No. 815,304. PATENTED MAR. 13, 1906.

C. A. MUDGE.

SYSTEM OF ELECTRIC MOTOR CONTROL.

APPLICATION FILED JUNE 27, 1905.

2 SHEETS—SHEET 1.

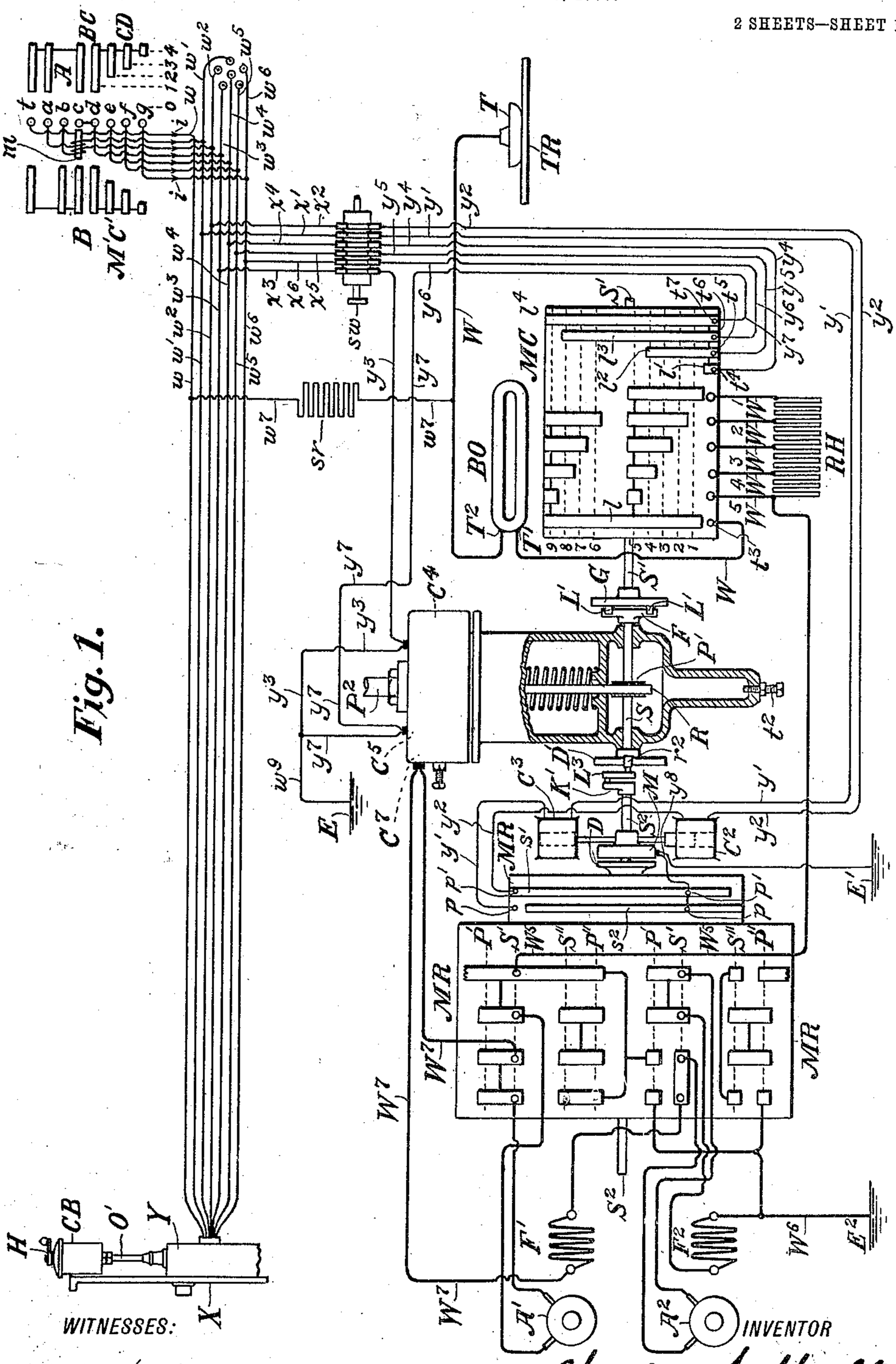

Fig. 1.

