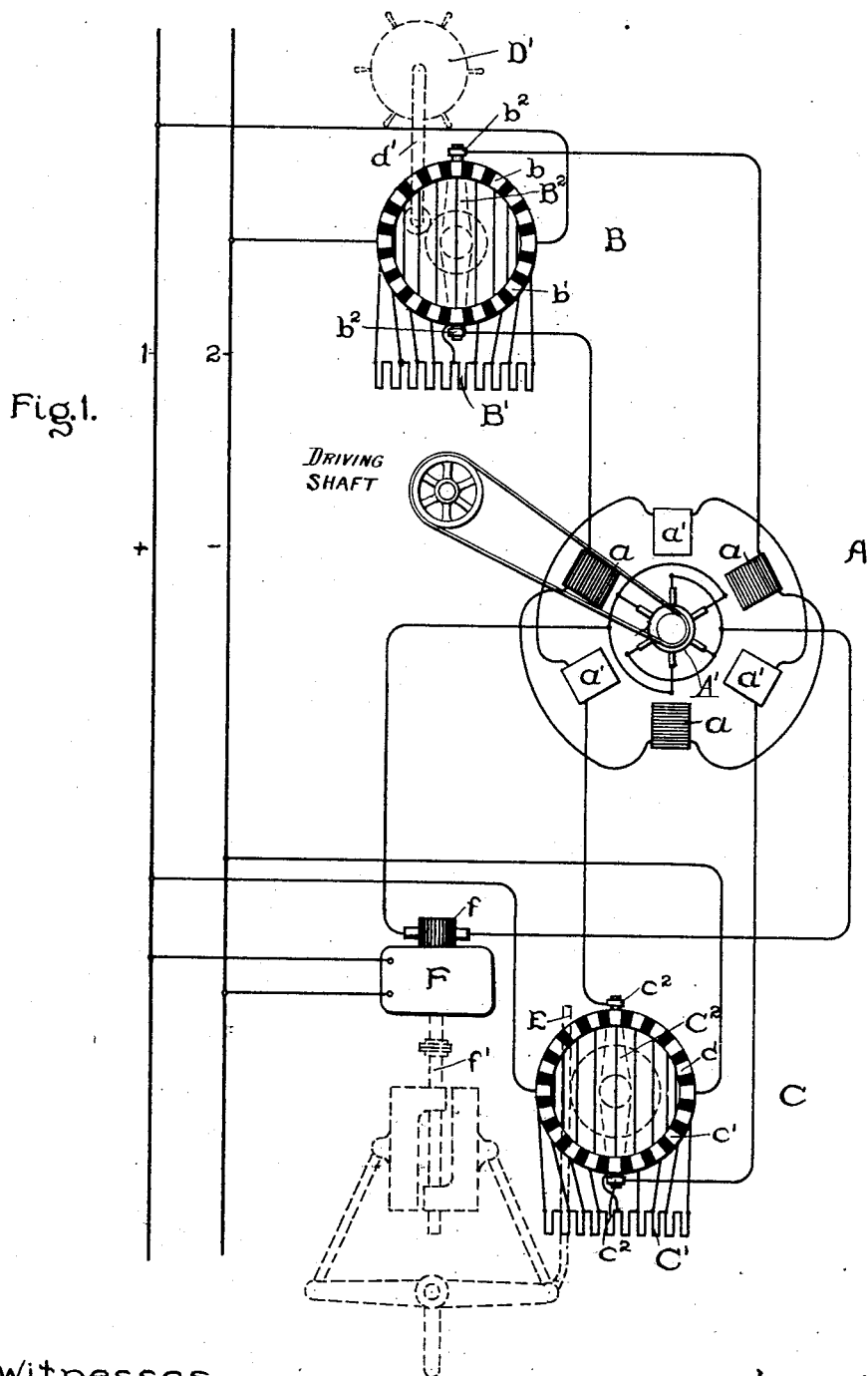


M. W. DAY.
ELECTRICAL STEERING GEAR.

(Application filed Aug. 23, 1901.)

(No Model.)

4 Sheets—Sheet. 1



Witnesses.

Ewing R. Gurney.
Fred Russ.

Inventor.

Maxwell W Day

by *Albert G. Davis*
Atty

No. 710,045.

