No. 626,009. Patented May 30, 1899.

E. RAVEROT & P. BELLY.

TRANSMITTING MOVEMENT TO A DISTANCE BY ELECTROMAGNETIC MECHANISM.

(Application filed June 27, 1898.)

(No Model.)

4 Sheets—Sheet I.

FIG. 1

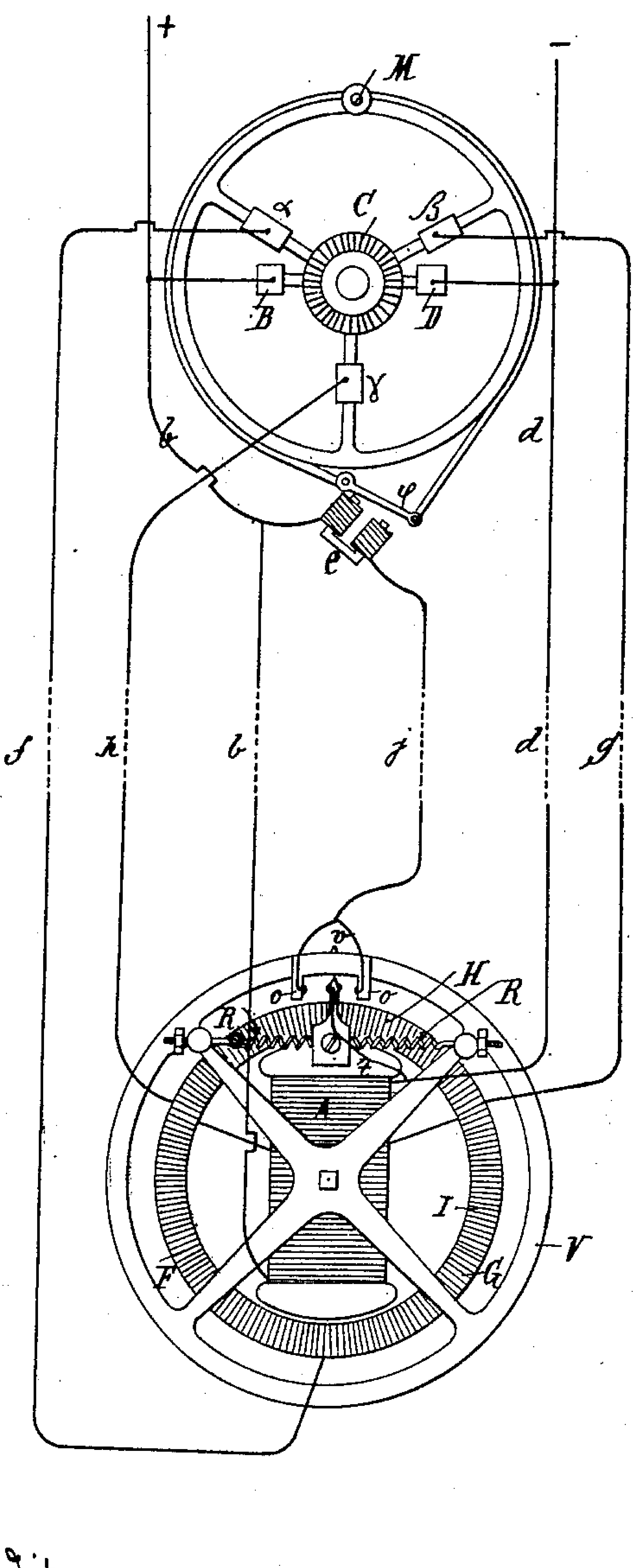

FIG. 2

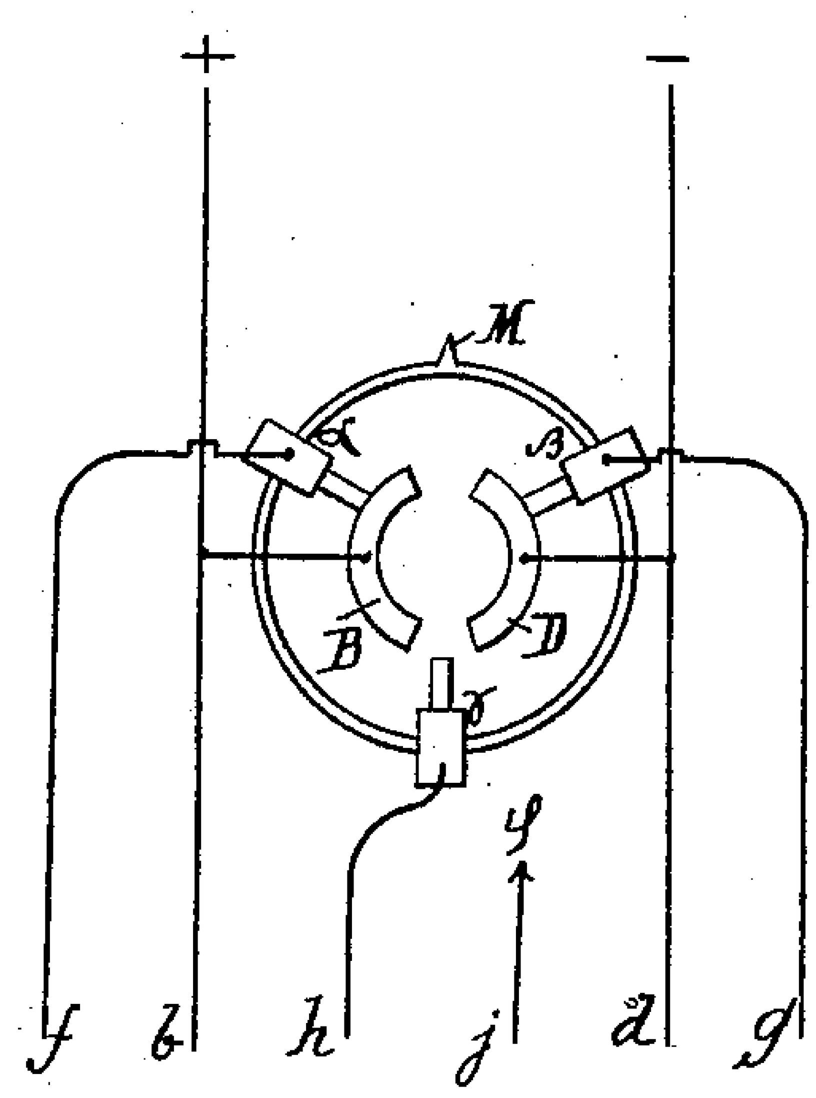

FIG. 3

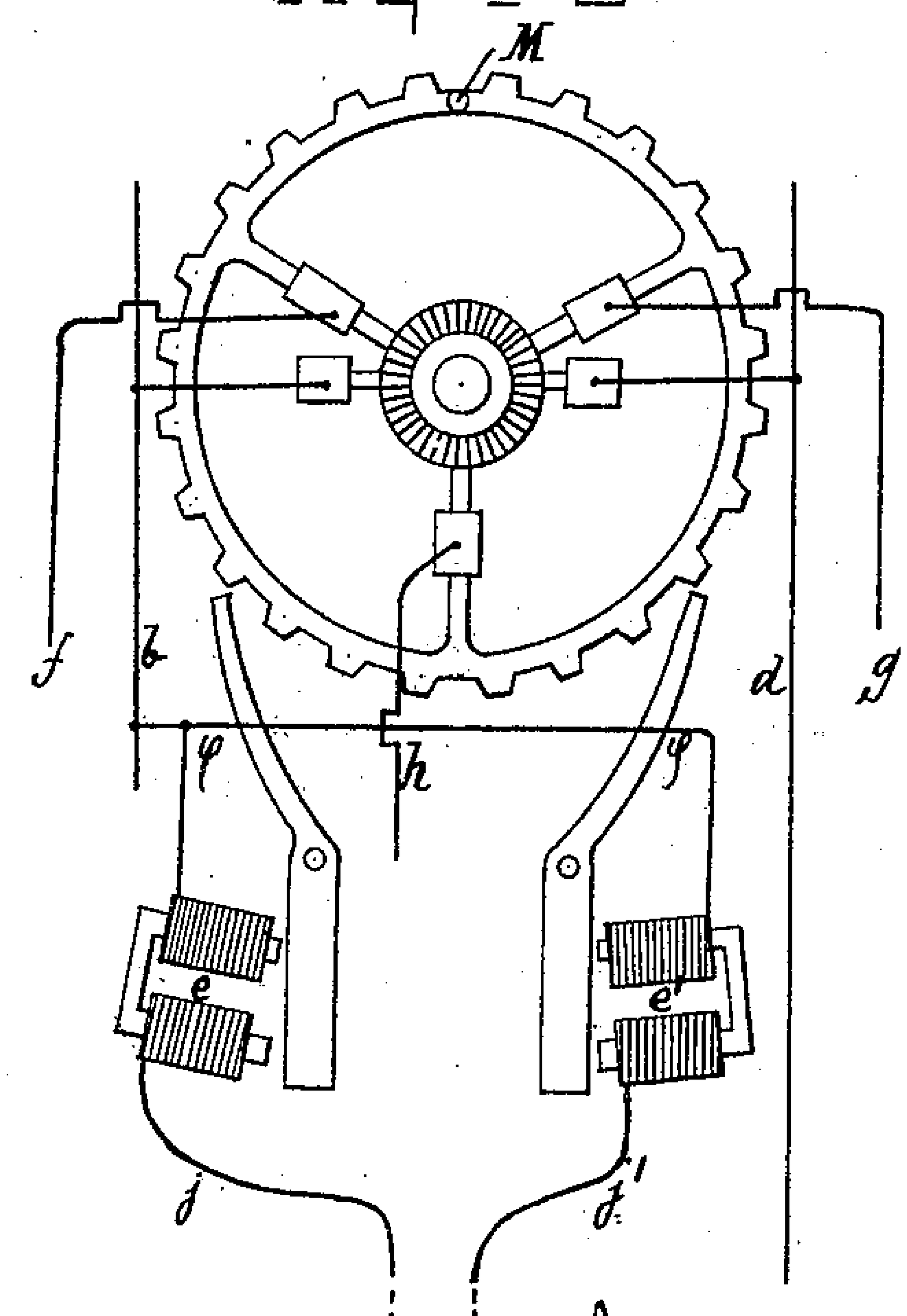

