N° 2924 A.D. 1914

(*Under International Convention.*)

Date claimed for Patent under Patents and Designs Act, 1907, being date of first Foreign Application (in France), 5th Feb., 1913

Date of Application (in the United Kingdom), 4th Feb., 1914

At the expiration of twelve months from the date of the first Foreign Application, the provision of Section 91 (3) (a) of the Patents and Designs Act, 1907, as to inspection of Specification, became operative

Accepted, 27th Aug., 1914

COMPLETE SPECIFICATION.

Improved System of Synchronising Electric Clocks.

I, CHARLES EDOUARD O'KEENAN, of 112, Boulevard Raspail, Paris, France, Engineer, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement;—

The system of synchronising clocks described in my prior Application for Patent No. 23,570 of 1913 may present certain practical difficulties when armatures are used similar to those employed in the O.K. meters, ampere-hour meters which comprise three segments in the commutator, perhaps on account of the form of the current undulations which are not sinusoidal but trapezoidal. Whatever it be, with this arrangement a certain difficulty is often found when it is desired to effect the synchronising connection and in addition there are produced energetic currents which may be referred to as synchronising and desynchronising currents, which, circulating in the receiver or secondary clocks, produce variations of speed ensuring or destroying their operation in synchronism with the master clock, the effect of which is to require a relatively large supplementary expenditure of electric energy; further the currents may react in a certain degree upon the master clock and produce it in variations of speed either positive or negative which may on occasion be so great as to destroy the synchronism.

These difficulties are overcome by means of the system hereinafter described, in which an interrupted continuous current is employed for directly and continuously driving the secondary or receiver clocks.

The master clock and receiver or synchronised clocks may be provided with armatures each comprised of a single winding (in place of the three windings which it has been the custom to employ in the O.K. meters as at present constructed) so that each armature (Fig. 1) is only in some sort a Deprez d'Arsonval galvanometer coil of which the upper part of the winding would be expanded to permit of the support of the concentrator formed by a cylinder (or a sphere) of soft iron. This coil can be consolidated by a cylinder of cardboard b^1 (Fig. 2) as in the O.K. meters or may be constructed as in an ordinary galvanometer of the type indicated. The master clock comprises an armature *a* formed by a

[*Price* 8*d*.]

winding of the form of a galvanometer coil wound about a fixed magnetic core as in the O.K. meter and in the magnetic field formed by the poles *b*, *c* of a permanent magnet. On the armature shaft is fitted the commutator formed in this instance of two segments *d* only connected respectively to the extremities of the winding of the armature and on the commutator rub the brushes *p*, *q* arranged at 180° from each other, connected to a circuit fed by continuous current from a battery *e*. In the circuit of the battery is intercalated a resistance *f* which serves to moderate the motor couple of the arrangement; this resistance may in certain cases be nothing, for instance when the electromotive force of the battery does not differ too much from the counter electromotive force of the motor.

The spindle of the armature gears with the mechanism of the clock by means of a worm *r*, a worm wheel *s*, a spindle *t* and an elastic coupling formed by a coil or spiral spring *x* as described in the prior application referred to. The angular speed is between the limits in which the oscillations of the escapement remain isochronous and thus rigourously independent of the intensity of these oscillations.

This arrangement is therefore in everything similar to that described in the prior application except that in this case the armature has only one winding and the commutator two segments; it is necessary to obtain rotation to start the armature the first time, for example by hand, in the same manner that one pushes the pendulum of a clock to cause it to start, because the brushes only supply current to the segments of the armature twice for each rotation.

At the opposite end to the commutator *d* is provided on the spindle of the armature a contactor, comprising two plates or segments *g*, *h* electrically connected together and insulated from the armature spindle, and rotating with the latter. On this contactor rub the brushes *l*, *m* spaced at 180° apart from each other, connected to the line conductors *n*, *o* in which is intercalated a battery e^1; the arrangement of the segments *g*, *h* and the brushes *l*, *m* constitutes what the applicant calls the contactor. Each time that the segments *g*, *h* pass under the brushes *l*, *m* they close the circuit of the battery e^1 on the line feeding the receiver clocks in such a manner that for each revolution of the armature of the master clock there will be two emissions of current from the battery e^1 in the line; the current thus emitted will be neither multiphase nor single phase and as it always remains of the same sense, one can consider it as formed of periodic half-phases always of the same sense.