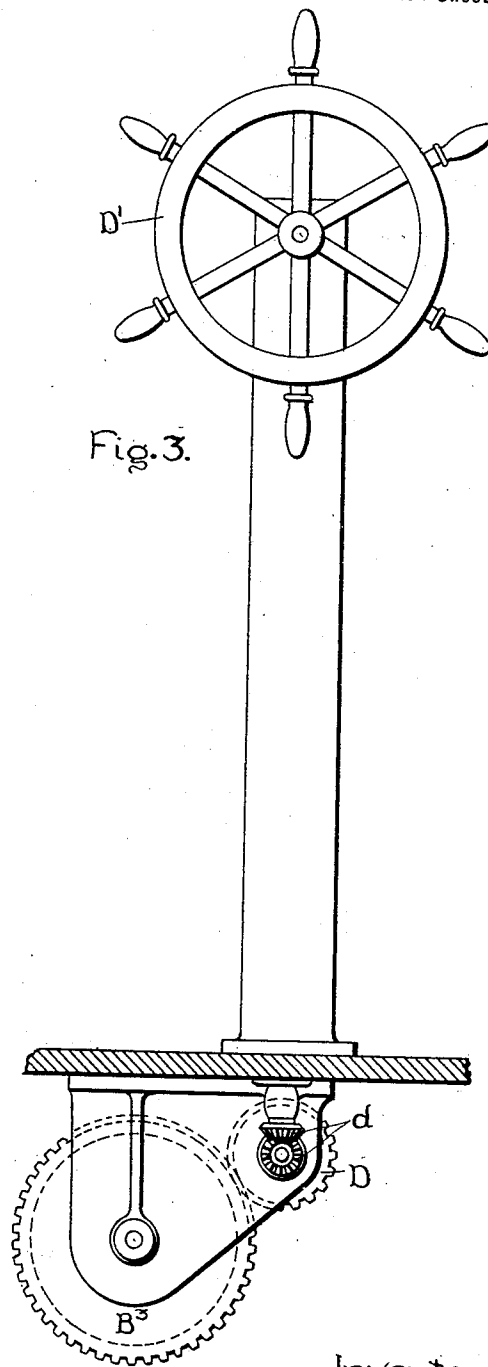
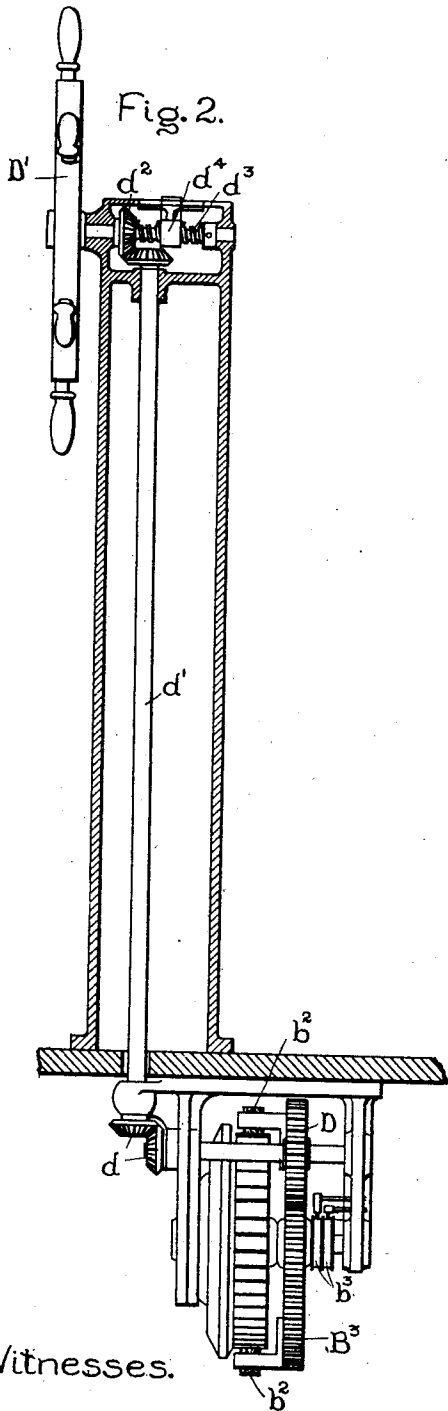
Patented Sept. 30, 1902.

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(Application filed Aug. 23, 1901.)

(No Model.)

