No. 638,150. Patented Nov. 28, 1899.

G. E. SAUTTER.

MEANS FOR CONTROLLING ELECTRICALLY MOVED APPARATUS.

(Application filed Feb. 20, 1896.)

(No Model.) 3 Sheets—Sheet 1.

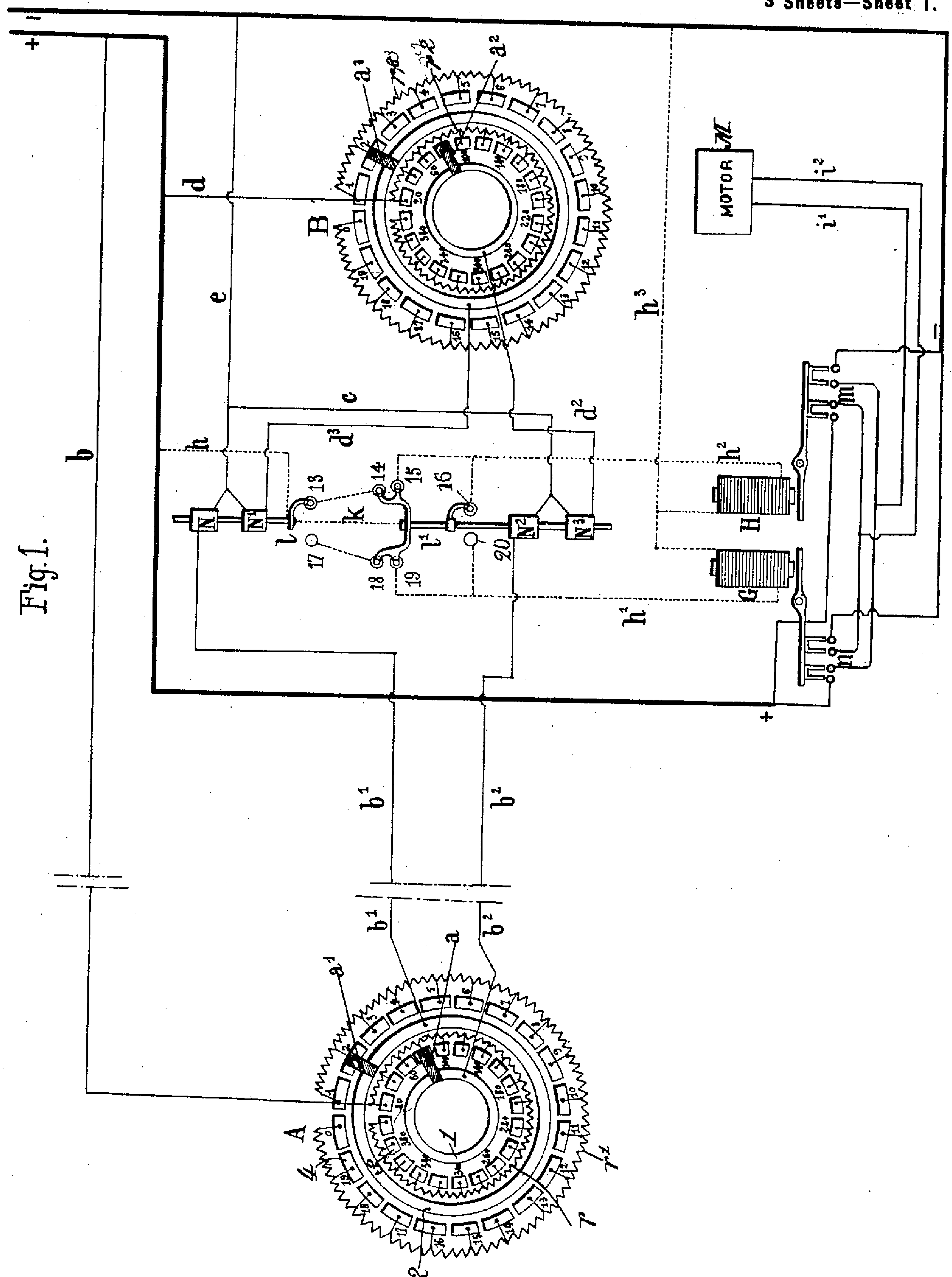

Fig. 1.

Witnesses.
H. E. Parker.
Robert Everett.

Inventor.
Gaston E. Sautter.
By James L. Norris.
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Fig. 2.