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FIG_4

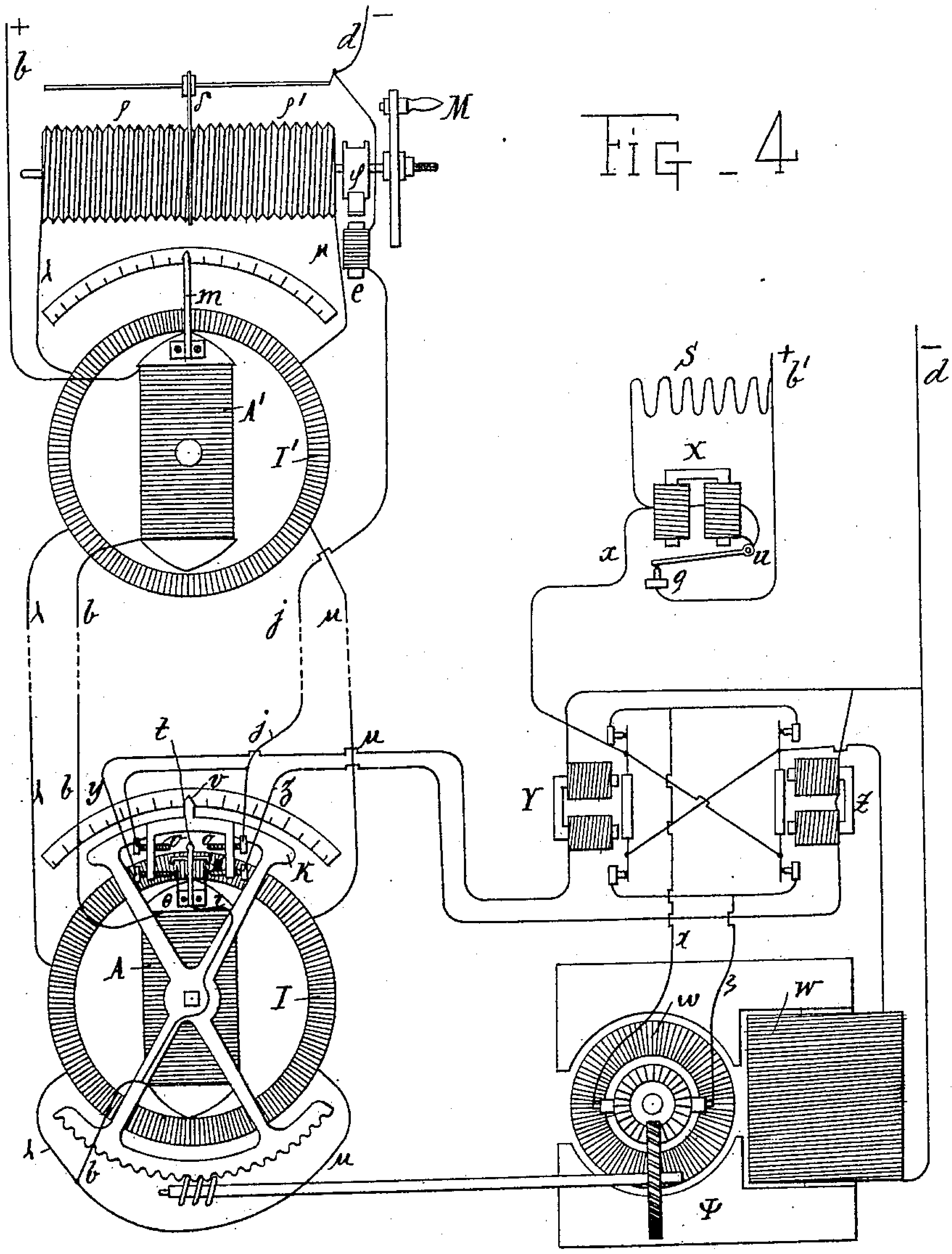

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FIG. 5.