4 Sheets—Sheet 2.



Witnesses.

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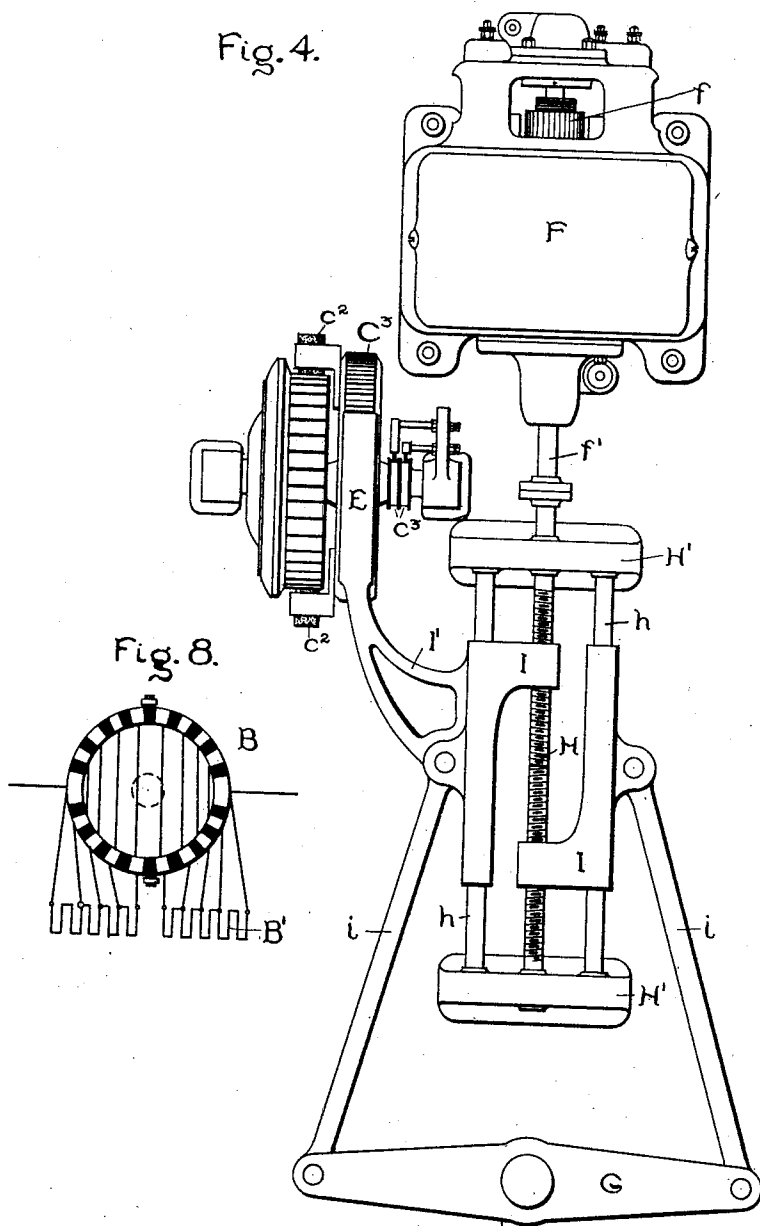
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4 Sheets—Sheet 3.



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ELECTRICAL STEERING GEAR.

(Application filed Aug. 23, 1901.)

(No Model.)

4 Sheets—Sheet 4.

Fig. 7.

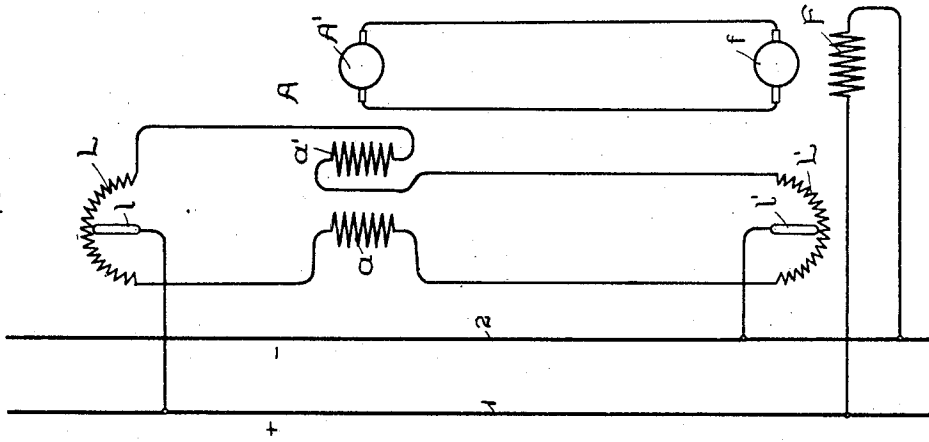


Fig. 6.