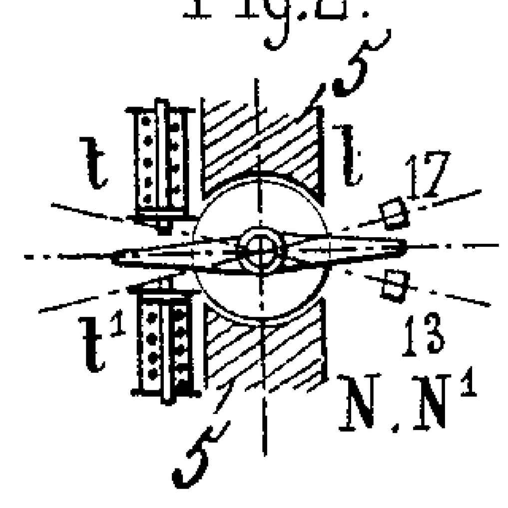


Fig. 3.

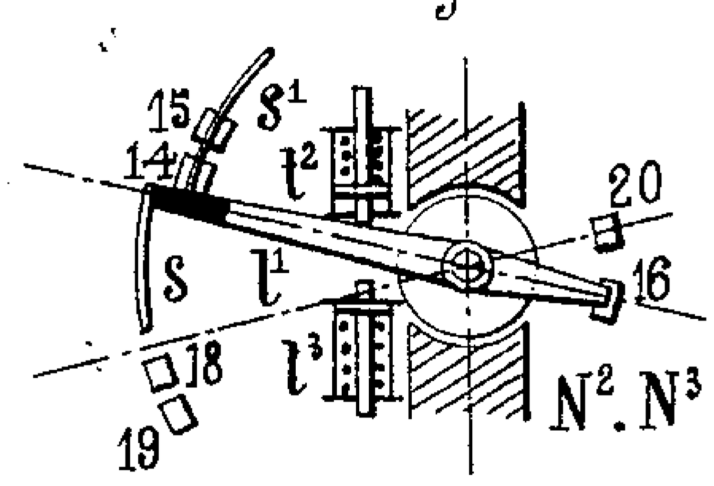


Fig. 4.

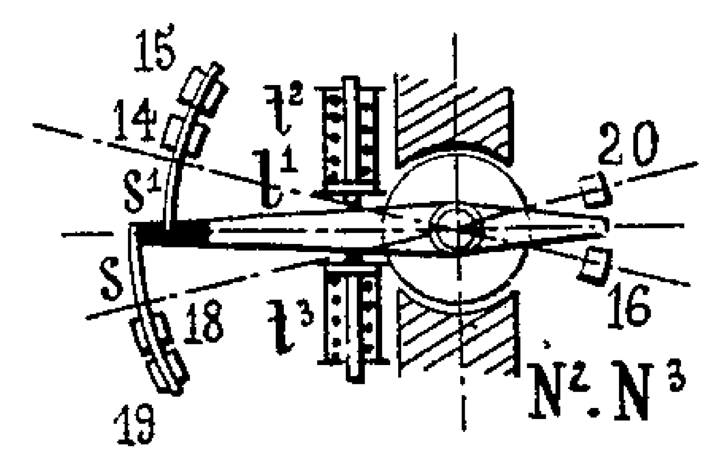


Fig. 5.

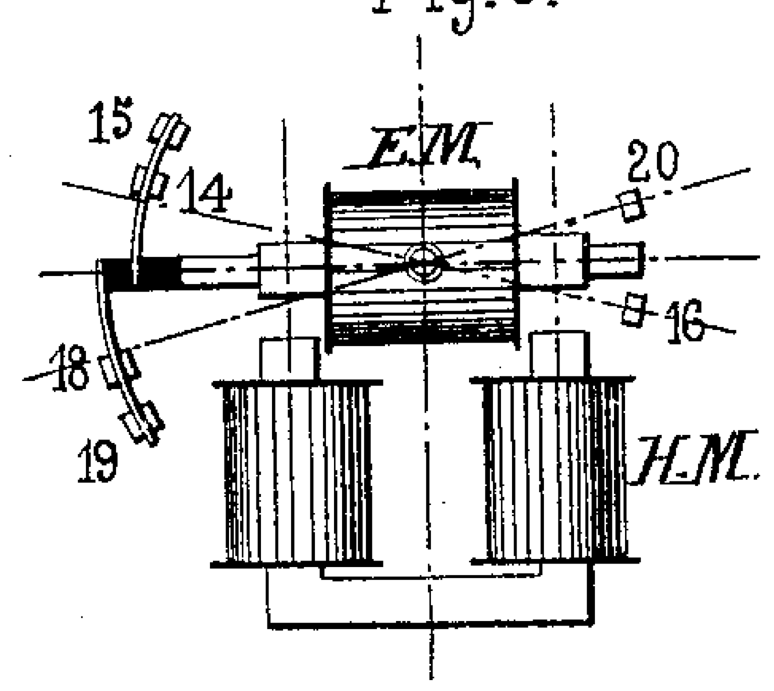


Fig. 6.

