No. 692,352. Patented Feb. 4, 1902.

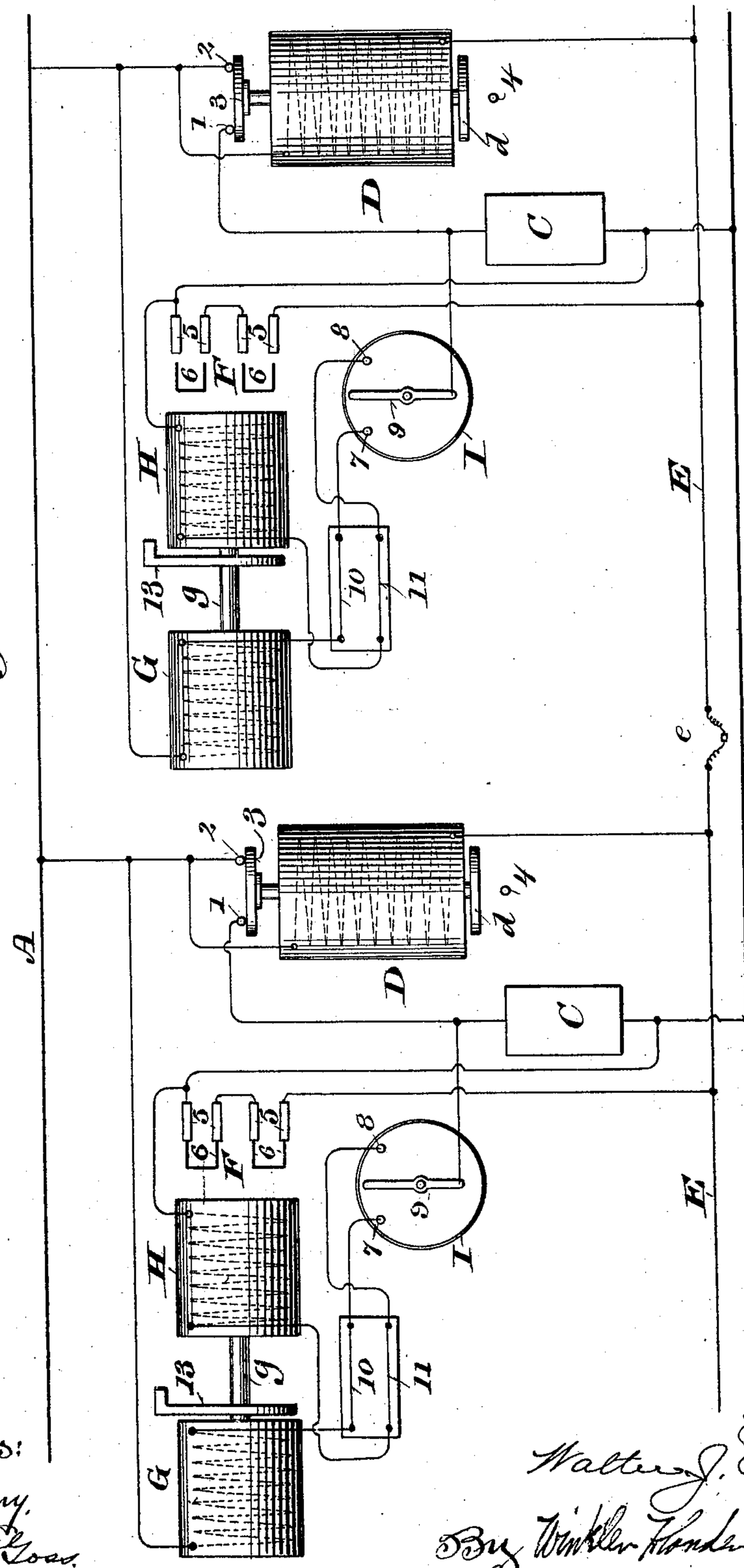
W. J. RICHARDS.

CONTROLLING APPARATUS FOR ELECTRIC MOTORS.

(Application filed Apr. 27, 1901.)