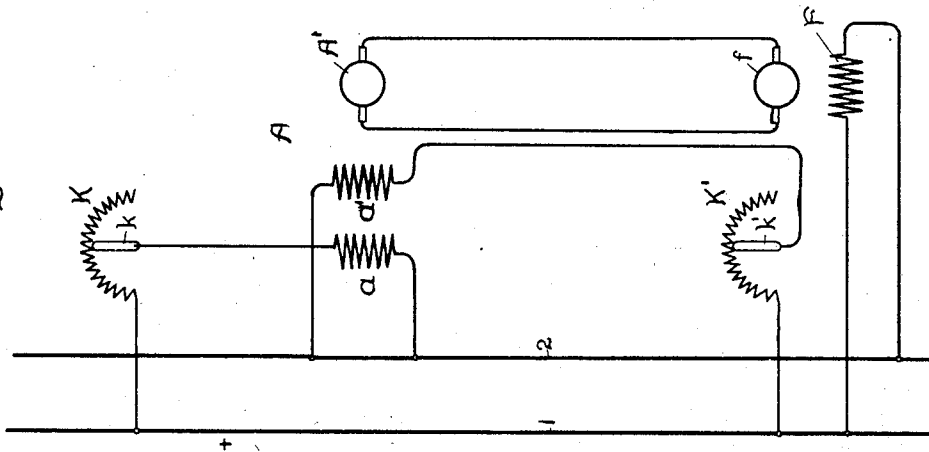
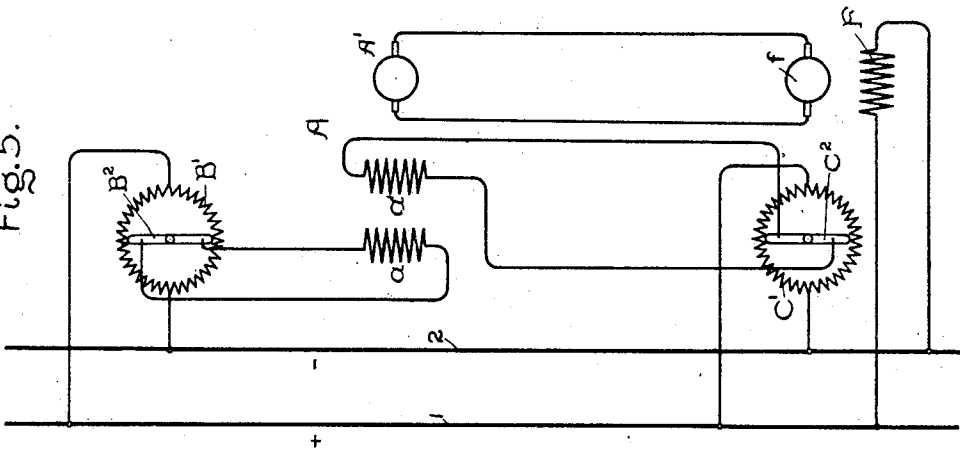


Fig. 5.



Witnesses.

Ewing R. Gurney.
Fried Russ.

Inventor:
Maxwell W. Day.
by *Albert H. Davis*
Att'y.

UNITED STATES PATENT OFFICE.

MAXWELL W. DAY, OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

ELECTRICAL STEERING-GEAR.

SPECIFICATION forming part of Letters Patent No. 710,045, dated September 30, 1902.

Application filed August 23, 1901. Serial No. 72,978. (No model.)

To all whom it may concern:

Be it known that I, MAXWELL W. DAY, a citizen of the United States, residing at Schenectady, in the county of Schenectady, State of New York, have invented certain new and useful Improvements in Electrical Steering-Gears, (Case No. 1,881,) of which the following is a specification.

This invention relates to means for reproducing at a distant point the motion of an operating or controlling handle. It is especially applicable to the steering of vessels, and will therefore be described in that connection, though useful in many other relations.