In a modified arrangement the brushes *l*, *m* may be mounted on the armature spindle to rotate therewith, and the contactor may be fixed, the connections otherwise being the same. Or again, the contactor instead of being mounted on the armature spindle may be mounted separately, but so arranged as to be operated or rotated from or by the rotation of the armature.

The receivers a^1 each comprise an armature which may be in all points similar to that of the master clock with a single wire winding of coil form (Figs. 2 and 3) supported by a cylinder of cardboard or other suitable substance, the extremities of the wire of this winding being connected to the two diametrically opposed segments d^1, d^1 of the commutator. These segments replace the rings shown in the arrangement described in the prior application.

The interrupted continuous current from the line arrives therefore at the double segment commutators of the receivers, and if these are started by hand, the rotation will be maintained synchronously with that of the master clock.

With this new arrangement the circuits of the master clock and the receivers being completely distinct and fed by different batteries *e* and e^1 perfect independence from the master clock is obtained. In addition the applicant has found in practice that with a battery of 1.4 volts, the interrupted continuous current receivers consume an average of from 45 to 90 micro-amperes, whilst with the original three-phase arrangement the expenditure by the receivers was an average of about 500 micro-amperes, nearly ten times as much.

Improved System of Synchronising Electric Clocks.

Theory and practice show that to obtain synchronisation, it is advantageous that the commutator of the receivers should be arranged slightly in advance with reference to the plane of the coil constituting the winding of the armature, for if one supposes a receiver armature a fraction of a revolution in retardation on the master clock in such a manner that the emission of current from the master clock reaches it whilst a portion of its winding is in the magnetic field of the air gap and the remainder of the winding is still outside, the counter electromotive force of reception being weaker, the battery will send a stronger synchronising current into the receiver and will produce a favourable accelerating effect, whilst if the armature is not in retardation of phase on the emission of current, the intensity will be normal; but if the commutator was not arranged in advance and the receiver armature was in advance and partly passed from the air gap, the battery would produce an accelerating desynchronising current in the receiver and this would without delay influence and cause the loss of synchronism.

On the contrary with a commutator arranged in advance in such a manner that the contact is broken a little before or at the moment that the armature of the receiver commences to pass from the air gap desynchronisation is avoided, and the system will operate with the greatest regularity and with a minimum expenditure of current, as has been stated above. The same result can be obtained without arranging the commutator in advance if the two segments of the same are sufficiently narrow, but generally in this case the flux of the magnet is not so fully utilised.

Instead of a special contactor on the master clock to close the emission current from the battery e^1, the commutator and the segments d which are used for feeding the motor may be utilised; for this it is only necessary that on the commutator of the master clock (Fig. 4) and at 90° with reference to the plane of commutation of the brushes which feed the armature with current from the battery e should be arranged two brushes l, m arranged in the same plane, that is to say tangential to the commutator and at the same side; each time that one segment of the collector passes under these two brushes it makes electrical communication between them and as a result closes the circuit of the battery e^1 on the line as in the arrangement shown in Fig. 1; the circuits of the batteries e, e^1 are nevertheless absolutely separated, for when the brushes p and q communicate respectively with the two segments d of the commutator, these are completely isolated from the brushes l and m and *vice versa*; independence is in this way complete.

Instead of armatures with two segments and one winding one may employ with the new arrangement herein described, armatures having three segments and three windings or n segments and n or n^1 windings, but it is necessary that the space between the segments should be of a width with reference to the segments sufficient to ensure that there would be no chance that the emissions of current would be received on any other segments and windings than those corresponding with the synchronism; in other words, as synchronism is generally produced with a slight oscillation of the receivers about their mean speed, if the space between the segments is sufficient the oscillation does not result in harmful contacts between the brushes and immediately adjacent sections; the contrary would be produced with commutators having very narrow spaces between the segments such as those which are generally used in the O.K. meters. In the case of three (or n) windings and segments of corresponding number the current is nevertheless always of the same sense but of greater frequency.