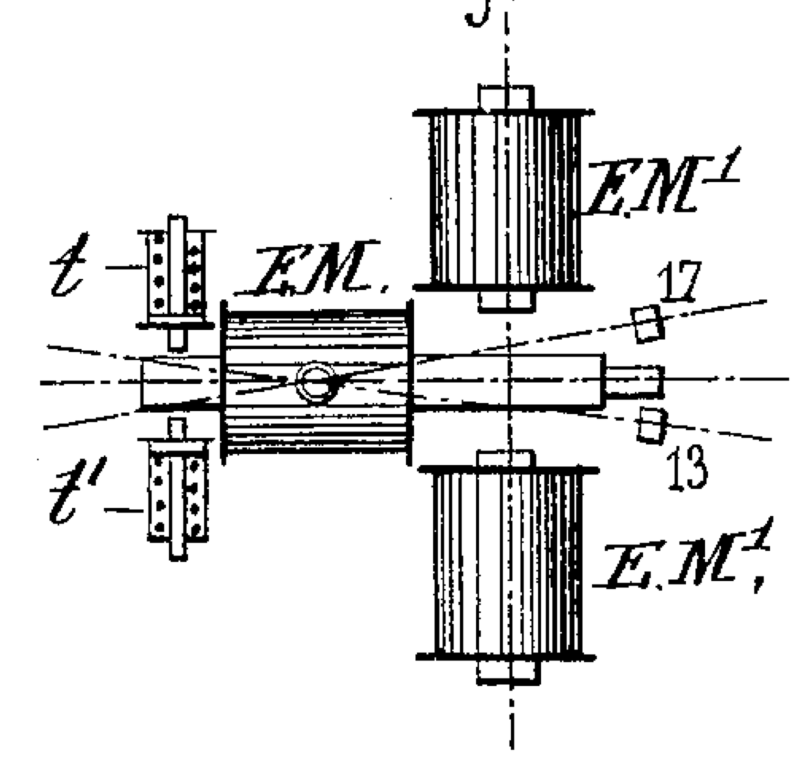


Fig. 7.