The object of the invention is to simplify existing systems for this purpose and insure a prompt and accurate response by the rudder or the like to the movements of the steering-wheel or other controlling-handle.

The present invention is an improvement upon that described in my pending application, Serial No. 31,132, filed September 26, 1900, (Case 1,215.)

The invention consists in a motor geared to the rudder and supplied with current from a generator having two field-windings wound in opposite directions and two rheostats controlling the supply of current to said field-windings, one rheostat being controllable by the steering-wheel and the other being mechanically connected to the motor. When both rheostat-arms stand in the same position, the two field-windings will be energized by equal currents, and as they oppose each other no current will be generated and the motor will remain at rest; but if the steering-wheel is moved, thereby shifting one rheostat-arm and causing a different current to flow through one field-winding from that in the other the resulting differential field will generate a current which will start the motor and cause it to shift the rudder and at the same time swing its rheostat-arm until the field-winding connected therewith receives the same current as the other, when the generator-current will cease and the motor will stop. Such a system is illustrated in the accompanying drawings, in which—

Figure 1 is a diagram of the preferred arrangement of circuits. Fig. 2 is a side sec-

tional elevation of the steering-wheel and its rheostat. Fig. 3 is a front elevation thereof. Fig. 4 is a plan view of the motor and its rheostat. Fig. 5 is a simplified diagram of the circuits of Fig. 1. Figs. 6 and 7 are similar diagrams of modifications. Fig. 8 shows a modified rheostat.

In Fig. 1 the generator is shown at A having its field-windings divided into two separate portions. The drawing shows six coils, three in each set; but any equivalent arrangement may be adopted, it being necessary only to have two distinct windings wound to oppose each other, so that when both are taking equal current no current will be generated by the armature. One of the windings is controlled by a rheostat B and the other by a similar rheostat C. I prefer a rheostat which controls both sides of its field-circuit, having two sets of contact-segments $b\ b' \ c \ c'$ cross-connected, as shown, and connected also with the coils of the resistance $B' \ C'$, connected across a source of supply, such as the ship's lighting-mains 1 2. A double rheostat-arm $B^2 \ C^2$ carries at each end a brush $b^2 \ c^2$, making contact with the two sets of segments. The terminals of the field-winding are connected with said brushes by flexible cables or through collector-rings $b^3 \ c^3$ on the hub of the rheostat-arm. In Fig. 1 the alternate field-coils a are connected with the brushes b^2 and the other field-coils a' with the brushes c^2 .

Each rheostat-arm is rotatable on an axis concentric with the segments, being preferably attached to or integral with a gear-wheel $B^3 \ C^3$, by means of which the brushes can be moved. For this purpose the wheel B^3 is preferably in mesh with a pinion D, connected, by bevel-gears d , an upright shaft d' , and bevel-gears d^2 , with the steering-wheel D' , which may be provided with a screw d^3 , actuating a nut d^4 , carrying an index to show the position of the rudder and serving as a stop to prevent the wheel from being turned too far.

The rheostat-gear C^3 is operated, preferably, by a rack E, actuated by the movement of the rudder, preferably as follows: The rudder-operating electric motor F has its field-coils constantly energized by current taken

from the lighting-mains 1 2. Its armature f is in circuit with the armature A' of the generator A . The shaft f' is geared to the rudder-head G , attached to the rudder G' , preferably through a right and left hand screw H , connected with the shaft f' and rotating in bearing H' . Each half of the screw carries a traversing nut I , sliding on a guide-rod h and connected with one end of the rudder-head by a link i . One of the nuts carries an arm I' , on which is the rack E . If desired, the rack may be pivotally connected with the rudder-head, as shown in Fig. 1.

