No. 871,407. PATENTED NOV. 19, 1907.

F. HOPE-JONES.

ELECTRIC CLOCK.

APPLICATION FILED MAR. 20, 1906.

4 SHEETS—SHEET 1.

Fig.1

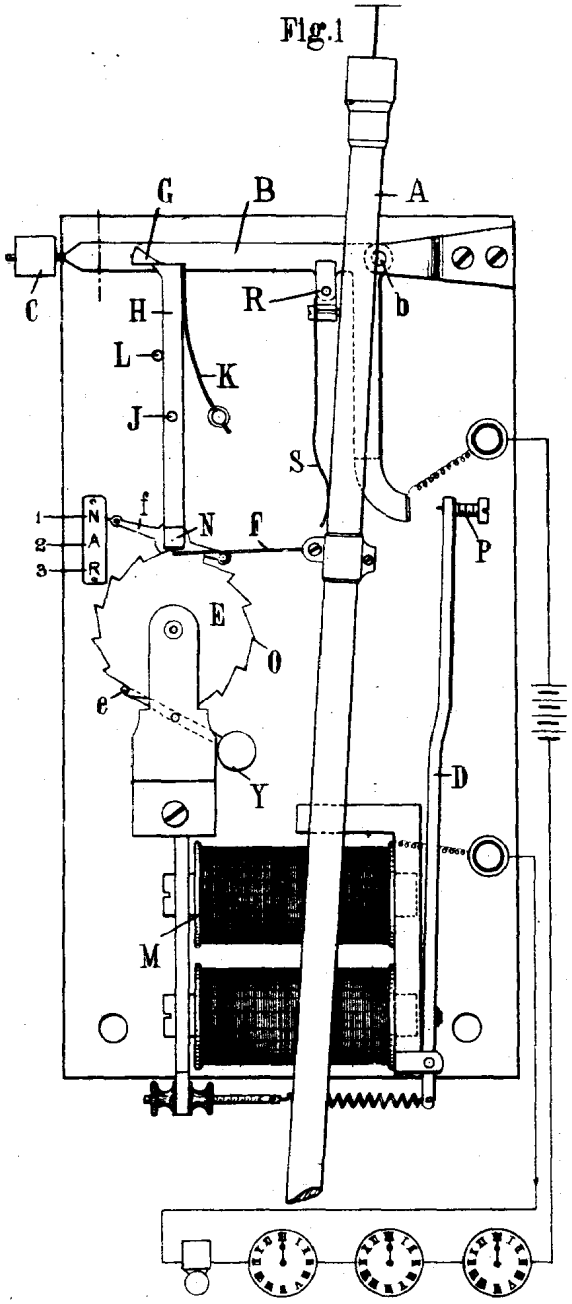
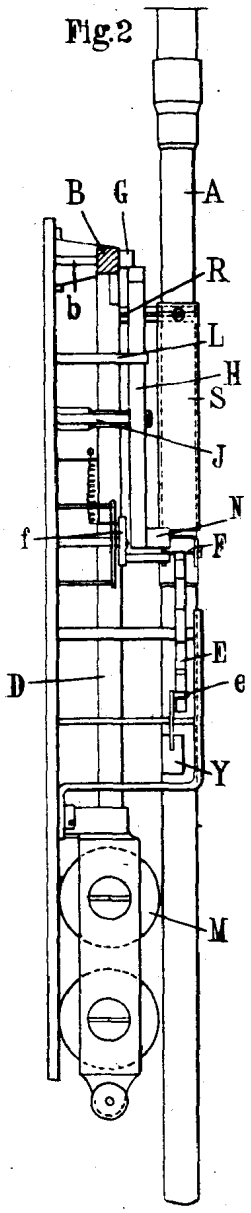


Fig.2



Witnesses

Albert W. Seale

Walter J. Peake

Inventor,

Frank Hope-Jones.

per Herbert Jeffrin Jones

Attorney

No. 871,407. PATENTED NOV. 19, 1907.

F. HOPE-JONES.

ELECTRIC CLOCK.

APPLICATION FILED MAR. 20, 1906.