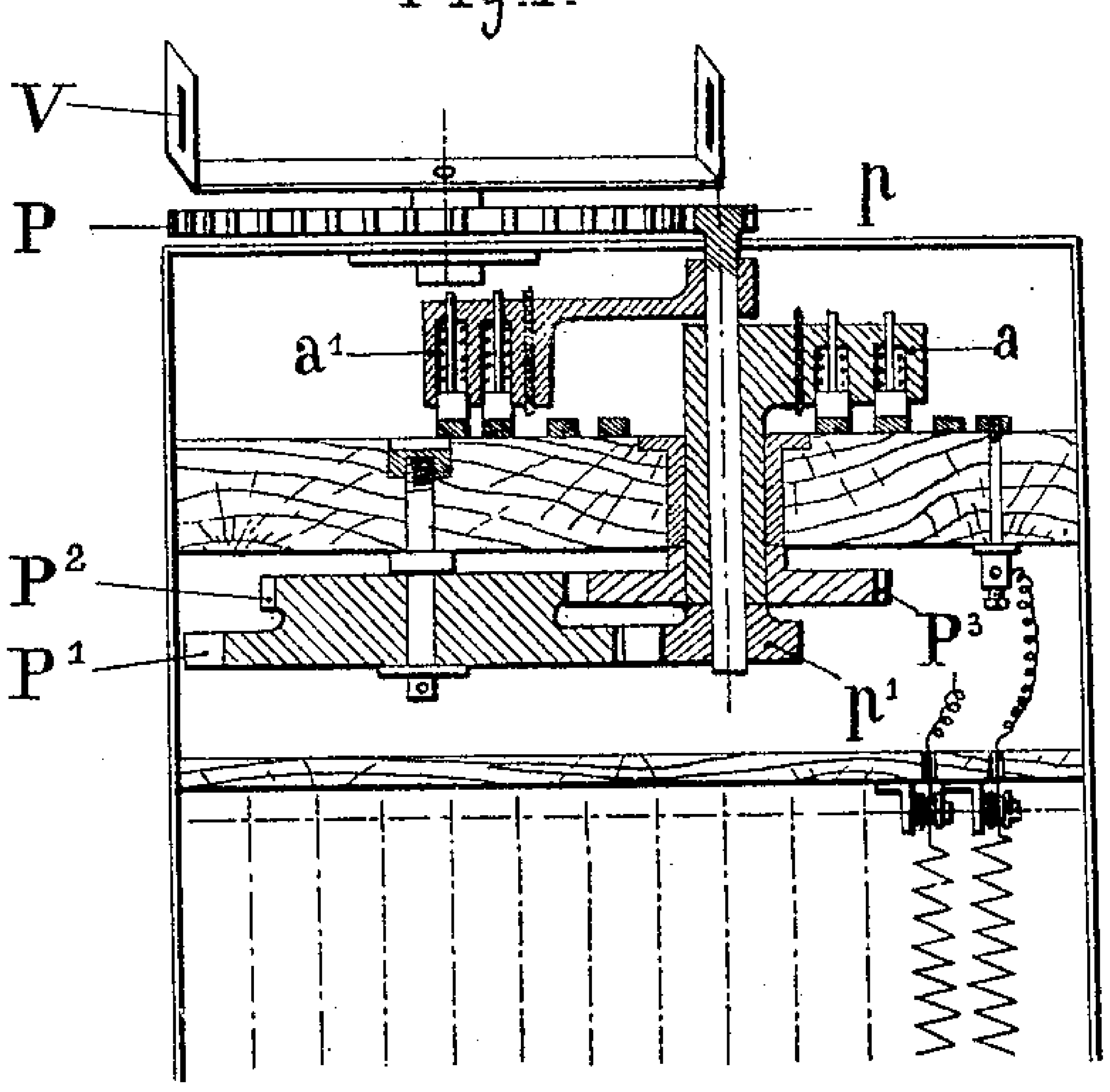
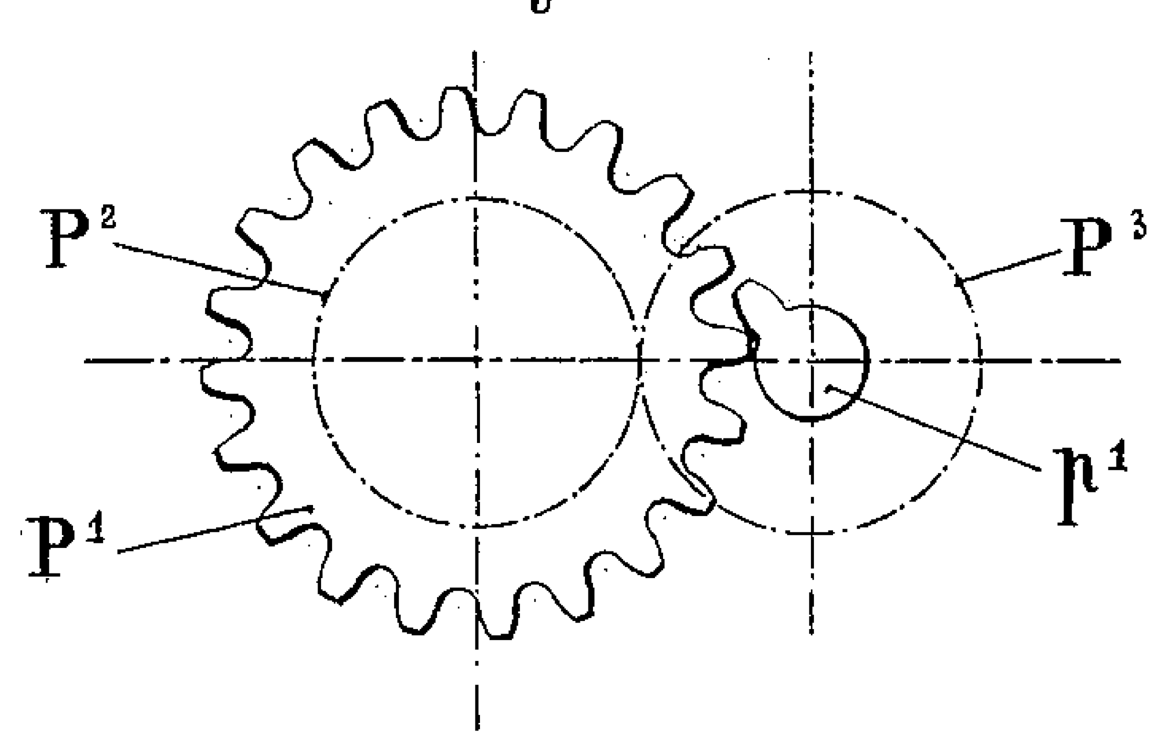


Fig. 8.