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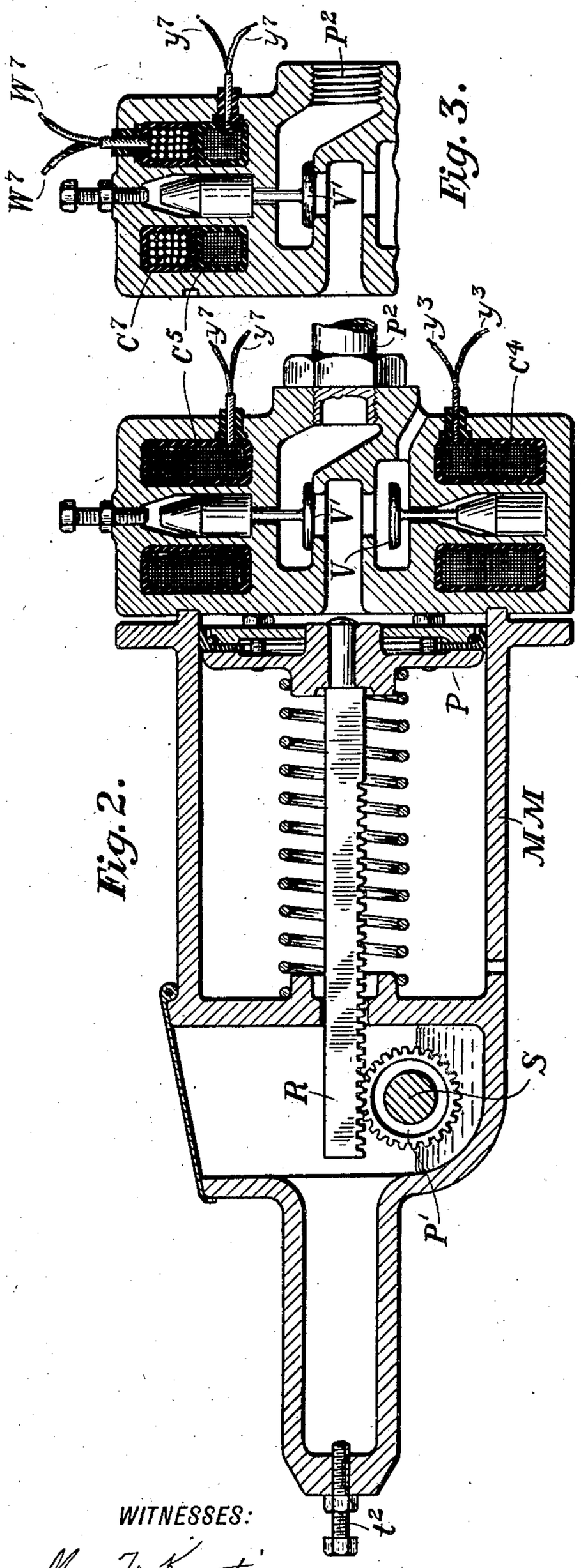


Fig. 2.

Fig. 3.

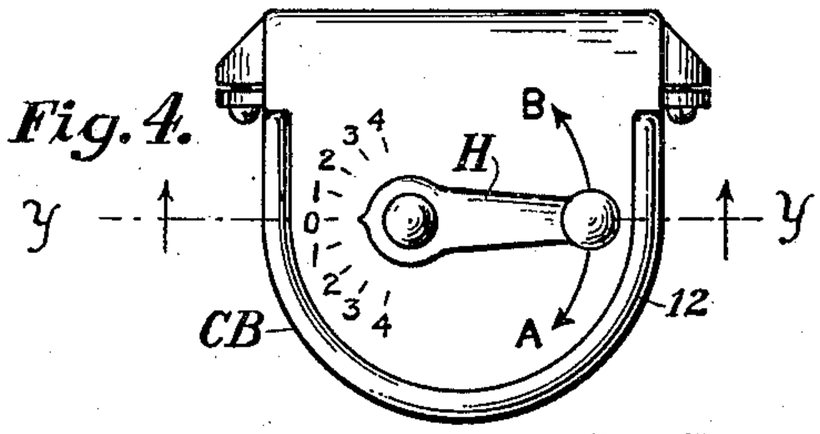


Fig. 4.

