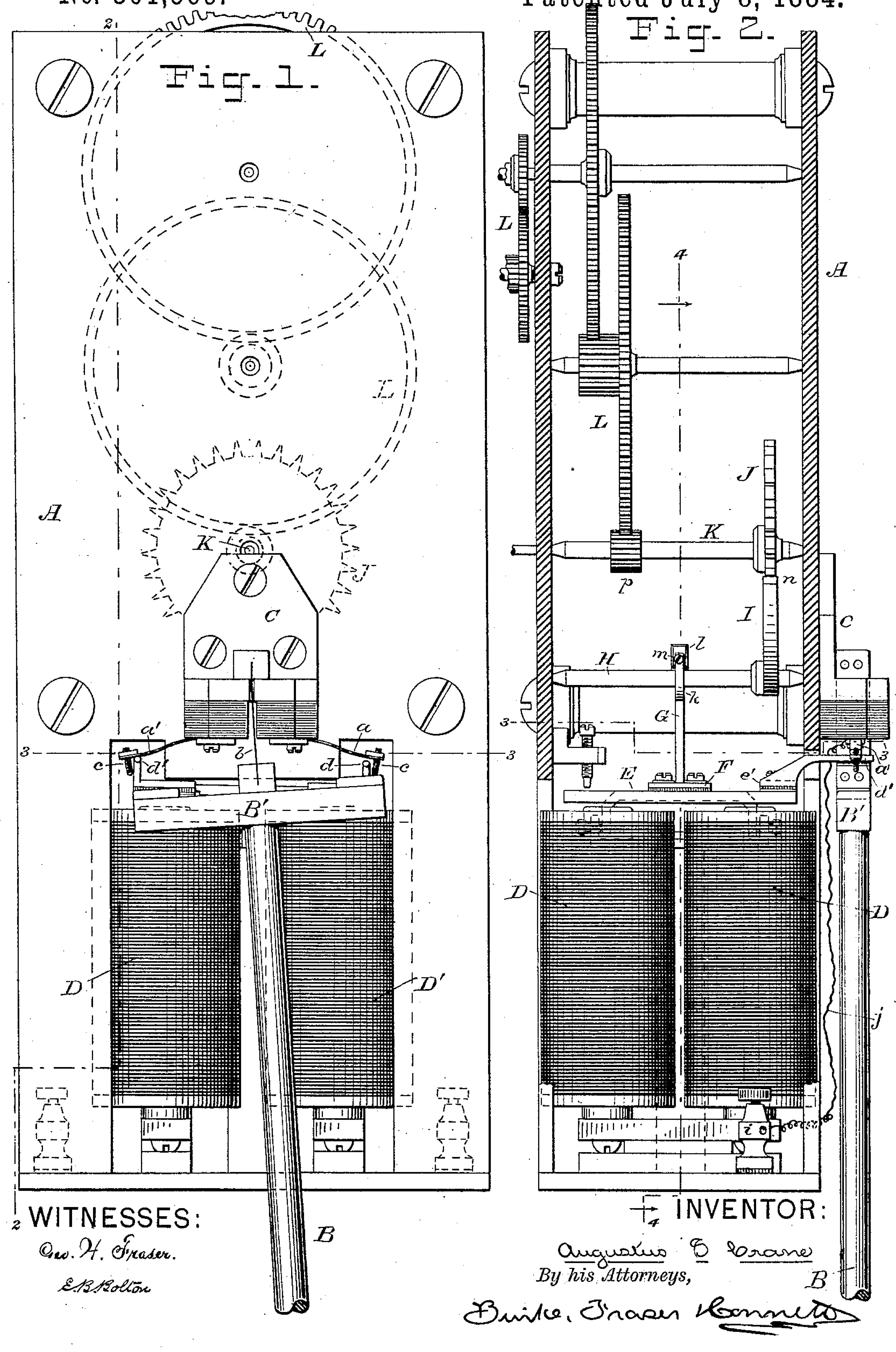
(No Model.)

3 Sheets—Sheet 1.

A. S. CRANE.

ELECTRO MAGNETIC CLOCK.

No. 301,569. Patented July 8, 1884.



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3 Sheets—Sheet 2.

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Fig. 3.