(No Model.) 3 Sheets—Sheet 1.

Fig. 1.



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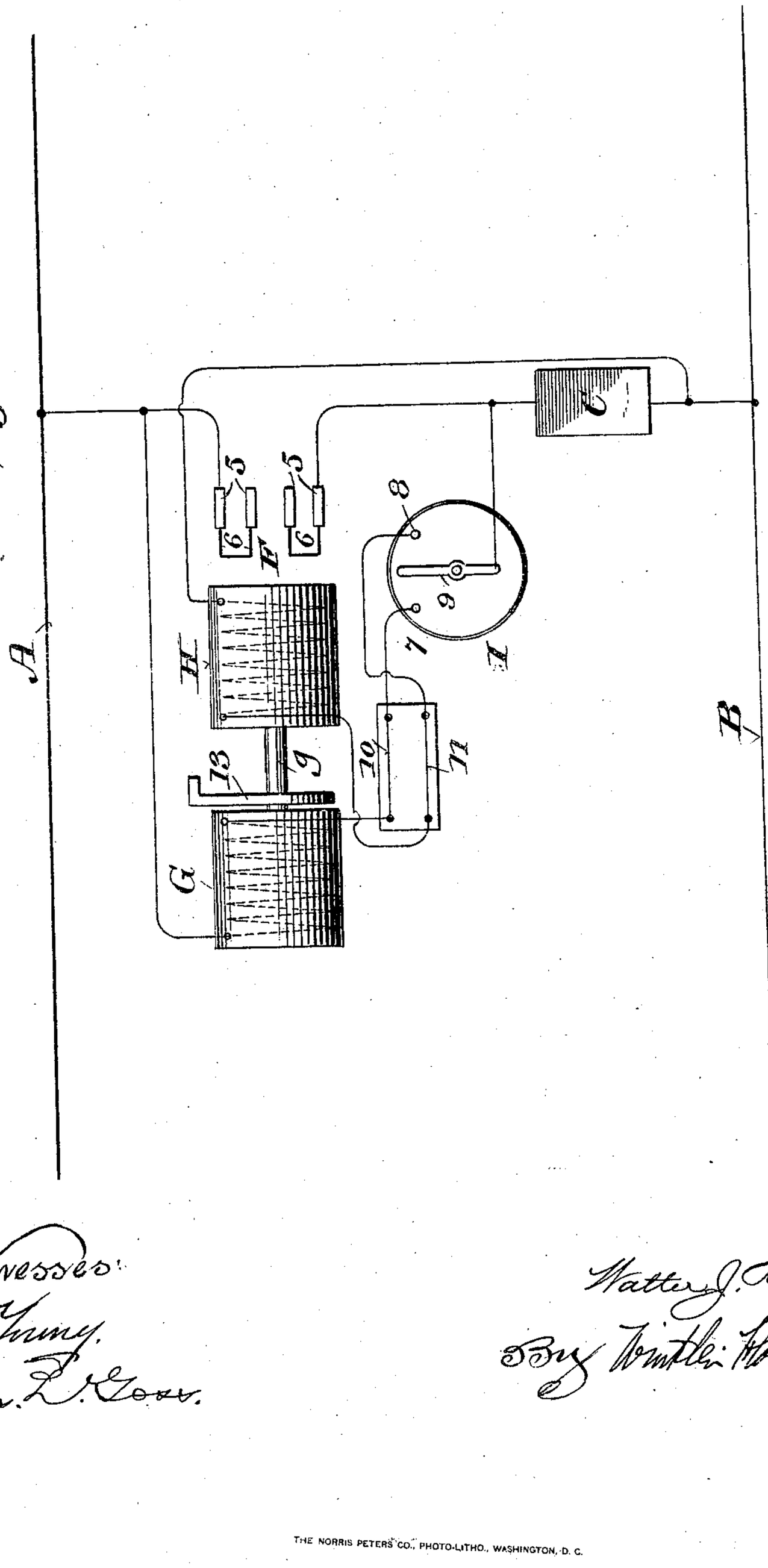
(No Model.) 3 Sheets—Sheet 2.

