No. 739,572. PATENTED SEPT. 22, 1903.

A. H. ARMSTRONG.

SYSTEM OF MOTOR CONTROL.

APPLICATION FILED JUNE 15, 1900.

NO MODEL. 2 SHEETS—SHEET 1.

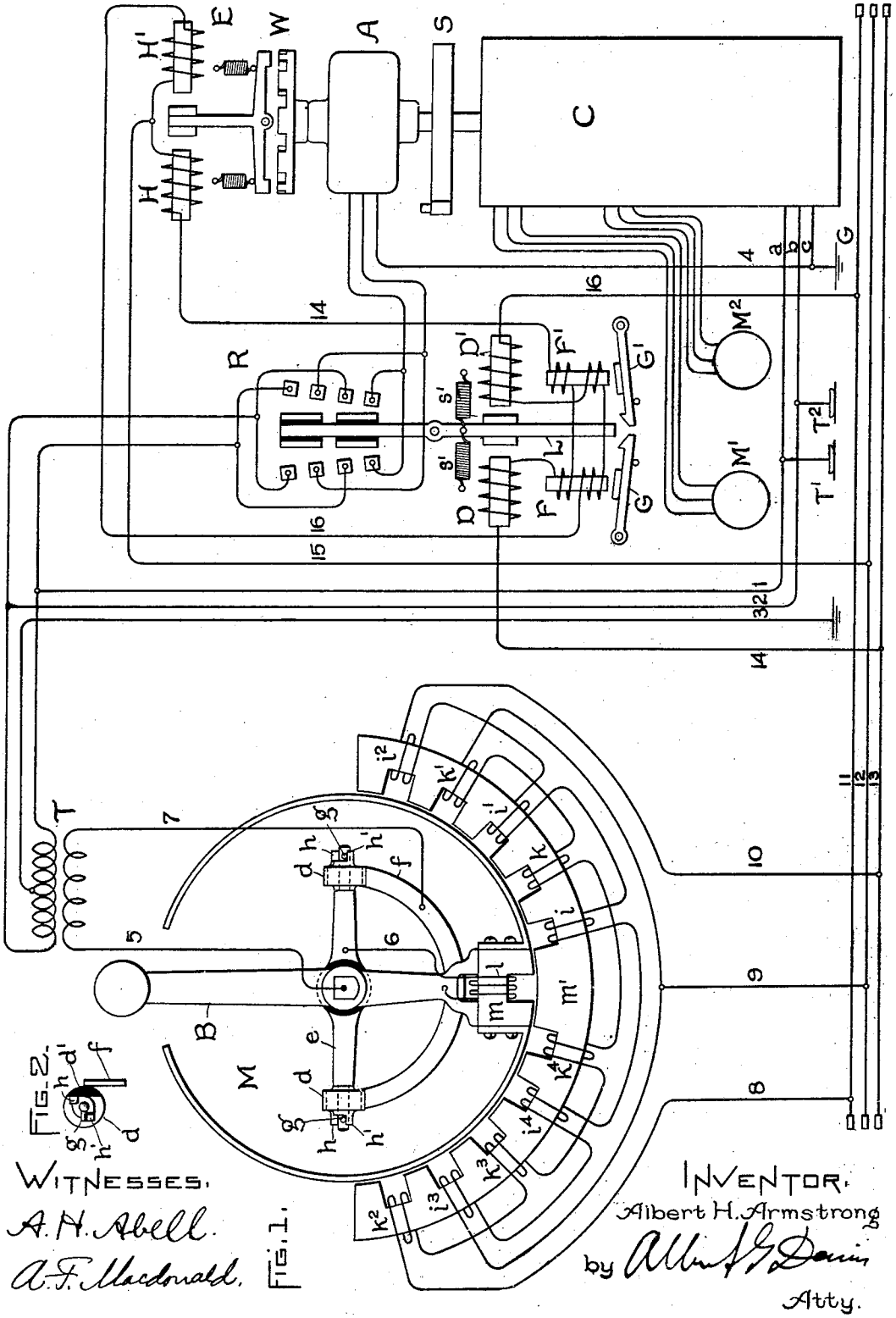


FIG. 1.