4 SHEETS—SHEET 2.

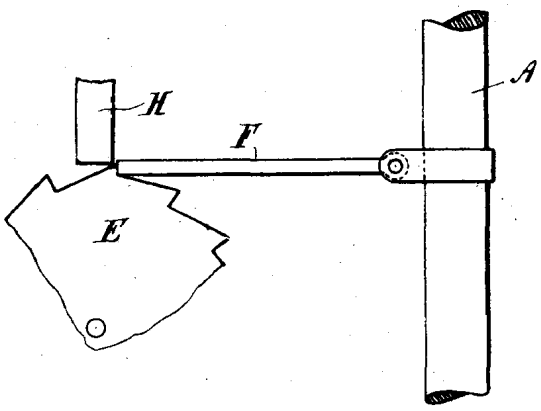


Fig. 1a

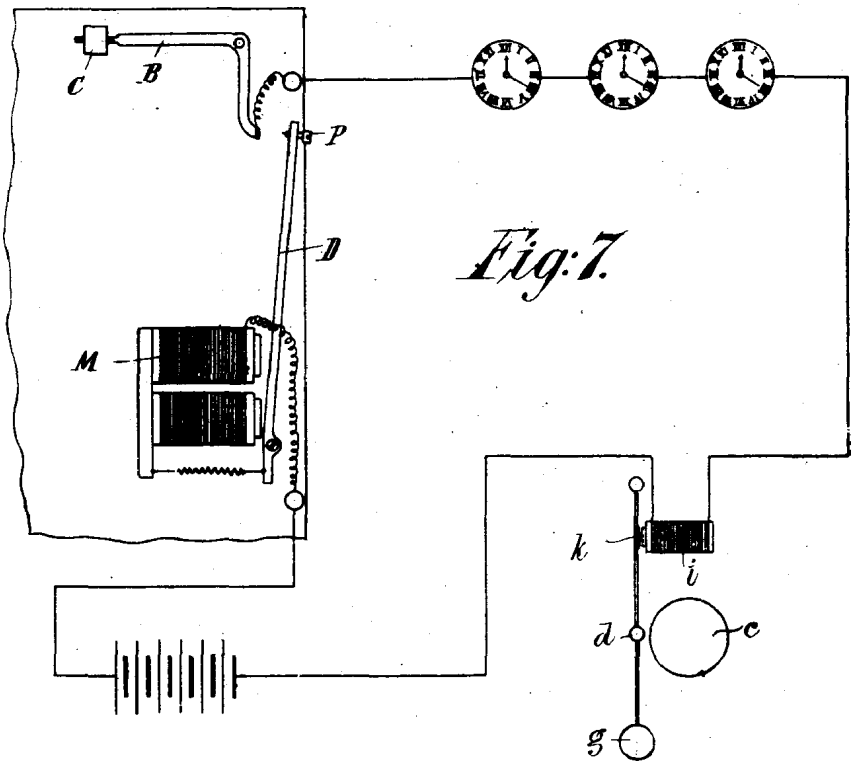


Fig. 7.

Witnesses.
Edwin. D. Bartlett.
Walter G. Rooke

Inventor
Frank Hope-Jones.
per Herbert Sefton Jones
Attorney.

No. 871,407. PATENTED NOV. 19, 1907.

F. HOPE-JONES.

ELECTRIC CLOCK.

APPLICATION FILED MAR. 20, 1906.