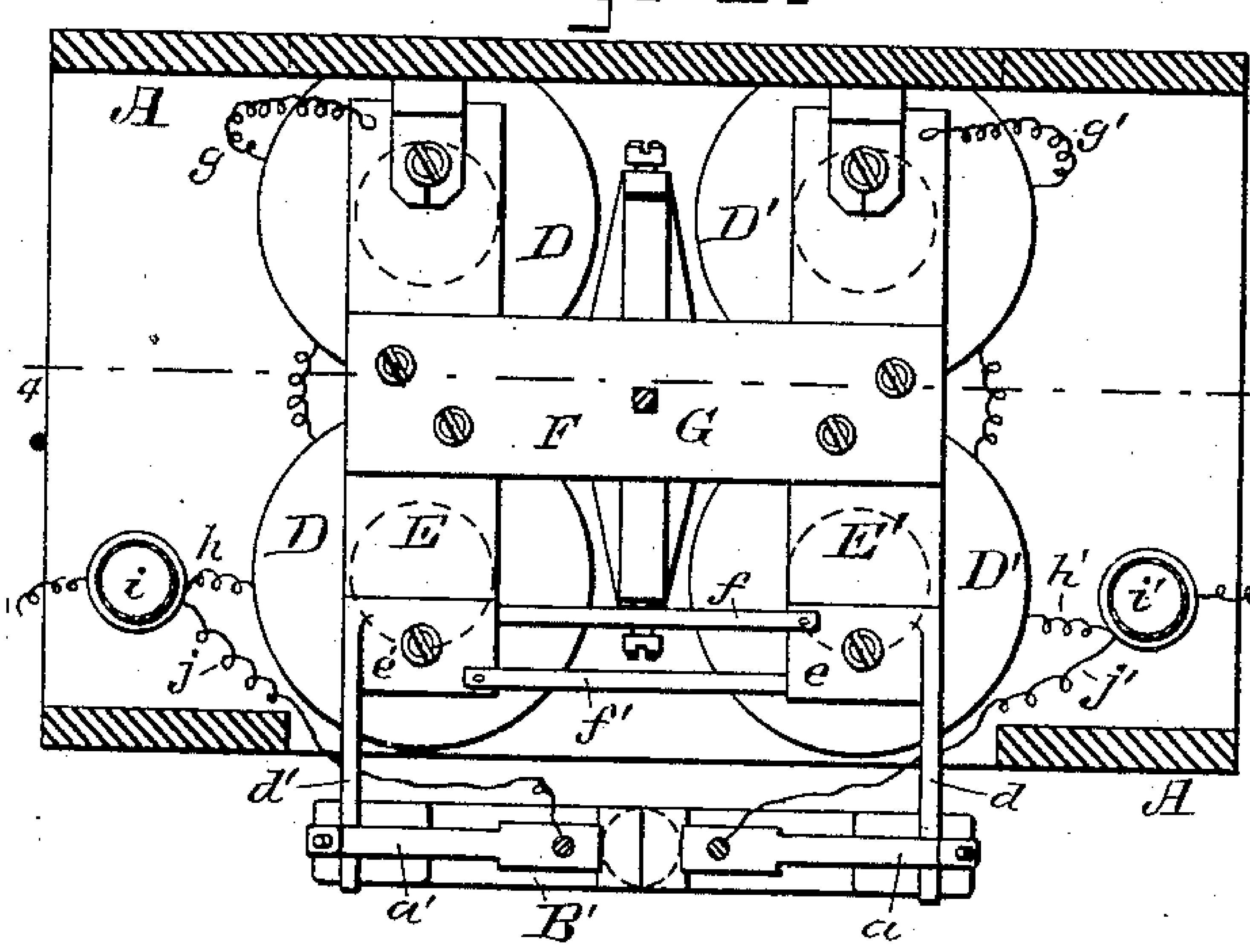


Fig. 5.

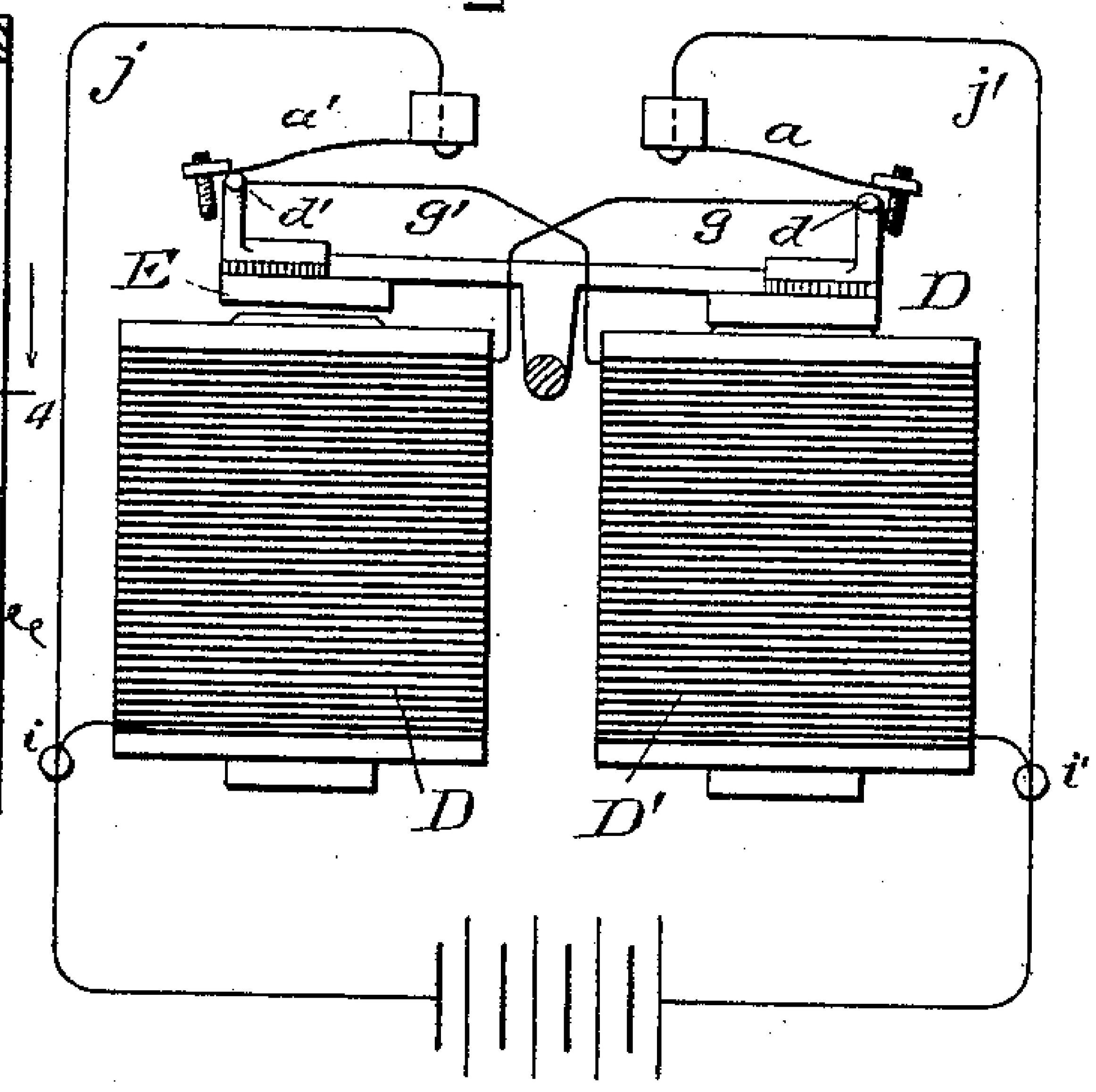


Fig. 4.