FIG. 2.

WITNESSES.

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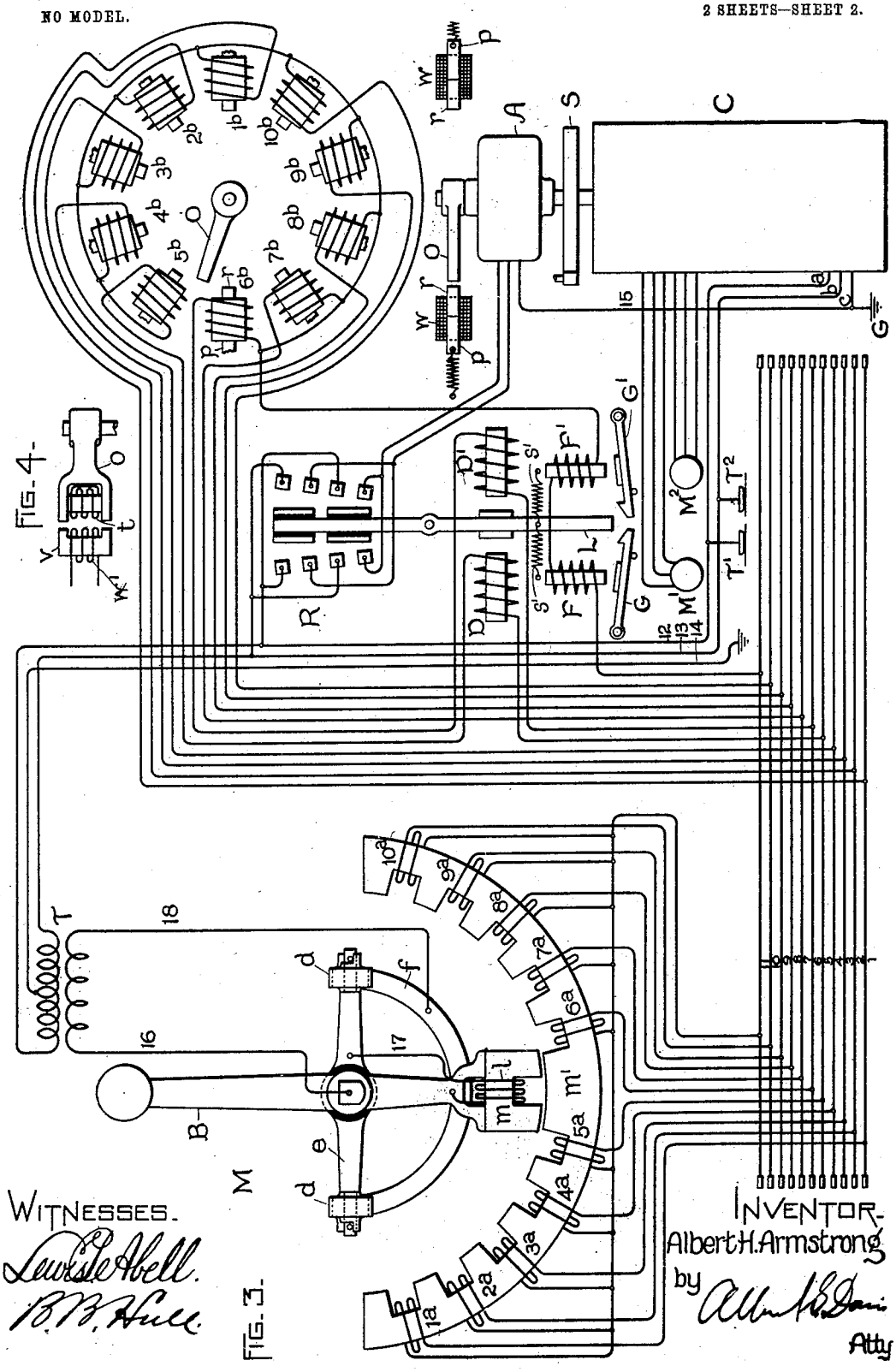


FIG. 4.