4 SHEETS—SHEET 3.

Fig.3

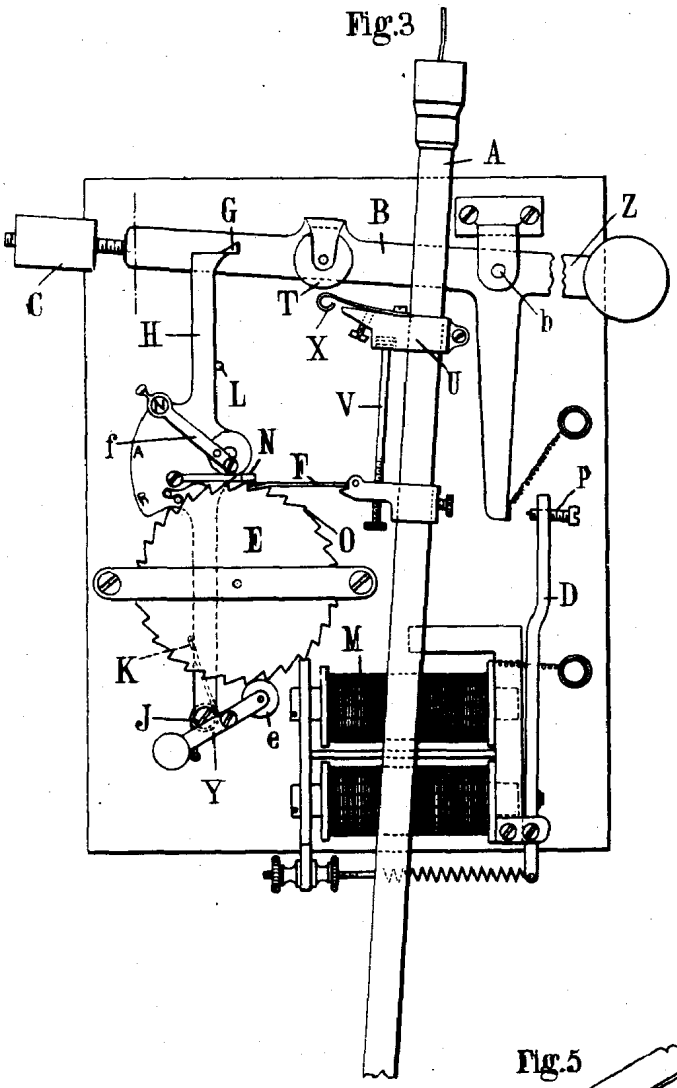


Fig.4

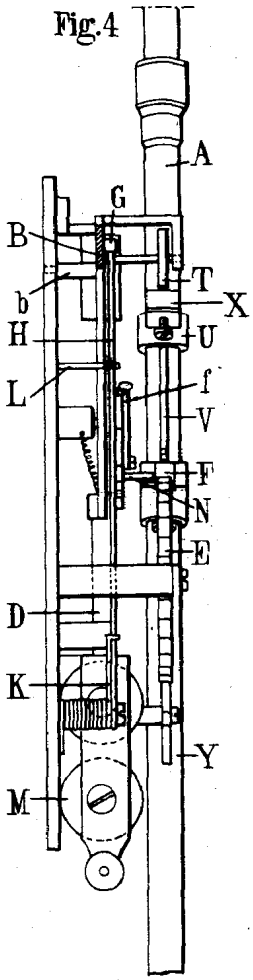
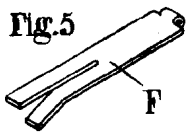


Fig.5



Witnesses

Albert W. Beals

Walter G. Peck

Inventor

Frank Hope-Jones.

per Herbert Leftwich Jones

Attorney

No. 871,407. PATENTED NOV. 19, 1907.

F. HOPE-JONES.

ELECTRIC CLOCK.

APPLICATION FILED MAR. 20, 1906.

4 SHEETS—SHEET 4.

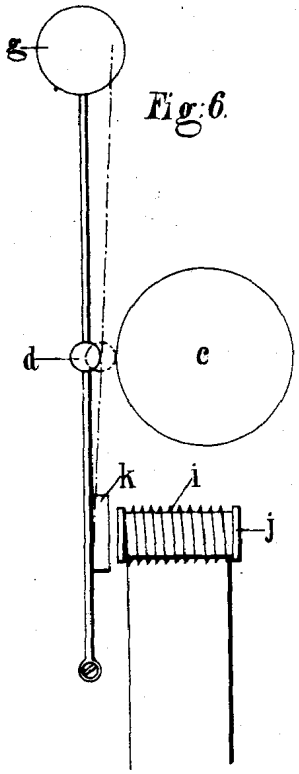


Fig. 6.

Witnesses

Albert Brake.

Walter F. Peck

Inventor

Frank Hope-Jones

per: Herbert Sefton-Jones

Attorney

UNITED STATES PATENT OFFICE.

FRANK HOPE-JONES, OF LONDON, ENGLAND.

ELECTRIC CLOCK.

No. 871,407. Specification of Letters Patent. Patented Nov. 19, 1907.

Application filed March 20, 1906. Serial No. 307,021.

To all whom it may concern:

Be it known that I, FRANK HOPE-JONES, a subject of the King of Great Britain, residing at 32 and 34 Clerkenwell road, London, E. C., in the county of Middlesex, England, have invented a new and useful Improvement in the Construction of Electric Clocks, of which the following is a specification.