The operation of my invention is as follows:
 15 When the brushes $b^2 c^2$ stand in the middle positions, as shown in Fig. 1, there is little or no current flowing to the field-windings of the generator, and hence no current is generated by it. Suppose, now, that the steering-wheel is turned over to starboard, moving the upper brush b^2 to the right and the lower one to the left in Fig. 1. This results in shunting more or less of the middle portion of the resistance B^2 and permits current to flow from the upper brush b^2 through the coils a to the lower brush b^2 . The constantly-rotating armature of the dynamo A at once sends current through the armature of the motor F , which immediately starts rotating, causing the nuts I to separate from each other and turning the rudder G' to port. At the same time the rack E rotates the gear C^3 and causes the upper brush c^2 to move to the right and the lower one to the left. This shunts the middle portion of the resistance C' and allows current to flow to the coils a' , but in a direction to produce an opposite magnetization to that generated by the coils a . As the movement of the brushes c^2 continues the opposing magnetism of the coils a' increases until it finally equals that of the coils a , at which point the armature-current has been reduced to zero and the motor stops, holding the rudder in a position corresponding to the angular movement of the brushes b^2 and c^2 . When a straight course is to be steered again, the steering-wheel is returned to its normal position, bringing the brushes b^2 again to the position shown in Fig. 1 and deenergizing the field-coils a . The field of force due to the coils d' will now cause the armature to generate a reversed current and the motor will at once start backward and return the rudder to its amidship position.

20 The circuits shown in Fig. 1 are diagrammed more simply in Fig. 5 in order to facilitate comparison with the modified circuits shown in Figs. 6 and 7. Also in this figure for the sake of simplicity of illustration the rheostat B' is shown as comprising two rheostats connected in multiple instead of a single rheostat cross-connected to two sets of contacts, as shown in Fig. 1.

It has already been explained that in the system of Fig. 1 the connections are so arranged that when the steering-wheel and rudder are both at their mid-position no cur-

rent will flow in the differential field-winding of the generator. While the arrangement illustrated in Figs. 1 and 5 is preferable in actual practice, it is of course only one of many possible embodiments of my invention.

In Figs. 6 and 7 I have illustrated two modified arrangements of the circuit connections, in both of which the sections of the differential field-winding are at all times supplied with current.

In the system illustrated in Fig. 6 the flow of current in the winding a of the generator A is controlled by means of a rheostat K , operatively connected to the steering-wheel, and the flow of current in the winding a' is similarly controlled by means of a rheostat K' , operatively connected to the rudder-actuating motor. The essential difference between the system illustrated in this figure and the system illustrated in Fig. 5 consists in this: that the rheostats K and K' operate merely to vary the amount of current flowing through their corresponding field-windings a and a' between maximum and minimum values, determined by the resistance of the rheostat, whereas in the system of Fig. 5 the current in the field-windings of the generator A may be varied between a maximum value in either direction and zero. The system of Fig. 6, therefore, requires a continuous supply of current to the field-windings of the generator, with a consequent increase in heating of said windings unless they are made of different character.

In both of the systems illustrated in Figs. 5 and 6 the current flowing in one of the sections of the differential field-winding is controlled wholly from the steering-wheel and the flow of current in the other section is controlled wholly from the rudder, while in Fig. 7 I have illustrated a system in which the flow of current in both sections of the differential field-winding is simultaneously and inversely varied by the operation of either of the controlling-rheostats. Referring to this figure, it will be noted that the terminals of the rheostats L and L' are connected at each end to one of the terminals of the windings a and a' , one of these windings being reversely connected. The movable arms l and l' of the two rheostats are connected respectively to the plus and minus mains of the supply system. With this particular arrangement and with the rheostat-arms in the position shown in the drawing current entering at the arm l will divide equally between the two sections a and a' of the generator field-winding. When the steering-wheel is operated to move the rheostat-arm l in one direction or the other, the flow of current in one of the generator field-windings is increased and the flow of current in the other correspondingly diminished, the balance being restored when the rudder-actuating motor has moved the arm l' into such a position as will again equalize the flow of current in the two windings.

It thus appears that by the use of a generator having a differential field, controlled by two rheostats geared, respectively, to the steering-wheel and rudder-motor I am able to effect a prompt and accurate movement of the rudder.

In the preferred arrangement as shown in Fig. 5 in any position of the steering rheostat-arm, except the mid-position, a certain amount of current will pass through the generator field-coils, this current being a maximum when the rudder is hard over in either direction; but even at this time the current is not excessive and lasts only for a short time. For the greatest portion of the time the rheostats will be at or near their mid-positions, and thus only a very small amount of current will be passing. Indeed, at the exact mid-position the brushes will rest on segments of equal potential, so that no current will flow through the field-windings. In all these instances, however, there will be a slight waste of current through the coils of the rheostats; but this waste can be made very small, and this arrangement does away with any objectionable sparking at the brushes. If it is desired to prevent all waste, the rheostats may be divided in the middle, as shown in Fig. 8, the brushes resting on an intermediate dead-segment when in mid-position. This arrangement may cause a little sparking when the brushes are moved to cut in the rheostat-coils, but not to any objectionable degree.