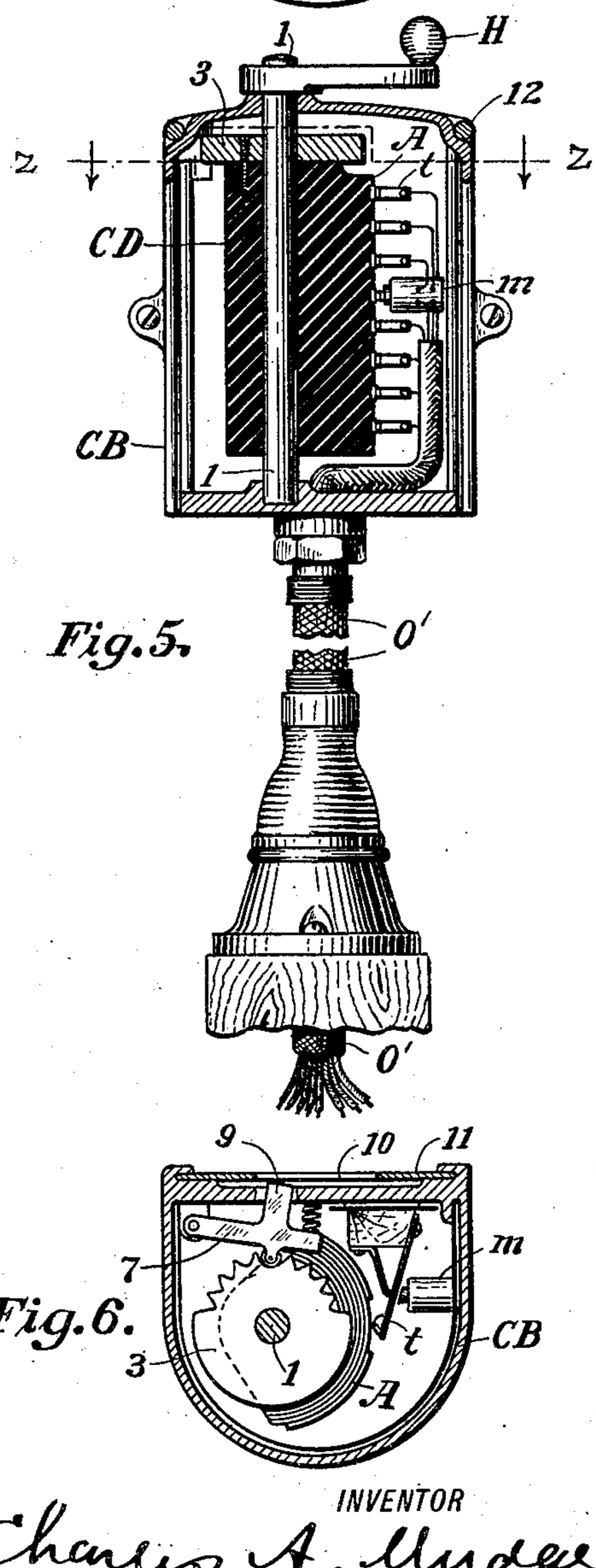


Fig. 5.

Fig. 6.

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## SYSTEM OF ELECTRIC-MOTOR CONTROL.

No. 815,304. Specification of Letters Patent. Patented March 13, 1906.

Original application filed March 2, 1905, Serial No. 248,121. Divided and this application filed June 27, 1905. Serial No. 267,204.

*To all whom it may concern:*

Be it known that I, CHARLES A. MUDGE, a citizen of the United States, residing in New York, borough of Manhattan, county and State of New York, have made a new and useful Invention in Systems of Electric-Motor Control, of which the following is a specification.

My invention relates particularly to improvements in systems of control for the motors of electrically-propelled cars or vehicles, although it is applicable generally to the control of electric motors where it is desired to operate the same at one or more relatively distant points, and the present application is directed to a modified form of apparatus disclosed in Figures 15, 16, 17, 18, 19, and 20 of the drawings of a prior patent granted to me on the 7th day of November, 1905, No. 804,156.

The objects of the present invention are substantially the same as those disclosed in the before-mentioned patent, the material points of novelty lying, essentially, in the structural device hereinafter described, and illustrated in the accompanying drawings, and particularly pointed out in the claims at the end of the specification.

For a full and clear understanding of my invention, such as will enable others skilled in the art to construct and use the same, reference is had to the accompanying drawings in which—

Fig. 1 is a diagrammatic view of this modified form of my improved system of control, illustrating the same as applied to an electrically-propelled car, the portable primary or master controller being shown on the left as attached to the dashboard thereof at one end of the car and on the right to the circuit-controlling contacts developed and operatively connected to the controlling-circuits, the main operating device being shown in part elevational, part sectional, view and operatively connected through rack-and-pinion gearing and shafting to the main controller and motor-circuit combiner and circuits and circuit connections, whereby the system may be effectually operated through the agency of compressed air, gas, or a liquid, illustrating also the application of means for preventing abnormal current-flow through the motors at any time and also for keeping the current-flow practically constant therethrough during acceleration. Fig. 2 is an enlarged sectional view taken through the main operating device, illustrating its operative connection through rack-and-pinion gearing with the primary driving-shaft and means for effecting the operation of said device through the agency of compressed air, gas, or a liquid, the controlling-valves being illustrated as electrically controlled. Fig. 3 is a detail sectional view taken through one of the coils and that part of the main controlling device which prevents abnormal current-flow through the motors at any time and also for keeping the current-flow practically constant therethrough during acceleration. Fig. 4 is a plan view of the primary or master controller of the drum or cylinder type, in which there is utilized a single controller-handle adapted to perform the functions usually attributable to the single controller-handle and reversing-lever of ordinary types of motor-controllers such as are used in electric-railway systems. Fig. 5 is a vertical sectional view taken through Fig. 4 on the line Y Y and as seen looking thereat from the bottom toward the top of the drawings in the direction of the arrows. Fig. 6 is a transverse sectional view taken through Fig. 5 on the line Z Z and as seen looking thereat from the top toward the bottom of the drawings.