Fig. 2.



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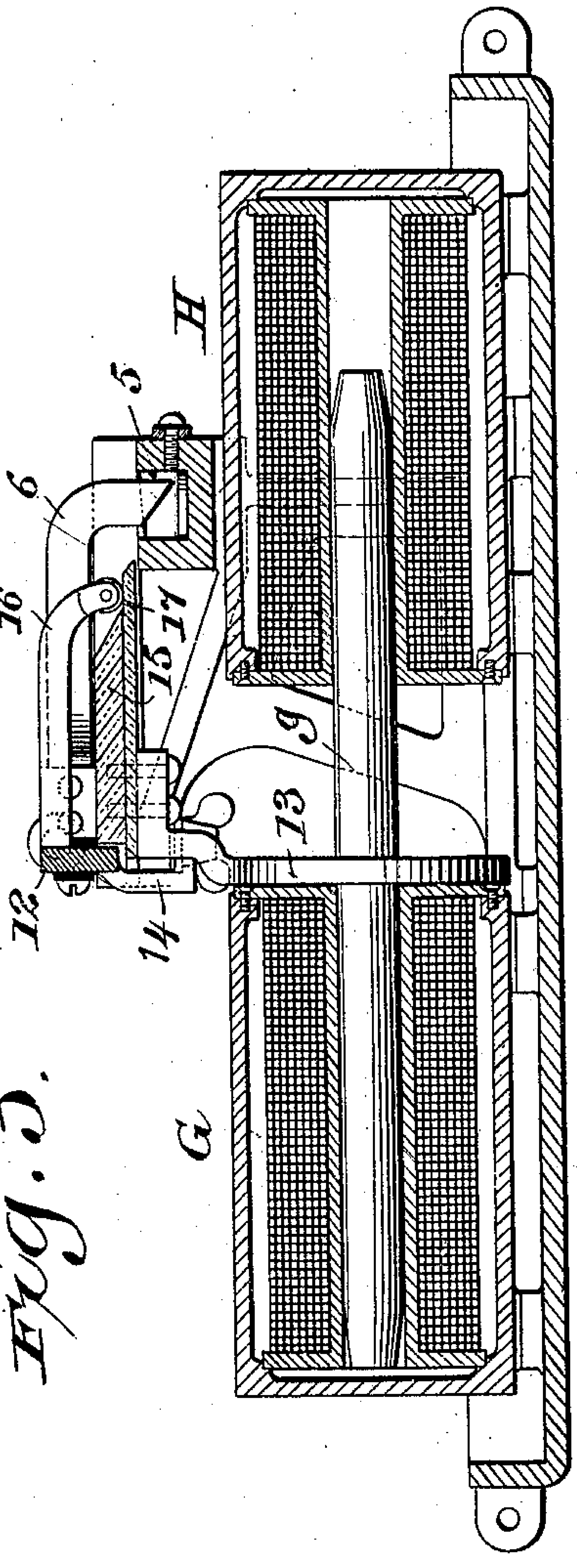

Fig. 3.

