, a pendulum impelled by the action of magnetism operating directly upon the pendulum in its swing, so as not to interfere with its free vibration, a toothed wheel for said train, and two impelling-pawls mounted on swinging arms, each oscillating with the pendulum from or near one extreme of vibration to or near the other, as and for the purpose described.

13. In an electric clock, the combination of a fixed impelling or synchronizing horseshoe-magnet having its poles arranged, respectively, at opposite sides of the center of oscillation of the pendulum, whereby said magnet may act at both extremes of vibration of the pendulum as a horseshoe-magnet, and a suitable armature on the pendulum adapted to bridge its poles.

14. In an electric clock, the combination of an impelling or synchronizing horseshoe electro-magnet having its poles arranged in the line of vibration of the pendulum and an armature on the pendulum that bridges said poles at or near each extreme of vibration of the pendulum.

15. The combination, in an electric clock, of a fixed horseshoe or bibranched electro-magnet having its poles arranged in a line parallel with the swing of the pendulum and an armature upon the pendulum, arranged in the manner described, so that the central portion will act alternately with the two extreme portions as a keeper for the electro-magnet at or near the extremes of vibration of the pendulum.

16. In an electric clock, the combination, with one and the same pendulum and the intermediate mechanism whereby the pendulum may serve as the actuating means for the clock-movement, of an electro-magnet in a circuit with devices for sending electric impulses from a controlling-clock in time with the normal beat of said pendulum, and an auxiliary electro magnet or magnets for assisting in giving impulses to said pendulum and keeping the same in vibration under the control of the first-named electro-magnet.

17. In an electric clock, the combination of an indicating movement, a propelling-pendulum, and two electro-magnets for controlling or actuating said pendulum, one in a circuit controlled in the clock itself and the other in a separate or synchronizing circuit, as described.

18. The combination, with an electric clock having a freely-swinging pendulum and a circuit-controller operated independently of the pendulum, so as to not interrupt its free vibration, of a circuit, also independent of the pendulum, containing an electro magnet or magnets, whereby said pendulum may be kept in action and one or more secondary clocks in said circuit.

19. The combination, with a secondary

clock, of a synchronizing-magnet in a circuit with a controlling or primary clock, a local or sub-circuit containing an electro magnet or magnets for keeping said secondary clock in action, and one or more separate clocks having their controlling or actuating magnets in such local or sub circuit.

20. The combination, in an electric clock, of an actuating magnet or magnets, a synchronizing-circuit independent of the actuating-circuit containing said magnet, and a magnet or magnets in the synchronizing-circuit for controlling the movements of said clock.

21. The combination, in a clock, of a pendulum, a synchronizing-circuit containing devices for acting on said pendulum so as to keep its movements synchronous with those of a primary or controlling clock, an impulse magnet or magnets acting on the pendulum for the purpose of keeping it in vibration, and a circuit-controller operated by the clock to which such impulse magnet or magnets are applied.

22. In a system of time-distribution, a main or controlling circuit governed by a primary clock, and having upon it one or more synchronized clocks whose movements are kept in synchronism with those of the primary clock by an electro magnet or magnets in the main circuit, and one or more step-by-step clock mechanisms whose actuating-magnets are also in the main circuit, so as to receive energizing-impulses in time with the synchronized clocks, but controlled directly by the prime regulator.

23. In a system of time-distribution, a main or controlling circuit governed by a primary or regulating clock and having upon it one or more clocks with electrically-synchronized pendulums, whose synchronizing magnet or magnets are in such main circuit, and one or more secondary electric clocks actuated by electro-magnets whose coils are also in the direct or main circuit, so as to receive energizing electric impulses in time with the movements of the synchronized clocks, but controlled directly by the main regulator.

24. In an electric clock, a pendulum, in combination with an actuating or synchronizing magnet or magnets, having simultaneously-attracting poles, arranged in a line substantially parallel with the line in which the magnet and armature move with reference to one another, and an armature acted upon by two or more of said poles simultaneously.

25. In a self-operating electric clock, a suitable dial-train, electro-magnet for giving motion to the pendulum by the influence of magnetism, and a circuit-controller and circuit independent of the pendulum.

26. In an electric time-movement, the combination of a wheel driven by the vibration of an arm carried by the pendulum, and flexible interposed connections between said wheel and pendulum, whose resiliency shall tend to prevent a sudden resistance to the vibration of the pendulum, with means for actuating the same by means of a circuit-controller and electro-magnet.

27. The combination, in an electric clock, of a pendulum, an armature, and a horseshoe or bipolar electro-magnet having its two poles arranged in a line substantially parallel with the line upon which the electro-magnet and armature therefor move with reference to one another, said magnet and armature being carried one by the pendulum and the other on a separate support.

28. The combination, in an electric clock, of a dial-train and propelling-pendulum therefor kept in operation by the force of magnetic attraction acting directly on said pendulum, an actuating-pawl moved by the pendulum and in constant engagement with the actuated wheel from or near one extreme to or near the other of the pendulum's vibration, and a yielding connection between said pendulum and the wheel actuated thereby.

29. The combination, in an electric clock, of a pendulum, a ratchet-wheel, and actuating-pawl engaging constantly with said wheel from one extreme of vibration to the other, and an arm or support for said pawl in constant connection with the pendulum, so as to be moved positively thereby in both directions and to actuate the wheel continually during the movement of the pendulum from or near one extreme of the pendulum's vibration to or near the other.

Signed at New York, in the county of New York and State of New York, this 12th day of June, A. D. 1884.

JULIAN E. CAREY.

Witnesses:

THOS. TOOMEY,

WM. H. BLAIN.