Instead of bell shaped armatures disc armatures without iron may also be employed such as those employed in the well known O.K. meters, or armatures of any other kind desired may be used taking care that losses by hysteresis and by Foucault currents are avoided.

Finally, the system can be fed by means of only one battery e^2 (Fig. 5) replacing the batteries e and e^1 by means of a single commutator for example

having two segments on which rub in addition to the two brushes p and q a third brush m^1; or again by means of a single battery e^3 (see Fig. 6) replacing the batteries e and e^1 and a single commutator for example having two segments on which rub in addition to the two brushes p and q two other brushes l and m arranged at for instance 90° from the brushes p and q in such a manner that the circuits e^3, p, q and e^3, l, m, o, n are traversed successively and not simultaneously by the current from the battery e^3 which renders the master clock and the receivers more independent of each other than in the case of Fig. 5.

Synchronisation between the master clock and the receivers may be easily secured as follows:—

If the commutator of the receiver is in retard of phase of that of the master clock synchronising current and acceleration of the receiver is produced in such a manner that its speed tends to catch up with that of the generator.

If the commutator of the receiver is in advance of phase of that of the master clock (which corresponds to a too great angular speed of the receiver) the current is automatically broken by the receiver, whilst the emission of current from the battery e^1 to the line is not yet terminated (and can continue to feed the other receivers); the current interrupted in the receiver in advance on this slows down its movement. It is clear therefore that each receiver is self regulating because it limits automatically the duration of reception of the current which traverses it, this duration being a fraction of the total time of an emission greater in proportion as the said receiver is less in advance with reference to the master clock, or which comes to the same thing, as the commutator of the said receiver is less in advance of phase of the commutator of the master clock.

If the battery e^1 has an electromotive force too powerful with reference to the counter electromotive forces of the receivers the effect of the emission or of the reception can be moderated either by intercalating a resistance R, see Fig. 1, or by regulating the spacing of the brushes l and m of the master clock in such a manner as to diminish the time of emission (Figs. 6 and 7) or by diminishing in each receiver the time of admission of the current, by adjusting one of the brushes, the other remaining fixed, or by adjusting both brushes (Figs. 8 and 9); or finally by employing some or all of these means in combination.

This arrangement permits of correcting the time of the receivers by correcting the time of the generator and three methods of doing this are by way of example described below:—

1. By varying the resistance f.

In this case for example if the master clock (and the receivers) are slow and if the resistance f is progressively diminished or if the intensity in the motor is increased, and in consequence its couple, and if the increase reaches a certain degree, the beat of the escapement will be accelerated, and the master clock (and the receivers) will be enabled to catch up with the time.

If the master clock (and the receivers) are fast, the resistance f will be increased progressively and the oscillations will be retarded and the clocks put right. The original resistance f will then be re-established, or slightly modified when the correct time is indicated.

2. By disengaging the escapement of the master clock for an instant whilst rotating for example by hand by means of a key as desired, the spindle carrying the second hand until this causes all the hands to indicate the correct time, and then putting the escapement in engagement again. In proceeding in this manner (if for example the master clock is slow before being corrected) the spring of the elastic coupling will be slackened to a certain extent, and consequently the antagonistic couple of this spring which the motor has to overcome to cause the clock to operate will be diminished and as a result the speed of the motor will be accelerated (and with it the speed of the receivers by reason of their

synchronism) and finally the spring of the coupling is returned to the same condition of operation as at the commencement, except that the master clock will give the right time, and its armature will rotate at the same speed as before it was put right; it will also be the same with the synchronising receivers of which the hands will be thus automatically put to right time.