In my prior patent above referred to, of which the present application is a division, reference is made to the advisability of locating the operative or controlling parts of a system of motors like that illustrated in the accompanying drawings at points relatively distant from the motors themselves and of effecting such control through the agency of currents of relatively small volume and a number of other desirable features attributable to the system described and claimed in the above-named patent and of which the system herein described and claimed is in the main a modified form, are pointed out. For the purpose of avoiding unnecessary prolixity in the present application reference is therefore had to the above-named patent as to these matters.

Referring now to the drawings in detail, it is to be noted at the outset that all of the controlling-conductors which connect the several parts of the system for the purpose of effecting the operation of the various appa-

ratus are represented by light lines and by the letters $w$ to $w^9$, inclusive, $x'$ to $x^6$, inclusive, and $y'$ to $y^8$, inclusive, while all of the conductors which convey the main or working currents to and through the main controller, the motor-circuit combiner, and the means for maintaining the current-flow to the motors practically constant during acceleration are represented by the heavy lines and letters W to $W^7$, inclusive.

In Fig. 1, CB represent the primary or master controller, shown at the left of the figure as incased in the metallic box and at the right as having its cylinder developed, being provided with movable contacts A, B, and BC, A being "ahead" and B "back" contacts. *sw* is a multiple switch for disconnecting all of the conductors $x'$ to $x^6$, inclusive, from the circuit. *sr* is a secondary resistance for limiting the current-flow from the main or working circuit W to the control-conductor *w*. MM is the main operating device, (illustrated in detail in Figs. 2 and 3,) which shows plainly the parts operated by compressed air as well as those operated by electrical energy. MC is the main controller, and RH is a main resistance divided into sections, as shown, and connected by the conductors W′ to $W^5$ to stationary contact-fingers in the main controller, and MR is the motor-circuit combiner. The movable contact-strips for cutting the resistance into and out of the circuit are carried by the drum of the main controller MC, which is supported by the shaft S′ and the motor-circuit combiner MR by the shaft $S^2$, both shafts being connected to the shaft S, which is journaled in the supporting-frame of the main operating device MM. $C^2$ and $C^3$ are solenoid-coils for operating the motor-circuit combiner MR and are included in the control-circuits $y^2$ and $y'$. A′ $A^2$ F′ $F^2$ represent the armatures and field-coils of two electric motors of the series type connected to the contact-fingers of the motor-circuit combiner MR. The main controller MC is represented as being of the drum or cylinder type, the construction and operation of which is familiar to those in the art and is shown as opening the motor-circuit in passing from series to parallel combination of the motors. I do not limit myself to this particular construction, as it is evident that any other construction which could be operatively connected to the shaft S′ might be used in its stead. The motor-circuit combiner MR, which is carried by the shaft $S^2$, is the same as that described in my before-mentioned prior patent, and reference may be made to the text and drawings thereof for a detail description of its construction and operation.

Referring to Fig. 2, I will describe the main operating device MM. The piston P is located in an air-cylinder and is provided with a rack R and a return-spring, said rack being geared to the pinion P′ and main shaft S. P′ is an inlet-pipe running to a supply of compressed air or gas, (not shown,) and V′ V are respectively the main and exhaust valves. $C^5$ and $C^4$ are solenoids for controlling the movement of the valves V′ and V, the arrangement being such that when air is admitted through the valve V′ it moves the piston P from right to left against the action of the spring, and when exhausted through valve V the piston moves from left to right under the return action of the spring.