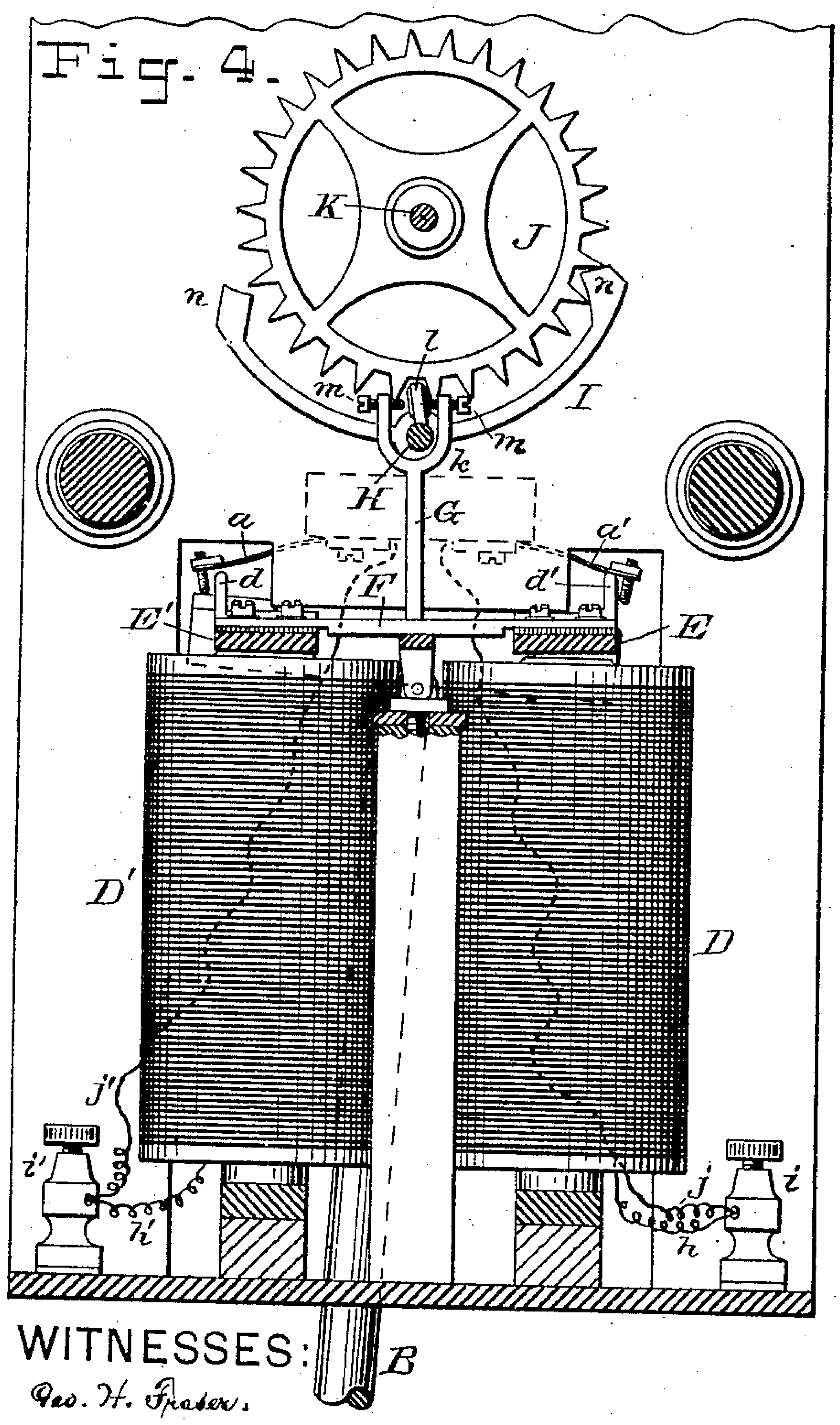


Fig. 6.

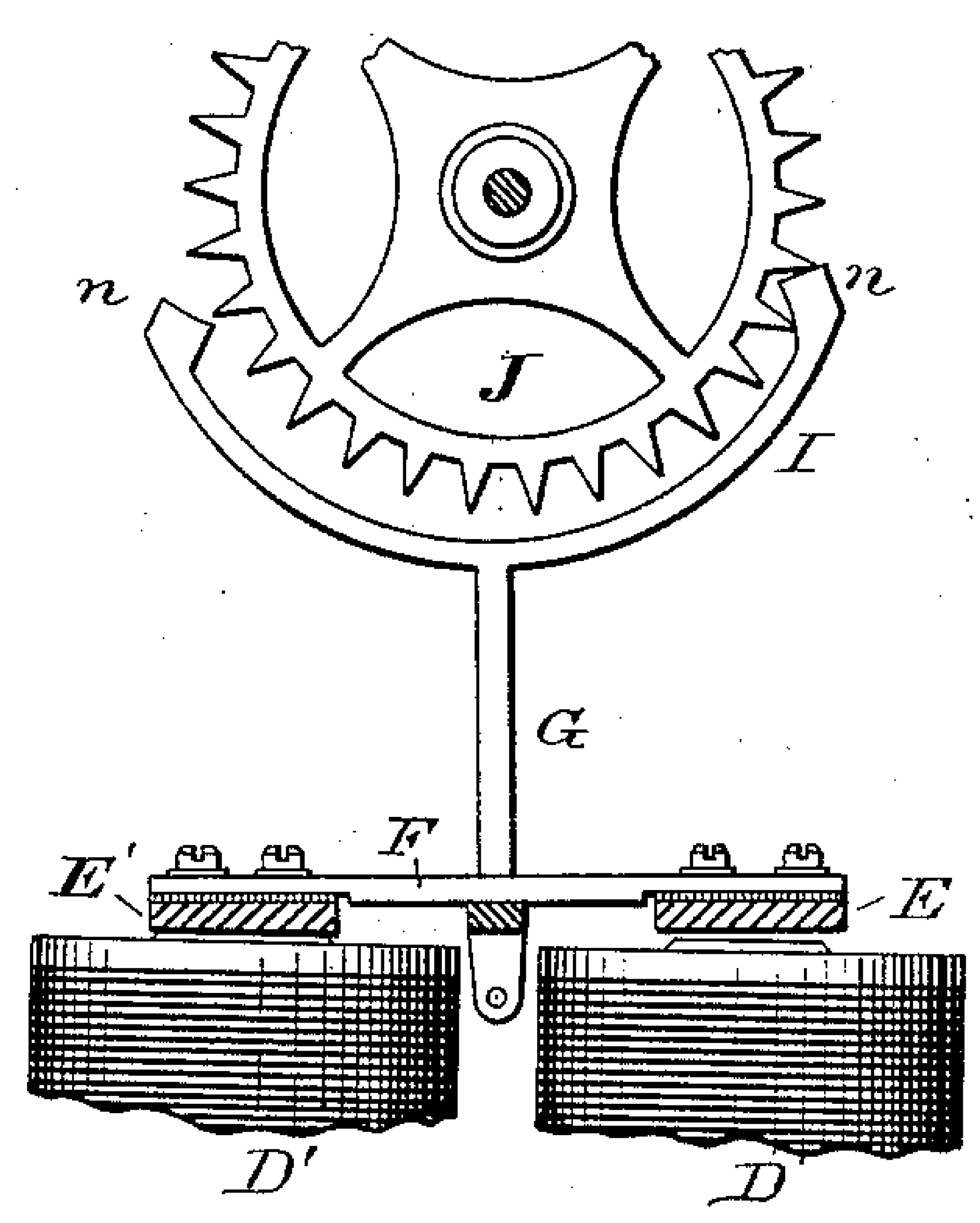
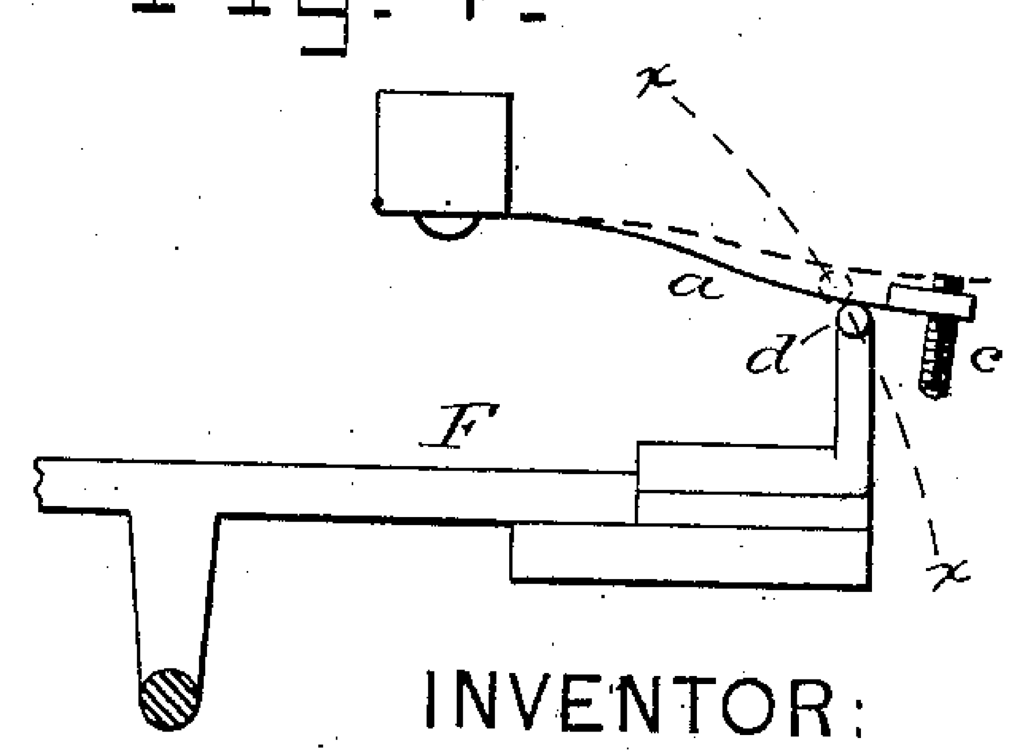