If, on the contrary, the master clock and receiver clocks were fast in putting them right after disengaging the escapement, then in re-engaging it the spring of the elastic coupling will be tightened from which will result a slowing down of the motor armature of the master clock and as a consequence of the armatures of the receivers until this coupling spring having retaken its normal tension all the clocks will be automatically put to right time.

3. By stopping the escapement for an instant when the clocks are fast. For example by stopping the pendulum by hand the master clock armature will not be stopped and will continue to act on or twist the spring of the coupling, but at a speed reducing as the spring twists up to that point where it would stop the armature if care was not taken.

It will result from this slowing down that the armatures of the receivers will equally diminish in speed and in this manner master clock and receivers will slow down synchronously; when it is judged that the correction is sufficient. the escapement is re-engaged.

When the clocks are slow, one can, on the contrary, accelerate the escapement for example by oscillating the pendulum rapidly by hand which will produce the desired result on both the generator and the receivers.

It is of course understood that the receivers may be employed to operate chiming mechanism in addition to or in place of ordinary time indicating devices.

Having now particularly described and ascertained the nature of my said invention, and in what manner the same is to be performed, I declare that what I claim is:—

1. Improvements in means for electrically communicating or distributing the time of day comprising an electric motor driven master clock; means operated thereby for feeding an interrupted continuous current to one or more secondary clocks, said secondary clock or clocks being provided with interrupted continuous current motor or motors adapted to directly and continuously drive it or them in synchronism with said master clock, substantially as described.

2. Improvements in means for electrically communicating or distributing the time of day comprising a master clock put in operation by an electric motor the rotation of the armature of which is governed by the escapement (pendulum or circular) of the clockwork; the motor being fed from a battery or other source of current and forming part of a circuit with or without an additional resistance adapted to moderate and to maintain, between certain limits, the intensity in the motor and in consequence its motive couple, and one or more receiver clocks having no escapement and consisting simply of small synchronous interrupted continuous current motors arranged in series or in parallel on the line wires, these motors being fed by the interrupted continuous current emitted by a battery through the intermediary of a rotating contactor and of fixed brushes (or *vice versa*) this contactor rotating in synchronism with the master clock on the shaft on which it is mounted or from which it receives its movement.

3. In electrical time distributing means of the type described in Claim 1, a master clock comprising an electric motor having an armature formed around a fixed magnetic core and rotating in a magnetic field produced by a permanent magnet and provided at one end with a segment commutator receiving the continuous current furnished by a battery or other source of continuous current, and at the other end with a contactor of two or more segments designed to connect together periodically brushes which engage thereon and by this means periodically to send current emissions produced by a battery into the line feeding the receiver clocks.

4. In electrical time distributing means of the type described in Claim 1, a receiver clock having an armature formed about a fixed magnetic core in the field of a permanent magnet and comprising a contactor commutator of two or more segments according to the nature of the current to be emitted on which rest brushes connected to the line the spindle of each armature driving through suitable gearing the time indicating clockwork and where necessary the chiming mechanism.

5. In electrical time distributing means of the type described in Claim 1, mechanism assuring the regularity of movement of the master clock comprising an elastic connection arranged between the shaft of the armature and a circular or pendulum escapement, said elastic connection comprising for instance a spring of any suitable kind such as a coil or helical spring.

6. In electrical time distributing means of the type described in Claim 1, the arrangement in the circuit of the battery or of the source of continuous current feeding the master clock of an additional resistance.

7. In electrical time distributing means of the type described in Claim 1, the employment in the master clock of a single commutator adapted alternately or simultaneously to secure the feeding of the master clock and the receivers.

8. Electrical time distributing means as claimed in Claim 1, so constructed and arranged that the correction or putting to right time of the master clock simultaneously corrects or puts right the secondary or receiver clocks.

9. Electrical time distributing means constructed and arranged substantially as described and shown with reference to the drawings.

Dated this 4th day of February, 1914.

ABEL & IMRAY,
Bank Chambers, Southampton Buildings, London, W.C.,
Agents for the Applicant.

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Fig. 1.