In Fig. 3 is shown the means applicable to this form of the invention for preventing abnormal current-flow through the motors at any time and also for keeping the current-flow practically constant therethrough during acceleration. In this part of the apparatus the coils $C^7$ and $C^5$ are so related that as the current in the coil $C^7$ increases it produces a field tending to weaken that produced by the coil $C^5$, thus allowing the valve V′ to close, which shuts off the air-supply and stops or retards the forward movement of the piston P. In the wiring of each car the conductors *w* to $w^6$, inclusive, are preferably inclosed in a flexible conduit or cable, like O′, and at each end of the car these conductors are provided with contacts, as shown diagrammatically at the right of Fig. 1 for the purpose of effecting the electrical connections of one or more cars, so as to make the system of control applicable to train service, a flexible interconnecting cable between each pair of cars being provided with contacts for connecting the adjoining sets of contacts above referred to, it being understood that when a number of cars are thus connected together the system of control is of the type known as the "multiple-unit" system. Tr represents the trolley-conductor or third-rail, and T the current-collector or trolley-shoe.

Referring now to Figs. 4, 5, and 6, and first to Fig. 6, I will describe the especial form of primary or master controller applicable for use in connection with this novel modified system of my invention. CB represents the primary or master controller inclosed in a metallic box, as shown, the same being illustrated in Fig. 1 as attached directly to the dashboard X on one of the platforms of a car through the agency of a locking-plate 11, having a slot 10, the arrangement being such that the controller can only be removed when the locking-pin 9 and lever 7 are in the position shown in Fig. 6, all substantially as described and shown in the before-mentioned prior patent and in which patent claims are embodied with relation to this particular feature of locking the master-controller permanently in position at all times when the controller-handle is in any other position than what is known as "off" position. *m* represents an electromagnet which is provided with two energizing-coils, one in circuit with the stationary contact *a* and the controlling-

conductors $w'$ $x'$ $y'$ and the other with the stationary contact $b$ and controlling-conductors $w^2$ $x^2$ $y^2$, running, respectively, to the reversing-solenoids $C^3$ $C^2$, the armature of the electromagnet being placed directly above the yielding supported contact $c$ in such manner as to hold said contact away from the A or B contacts, according as the handle H is rotated either to the left or to right when the magnet $m$ is energized, as will be more particularly described in connection with the description of the mode of operation.

The several indicated positions for ahead and back are directly on the top plate of the controller and indicated by the numerals 1 2 3 4 in either direction from the numeral 0 indicating the off position, and the other numerals the ahead or back positions, according as the handle is turned, as shown by the curved arrows. (See Fig. 4.)

Referring now to the diagrammatic view illustrated in Fig. 1, I will describe the mode of operation upon the suppostion that the portable primary or master controller CB has been transferred from the position shown at the left of the drawing to the right-hand position, where the operating-contacts are shown as developed. With the contacts in the position shown in this development there is electrical potential from the trolley T through the conductor W to the point $t^3$ on the main controller MC, an additional potential occurring through the branch conductor $w^7$, through the secondary resistance $sr$ to conductor $w$, and thence to contact-finger $t$ of the master-controller. For forward running the contacts A and BC are moved under the contact-fingers to position marked "1," which completes the circuit from $t$ to $a$, through the magnet $m$, to conductor $w'$ $x'$ $y'$, through solenoid-coil $C^3$, to the stationary brush $p$ on the drum of the motor-circuit combiner MR, where the circuit is interrupted, which means that the motors are properly connected for a forward motion of the car as observed from the right-hand platform. If a reverse motion of the car is desired, the contacts B of the master-controller are moved under the contact-fingers to a position "1" corresponding to that in the forward position, which completes the circuit from $t$ to $b$ through the magnet $m$, raising the finger $c$ from its contact-strip, to conductor $w^2$ $x^2$ $y^2$ through solenoid-coil $C^2$, to the stationary brush $p'$, contact-strip $s'$, conductor $y^8$, coil of the magnetic clutch M, to earth at E'. Current flows through this circuit and energizes the solenoid $C^2$, which attracts its core. The magnetic clutch M is attracted and held fast to the disk D, which is attached to the shaft $S^2$, and the motor-circuit combiner MR is rotated until the current is interrupted by the contact-strip $s'$ passing from under the lower right-hand brush $p'$ as it slides off the contact-strip $s'$, which takes place when the circuit-connecting contact-fingers carried by the motor-circuit combiner MR are in the position S'', giving proper connections for a reverse motion of the car as observed from the right-hand platform. As soon as the motor-circuit combiner is in its proper position the circuit is interrupted and the magnet $m$ in the master-controller is deënergized, allowing the contact-finger $c$ to fall on its contact-strip, which completes the circuit $d$ $w^3$ $x^3$ $y^3$, coil $C^4$ to earth at E, closing the exhaust-valve V.