Fig. 7.



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(No Model.) 3 Sheets—Sheet 3.

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Fig. 8.

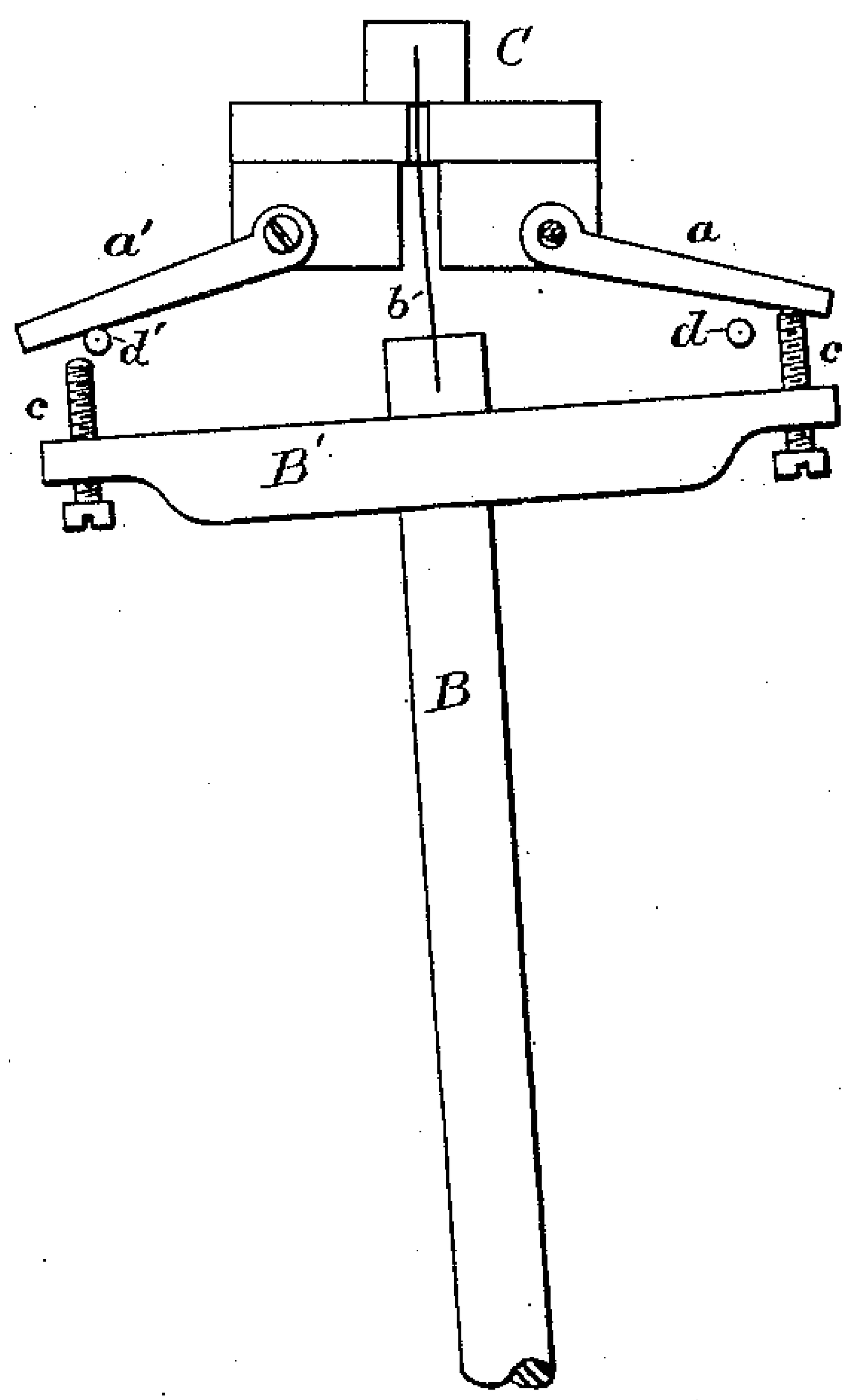


Fig. 10.