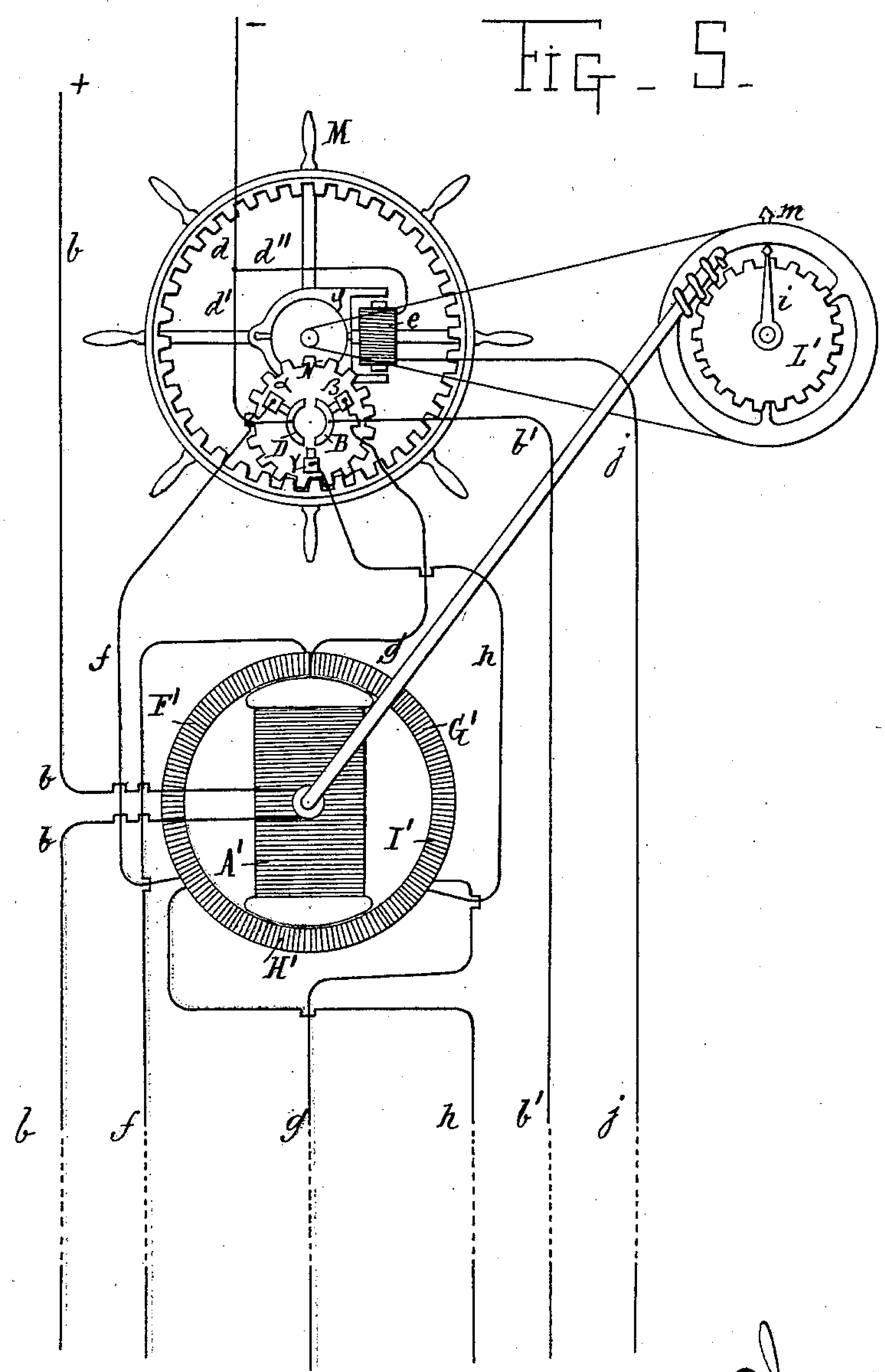

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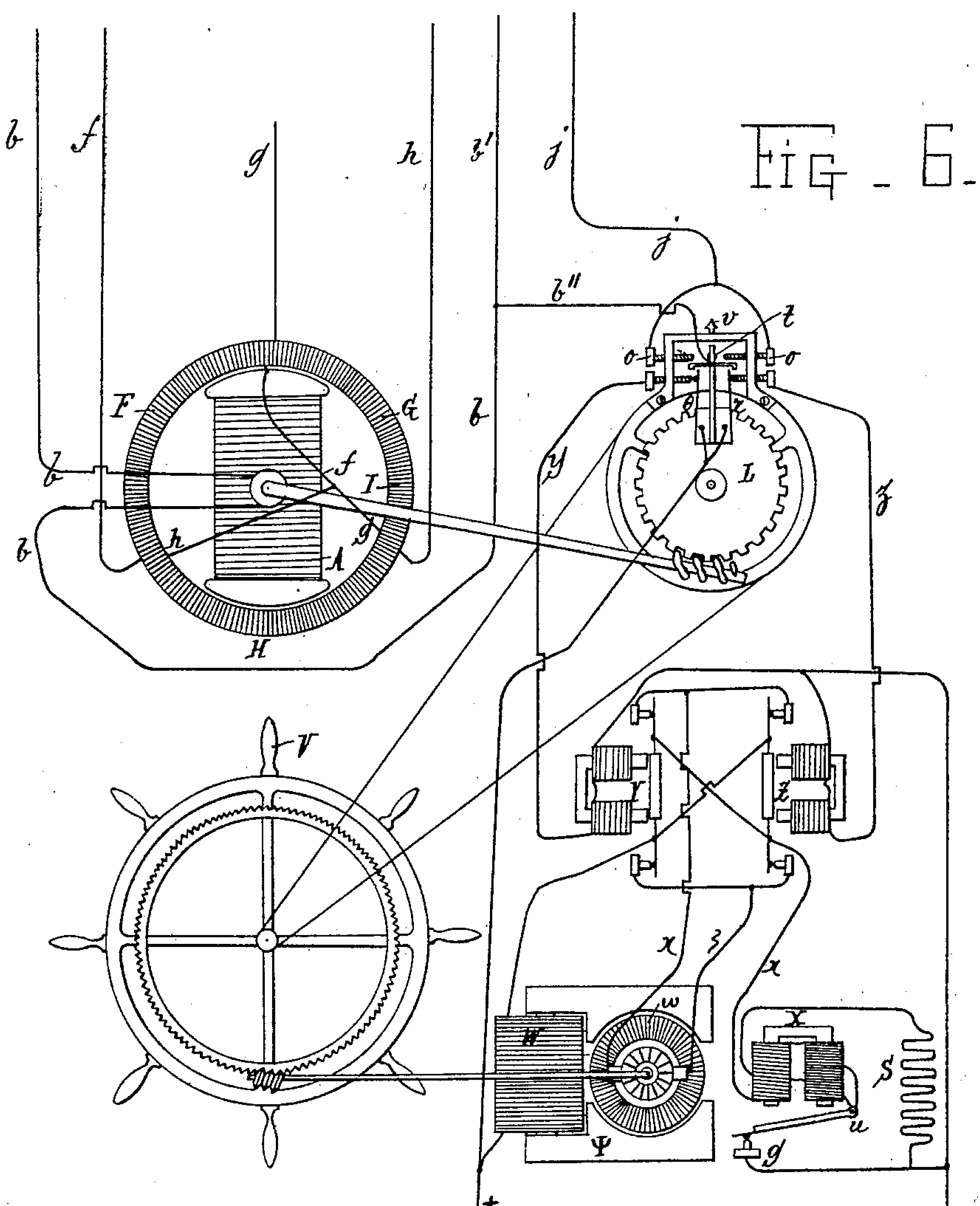
FIG. 6.



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UNITED STATES PATENT OFFICE.

EMILE RAVEROT AND PIERRE BELLY, OF PARIS, FRANCE.

TRANSMITTING MOVEMENT TO A DISTANCE BY ELECTROMAGNETIC MECHANISM.

SPECIFICATION forming part of Letters Patent No. 626,009, dated May 30, 1899.

Application filed June 27, 1898. Serial No. 684,644. (No model.)

To all whom it may concern:

Be it known that we, EMILE RAVEROT and PIERRE BELLY, citizens of the Republic of France, and residents of Paris, in the Republic of France, have invented certain new and useful Improvements in Transmitting Movement at a Distance by Electromagnetic Mechanism; and we do hereby declare that the following is a full, clear, and exact description of the invention, such as will enable those skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, forming a part of this specification.

The object of the invention above specified is to work, at a distance and at will, any device or apparatus employed for controlling mechanical motion, this being effected through the intermediary of electric conductors instead of using a mechanical connection or joint, the operation being such that the electromagnetic transmission exerts upon a flywheel, lever, sector, or analogous mechanism the effort which would be required if the controlling were to be effected directly.

The principle of this electric-telemotor system which we have invented essentially consists in the operation of an electromagnetic mechanism working with continuous currents of variable strengths and with a compound magnetic field turning as required.