Position "2" of the master-controller establishes the circuit $e$ $w^4$ $x^4$ $y^4$ $t^4$ $l'$ $l^4$ $t^7$ $y^7$, coil $C^5$, to earth at E. This opens the valve V', admitting compressed air or gas through the inlet-pipe $P^2$ to the rear of the piston P, driving it forward, and thus rotating the main controller MC until the contact at $t^4$ $l'$ is broken, which interrupts the current through the coil $C^5$, and the valve V' drops, cutting off any further air-supply, and the main controller MC is held in position "1," which is the first running position of the motors—series combination with all resistance in circuit. Position "3" of the master-controller advances the main controller in a similar manner to position "5"—motors in series combination with all resistance out of circuit

Position "4" of the master-controller advances the main controller to position "9"—motors in parallel combination with all resistance out of circuit. Between positions "5" and "6" of the main controller the motor-circuit combiner operates to throw the motors into parallel. This is effected by the cam D', Fig. 1, moving the roll $r^2$, which is attached to the crank-arm K' through the link $L^3$ away from the center of the shaft S, thus turning the crank-arm K' and the attached shaft $S^2$ with the cylinder of the motor-circuit combiner MR through an angle sufficient to move the contact-strips far enough so that the contact-terminals of the motor-circuit combiner shall take the position P' or P'', giving parallel combinations of the motors for forward or reverse running. Inasmuch as this operation takes place while the motor-current is interrupted, no arcing can possibly occur at the motor-circuit-combiner terminals, and hence no arc-interrupting device is required.

If it is desired to run at a speed corresponding to any other than positions "1," "5," or "9" of the main controller, the master-controller is returned to position "1" when the desired speed has been reached. This arrests any further movement of the main operating device and the main controller. To cut the motors out of circuit, the master-controller is returned to off or 0 position, which interrupts all control-circuits and the valve V of the main operating device opens, allowing the air in the cylinder to exhaust, and the

piston P is returned by the spring to its off position, as illustrated in Fig. 2.

Fig. 3 represents the means employed for obtaining a constant acceleration of the motors as well as for keeping the motor-current within a predetermined limit. The coil $C^7$ is connected in either series or shunt with one of the motors, the same being represented in Fig. 1 in series, and the magnetic field produced by it varies with the motor-current. The valve V′ is adjusted to open wide enough through the influence of the coil $C^5$ to give the piston P and its connecting parts a speed which would tend to cut the resistance out of circuit too rapidly, thus starting the motors up too quickly. As the motor-current increases above an amount which produces a torque sufficient for the desired acceleration, the current in coil $C^7$ produces by its differential action a field which weakens that produced by coil $C^5$ and the valve V′ closes, thereby retarding the movement of the piston P and the cutting out of the main resistance in the motor-circuit. As the counter-electromotive force of the motors increases the current in the coil $C^7$ is decreased, allowing the valve V′ to open again and the piston P to move more rapidly. In this manner the current in the motor-circuit is kept practically constant during the starting of the motors and is also kept from exceeding a predetermined value. This feature also makes it possible to turn the master-controller immediately to the full parallel running position, the car starting forward at a predetermined acceleration independent of the will of the motorman.

In case the motor-current is interrupted at any time during the operation of the main operating device—as, for instance, in passing from series to parallel with the form of main controller shown in Fig. 1—the valve V′ would open widely, allowing this transition to be made very rapidly. This is due to the fact that the current in the coil $C^7$, Fig. 3, is interrupted, and consequently there is no opposing field to that formed by the coil $C^5$, which acts to open the valve V′ to its fullest extent, thereby allowing more air to rush in behind the piston P, thus driving it rapidly forward, the main controller being turned quickly to a parallel position, having the same current value per motor that the last series position had. This automatic feature insures the shortest interruption of current, and hence motor torque, in that form of controller which opens the circuit between the series and parallel combinations of motors. If the trolley-current is interrupted at any time, all of the apparatus controlling the motor-currents returns immediately to the off position without any action on the part of the motorman, and if he does not return the master-controller to the off position before the trolley-current is again established the motor-controlling apparatus is automatically turned into that position corresponding to the speed of the car at the time the trolley-current was reëstablished.

I do not limit my invention to the numerous details of construction illustrated in the accompanying drawings and hereinbefore described, as a number of the features thereof might be materially departed from and still come within the scope of my claims hereinafter made.

I also desire it understood that while I have shown my means of motor control as applicable to two motors of the series type I do not wish to be limited specifically to this combination, as the same might be applied to any number of motors, either of the direct or alternating current type.

It is of course obvious that numerous details in the nature of hand-switches, fuses, circuit-breakers, &c., are purposely left out of the drawings, so as to avoid confusion.