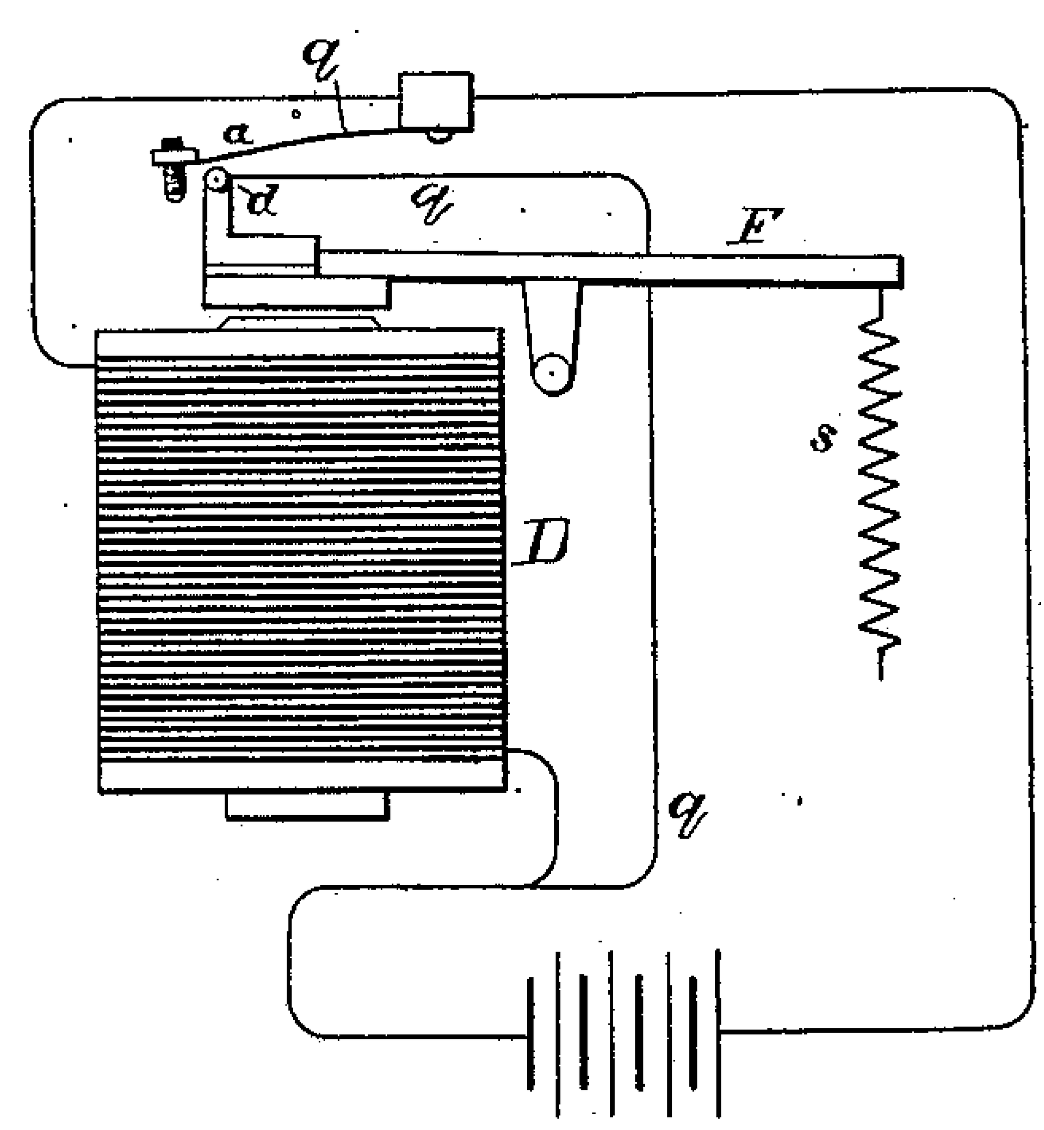


Fig. 9

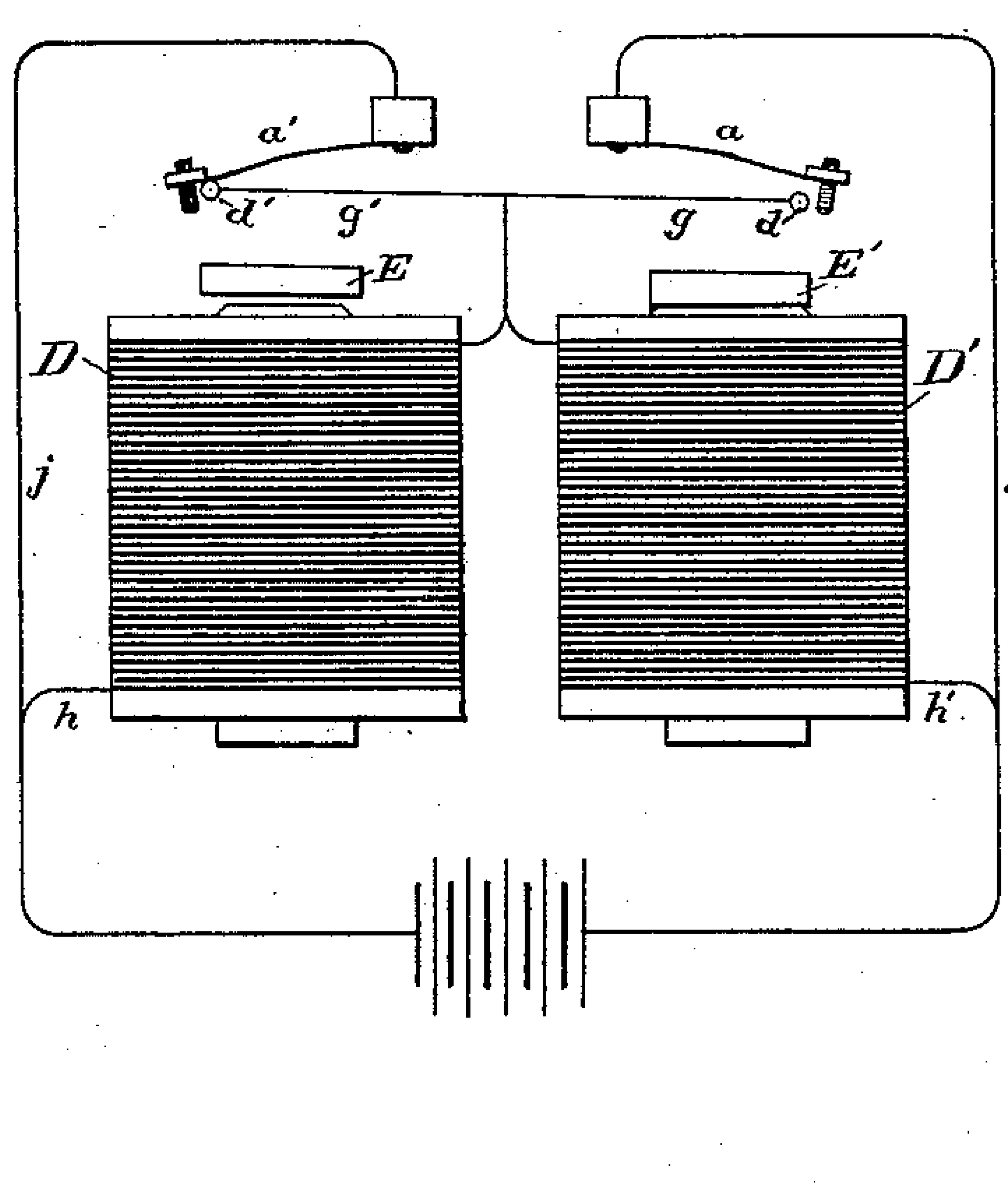
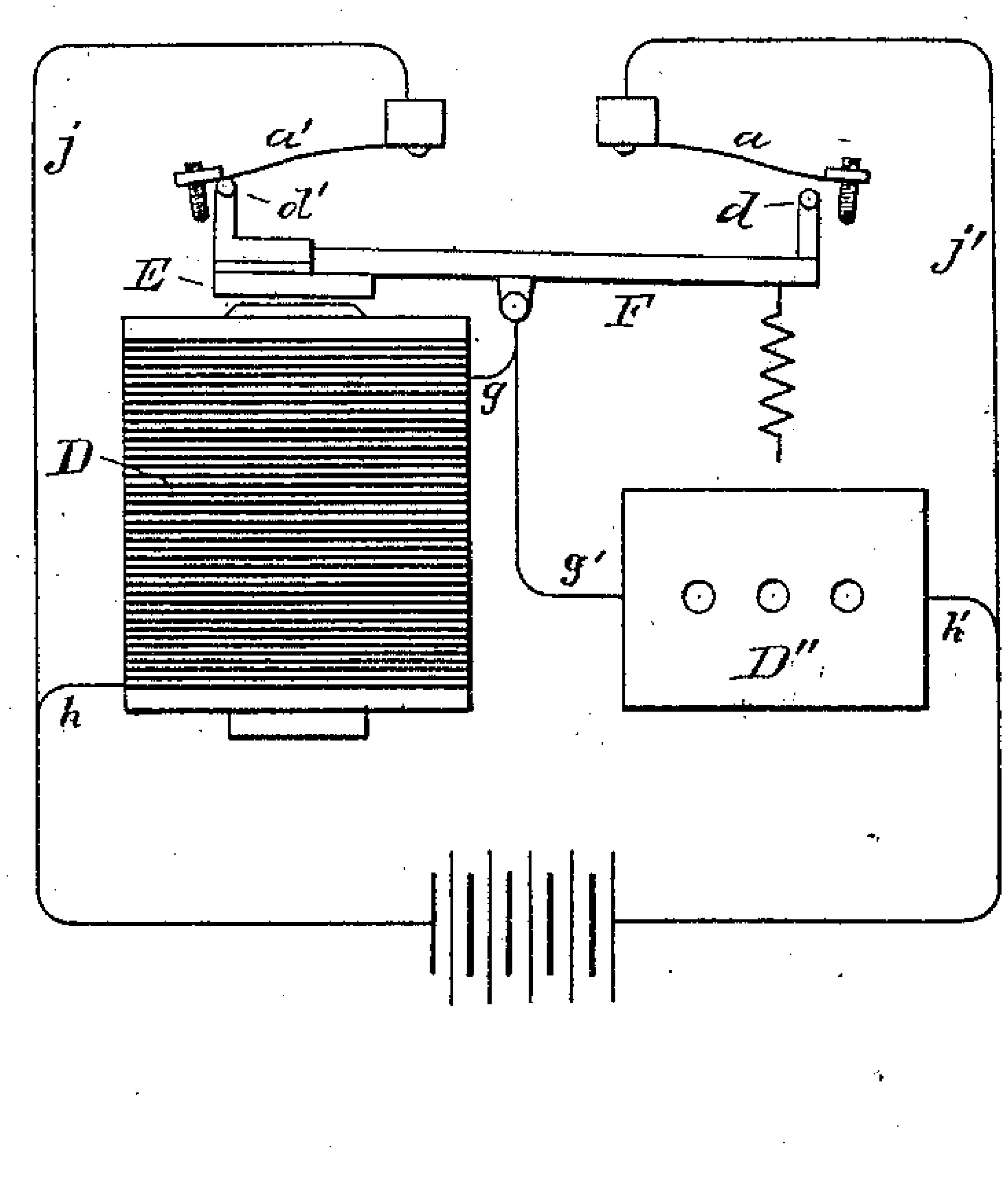


Fig. 11.



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UNITED STATES PATENT OFFICE.

AUGUSTUS S. CRANE, OF NEWARK, NEW JERSEY.

ELECTRO-MAGNETIC CLOCK.

SPECIFICATION forming part of Letters Patent No. 301,569, dated July 8, 1884.

Application filed January 26, 1883. (No model.)

To all whom it may concern:

Be it known that I, AUGUSTUS S. CRANE, a citizen of the United States, residing at Newark, in the county of Essex and State of New Jersey, have invented certain Improvements in Electro-Magnetic Clocks, of which the following is a specification.

This clock belongs to that class which is propelled by electrical power, instead of by the power of a weight or spring.

The object of the invention is to produce a clock which shall give a uniform impulse to the pendulum, whether it be actuated by a weak or strong current, in which there shall be no spark upon the separation of the circuit-breaking contacts, in which these contacts shall be constantly rubbed and kept bright, and which shall have other desirable attributes, as will hereinafter more fully appear.