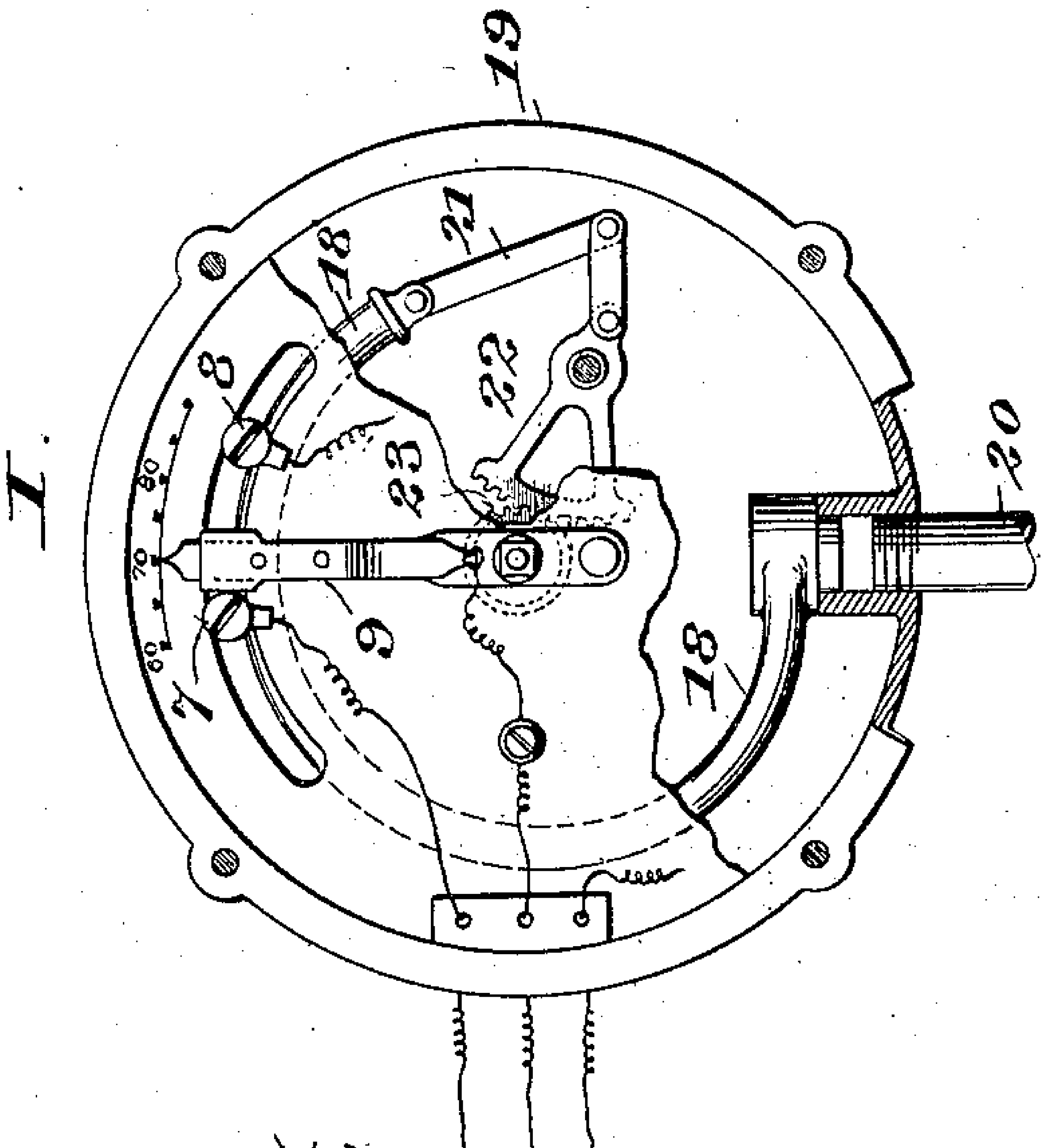

Fig. 4.

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CONTROLLING APPARATUS FOR ELECTRIC MOTORS.

SPECIFICATION forming part of Letters Patent No. 692,352, dated February 4, 1902.

Application filed April 27, 1901. Serial No. 57,680. (No model.)

To all whom it may concern:

Be it known that I, WALTER J. RICHARDS, a citizen of the United States, residing at Milwaukee, in the county of Milwaukee and State of Wisconsin, have invented certain new and useful Improvements in Controlling Apparatus for Electric Motors, of which the following is a specification, reference being had to the accompanying drawings, forming a part thereof.

My invention relates to automatic controlling apparatus for electric motors of the class shown in United States Letters Patent No. 644,128, granted February 27, 1900, to N. A. Christensen.