Since the maximum voltage of the dynamo is available for varying the field, I can use high-resistance rheostats, so that the amount of energy wasted in the rheostats is small. It is apparent that this system is of great usefulness in many other applications, such as working signals, turrets, train-control apparatus, and the like.

What I claim as new, and desire to secure by Letters Patent of the United States, is—

1. In a system for controlling movement at a distance, the combination with a generator, of a motor in circuit with the armature of said generator, manually-controlled means for inducing a field of force in said generator, and means controlled by the motor for inducing an opposing field of force in said generator.

2. In a system for controlling movement at a distance, the combination with a generator, of a motor in circuit with the armature thereof, manually-controlled means for inducing a variable field of force in said generator, and means controlled by the motor for inducing an equally-variable opposing field of force in said generator.

3. In a system for controlling movement at a distance, the combination with a generator having a differential field-winding, comprising two independent windings arranged to be supplied with current from a suitable source, of means for causing unequal currents to flow in the two windings, a motor in

circuit with said generator, and means controlled by the motor for equalizing the currents in the two windings.

4. In a system for controlling movement at a distance, the combination with a generator having two independent field-windings, of means for sending balanced currents through said windings, means for unbalancing said currents, a motor in circuit with said generator, and means controlled by the motor for restoring the balance between said currents.

5. In a system for controlling movement at a distance, the combination with a generator having a differential field-winding, of a motor, means for manually controlling one part of the field-winding, and means whereby the motor controls the other part.

6. In a system for controlling movement at a distance, the combination with a generator having two independent field-windings, of a motor in circuit with the armature of said generator, means for sending a current of varying volume through one of said field-windings, and means controlled by the motor for sending a similar current in the opposite direction through the other winding.

7. In a system for controlling movement at a distance, the combination with a generator having two independent field-windings, of a motor in circuit with the armature of said generator, means for sending a current of varying volume in either direction through one of said field-windings, and means controlled by the motor for sending a similar current in the opposite direction through the other winding.

8. In a system for controlling movement at a distance, the combination with a generator having two opposing field-windings, of two rheostats respectively connected with said windings, means for controlling one of said rheostats manually, and an electrodynamic device actuated by current from said generator, and controlling the other rheostat.

9. In a system for controlling movement at a distance, the combination with a generator having two independent field-windings, of a movable contact connected with each terminal of said windings, a source of current-supply, two resistances connected therewith, means for manually shifting two of the contacts along one of said resistances, a motor actuated by the generator-current, and means whereby said motor can shift the other contacts along the other resistance.

10. In a system for controlling movement at a distance, the combination with a generator having two independent field-windings, of a movable contact connected with each terminal of said windings, a source of current-supply, two resistances connected therewith, means for manually shifting the contacts connected with one of said windings to cut out more or less of one resistance, and means actuated by the generator-current for shifting the contacts of the other winding to cut out more or less of the other resistance.

11. In a system for controlling movement at a distance, the combination with a generator having two independent field-windings, of means for supplying current to said windings and producing therein opposing and equal magnetizing effects, means for manually varying the current in one winding, a motor in circuit with said generator, and means controlled by the motor for varying the current in the second winding to a degree corresponding with the variation of that in the first winding.

12. In a system for controlling movement at a distance, the combination with a generator having two independent field-windings, of means for supplying current to both windings, a resistance in circuit with each winding, means for manually varying one resistance, a motor in circuit with the generator, and means controlled by the motor for similarly varying the other resistance.

13. In a steering apparatus, the combina-

tion with a rudder-actuating motor, of a generator for supplying energy thereto, having a differential field-winding, means connected with the steering-wheel for controlling one part of the field, and means connected with the rudder-actuating motor for controlling the other part of the field.

14. In a steering apparatus, the combination with a rudder-actuating motor, of a generator for supplying energy thereto having a differential field-winding, a rheostat geared to the steering-wheel for controlling one part of said field, and a rheostat geared to the motor for controlling the other part of the field.

In witness whereof I have hereunto set my hand this 20th day of August, 1901.

MAXWELL W. DAY.

Witnesses:

EDWARD WILLIAMS, Jr.,
JAMES O. CARR.