Figure 1 of the accompanying drawings is a rear elevation of my clock. Fig. 2 is a side elevation, the frame being partly in vertical section cut in the plane of the line 2 2 in Fig. 1. Fig. 3 is a horizontal section cut along the lines 3 3 in Figs. 1, 2, and 4. Fig. 4 is a fragmentary vertical section cut along the lines 4 4 in Figs. 2 and 3, and looking from the front. Fig. 5 is a diagram illustrating the preferred circuit arrangement. Fig. 6 is a fragmentary view similar to Fig. 4, showing a modified construction. Fig. 7 is an enlarged fragmentary view. Fig. 8 is a fragmentary rear elevation showing a modification; and Figs. 9, 10, and 11 are diagrams showing modified electrical arrangements.

Referring to Figs. 1 to 4, A is the frame of the clock, of any suitable construction, and B is the pendulum, only a portion of which is shown, and which is hung by a spring, *b*, as usual, from a bracket, C, on the rear side of the case, and has a cross-bar, B′, at its top. The impulse-springs *a a′* are attached to the insulated bracket C, and their free ends bear alternately upon the cross-bar B′ as the pendulum swings. Their ends are fitted with minute screws *c c*, through which they bear upon the cross-bar, and by which the duration of their contact with the cross-bar may be adjusted. The cross-bar might, instead, be fitted with upwardly-projecting screws in its ends.

Beneath the springs *a a′* are fingers *d d′*, on which the springs rest, except when lifted off by the cross-bar B′. When the pendulum is at mid-stroke, both springs are resting on these fingers. The fingers have a slight up-and-down movement, and are connected together, so that as one moves up the other moves down, by means which will be presently described.

In Fig. 1 the pendulum is shown at the extreme of its right-hand swing, (when viewed from the rear,) and the spring *a* is pressing on the right-hand end of the cross-bar B′, thus impelling the pendulum to swing to the left. The finger *d* is depressed, and the finger *d′* is elevated and upholds the spring *a′*. When the pendulum swings far enough to the left for its cross-bar B′ to strike the screw *c* of the spring *a′*, it lifts that spring out of contact with the finger *d′*, whereupon the latter instantly descends and the finger *d* ascends. Thus the spring *a′* is then left upheld wholly by the cross-bar B′, and is free to exert its downward tension to impel the pendulum to the right, which it continues to do until it strikes the finger *d′* or the bar B′ lifts the spring *a*. This operation is continued during the entire life of the clock, the pendulum being given an equal impulse at each vibration by the springs *a a′*. These springs are very light and elastic, and exert but a slight pressure on the cross-bar B′; but they suffice to overcome the almost infinitesimal friction of the pendulum, and after it is once started will keep it in vibration for years, or until the parts are worn out.

I will now describe the means whereby the fingers *d* and *d′* are raised and lowered with special reference to Figs. 2, 3, and 4.

D and D′ are two electro-magnets, and E and E′ are their armatures, which are both fixed to and insulated from an armature-lever, F. The fingers *d d′* are horizontal projections from plates *e e′*. The plate *e* is fixed on the armature E′, and the plate *e′* on the armature E. Both plates are insulated from the armature to which they are fixed, and each is connected electrically with the opposite armature by a copper strip, the strip *f* connecting the plate *e* to the armature E and the strip *f′* connecting the plate *e′* to the armature E′. These plates *e e′* are fixed on the rear ends of the armatures.

To the front ends of the latter wires *g g′* are connected, the wire *g* leading from the armature E and joining one terminal of the electro-magnet D, and the other wire, *g′*, leading from the armature E′ and joining one terminal of the magnet D′. Thus through plate *e*, strip *f*, armature E, and wire *g* the finger *d* is connected electrically with the magnet D. The finger *d′* is in like manner connected with the magnet D′.

In the diagram Fig. 5, the wires *g g′* are shown for the sake of clearness as leading directly from the fingers. The opposite terminal of the magnet D is connected by a wire, *h*, with a binding-post, *i*, to which one pole of the battery is connected; and the corresponding terminal of the magnet D′ is connected by a wire, *h′*, with the other binding-post, *i′*, to which the opposite pole of the battery is connected. A wire, *j*, leads from the binding-post *i* to the spring *a′*, and a wire, *j′*, leads from the post *i′* to the spring *a*.

The operation may now be understood by reference to Figs. 4 and 5, where the pendulum is assumed to be in the same position as in Fig. 1. The spring *a* is lifted off the finger *d*, so that the circuit between them is broken; but the spring *a′* and finger *d′* are in contact. The current then passes, Fig. 5, from positive pole of battery through wire *j*, spring *a′*, finger *d′*, wire *g′*, magnet D′, wire *h′*, and thence to the negative pole of battery. The magnet D′ is thus excited so that its armature E′ is attracted and the finger *d* is held down, while the finger *d′* is elevated; but when the pendulum swings to the opposite side and lifts the spring *a′* off from the finger *d′* (by which time the spring *a* will have descended to and rested on the finger *d*) the course of the current is changed. It then flows through wire *h*, magnet D, wire *g*, finger *d*, spring *a*, and wire *j′*, thereby exciting magnet D, whereupon the armature E will be attracted thereto, will drop finger *d′* and rock lever F, thereby lifting armature E′ and finger *d*, which lifts (and compresses) spring *a*. Spring *a′* is thus left free to descend and impel the pendulum, while spring *a* is lifted ready for a fresh impulse. By the means thus described the two magnets are charged alternately, and the lever F is vibrated with perfect regularity, assuming, of course, that the length of the pendulum remains unaltered. To this end a compensating-pendulum should be used. The movement of the lever F is utilized to actuate the wheel-work of the clock by means which I will now describe. An arm, G, Fig. 4, is fixed to the lever F, and projects upwardly, its upper end terminating in a fork, *k*. A spindle or arbor, H, passes through this fork, and on it is fixed the anchor I, engaging the escape-wheel J. To the spindle H is fixed an arm, *l*, within the fork *k*, and two adjusting-screws, *m m*, passing through the arms of the fork, embrace this arm *l* loosely between them. As the lever F and arm G vibrate, the screws *m m* impel the arm *l* from side to side, and so vibrate the anchor. Instead of this indirect connection between the lever F and the anchor, the latter may be fixed directly on the arm G, as shown in Fig. 6; but the construction shown in Fig. 4 is preferred for very accurate clocks, as it permits of the adjustment of the play of the armatures and of the anchor independently of each other.