Its main objects are to prevent arcing between the contact-pieces of the switches or circuit-controllers of the apparatus, to dispense with the contact-springs or auxiliary switch shown in the aforesaid patent for opening and closing the circuit through one of the switch-operating magnets, to automatically stop and start a compressor-motor at predetermined maximum and minimum limits of pressure, to govern the operation of a number of motors by a single primary switch or circuit-controller, and generally to improve the construction and operation of apparatus of the class above mentioned.

It consists in a certain novel construction and arrangement of parts and in the combinations of parts hereinafter particularly described, and pointed out in the claims.

The invention is applicable to the control of a single motor or to the control of a number of motors arranged in a "multiple-unit system."

For the purpose of illustration I have shown and described apparatus embodying the invention as specially designed for air-brake service on electric railways; but the invention is applicable to other uses.

In the accompanying drawings like characters designate the same parts in the several figures.

Figure 1 is a diagram of a multiple-unit system of control embracing two equipments capable of separate and independent as well as joint operation. Fig. 2 is a diagram showing a modification of the apparatus as applied to the control of a single compressor-motor. Fig. 3 is a sectional view, on an enlarged scale, of one of the electromagnetic switches or circuit-controllers; and Fig. 4 is a detail view, on an enlarged scale, of one of the primary fluid-pressure-operated switches or circuit-controllers employed in the apparatus.

Referring to Fig. 1, A and B designate the main conductors, A being the trolley or supply conductor and B the ground or return conductor. C C are compressor-motors connected on one side with contact-pieces 1 of the main switches, which are operated by electromagnets D D, and on the other side with the ground or return conductor B. Other contact-pieces 2 of the main switches are connected with the trolley or supply conductor A. One terminal of each magnet D is connected with the conductor A and the other terminal with an equalizing or balancing conductor E, which when the apparatus is applied to railway-cars and adapted for multiple-unit service is provided between the cars with couplings *e*. Any suitable kind of switches may be employed for directly controlling the motor-circuits, and these switches may be operated by electromagnets of any suitable form. For this purpose I have shown in a general way solenoid-magnets the cores or plungers *d* of which are adapted to actuate contact-pieces 3 for connecting the fixed contact-pieces 1 and 2 when the magnets are energized. When the circuit is opened through these magnets, the plungers *d* drop against stops 4 and the movable contact-pieces 3 fall with them away from the fixed contact-pieces 1 and 2, thereby breaking the motor-circuits. F F are relay-switches having fixed contact-pieces 5 5 and movable contact-pieces 6 6, adapted when the switches are closed to electrically connect the fixed contact-pieces 5. One of the fixed contact-pieces 5 is connected with the equalizing-conductor E and another with the ground or return-conductor B. The movable contact-pieces 6 of each relay-switch F are actuated by the armature or plunger *g* of two magnets G and H. I I are primary switches adapted to control the circuits of the relay-magnets G and H, according to variations in the pressure produced by the compressor-motors C. They each have minimum and maximum pressure contact-pieces 7 and 8, and a third contact-piece 9, which is connected with the associated motor-circuit be-

tween the supply-conductor A and the motor C. The minimum contact-piece 7 is connected through a fuse 10 with one terminal of the magnet G and the maximum contact-piece 8 is connected through a fuse 11 with one terminal of the magnet H. The other terminal of the magnet G is connected with the conductor A, while the other terminal of the magnet H is connected with the conductor B.

Referring to Fig. 3, which shows in detail on an enlarged scale one of the relay-switches F, with the associated magnets G and H, the movable contact-pieces 6, which consist of metallic spring-arms, are attached to and insulated from a rocking bar 12 and are preferably bent at their free ends to embrace the fixed contact-pieces 5. The movable core or plunger *g* is provided between the magnets with an armature-plate 13, which when the plunger is moved to the left by the magnet G engages with an arm 14 on the rocking bar 12 and turns the arms 6 into engagement with the contact-pieces 5. Upon the armature-plate 13 is mounted a beveled block or wedge 15, which is adapted, when the plunger is moved to the right by the magnet H, to engage with an arm 16 on the rocking bar 12, and thereby turn the arms 6 out of engagement with the contact-pieces 5. A sheet 17 of asbestos board or other non-conducting material carried by the plate 13 is adapted to be thrust between the fixed and movable contact-pieces of the switch when they are separated, and thus intercept and extinguish arcs produced by their separation.