The invention is illustrated in the accompanying drawings.

Figure 1 is a diagram showing one mode of carrying out our invention. Fig. 2 is a modified form of transmitting device. Fig. 3 is a modified form of brake. Fig. 4 shows a modification of the system for operating a lever at a distance. Fig. 5 illustrates the system applied to a steering-wheel, being the transmitting device for such an application of it. Fig. 6 shows the receiving device for this application of the system.

The arrangement of the whole device and the general method of construction of this essential mechanism (represented in Figs. 1, 4, 5, and 6 of the drawings) are those of an electric motor deprived of the commutator. Its induced ring or field is arranged externally and is fixed, while the inductor or armature A is movable. The armature A operates like every armature of a continuous-current machine and generates its ordinary magnetic field. The stationary ring I, while fulfilling with regard to the armature the function of the ordinary field of a continuous-current machine, possesses no collector and works in a special manner. Its windings are of a complex type and produce a magnetic field, the direction of which changes according to the variable strengths of the different continuous currents supplied thereto. The ring is, in fact, constructed in the manner of the rings used in alternating machines with rotary field, (multiple phases.) The winding of the rings represented in Figs. 1, 5, and 6 is supposed to be analogous to the star-winding type of a three-phase alternating machine. The rings represented in Fig. 4 have a kind of two-phase winding.