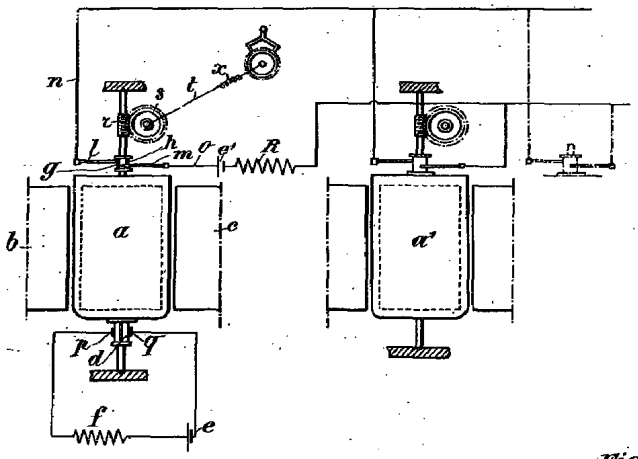


Fig. 4.

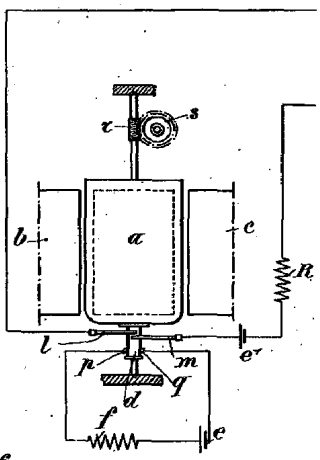


Fig. 5.

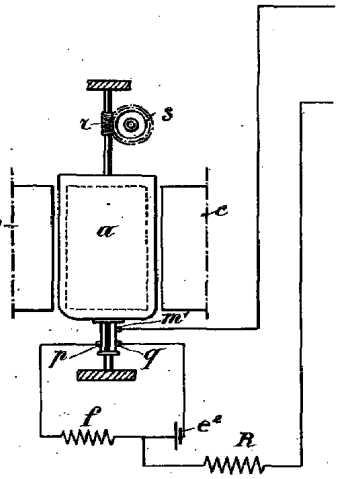


Fig. 2

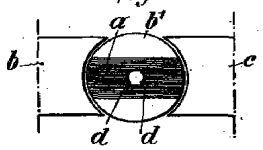


Fig. 3

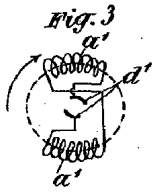


Fig. 6.

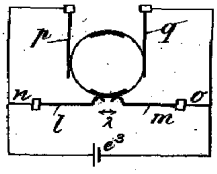


Fig. 7.

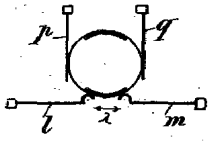


Fig. 8.

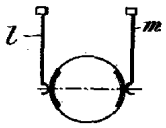


Fig. 9.

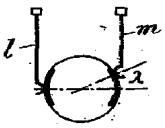


Fig. 1.