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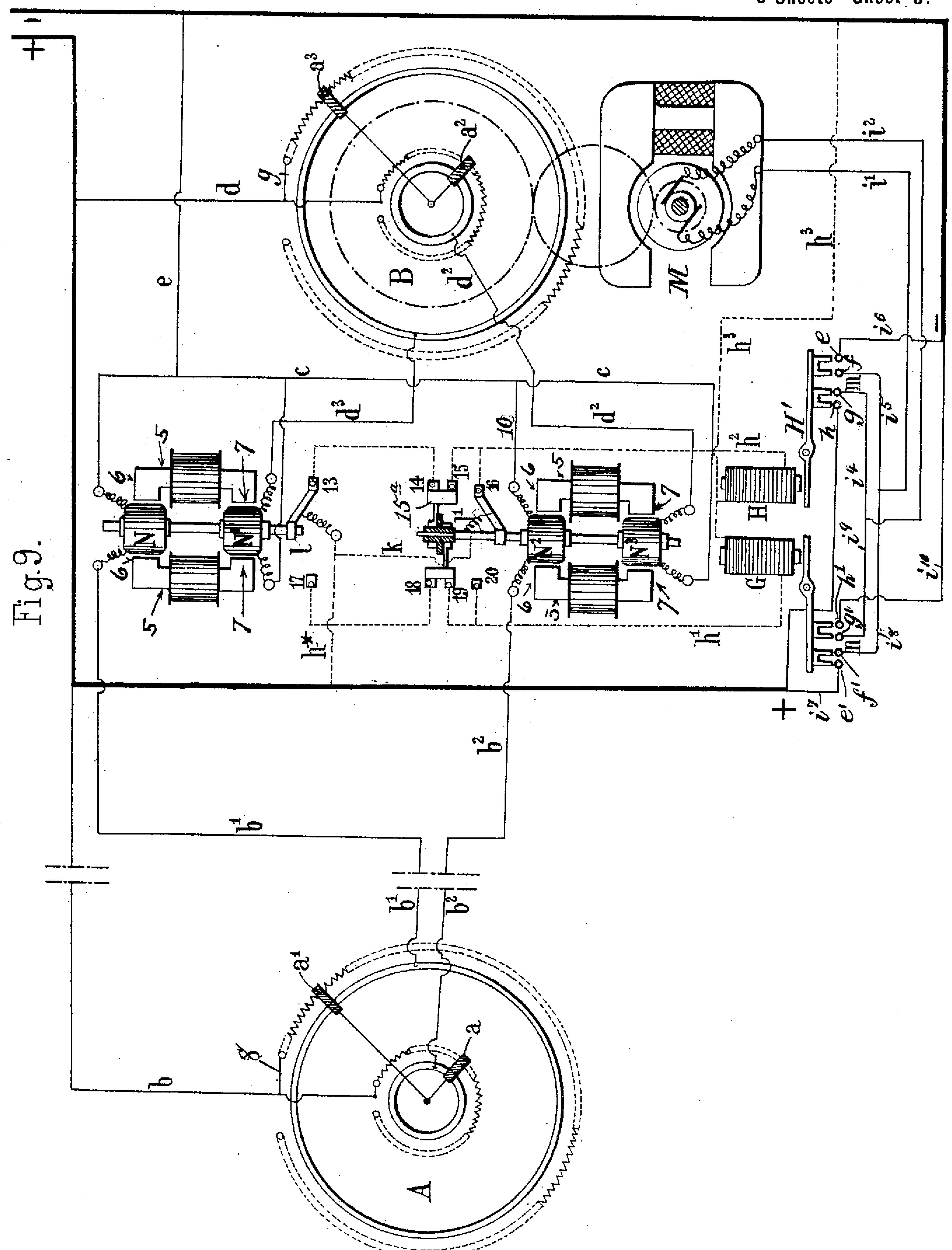

Fig. 9.

Witnesses,
[signature]
Robert Everett.

Inventor.
Gaston E. Sautter.
By James L. Norris.
Atty.

UNITED STATES PATENT OFFICE.

GASTON EMMANUEL SAUTTER, OF PARIS, FRANCE.

MEANS FOR CONTROLLING ELECTRICALLY-MOVED APPARATUS.

SPECIFICATION forming part of Letters Patent No. 638,150, dated November 28, 1899.

Application filed February 20, 1896. Serial No. 580,054. (No model.)

To all whom it may concern:

Be it known that I, GASTON EMMANUEL SAUTTER, a citizen of France, and a resident of Paris, in the Department of the Seine, France, have invented a new and useful Improvement in Means and Apparatus for Controlling at a Distance Electrically-Moved Apparatus, of which the following is a specification.

My invention relates to electrical-control apparatus—such, for example, as means for lifting and carrying from point to point ladles or crucibles filled with melted metal and for moving heavy guns, armored turrets, and other structures or bodies capable of being moved or propelled at any speed and in any given line by electrical energy.

It is the purpose of my invention to provide controlling apparatus electrically operated and capable of indicating with exactness the successive fractional increments which make up a single unit of movement, the equal divisions of fractional parts being carried to a high degree of attenuation.

It is a further purpose of my invention to provide means by which the movement of a mechanism, body, or structure may be intelligently controlled, both as to its range and direction, by apparatus arranged at a distance or even concealed from the body, structure, or mechanism controlled or at a point from which said body, structure, or mechanism is invisible.

It is also my object to accomplish other novel and useful results, all of which will be fully explained hereinafter and then particularly pointed out and defined in the claim which concludes this specification.