The electromagnetic movement of the mechanism will be readily understood upon observing that if the ring I of Fig. 1 were traversed by a three-phase alternating current while a continuous current were energizing the armature A, the same would revolve at the speed corresponding to the period of the current, the rotary field generated in the field-magnet reacting upon that of the armature. Hence in order to obtain no longer a periodical speed, but at will to obtain the movement of the armature, it is only necessary to feed the complex windings of the field-magnet I with continuous currents capable of taking up, according to requirement and successively, those strengths of current which correspond to the instantaneous values of the three-phase alternating current. The continuous currents in the relation indicated are directly obtained from any continuous-current dynamo-machine (generating machine or motor) by the aid of three additional brushes simultaneously movable and turning freely about the collector of the machine.

The diagram shown in Fig. 1 represents in a similar form the electromagnetic transmission of movement. C is the commutator of a continuous-current dynamo-machine in action. B and D are the two ordinary fixed brushes of the dynamo, (which latter, for the sake of simplicity, is not represented in the drawings.) $\alpha\ \beta\ \gamma$ are the additional brushes movable simultaneously with the crank M and connected by means of the conductors $f\ g\ h$ to the star-windings F G H of the field-magnet I of the receiving mechanism. *b* A *d* represent the exciter-circuit for the armature A. The same is connected in shunt upon the stationary brushes B and D. The dynamo C feeds, on the one hand, by means of B and D, the armature A and, on the other hand, by the aid of α β γ the windings F G H of the rotary field of the receiving mechanism I A. The current is divided according to the sinusoidal distribution of the potential around the commutator of every continuous-current machine and generated under conditions of an effectual electric yield. The receiving mechanism is constructed and fed so as to produce a torque of work analogous to that of a dynamo-electric machine. A wheel V is journaled loosely upon the shaft of the armature A, with which said wheel is connected mechanically by a pair of springs R R, attached to a contact *t* on the armature A. On the wheel V is mounted a double or counter abutment *o o*, the contact *t* lying between said abutments. The rim connecting the crank M and the movable auxiliary brushes α β γ is provided with an electromagnetic band or analogous brake.

The operation is as follows: The movement of the crank M in one direction or the other alters the position of the auxiliary brushes α β γ upon the commutator C in operation, and thereby causes the respective strength of the currents in f^F g^G h^H, and consequently also the direction of the rotary component of the receiving mechanism I A, to be varied. The armature A moves in proportion to the resultant variation of the compound magnetic field in the same direction as the crank M and in its movement carries along the loose wheel V through the intermediary of the spring-coupling R R. The tension of the springs R R is adjusted to correspond to a given fraction of the stress or effort of actuation which the electromagnetic transmission of movement is to produce under normal conditions, so that the transmission of movement repeats the movement of the crank M at a given angular distance—limited, for example, to sixty degrees. If, owing to any cause—too abrupt a movement of the crank M or an accidental resistance to the working of the loose wheel V—the stress or effort exceeds the given limit, the contact-finger *t* comes against an abutment *o* and closes the circuit of a brake φ that retards the controlling-wheel M by means of the conductor *j*, the electromagnet *e*, band-brake φ, grip, or other brake, until the loose wheel V has been able to follow the movement within the given limit of distance. This arrangement insures the reliability of movement of the loose wheel V and of the controlling-wheel M. It constitutes as a whole the proper regulating mechanism of the electromagnetic transmission of torque. This form of electromagnetic transmission of movement is susceptible of various modifications.

Fig. 2 is an exemplification thereof. The same is a transmission device indicating twelve positions per revolution—the movement which is obtained by substituting for the commutator C in action two stationary sectors B and D as the poles of any source of continuous current, (system of distribution, accumulator-batteries, or elements.) These sectors are concentric and of equal radius. In the case of the dynamo the current conducted to the windings F G H was varying in every position and took a number of different values as great as desired. According to the arrangement of Fig. 2 the relative values of the current distributed over the windings F G H, limited for each revolution to twelve values corresponding to the twelve different portions which follow the three movable brushes α β γ around the sectors B and D, are, on the contrary, as follows:

Positions.	Values.			Positions.	Values.		
	f.	*g.*	*h.*		*f.*	*g.*	*h.*
1	$+\frac{1}{2}$	-1	$+\frac{1}{2}$	7	$-\frac{1}{2}$	$+1$	$+\frac{1}{2}$
2	0	-1	$+1$	8	0	$+1$	-1
3	$-\frac{1}{2}$	$-\frac{1}{2}$	$+1$	9	$+\frac{1}{2}$	$+\frac{1}{2}$	-1
4	-1	0	$+1$	10	$+1$	0	-1
5	-1	$+\frac{1}{2}$	$+\frac{1}{2}$	11	$+1$	$-\frac{1}{2}$	$-\frac{1}{2}$
6	-1	$+1$	0	12	$+1$	-1	0

Position 12 is that of the figure. In this transmission device the total amount of the current conveyed to the sector B (or D) is transmitted to the rotary field. The transmission is effected either by causing α β γ to turn around B and D, which are stationary, as represented in Fig. 2, or, on the contrary, by leaving α β γ stationary and causing B and D to freely turn.