Referring to Fig. 4, which illustrates in detail on a larger scale a suitable form of primary switch for use in my improved controlling apparatus, 18 is a curved spring-tube like or similar to those employed in pressure-gages. It is attached at one end to a nipple inside of a case 19 and communicates at that end with a pipe 20, which connects it with the associated compressor or with a reservoir (not shown) supplied with compressed air by said compressor. The free end of said tube is connected by a link 21 with a segment-gear 22, which meshes with a pinion 23 on the pivot-pin of an arm, like or similar to the hand of a pressure-gage, which carries the contact-piece 9 between the minimum and maximum pressure contact-pieces 7 and 8. The contact-pieces 7 and 8 are adjustably secured in a curved slot in the face or cover of the case 19 to admit of varying the maximum and minimum limits of the pressure to be maintained. Both the primary and the relay switches, including their actuating devices and connections, may be variously modified as to the construction and arrangement of their component parts without affecting the principle of the apparatus. The minimum and maximum pressure contact-pieces 7 and 8 of the primary switch may be made movable, while the contact-piece 9 is made stationary, without change in result.

The apparatus arranged as hereinbefore described for multiple-unit service operates as follows: Assuming that the air-pressure is at zero, that current from the trolley or supply conductor A is cut off, and that the relay-switches F and the main switches controlled thereby are open, under these conditions the gage-hands or movable contact-pieces 9 will rest against the minimum-pressure contact-pieces 7 and the armature-plates 13 will rest, as shown at the right in Fig. 1, against the magnets H. When a connection is established between the trolley or supply conductor A and the controlling apparatus on either of the connected cars, the balancing-wires E being coupled together between the cars, current will pass from the conductor A through magnets G, fuses 10, contact-pieces 7 and 9, and thence through the motors C to the ground or return conductor B. The magnets G being thus energized will draw the armature-plates 13 toward them and close the switches F, as shown at the left in Fig. 1. The current passing through the magnets G, which are made of high resistance, is insignificant as compared with the current required to start the motors C, and consequently the motors are unaffected by it. The resistance of the motors being very small as compared with the resistance of the magnets G, its effect is negligible in diminishing the amount of current flowing through said magnets in the circuits above traced, and hence the motors under these conditions serve as ground or return connections for the coils of said magnets. When the switches F are closed, as above stated, current will flow from the conductor A through magnets D, equalizing-wires E, contact-pieces 5 and 6 of the switches F, and thence to the ground or return conductor B. The magnets D being thus energized close the main switches and start the motors C C, current flowing from the conductor A through the contact-pieces 1, 2, and 3 of said switches and thence through said motors to the conductor B. When the motors attain their full speed, and consequently their full counter electromotive force, the connections of the coils of magnets G with the motor-circuits become of the same potential as the trolley or supply conductor A. It follows that when the motors are in full operation there will be no difference of potential between the terminals of the coils of magnets G, and consequently no current will flow under these conditions through the contact-pieces 7 and 9 of the primary switches I. Accordingly when the pressure has been increased sufficiently by the operation of the compressor-motors to move the gage-hands or contact-pieces 9 away from the minimum contact-pieces 7 arcs will not be produced by their separation. As the pressure increases the gage-hands or contact-pieces 9 will be turned gradually to the right, and when they finally engage with the maximum contact-pieces 8 circuits will be closed through the magnets H and current will flow from the conductor A through the main-