For the purpose of the following description reference will be had to the accompanying drawings, in which—

Figure 1 is a diagram showing the arrangement of circuits, electrically-operated mechanism, control apparatus, and indicator-dials. Fig. 2 is a detail view of the balanced switch-arm, showing the means for maintaining its equilibrium. Figs. 3 and 4 are detail views showing the controlling switch-arm in two different positions, the contacts with which it engages in each of said positions being also shown. Figs. 5 and 6 are detail views showing horseshoe-electromagnets with pivoted electromagnets capable of being substituted for the devices seen in Figs. 3 and 4. Fig. 7 is a sectional view illustrating the construction of one of the manipulators. Fig. 8 is a detail view showing part of the gearing of the manipulator in Fig. 7. Fig. 9 is a diagram showing a complete apparatus with modifications of certain parts.

The reference-letters A and B in said drawings indicate, respectively, the control or directing dials and the indicator or differentiating dial, which for brevity I will term the "manipulator" and the "receiver." Each dial, the two being substantial duplicates, has two concentric rings 1 and 2, which are graduated to the same number of equal divisions. Upon the inner ring 1 of the dial A moves a short centrally-pivoted index a, and on the outer ring 2 moves a long index a'. The two are connected electrically to concentric series of contacts 3 and 4, the short index a to the ring 3 and the long one a' to the ring 4. Their ends move in electrical contact with the graduated rings, rheostats r being inserted between the contacts 3 of the inner ring and similar rheostats r' between the contacts 4 of the outer ring. The receiver-dial is identical, and the parts are indicated by the same letters, except the short and long index-hands, which are lettered a^2 and a^3 and the rheostats r^2 and r^3. The manipulator is connected to the receiver by a circuit of two wires only, in which are included the rheostats r r' of said manipulator, as well as r^2 r^3 of the receiver, and the "driving" apparatus, so called.

The reference-letters N N′ indicate two dynamo-armatures which are identical and placed between pole-pieces 5, of soft iron, provided with exciting-coils. When equilibrium has been established and the armature-shaft is in a state of repose, currents of equal strength pass through the two coils of the armatures. Their rotating elements being of the same strength, but turning in a contrary direction, mutually bring about a state of equilibrium. If the needle of the manipulator A be advanced in one direction or the other, the variation introduced by the rheostat changes the value or strength of the current of one of the armatures, the state of equilibrium is broken, the armature-shaft turns on its axis and causes the current from the source of electricity to pass into a relay, which opens or closes the main circuit of the independently-driven electric motor M and drives the latter in a predetermined direction. This is now set in motion, engaging the engine which is to be operated, at the same time causing the needles a^2 and a^3 of the dial B, to which it is connected mechanically, to move forward. The movement continues so long as the equilibrium is broken, and it is only when the needles on the dial B reach a position exactly corresponding to those on the dial A that the currents passing through the armatures N and N' again become equal and the whole system returns to a state of equilibrium. The operation of the needles on the dial B of the receiver-rheostat may be effected either by the electric motor directly by means of any mechanical transmission-gear, or by the engine itself, whose movement may also be transmitted by any suitable transmission-gear. The receiver B is connected to register accurately the movements of the engine which is being operated. If the engine turns to the left, the needle of the receiver, rheostat is also displaced to the left, and if to the right the needle likewise turns to the right.

Referring to Fig. 9, the numeral 6 represents two like poles of the magnets or pole-pieces 5—for example, two north poles—and the numeral 7 two south poles. The current passing through the armatures N N', mounted in series, is of a certain constant strength, and the rheostats of the manipulator A and of the receiver B are inserted the one in the circuit of the armature N and the other in the circuit of the armature N'. When the resistance of the first is changed by working the manipulator A, the corresponding field is changed, and the system of the two armatures being subjected to unsymmetrical actions is put in motion, only returning to its place when the motor moves the index-hands a^2 a^3 of the receivers B to a position corresponding with that of the manipulator A. The result obtained is thus identical with that obtained by the first-described arrangement. This system realizes the conditions already stated, only two connecting-wires being employed between the manipulator and receiver, which is the minimum which can be reached.