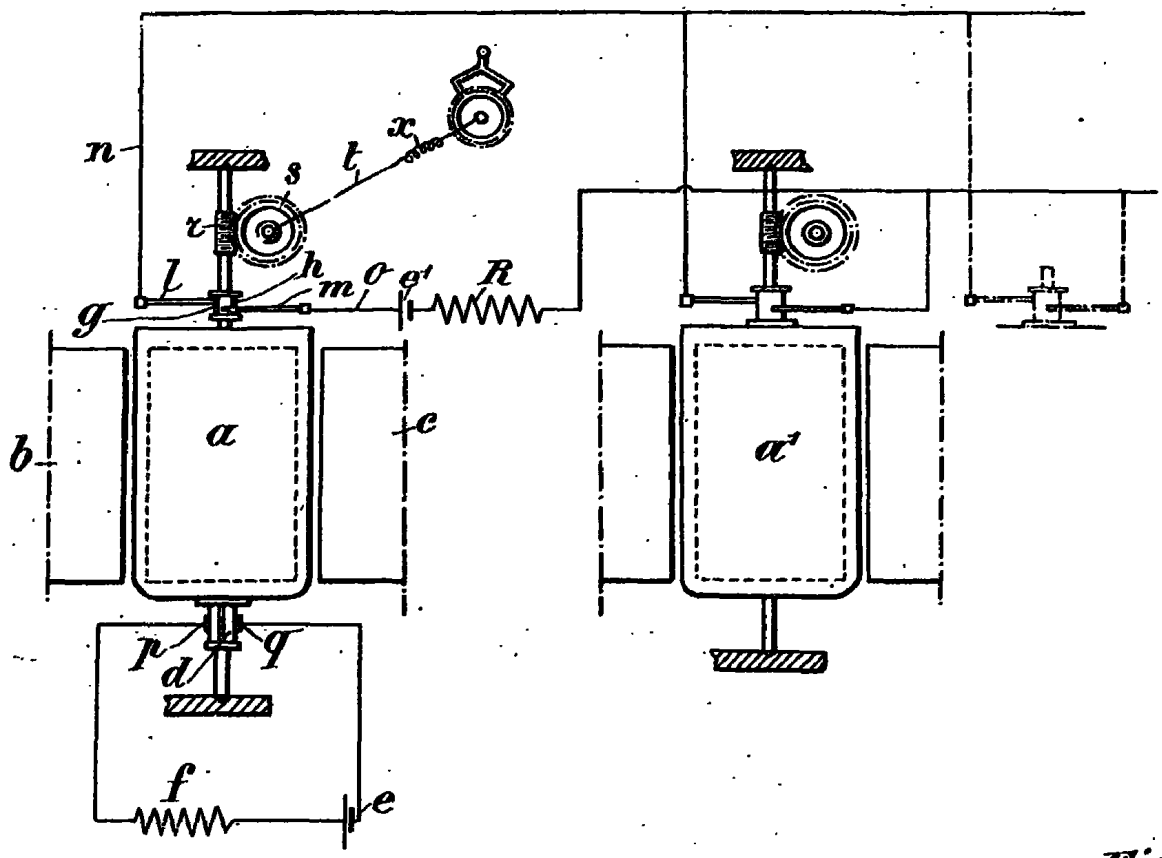


Fig. 2

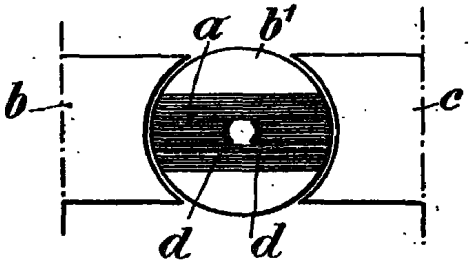
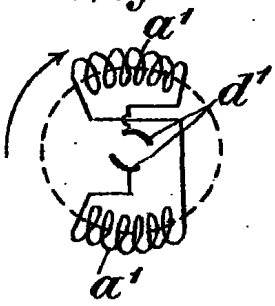


Fig. 3



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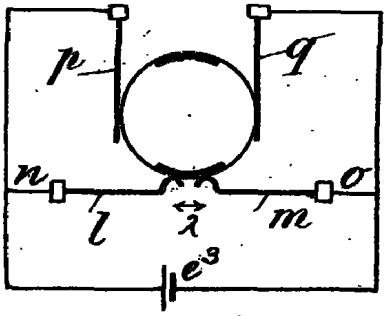


Fig. 4.

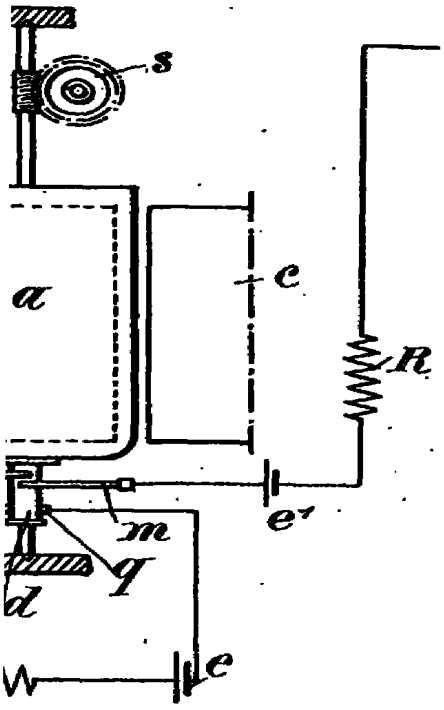


Fig. 5.