This invention has for its object improvements in the construction of electric clocks, especially of the type set forth in my previous United States Patents Nos. 610539 and 628325. These improvements comprise a method of maintaining the vibrations of a pendulum automatic and of transmitting periodic electrical impulses to operate secondary dials or the like; also to obviate certain drawbacks inherent in previous systems of electrically synchronizing and propelling clock mechanisms.

In order more clearly to set forth my invention I have illustrated the same in the accompanying drawings, in which

Figure 1 shows diagrammatically a front elevation of my improved mechanism. Fig. 1ª shows the part F in position to move the lever H. Fig. 2 a side elevation of the same, and Fig. 3 a modification in front elevation. Fig. 4 a side elevation of Fig. 3. Fig. 5 shows the pawl F in detail. Fig. 6 shows the bell signal for indicating battery exhaustion. Fig. 7 shows the electric bell mechanism in connection with its operative circuit.

In my first-cited prior patent the weighted lever or fly wheel adapted to be periodically reset by the electromagnet was normally engaged in driving the pendulum through the medium of an escapement, and was consequently let down slowly and by very small steps into contact with the armature.

By my present invention the weighted lever is normally supported by a catch, and is liberated by the pendulum itself not necessarily as in the previous patent at every beat but at a given interval. For instance it may be liberated every fifteen, thirty, or sixty seconds as may be desired and acts as a gravity arm, giving one comparatively long and powerful impulse to the pendulum at the predetermined period of time instead of a short and small impulse at every beat. Further by the improved construction hereinafter set forth I insure the continued regular action of the mechanism even in the event of failing battery strength because in my present system the pendulum itself will assist the armature in completing the return of the gravity lever. A further advantage arising from this construction is found in the indication given of failing battery strength by the prolongation of the periods of contact at each impulse, which prolongation of contact may be used to operate a single stroke electric bell so adjusted that it will not be sounded by contacts of the normal and shorter duration. Another advantage of my present construction is that in the event of stoppage of the clock from any cause this will occur on open circuit so that electric current cannot be wasted while the apparatus is standing still. Finally I have provided means for more easily advancing or retarding the pointers of the dials without interfering with the normal working of the clock or stopping the pendulum.

The pendulum A is of any ordinary form. The gravity arm B with weight C is centered at *b* which in conjunction with the armature D and electro-magnet M constitute the essential electro-mechanical part of the switching action shown in Fig. 2 of Patent No. 610539 above referred to and Fig. 1 of Patent No. 628325. A ratchet wheel E is adapted to be revolved one tooth at a time by the pawl F pivoted on the pendulum A. The pawl F is divided as shown in Fig. 5, one half slightly curved downwards, serving to operate the wheel E while the other straight part operates the block N. An arm *f* is mounted on the base and a pin projects from it which raises the pawl F into one of three positions indicated respectively by the Figs. 1, 2, 3 according as the working is normal, accelerated or retarded. A steel spring S is mounted on the lever B at R. A lightly pivoted lever Y carries a roller or pin *e* which is gently pressed against the teeth of the wheel E thereby limiting and defining its progression to exactly one tooth at a time with the minimum of frictional disturbance. A small block or pallet G is fixed upon the weighted lever B by means of which the lever is normally supported on the upright click H centered at J. The click H is provided with a spring K pressing it lightly against the fixed stop L. A small block N is mounted on the click H just sufficiently high to clear the point of the pawl F in the normal position. One tooth O of the ratchet wheel E is not cut as deeply as the rest of the teeth, so that when the pawl F mounted on the pendulum

A in propelling the wheel E one tooth at each oscillation picks up the shallow tooth O, it rides at a higher level and meets the block N on the click H thereby liberating the gravity arm B which then falls with the pendulum A imparting an impulse thereto by means of the spring S or the roller T falling on the spring X. The arm of the weighted lever B then meets the contact screw P in the tail of the armature D thereby closing the circuit and causing the magnet M to raise the weight to its initial position.

The action of the apparatus is as follows:— When the pendulum A oscillates it rotates the wheel E by means of the pawl F which rides underneath the block N on the click H until the tooth O meets it and the pawl rides at a higher level and meets the stop N thrusting the click H from underneath the block G. The weighted lever then falls and communicates an impulse to the pendulum A through the spring S in the manner of an ordinary gravity escapement until the prolongation of B reaches the contact screw P in the tail of the armature D thus closing the electric circuit of the magnet M and its battery, which circuit includes a number of step-by-step electrically propelled dials. The magnet M then attracts the armature D towards it with acceleration, the armature coming up with a rush against the poles of the magnet or other fixed stop and the weighted lever being free to travel further is carried up by its momentum, breaks the circuit rapidly and falls again upon the support H.