I am aware that there are many systems of motor control in which the current-controlling devices are operated pneumatically; but to my knowledge there are none in which these devices are operated by the continued application of a fluid medium. Most of the systems heretofore proposed and constructed operate either by step-by-step motion of the controller produced by the reciprocating motion of an air-piston or the successive closing of contacts through separately-operated pneumatic devices. In the system herein described the pneumatically-operated device advances far enough in one direction to turn the controller through the different running positions of the motors either in a step-by-step motion or a continuous motion, depending upon the way in which the master-controller is operated and also upon the value of the current in the motor-circuit. For instance, if the current is turned on while the car is coasting the main operating device is turned rapidly forward, advancing the controller to a position corresponding to the speed, after which it proceeds in a step-by-step motion until the motors are in the position indicated by the handle of the master-controller. The manner in which this important feature is attained is new, as far as I am aware, and the claims appended hereto are intended to include it.

Having thus described my invention, what I claim, and desire to secure by Letters Patent of the United States, is—

1. In a system of motor control fluid means operatively connected with current-controlling devices; in combination with independent inlet and exhaust valves therefor and independent electromagnetic means for operating said valves, whereby said fluid means is operated through successive steps by the continued application of a fluid medium, substantially as described.

2. In a system of motor control fluid means operatively connected with current-controlling devices; in combination with independent inlet and exhaust valves therefor and independent electromagnetic means for operating said valves; together with a master-controller provided with indicating means, the fluid means being advanced by the continued application of a fluid medium, substantially as described.

3. In a system of motor control fluid means operatively connected with current-controlling devices, said fluid means embracing a piston, a cylinder and independent electrically-controlled valves therefor, the arrangement being such that the piston is advanced by the continued application of a fluid medium, substantially as described.

4. In a system of motor control pneumatic means operatively connected to current-controlling devices, said means embracing a piston, and independently-operated valves for advancing the piston through the continued application of a fluid medium; in combination with a master-controller provided with indicating means, substantially as described.

5. In a system of motor control pneumatic means operatively connected with current-controlling devices; in combination with electromagnetic control-valves therefor, and circuit connections whereby the speed at which the pneumatic means operates is made dependent upon the motor-current, and the movement of the operative parts of the pneumatic means is made continuous by the application of a fluid medium, substantially as described.

6. In a system of motor control pneumatic means operatively connected with current-controlling devices; in combination with electrically-operated valves independently controlled for stopping and retaining said controlling devices in different positions, the operative parts of the pneumatic means being advanced by the continued application of a pneumatic medium, substantially as described.

7. In a system of motor control a master-controller, a main pneumatic operating device and electrical connections therefor, whereby the operating device is continuously advanced through successive steps by the application of a pneumatic medium made dependent upon the motor-current; in combination with current-controlling devices operatively connected to the main operating device, and means at the master-controller for indicating the different steps, substantially as described.

8. In a system of motor control a main operating device, current-controlling means mechanically connected thereto, a master-controller electrically connected thereto, and circuits and circuit connections between the motors and the main operating device, whereby the movable parts of said main operating device are advanced at a rate made dependent upon the motor-current through successive steps by the continued application of a pneumatic medium, said master-controller being provided with means for indicating any definite step, substantially as described.

9. In a system of motor control a controller; a pneumatic main operating device therefor provided with electromagnetic means of control embracing two circuits one of which is included in the motor-circuit proper and embraces an electromagnetically-controlled valve, whereby the motor-current is kept practically constant at starting, substantially as described.

10. In a system of motor control a controller; a main operating device provided with pneumatic means for advancing it through successive steps; in combination with additional means embracing two electric circuits so related that the effects produced by one of said circuits tend to neutralize those of the other circuit, thereby maintaining the current-neutralizing circuit within a predetermined value, substantially as described.

11. In a system of motor control a main operating device pneumatically operated and current-controlling devices connected thereto, the said main operating device embracing an electrically-controlled valve which operates in such a manner that the current-controlling devices tend to keep the motor-current constant during the starting of the motors as well as to prevent said current from exceeding a predetermined value during the operation of the motors; the electrically-controlled valve being operated by the combined influence of the motor-current, or a part thereof, and an independent current thereto, substantially as described.

12. In a system of motor control a controller; pneumatic operating means therefor; in combination with two independent controlling-circuits including an electromagnetically-controlled valve adapted to operate in such manner that the motor-current is maintained practically constant during starting, substantially as described.

13. In a system of motor control a controller; pneumatic operating means therefor; in combination with two independent controlling-circuits therefor, one of which is included in the motor-circuit and both of which include an electromagnetic controlling-valve, the arrangement being such that the combined current effects of said circuits maintain the motor-current within a fixed value during the operation of the motors, substantially as described.