The anchor I and wheel J do not constitute an escapement; but the anchor is constructed to propel the wheel, its pallets *n n* being wedges, or having inclined surfaces which engage the teeth of the wheel and propel it a half-tooth forward on each motion of each pallet toward the wheel. The wheel J is fixed on the seconds-arbor K, on which is a pinion, *p*, which communicates motion to the train of gears L L, which actuate the hands of the clock. All these parts are of the usual construction and require no description.

The battery used to run this clock should furnish a current of considerable quantity, but low tension. A single sawdust-cell answers admirably and will run the clock six months or more without recharging. The current must have strength enough to give the magnets sufficient attractive power to cause the armatures to vibrate with force sufficient to raise the springs *a a′*, and to overcome the friction of the lever F, anchor, train, and other parts; but beyond this a current of any ordinary strength may be used without impairing the operation of the clock, as the impulse given to the pendulum is wholly independent of the strength of the current. The springs *a a′* serve as conductors of the electric current only when they are not employed in impelling the pendulum, so that whatever change in their tension may be caused by the passage of a current through them ceases the instant they are lifted by the cross-bar B′, and the current is not resumed until they have ceased to impel the pendulum. The pendulum forms no part of the circuit—a feature wherein my clock is superior to many others heretofore made. When the pendulum is at mid-stroke, neither spring *a a′* is upheld by the cross-bar, both then resting on the fingers *d d′*. The current has consequently two paths, which should be of equal resistance, so that it will divide, and one-half will flow through each magnet. This continues for a moment, or while the pendulum is swinging from the center to either side, and until, when at nearly its extreme swing, it lifts one of the springs, and thereby breaks one branch of the circuit. The current then has to wholly follow the other branch; but as it still has a continuous path, no spark follows the separation of the spring from its finger. I thus avoid one of the most troublesome defects of electric clocks as heretofore made—namely, the oxidation of the circuit-breaking contacts by the electric spark, which in a few months will impair the operation of the clock.

The contacting surfaces of the impulse-springs and fingers are kept bright by causing the fingers to rub across the springs at each movement. This is done by pivoting the lever F considerably below the plane of the fingers, so that the latter move in the direction of the arc x x in Fig. 7, instead of vertically. An equivalent result might be produced by fulcruming the lever F on an axis above the fingers d d', or by any other arrangement which will cause the fingers to slide along the springs while lifting them.

It will be understood that the current which excites either magnet is caused to pass longitudinally through the armature of that magnet, thereby increasing the attractive power of the magnet in the manner well known to electricians. This is desirable, but not essential, as the wires g g' may be joined directly to the fingers d d'.

Instead of using springs for giving the impulse, small weights may be used. In Fig. 8 two loosely-pivoted dogs, a a', are shown, instead of springs, and operating in the same manner.

In Fig. 9 a different circuit arrangement is shown, the difference being that the wires g g' are in fact connected with each other, so that when both springs a a' are in contact with both fingers d d' the current does not divide, but is shunted around both magnets, following the path i, j, a', d', g', g, d, a, j', and i'. This method is less desirable than that shown in Fig. 5, as upon the separation of either pair of contacts the entire resistance of one magnet is thrown into the circuit, whereby with the preferred arrangement only half that resistance is thrown in.

Instead of using two magnets and two impulse-springs, one magnet and one spring may be used, as shown in Fig. 10. Here there is one continuous circuit, which includes the magnet and is never broken, and a shunt-circuit, q q, in which are the circuit-breaking contacts a d. When a is touching d, the current traverses the path q q of least resistance, and almost entirely ceases to traverse the magnet D, leaving a retracting-spring, s, free to lift the armature. A single impulse gives a slightly unequal motion to the pendulum, and hence a double impulse is preferable. Fig. 11 shows how a double impulse may be given by a single magnet. The arrangement is the same as in Fig. 9, except that a rheostat, D'', is substituted for the magnet D', and a retracting-spring, s, is used. The resistance of the rheostat D'' should be about equal to that of the coils of the magnet D.

My clock is well adapted for use as the primary or regulating clock controlling a number of secondary clocks arranged all on one circuit. For this purpose it should be provided with some good circuit-breaking device to manipulate the line-circuit, it being preferable to employ a line-circuit distinct from the circuit which actuates the clock.

The secondary clocks may each consist of one or both magnets, D D', their armatures, lever F, anchor I, wheel J, and the train.

I claim as my invention—

1. The combination, in an electric clock, of a pendulum, an impulse spring or weight arranged to be lifted intermittently by the pendulum, a finger arranged to uphold said spring or weight, except when it is so lifted by the pendulum, an electro-magnet, its armature connected with and arranged to move said finger, and an electric circuit divided into two branches, one branch traversing said spring and finger and the other branch traversing said electro-magnet, whereby, upon the lifting of the impulse-spring off said finger by the pendulum, the branch of the circuit traversing the spring and finger is broken, and the entire current is caused to traverse said magnet, thereby exciting the latter and drawing down said finger, substantially as set forth.

2. The combination, in an electric clock, of a pair of electro-magnets, their armatures mounted both on one armature-lever, two fingers connected to and operated by said armatures, two impulse springs or weights arranged over and adapted to be held by said fingers, a pendulum adapted when at either extremity of its swing to lift one or other of said springs or weights off its finger, and an electric circuit divided into two branches, each traversing one of said magnets and one of said springs or weights and fingers, in substantially the manner and to the effect set forth.

3. The combination, to form an electric clock, of pendulum B, cross-head B', impulse springs or weights a a', fingers d d', armature-lever F, bearing said fingers, armatures E E' thereon, alternately-acting electro-magnets D D', propelling-anchor I, receiving motion from lever F, and toothed wheel J, substantially as set forth.

4. In an electric clock, the combination of a circuit divided into two branches, a circuit-breaking impulse-spring arranged in one of said branches, and the pendulum arranged to lift said spring, and thereby break the circuit in said branch, whereby during the impulse the current flows wholly through the other branch and no current traverses said spring, substantially as set forth.

5. The combination of pendulum B, cross-head B', impulse-springs a a', armature-lever F, armatures E E', fingers d d', mounted on and insulating from the rear ends of said armatures, crossing conductors f f', joining each finger to the opposite armature, wires g g', leading from the front ends of said armatures, and electro-magnets D D', substantially as set forth.

6. In an electric clock, the combination of magnets D D', armatures E E', lever F, arm G, fork k, screws m m, arbor H, arm l, and anchor I thereon, and toothed wheel J, substantially as set forth.

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

AUGUSTUS S. CRANE.

Witnesses:
ARTHUR C. FRASER,
HENRY CONNETT.