Referring to Figs. 3 and 4 in which equivalent parts are denoted by the same letters, the moment of inertia of the weighted lever B is increased by adding to its mass and partly counterbalancing it by the arm Z.

The gravity arm B is provided with a wheel T instead of the spring S, and the pendulum A is provided with an arm U the upper surface of which forms part of the circumference of a circle whose center is coincident with the center of suspension of the pendulum. This arm may be readily made adjustable in a vertical direction by some such means as the screw V. When the gravity arm B is released the wheel T falls upon the surface of the spring X on the arm U, and as the pendulum swings to the right the main effective impulse is imparted to it when the wheel rolls down the curved or impulse surface of the spring X on the arm U.

The number of impulses imparted to the pendulum in a given time may of course be varied. In both the illustrations, the periodicity is every half minute. In Fig. 1 this is obtained by means of a ratchet wheel with fifteen teeth, only one of which causes the release of the gravity arm B, while in Fig. 3 in which the pendulum beats half-seconds, the wheel has thirty teeth. In each case the number of teeth may be doubled or quadrupled and two or four releasing teeth may be provided if half minute periodicity is required. Whereas if minute periodicity is required the number of teeth would be doubled without further alteration, and if quarter-minute periodicity is required, the wheels would remain as drawn, and the releasing tooth would be duplicated across the wheel.

It is obvious that the periodical releasing of the gravity arm B may be equivalently accomplished by a pin or pins set in the periphery of wheel E, so disposed that they will engage the block N of the vertical support H. In this case the teeth of the wheel E may all be of equal depth (but in such case the setting forward of the circuit of dials cannot be accomplished automatically in the method subsequently described).

Apart from the well known advantages in accuracy of time-keeping resulting from the use of a free or almost entirely free pendulum receiving its impulse from a gravity arm, which advantages are here secured in their entirety, there are many unique and previously unattained advantages resulting from the novel combination of a periodically released gravity arm with the switching and self-winding actions described in my previous patents above referred to. I find these advantages result in the perfect synchronous propulsion of simple single acting step-by-step indicator dials such as those described in the latter patent, and I enumerate them as follows:—

The weighted lever is let down by the pendulum with a clear and steady movement straight into contact with the contact screw P in the tail of the armature D at a fairly rapid rate but not too rapid so as to cause it to bounce, chatter or vibrate, whereas in the first patent referred to, it approached slowly and in very small steps, with the obvious disadvantage that during the second or part of a second immediately preceding contact, the air gap between the two moving members of the switch might be immeasurably small.

The stroke of the weighted lever is considerably increased, with the result that the stroke of the armature and the distance of the travel in company of these two moving parts may also be increased. This gives more control of the duration of the contact and tends to increase it, which is found to be desirable. In the patent above referred to the duration of the contact was mainly dependent upon the time constant of the circuit and the moment of inertia of the two moving members of the switch. The considerable increase or variation of the travel in company provides a third means of controlling the duration of the contact.

The wearing away or burning of the surfaces of the contact which in course of time is found to be troublesome in switches the

movement of whose parts has a small amplitude, and to require re-adjustment, will cause little trouble where the amplitude is greatly increased, and such attention will seldom if ever be required.

Any gradual failure of the source of electricity such for instance as the rise of internal resistance or drop of voltage of a primary battery will not at once stop the clock nor will it under any circumstances upset the circuit of propelled dials by throwing them out of step. On reference to the drawings it will be observed that when the prolongation of the gravity arm B falls upon the armature at P if the electrical energy developed is insufficient to replace it at once, the pendulum A in its return swing will assist the electro-magnet to raise the gravity arm B in cooperation with the magnet, until the armature having approached the poles of the magnet sufficiently closely, the energy of the magnet is sufficient to complete the operation of re-setting the weight and restoring the parts to their initial position. It is found in practice that the increased duration of contact resulting from this practically compensates for the reduced amperage rate in the circuit of dials, and that the latter will continue to work perfectly. At the same time every instrument in the circuit performs the function of a battery indicator and gives warning of impending failure by the long duration of contact.