switch contact-pieces 1, 2, and 3, contact-pieces 9 and 8 of the primary switches, and the coils of magnets H to the ground or return conductor B. The magnets H being thus energized draw the plungers *g* and armature-plates 13 to the right and open the relay-switches F. If the relay-switches are opened simultaneously, the circuits of the magnets D will be broken, and the main switches will be opened at the same time; but if the relay-switches are not opened simultaneously on account of unavoidable variations in the adjustment of the primary switches I the circuits of the magnets D will remain closed through the equalizing-wires E and that relay-switch F which is the last to be opened. When the connection between the equalizing-conductor and the ground or return conductor is broken by the relay-switch F which opens last, the magnets D will be deënergized, release the contact-plates 3, and open the main switches, thereby breaking the motor-circuits and stopping the motors. As the pressure falls the gage-hands or contact-pieces 9 will move back to the left away from the maximum-pressure contact-pieces 8 without producing arcs, because their connection with the trolley or supply conductor has been broken by the opening of the main switches, as above explained, and that primary switch I which is adjusted to close the circuit through the associated magnet G at the highest minimum pressure will assume control of the entire system, and the other primary switches, with the associated relay-switches, will remain inoperative as long as the first-mentioned primary switch continues in service. If, however, the primary switch having control of the system fails for any cause to close the circuit through magnet G, the primary switch which is adjusted to close the circuit at the next lower minimum limit will assume control of the system. When the gage-hand or contact-piece 9 of the primary switch having control of the system reaches the minimum-pressure contact-piece 7, the associated relay-switch F will be closed and a ground or return connection established through it and the equalizing-conductors E for all the main-switch magnets D of the system. Hence all the motor-circuits will be closed and all the motors started simultaneously. All the other relay-switches F of the system will remain open, since the fall in pressure is not sufficient to permit the gage-hands or movable contact-pieces 9 of the associated primary switches to reach the minimum-pressure contact-pieces 7. As the pressure increases the gage-hands or contact-pieces 9 will be turned back again toward the maximum-pressure contact-pieces 8, and when the gage-hand or contact-piece 9 of the primary switch having control reaches the maximum-pressure contact-piece 8 current will flow through the associated magnet H, the associated relay-switch F, and all the main switches will be opened and all the motors will be stopped. The foregoing operations will be repeated in the manner explained as the pressure rises and falls.

Grounding the magnets G through the motors, as herein shown and described, not only dispenses with extra contact-springs or circuit-controllers, which have been found a source of trouble in connection with said magnets, but also insures a more certain and perfect engagement of the contact-arms 6 with the contact-pieces 5 of the switches F. Since said magnets remain energized when circuits are closed through them by the primary switches I until the motors attain their full speed and counter electromotive force, the recoil of the plungers *g* and the consequent separation and burning of the contact-pieces of the switches F, which are liable to occur when the magnets are but momentarily energized and the circuits through them are abruptly broken, are prevented.

Referring to Fig. 2, which illustrates a modification in the arrangement of the apparatus and circuit connections adapted for use with a single motor, the main switches, with their operating-magnets D and the equalizing-conductor E employed in a multiple-unit system, as hereinbefore described, are dispensed with. The switch F, which serves as a relay-switch in the multiple-unit system, takes the place of the main switch, one of its contact-pieces 5 being directly connected with the conductor A and another with the motor C. In other respects the apparatus is arranged and operates substantially like one of the complete individual equipments of the multiple-unit system shown in Fig. 1 and hereinbefore described.

The current or the connections of the main conductors A and B with the apparatus may be reversed without change in the result. Fluid-pressure obtained from other sources than the compressors, which are controlled by the herein-described apparatus or even other forces, may be employed for some purposes under certain conditions to actuate the primary switches I. In short, various changes in the construction and arrangement of component parts of the apparatus may be made without materially affecting its operation or departing from the spirit and intended scope of the invention.

I claim—

1. In controlling apparatus for electric motors, the combination with an electric motor and main conductors of a switch controlling the motor-circuit, a magnet for closing said switch having one terminal connected with one of said conductors, and a primary switch having a contact-piece connected with the other terminal of said magnet and another contact-piece connected with the motor-circuit between the motor and the point at which said circuit is opened and closed, substantially as described.

2. In controlling apparatus for electric motors, the combination with an electric motor and main conductors of a switch controlling

the motor-circuit, two magnets for opening and closing said switch, and a primary switch having maximum and minimum pressure contact-pieces connected with the coils of said magnets and a third contact-piece connected with the motor-circuit between the motor and the point at which said circuit is opened and closed, substantially as described.