14. In a system of motor control a controller and pneumatic operating means therefor; in combination with valves and controlling-electromagnets therefor; together with circuits and circuit connections whereby the

normal speed of the operating means is automatically increased or decreased by the operation of the said parts when the motor-current is below or above a definite value, substantially as described.

15. In a system of motor control a main controller; a main pneumatic operating device connected thereto; a master-controller provided with means for indicating the various steps; in combination with circuits and circuit connections between all of said parts whereby the main operating device and the main controller are advanced continuously, step by step, and the movements thereof indicated at the master-controller, substantially as described.

16. In a system of motor control for electric-railway cars a series of control-circuits on each car and interconnecting contacts and conductors whereby the control-circuits of one car may be connected to the corresponding circuits of another car; a portable master-controller adapted to be utilized on any car; in combination with electric motors and current-controlling devices on one or more cars, said devices being operated by a single pneumatic operating device located on each car and advanced through successive steps at a speed depending upon the motor-current by the continued application of a pneumatic medium and electrically controlled by the master-controller from any of the said cars, substantially as described.

17. In a system of motor control for electric-railway cars coupled together to form a train, control-circuits on each car and interconnecting contacts and conductors whereby the control-circuits on one car may be connected with those of the adjoining car; in combination with electric motors on one or more cars, a single pneumatic operating device operated on each car and advanced through successive steps at a speed depending upon the motor-current by the continued application of a pneumatic medium, said operating device being connected to current-controlling devices together with a portable master-controller adapted to be used on any car in the train, said master-controller being so connected to the current-controlling devices and the pneumatically-operating device through the control-circuits that it controls and indicates at all times the combinations of the motors, substantially as described.

18. A master-controller embracing means whereby the forward or reverse connections and the running combinations of the motors it controls are made through the operation of a single handle; in combination with electromagnetic means embracing a part of the master-controller and operating so that the motors receive current only after the said forward or reverse connections have been made, substantially as described.

19. In a system of motor control a motor-circuit combiner, a main controller, and a portable master-controller embracing electromagnetic means for so governing the operation of the motor-circuit combiner and the main controller that the latter cannot be operated until the former is in a position giving either forward or reverse connections of the motors, substantially as described.

20. In a system of motor control a master-controller embracing a magnet adapted to attract a contact-finger away from its contact-strip and to thus interrupt a circuit controlling the operation of a main controller, said circuit remaining interrupted until a motor-circuit combiner has operated to give the forward or reverse connections of the motors, thereby making it impossible for the motors to receive current before they have been properly connected, substantially as described.

21. A portable master-controller embracing a single contact-cylinder operated by a single handle through which the forward, reverse and running combinations of the motor or motors it controls are made, said controller being so arranged that it cannot be removed from its seat without first interrupting all circuit connections through it, substantially as described.

22. A portable master-controller embracing electromagnetic means, circuits and circuit connections such that it is impossible for the motors controlled to receive current before they are interconnected for a forward or reverse rotation, and means at the master-controller for indicating the same.

23. In a system of motor control for electric-railway cars a portable master-controller adapted to be connected at different points in a control-circuit extending throughout the cars, one or more of which is supplied with electric motors and suitable controlling apparatus; said apparatus being operated by a single fluid-operating device located on each motor-car and controlled by electric means through the master-controller, substantially as described.

24. In a system of motor control a controller connected with pneumatic means for operating it; in combination with regulating means and circuits and circuit connections whereby said pneumatic means operates more rapidly when the motor-current falls below a predetermined value and operates slower, or stops entirely, when the motor-current exceeds this value, substantially as described.

25. Two or more electric motors and a main resistance therefor; in conbination with electrically-controlled pneumatic means for effecting various relations between the motors and the resistance; together with means for interrupting the motor-circuit, said pneumatic means being so constructed that its

movable part will advance at increased speed during the intervals that the motor-circuit is interrupted, substantially as described.

26. In a system of motor control pneumatic means for operating the motor-controlling apparatus; in combination with electromagnetic means for so controlling the operation of said pneumatic means that the speed of operation is inversely proportional to the motor-current, substantially as described.

27. In a system of motor control, a main controller; a pneumatic operating device connected thereto and provided with an exhaust-valve adapted to be operated by a single control-magnet included in the control-circuit, the arrangement being such that if the current-flow through said magnet be interrupted at any time during the operation of the motors the controlling apparatus will be automatically turned to its "off" or open-circuit position by said pneumatic device, substantially as described.

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

CHARLES A. MUDGE.

Witnesses:
C. J. KINTNER,
M. F. KEATING.