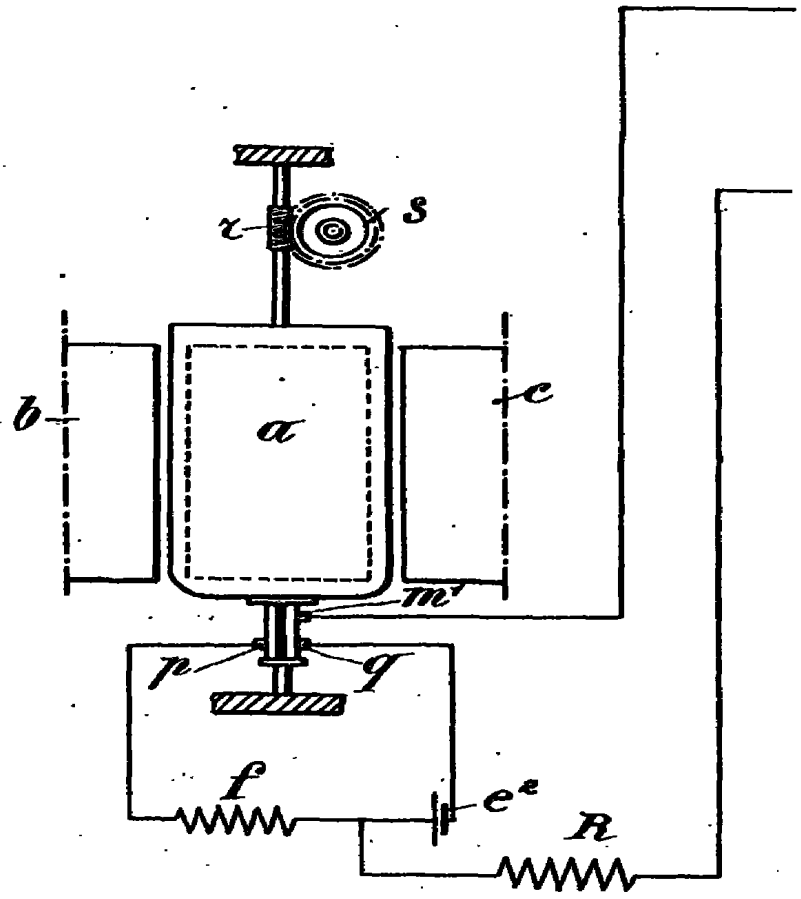


Fig. 7.

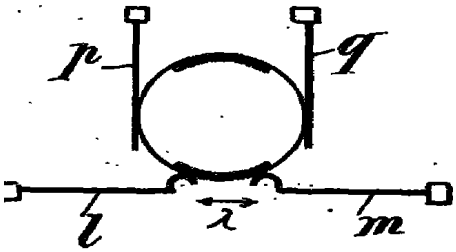


Fig. 8.

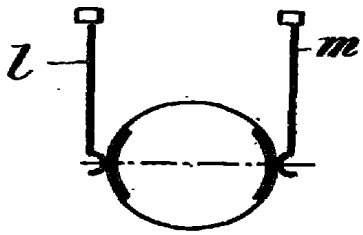
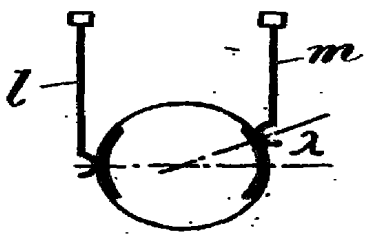


Fig. 9.



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