According to Fig. 2 the source of the positive and negative currents feeds in shunt the armature A and the sectors B and D. The feed may as well be effected in tension.

A larger fractioning per revolution than that of Fig. 2 would, if required, be obtained with any larger odd number of brushes and a corresponding multiple winding.

Regarding the proper regulating mechanism of the electromagnetic transmission of movement, it is shown in Fig. 3 that the movement to the right and the movement to the left admit of being separately braked by a distinct stopwork. Each of the two abutments O of the receiving mechanisms then communicates separately by a different conducting-wire *j* and *j'* with an electromagnet *e* and *e'*, which when energized throws a detent-lever into engagement with locking-teeth on the wheel M.

Fig. 4 shows a different example of the system of electromagnetic transmission utilized for the angular operation at a distance of a controlling lever or sector. The transmission mechanism proper operates by a variation of two shunt-currents, the effect of which is indicated by a similar mechanism I' A'. The rings of the fields I and I' carry each a kind of two-phase winding, the components of which acting alone would each direct the corresponding armatures A and A′ in a different azimuth. The movement of the armatures A and A′ in their respective magnetic fields is determined by the operation of the resistance ρ ρ' with crank M, controlling the proportion of shunt of the current, according to the variable position of the contact ς. Owing to the construction the displacement of the point ς from one extremity to the other of the resistance produces a variation between the current strength at ς and that at ς' which is greater than that required to turn the armature A within the angular limits of its displacement. As the armature A is displaced it carries along with it the sector K through the intermediary of locally-used parts, as will be hereinafter indicated. It is, however, preferable to first describe the method of regulating from a distance the electromagnetic transmission device itself. If the angular displacement of the armature A in one direction or the other is not followed by that of the sector K, the contact will strike against one of the abutments *o* and will, by the closing of the circuit *b t o j e d* and the action of the brake φ, hold the initial controlling mechanism M out of operation until the displacement of the sector K has caught up with that of the armature A within the limit of the distance provided according to the construction. The local actuation of the sector K by the armature A may be effected by any local auxiliary device. The one represented is an electric auxiliary or controlling device which offers certain particular features only. The springs τ and θ, carried by the armature A, close, respectively, by means of contacts in connection with the corresponding abutment-screws fixed to the sector K, the circuit of the relay Y and of the relay Z. These two relays close, each in a different direction, the local circuit, which by the intermediary of ξ and χ feed the armature of the electric motor Ψ. They act simultaneously as long as the positions of the sector K and of the armature A exactly coincide and the armature *w* of the motor is short-circuited. A device of automatic resistance X S in circuit renders this organization possible. As soon as the armature A of the transmission device commences to displace itself one of the contacts τ or θ is broken. One of the relays Y or Z becomes inactive, while the other remains closed. A current of a given direction passes through ξ and χ in the armature ω of the dynamo-motor Ψ and actuates the same. The movement of the latter, transmitted by gearings and endless screws, causes the sector K to move until it again coincides with the position of A and reëstablishes the normal simultaneous closing of the contacts in τ and θ.

The local feed-circuit of the motor includes in series its field W and the special mechanism of automatic resistance above referred to. This special mechanism consists of an electromagnet X with double winding and of a resistance S, which is either left in series or short-circuited by the operation of the armature pivoted at *u*. The current passing through *b′ q u x* determines the attraction of the armature for the allowed maximum strength I, (with a number of ampere revolutions *n* I,) *n* being the number of turns of the windings of *u* to *x′* when the armature is once attracted. The resistance S is in series, as are the two coils of the electromagnet comprising (*n* and *n′*) turns. The current passes through *b′ s u x*. The attraction is kept up with a number of ampere revolutions (*n* and *n′*) *i* until one has attained $(n \text{ and } n')\, i < n\,\mathrm{I}$. The interval of the values from *i* to I, as well as the resistance S, is to be calculated according to the circuit given. In order to regulate between large limits, a number of "automatic resistances," inserted in form of cascades into the circuit of one another, may become necessary; but the one represented evidently suffices for the purpose of specifying in general the peculiarity of the device.