If desired the circuit may include a single stroke bell so adjusted that it will operate only on these impulses of longer duration. This device is illustrated in Fig. 6. An electric bell *c* of ordinary type has its hammer *d* weighted with the heavy block *g;* the coil *i* on the magnet *j* has the impulses of the electric time circuit passing through it; as long as the battery is of normal strength, the duration of the impulse is insufficient to overcome the inertia of the armature *k;* when, however, the failing battery strength causes a longer contact period, the armature is attracted by the magnet and the bell rings.

Another important advantage which this invention is designed to secure is that in the event of the above automatic warnings having been disregarded, with the result that the clock eventually stops, the stoppages does not leave the switch closed as was the case in the patent above referred to, but the battery is saved.

Another advantage of this invention is the convenience with which the circuit of electrically propelled dials may be accelerated or retarded without interference with the pendulum itself. The wheel E being perfectly free may be rotated by hand in a forward direction at any moment thereby advancing the shallow tooth nearer towards the supporting click H; each tooth advancement being equivalent to two seconds in a seconds pendulum and one second in a half seconds pendulum.

If it is desired to accelerate the circuit of electrically propelled dials to the extent of some minutes or hours instead of only a few seconds the lever *f* is turned so as to raise the pawl F to the level it occupies when riding in the tooth O, as shown in Fig. 1. In Fig. 3 the block N is moved down to meet the pawl F. The pawl F will then release the gravity arm B and the switch will propel the dials at each complete vibration of the pendulum instead of at each 15th vibration.

To set back the circuit of dials any desired amount the lever *f* (Figs. 1 and 2) is turned farther so as to raise the pawl F entirely out of engagement with the wheel E or block N, thus stopping the clock for as long as may be required without touching the pendulum or interfering with it in any way.

In the modification shown in Figs. 3 and 4 the block N is lowered so that the pawl F will ride above it.

What I claim is:—

1. In an electric clock mechanism, a gravity propelling lever, a spring catch adapted to support the said lever, a freely supported pendulum, a pawl on said pendulum, a releasing wheel operated by said pawl, said wheel adapted to direct the said pawl periodically against the spring catch in order to release the lever, means for transmitting impulses to the pendulum by the fall of the said lever, a battery, an electromagnet, an armature on said magnet, said armature adapted to make contact with the gravity propelling lever and restore it to its initial position, an electric circuit through the clock mechanism, the magnet, the battery, and a series of dials, and means for automatically indicating the approaching exhaustion of the battery, substantially as set forth.

2. In an electric clock mechanism, a counterweighted propelling lever, a spring catch adapted normally to support said lever, a freely supported pendulum, a bifurcated pawl on said pendulum having one branch adapted to engage the releasing wheel and the other branch adapted to engage a stop on the spring catch and release the propelling lever, a releasing wheel operated by said pawl and adapted periodically to direct it against the stop of the spring catch, means for transmitting an impulse, on the fall of the said lever, through a spring to the pendulum, a battery, an electromagnet, an armature adapted to make electric contact with the said propelling lever and raise it to its initial position, a bell adjustable to sound at a prolongation of contact, and an electric circuit through the mechanism and a dial system, substantially as set forth.

3. In combination with an electric clock mechanism, the lever B, a spring catch supporting said lever, means for periodically

releasing and returning the lever, the wheel T on said lever, the pendulum A, the arm U on said pendulum, and the spring arm X adjustable on the pendulum, so arranged as to receive and transmit the pressure of the lever B on contact with the wheel.

4. In combination with an electric clock mechanism of the type set forth, the releasing wheel E, the pivoted member *f*, the spring catch N, the bifurcated pawl F having a blade at one angle adapted to engage with the releasing wheel E, and a blade at another angle adapted to engage with the spring catch N, substantially as set forth.

5. In combination with an electric clock mechanism of the type set forth, means for indicating approaching failure of battery strength, comprising the electric bell *c* the weighted bell hammer *d*, the electromagnet *j*, the armature *k* attached to the bell hammer and the coil *i* in circuit with the battery, the whole so arranged that the normal duration of contact in the clock mechanism when the battery is in normal operation will be insufficient to overcome the inertia of the bell mechanism; but on approaching exhaustion of the battery current and consequent prolongation of the period of contact, the magnet *j* will be energized sufficiently long to attract the armature *k* and ring the bell, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

FRANK HOPE-JONES.

Witnesses:

LEONARD E. HAYNES,

FRANK FAWCETT.