For the sake of clearness we will suppose that the dials of the small needles a and a^2 each correspond to a rheostat divided into twenty equal parts and that this is also the case with the dials of the large needles. The small and large needles of each apparatus are so connected that when the large needle has made a complete revolution over its dial the small needle is moved through one division in the same direction. This movement does not take place continuously, as in a watch, the large needle only engaging with the small needle at the exact moment when it has made a complete revolution and is leaving the end of its rheostat—*i. e.*, the last contact in its series. Each of the needles, small or large, passes over the twenty sections or the twenty corresponding contacts connected to each other by the rheostat at each revolution. When, therefore, the large needle has made a complete revolution, it passes over the twenty divisions of its rheostat, displacing the small needle for one division of its rheostat. When the small needle has made a complete revolution over its dial, the large needle has made twenty complete revolutions over its dial and the values of the current have been modified four hundred times. This arrangement gives in a simple manner the result obtainable with a rheostat divided into four hundred equal parts. Thus the possible horizontal displacement of an engine can be divided up into four hundred equal parts, each displacement of the large needle through a division corresponding to the displacement of the engine through one four-hundredth part of a turn or of less than a degree in amount. The current from the positive pole of the source of electricity passes by the conductor b (see Figs. 1 and 9) into the manipulator, where it is divided into two parts. The one part of the current passes through the rheostat series r' of the large needle a', the needle itself, and the circle of contacts 4 and goes by the line b' to the armature N, corresponding to the large needle of the receiver, and leaves the same on its return to the negative pole of electricity by the conductor e. The current for the rheostat series r' is taken off the conductor b by a branch wire 8. (Shown in Fig. 9.) The other part of the current passes through the rheostats r, the small needle a, and its series of contacts 3 by the line b^2 to the armature N^2, corresponding to the small needle, returning to the negative pole of the source of electricity by the line c, which is tapped on the wire e. The second armature N' is fed by the current passing through the rheostats of the receiver B. This current passes from the source of electricity by the line d and a branch 9 to the rheostats r^3 of the large needle a^3 and passes through the said needle by the circle of contacts and the conductor d^3 to the armature N', returning to the negative pole by the line e. The return-wire from N' is tapped on the wire e, which serves a common return for both the armatures. The connections described are for the armatures N and N', the former deriving current through the series of resistances r', which are cut in and out by the movement of the long index a' of the manipulator A, while the latter armature N' derives its current from the wire d and branch wire 9 through the series of resistances r^3, cut in and out by the long index a^3 of the receiver B. The armature N^2 is supplied with current by a wire b^2, connected through the series of resistances r, which are cut in and out by the short index a of the manipulator A. The current returns to its source from the coils of the armature N^2 by a wire 10, which taps on the wire c, the latter wire being a common path for the return current to the point where wire c unites with the return-conductor e. The armature N^3 is supplied with current by a wire d^2 through the series of resistances r^2 of the receiver B, which are cut in or out by the short index a^2.

The system of relays for operating the motor M consists of a relay H when going to the right and of a relay G when going to the left. When the electromagnets of these relays have been excited, they attract their armatures 12 and 13 and close the contacts e, f, g, h, e', f', g', and h'. The exciting-currents for the electromagnets of these relays are taken derivatively from the terminals of the source of electricity and pass through contact-levers l l', keyed on the shaft of the armatures N N' and N^2 N^3.

Fig. 2 shows the manner in which the lever l is constructed and the two contacts 13 17, between which it is normally kept in equilibrium. When the armatures N and N' are no longer in equilibrium, the lever l closes with the contact 13, and the current then passes from the positive main over the wire $h^{\times}$ to the lever l and then from contact 13 to the contact 14, which is coupled to a second contact 15 by a bridge-contact S', which is carried by an insulated part of the lever l', on which is also a second bridge-contact s, extending in the opposite direction. When the lever l' is in the extreme position shown in Fig. 3, the circuit is closed between the contacts 14 and 15 and broken between 18 and 19, and vice versa in Figs. 3 and 4. If the lever l' is in equilibrium, the current passes from 14 to 15 by said contact, Fig. 4, and by the line h^2 to the electromagnet H, on leaving which it returns by the line h^3 to the negative pole of the source of electricity. If the lever l' is no longer in a state of equilibrium, but occupies the position shown in Fig. 3, the current still passes from the contact 14 to the contact 15 and thence to the electromagnet H. There is also a second derived current coming by the line k and passing through the lever l' and a contact 16. This is also the case when the lever l closes with the contact 17 and the lever l' closes with the contact 16. It is then the derived current through k, l', 16, and 15, which alone excites the electromagnet H for going to the right. The same positions are symmetrically reproduced for exciting the relay G when going to the left by means of the contact 17 of the lever l and the contacts 18, 19, and 20 of the lever l'.

When the system is in equilibrium, the index-hands of the manipulator and of the receiver are in identical positions and no current passes through the armature of the motor M. If the large hand a' of the manipulator be turned in the direction of the hands of a watch through a certain space, the equilibrium is broken, since currents of different strengths pass through the armatures N and N'. The lever l will close with the contact 13, and the current will pass by the contact 13 to the contacts 14 and 15, which will give a passage for it, the armature N^2 N^3 being in equilibrium. The electromagnet H for effecting movement to the right will then be excited and will attract its armature H'. The main current from the source of electricity will pass through the motor M, through the contacts h g, over wires i^4 i^3, then back along the lines i' i^5, and through contacts f e to wire i^6 and back to the negative main. The motor when in motion will turn the index a^3 of the receiver until equilibrium be reëstablished and the two needles a' and a^3 occupy identical positions. For working to the left the needle a must be moved in the opposite direction to that of the hands of a watch, and the current will pass by the contact 17, 18, and 19 to the electromagnet G. The closing of this relay will feed the armature of the motor by the circuit i^7, contacts e' f', and wires i^8 and i' to the motor, returning by the wires i^2 i^9, contacts g' h', and wires i^{10} to the negative main.