The system claimed by the whole of this specification constitutes a method of transmission of an effort serving for distance operations of all kinds. Its general application is expressly specified with the variations of detail arrangements within reach of persons skilled in the art. Moreover, and by way of exemplifying a particular application, Figs. 5 and 6 represent in separate diagrams a simple system for the transmission of the controlling motion of a steering-wheel (or of an auxiliary motor) of a vessel. At M will be seen the controlling-wheel, carrying an internally-toothed rim working the gearing N. The latter in its movement actuates the brushes α β γ, which are simultaneously movable around the stationary sectors B and D. A′ I′ and A I are two electromagnetic transmission devices formed like those of Fig. 1. V is the steering-wheel (or the wheel of the auxiliary motor) to be actuated. Its movement is dependent on that of the motor Ψ. L and L′ are double-axis meters indicating the movements controlled, transmitted, and effected. In the conventional way the diagram supposes the index *m* to be dependent on the movement of M, the index *v* to be dependent on the movement of V and the index *i* (by means of an endless screw the shaft of which turns in unison with A′) dependent on the movement of A′. Y and Z are the relays; Ψ, the electric motor, and XS the automatic resistance, which fulfils the local function described with reference to Fig. 4. At the top and at the left-hand side of Fig. 5 the signs + and − indicate the origin of the current which feeds the electromagnetic transmission device (taken from a distributing system) from accumulators or elements. The same signs at the bottom of Fig. 6 refer to the local source of energy at the receiving-post as regards the wires. One and the same letter designates the same conductor all along its extent.

The operation of the application represented by the diagrams Figs. 5 and 6 conforms in detail to that which has already been explained and operates in its whole arrangement as follows: The movement of the wheel M, displacing through the medium of N the brushes α β γ upon the stationary sectors B and D, changes the distribution between f g h. The displacement of the armatures A and A′ then follows. The displacement of A causes at the receiving-post a movement of the corresponding wheel of L and causes the breaking of one of the contacts at τ or θ. By the operation of the relays Y and Z the armature w of the motor Ψ is supplied and causes the wheel V to turn until the index v of its axiometer catches up with the movement of t. The advance of the movement of A (and consequently of M) relatively to V is limited to a fixed value, according to construction. The contact (or t) with one or the other of the abutments at once brakes the initial driving operation of M by closing the circuit b'' to j e d'' and throwing into gear the gripping-brake, which is actuated by the electromagnet e. This arrangement constitutes the proper regulating device of the distance-transmission mechanism. The simultaneous operation at the starting-post of the second transmission mechanism A′ I′ enables the operator to have proper control over the reliable electric operation of the transmission mechanism by simply inspecting the movement of i catching up with the movement of m.

What we claim is—

1. In an electric-telemotor system, the combination with continuous-current positive and negative mains, of two concentric terminals of equal radius and of opposite polarity, an odd number of equidistant brushes in contact with said terminals, and means for relatively varying the position of the brushes and the terminals, substantially as described.

2. In an electric-telemotor system, the combination with a hand-wheel, of a gear-wheel geared thereto, an odd number of equidistant brushes on said gear-wheel, two stationary concentric sectors of equal radius with which said brushes engage, and positive and negative mains connected respectively with said sectors, substantially as described.

3. In an electric-telemotor system, the combination with a transmitting device, of a receiving device having a rotatable armature, a driven element rotatable independently of said armature, contact-points moving with said driven element, a contact moving with said armature, and a brake for the transmitting device in electrical connection with said contacts, substantially as described.

4. In an electric-telemotor system, the combination with a transmitting device, of a brake therefor, a receiving device having a rotatable armature, a contact moving with said armature, a driven element rotatable independently of said armature, two contacts carried by said driven element and standing on each side of the armature-contact, and circuit connections between said contacts and the brake, substantially as described.

5. In an electric-telemotor system, the combination with a rotatable armature, of a driven element rotatable independently of said armature, an electric motor for driving it, contacts movable with the armature and with the driven element, and circuit connections whereby any independent movement of the armature will cause the motor to operate and return the armature and the driven element to their relative normal positions, substantially as described.

6. In an electric-telemotor system, the combination with a rotatable armature, of a driven element rotatable independently thereof, an electric motor for driving it, two fixed contacts movable with the driven element, two spring-contacts movable with the armature and normally closed upon those of the driven element, an automatic switch controlling the motor, and circuit connections between said switch and the contacts, substantially as described.

7. An automatic reversing-switch for an electric motor, comprising two electromagnets in multiple arc, means for breaking the circuit of each electromagnet, an armature for each electromagnet, each armature carrying two separate contact-arms, a stationary contact coöperating with each arm, two supply-mains each connected with two diagonally opposite contact-arms, and two distributing-mains each connected with two directly opposite stationary contacts, substantially as described.

8. In an electric-telemotor system, the combination with a transmitting device, of a telltale comprising an auxiliary receiving device at the transmitting-station, in parallel circuit with the transmitting device and the main receiving device, and two concentric pointers, one geared to the transmitting device and the other to the auxiliary receiving device, substantially as described.

In testimony that we claim the foregoing we have hereunto set our hands this 11th day of June, 1898.

EMILE RAVEROT.
PIERRE BELLY.

Witnesses:
EDWARD P. MACLEAN,
VICTOR MATEOR.