3. In controlling apparatus for electric motors, the combination with a compressor-motor and main conductors, of a switch controlling the motor-circuit, a magnet for closing said switch having one terminal connected with one of said conductors, and a primary switch having a fluid-pressure-actuating connection and contact-pieces, one of which is connected with the other terminal of said magnet and another with the motor-circuit between the motor and the point at which said circuit is opened and closed, substantially as described.

4. In controlling apparatus for electric motors, the combination with a compressor-motor and main conductors, of a switch controlling the motor-circuit, two magnets for opening and closing said switch, a primary switch having maximum and minimum pressure contact-pieces connected with the coils of said magnets and a third contact-piece connected through the motor with one of said conductors, and a fluid-actuating connection with said primary switch whereby its connection with the motor-circuit is automatically opened and closed by variations in fluid-pressure, substantially as described.

5. In controlling apparatus for electric motors, the combination with an electric motor and main conductors, of a main switch controlling the motor-circuit, a magnet for operating said switch, a relay-switch controlling the circuit of the main-switch magnet, a magnet for closing the relay-switch, having a connection with the motor-circuit between the motor and the main switch, and a primary switch controlling said connection, substantially as described.

6. In controlling apparatus for electric motors, the combination with an electric motor and main conductors, of a main switch controlling the motor-circuit, a magnet for operating said switch, a relay-switch controlling the circuit of the main-switch magnet, two magnets for operating the relay-switch, and a primary switch having maximum and minimum pressure contact-pieces connected with the coils of the relay-magnets and a third contact-piece connected with the motor-circuit between the motor and the main switch, substantially as described.

7. In controlling apparatus for electric motors, the combination with an electric motor and main conductors, of a main switch controlling the motor-circuit, a magnet for operating said switch, a relay-switch controlling the circuit of the main-switch magnet, a magnet for closing said relay-switch, having a connection with the motor-circuit between the motor and the main switch, a primary switch controlling said connection, and an equalizing-conductor for connecting said main-switch magnet with a corresponding magnet controlling another motor-circuit, substantially as described.

8. In controlling apparatus for electric motors, the combination with an electric motor and main conductors, of a main switch controlling the motor-circuit, a magnet for operating said switch, a relay-switch controlling the circuit of the main-switch magnet, two magnets for operating the relay-switch, a primary switch having maximum and minimum pressure contact-pieces connected with the coils of said magnets and a third contact-piece connected with the motor-circuit between the motor and the main switch, and an equalizing-conductor for connecting the main-switch magnet with corresponding magnets controlling the circuits of other motors, substantially as described.

9. In controlling apparatus for electric motors, the combination with a compressor-motor and main conductors, of a main switch controlling the motor-circuit, a magnet for operating said switch, a relay-magnet controlling the circuit of the main-switch magnet, a magnet for closing the relay-switch, having a connection with the motor-circuit between the motor and the main switch, a primary switch having a fluid-actuating connection with the compressor and adapted to automatically open and close said connection according to variations in the pressure produced by said motor, and an equalizing-conductor for connecting the main-switch magnet with corresponding magnets of other motor-circuits, substantially as described.

10. In controlling apparatus for electric motors, the combination with a compressor-motor and main conductors, of a main switch controlling the motor-circuit, a magnet for operating said switch, a relay-switch controlling the circuit of the main-switch magnet, two magnets for operating the relay-switch, a primary switch having maximum and minimum pressure contact-pieces connected with the coils of said magnets and a third contact-piece connected with the motor-circuit between the motor and the main switch, a fluid-actuating connection with the compressor for operating the primary switch according to variations in the pressure produced by said motor, and an equalizing-conductor for connecting the main-switch magnet with corresponding magnets of other motor-circuits, substantially as described.

In witness whereof I hereto affix my signature in presence of two witnesses.

WALTER J. RICHARDS.

Witnesses:
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