Hitherto we have supposed that the small needles retained their initial position and that the armatures N^2 and N^3 of the electromagnet D remained in equilibrium. This is the case until the large needle a' of the manipulator has made the complete round of the dial. When, however, the needle a, moving in the direction of the hands of a watch, has passed beyond the end of its series of resistances at the moment when it leaves the last of the connected contacts 4, the directions of the currents in the armatures N and N' would be found to be reversed, for at this moment the current which has hitherto constantly decreased by the continually-increasing resistances retakes its maximum value, while the rheostat is sharply cut out of circuit. The needle a^2, on the other hand, not having reached the limit of its rheostat is retarded, and consequently the current transmitted by the receiver-rheostat, which was just now greater than that coming from the manipulator, suddenly becomes less. The lever l breaks with the contact 13 and forms contact with 17, and if no change was to occur in the system the current would then pass from the lever l by the contact 17, 18, and 19 and the line 20 into the relay G, and the motor would turn to the left, which, however, it should not do. This change of direction of working does not take place, the complete revolution of the large needle a' causing the small needle a to advance through one division. The equilibrium in the system being thus broken, the armatures N^2 and N^3 bring the lever l' into the position shown in Fig. 3. The contacts 18 and 19 are opened, and the current from the line k passes through the lever l' by the contact 16 and the line 15 to the relay H, which continues to be excited. The motor then keeps on working to the right, turning the index a^3 and then a^2 of the receiver until they assume the positions of those of the manipulator, and the equilibrium is reëstablished. Since the arrangement for operating can move in both directions, it will be readily understood that if the motor does not stop quickly enough or engages the receiver beyond the corresponding point on the manipulator the currents could be reversed and the movement produced in the opposite direction until the position of equilibrium has been obtained. The proper service of the electrical system is thus entirely realized.

In the system just described and shown in Fig. 1 we have supposed the manipulator and receiver to have been formed with two series of rheostats, with two index-hands, each of which corresponds to one of the armatures placed in equilibrium.

Figs. 5 and 6 show two modifications. Instead of employing two dynamo-armatures with their coils wound thereon an electromagnet E M may be employed, pivoted on its center, and whose ends are attracted by those of a horseshoe-electromagnet H M. When the currents which pass through the coils of the horseshoe-magnet are unequal, the state of equilibrium is broken and contact is formed with either 16 or 20. In the arrangement shown in Fig. 6 the electromagnet is mounted on a pivot and is kept in position by antagonistic springs t t'. It is attracted by two separate electromagnets E M', which tend to keep it balanced in a position of equilibrium. Any other analogous arrangement may be employed by varying the form and arrangement of the electromagnetic system.

The construction of the manipulator is shown in Figs. 7 and 8. Upon the axis of a toothed wheel P is a sighting device V. The wheel P gears with a pinion p, the ratio being twenty to one. On the lower end of the axis of the pinion p is a wheel p', having a single tooth, which engages a wheel P', having twenty teeth, and which carries the wheel P^2, gearing with an equal wheel p^3, which operates the hand a, the hand a' being keyed upon the common axis of both the pinions p and p'. In this manner if the index or sighting device V rotates one four-hundredth ($\frac{1}{400}$) of a revolution the hand a' passes from one of the segments to the one following. If the index V rotates twenty four-hundredths ($\frac{20}{400}$) of a revolution, the hand a' makes a complete revolution and the hand a passes from one segment to the following.

What I claim is—

In an apparatus for controlling electrically-operated mechanism, the combination with an electromagnet and two armatures normally in equilibrium, of two sectional rheostats electrically connected with each other, one constituting a manipulator and the other a receiver and each connected in series with one of the said armatures, an electromotor, motor-reversing mechanism, means operated by the armatures for operating the motor-reversing mechanism, switch mechanism operated by the armatures for throwing in and out the motor-reversing mechanism, means for throwing any number of the manipulator-rheostats into circuit to destroy the equilibrium of the armatures, and mechanism actuated by the motor for throwing the rheostats in the receiver into correspondence with the rheostats in the manipulator and thus restoring the equilibrium of the armatures and throwing the motor out of operation, substantially as described.

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

GASTON EMMANUEL SAUTTER.

Witnesses:

CLYDE SHROPSHIRE,

W. JOUE.