FIG. 3.

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No. 739,572. Patented September 22, 1903.

UNITED STATES PATENT OFFICE.

ALBERT H. ARMSTRONG, OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

SYSTEM OF MOTOR CONTROL.

SPECIFICATION forming part of Letters Patent No. 739,572, dated September 22, 1903.

Application filed June 15, 1900. Serial No. 20,384. (No model.)

To all whom it may concern:

Be it known that I, ALBERT H. ARMSTRONG, a citizen of the United States, residing at Schenectady, county of Schenectady, State of New York, have invented certain new and useful Improvements in Systems of Motor Control, of which the following is a specification.

My invention relates to a control system for alternating-current motors, and has for its principal object to provide a system especially adapted for the operation of a train of cars supplied with current from an alternating-current source. Train-control systems have heretofore been devised for simultaneously controlling the operation of a plurality of motors or motor equipments from any desired point on a train, and in such systems there have been provided propelling-motors and controllers therefor upon one or more cars of the train, together with pilot-motors for driving the motor-controllers and master-controllers located at any desired points on the train, from any one of which the pilot-motors on the several cars may be simultaneously operated. In those systems in which the control is electrical the master-controller generally consists of a switch provided with fixed and movable contacts through which current is supplied in different positions of the master-controller to different controlling-circuits. When alternating currents are used, it is preferable never to open the controlling-circuits, for the reason that in alternating-current systems it is difficult to extinguish the arc which is formed at the time the circuit is broken; and one of the features of my invention consists in so constructing the master-controller that current may be supplied from an alternating-current source to the controlling-circuits without at any time opening a circuit through which current is flowing.

My invention also comprises a novel transformer construction and a novel switch for controlling the circuit connections between the source of supply and the transformer.

Another feature of my invention consists in so arranging a reversing-switch for each pilot-motor that it will be thrown one way or the other whenever the master-controller is moved into its first operative position and will then be locked in the position into which it has been thrown.

My invention will be more clearly understood by reference to the following description, taken in connection with the accompanying drawings, while its scope will be pointed out in the appended claims.

Referring to the drawings annexed to this specification, Figure 1 shows diagrammatically a system of control arranged according to my invention. Fig. 2 shows a detail in the construction of the master-controller. Fig. 3 shows a modified system of control, and Fig. 4 shows a modified form of the stop for the motor-controller in Fig. 3.

In illustrating my invention I have shown only a single motor-controller with its controlling devices connected to a system of conductors, to which are also connected the leads from a master-controller. This system may be of any desired length and may have connected thereto any desired number of controlling devices and any desired number of master-controllers. As shown in the drawings, the system of conductors is supposed to represent the train-conductors of a single car in a train-control system, terminal connections being indicated at each end of each of the conductors by means of which they may be connected to the corresponding conductors of the next adjacent car. Since the arrangement of motor-controllers and master-controllers in a train-control system is now well understood in the art, it is not deemed necessary to illustrate the system as actually applied to a train, it being evident that the train system involves only a duplication of the elements of the single equipment shown in the drawings.

Referring to Fig. 1, C indicates the motor-controller for the two alternating-current motors indicated by the circles M' M^2. The controller C is operated in either direction by means of an alternating-current motor A of any desired type mounted on or suitably geared to the shaft of the controller. In order to return the controller to its off position when the circuit of the pilot-motor is opened, a spring S is provided. The operation of the motor A, and therefore the movement of the controller C, is controlled by means of a lim-

iting device or escapement E, which is actuated by the two electromagnets H and H′ to engage a notched wheel mounted upon the shaft of the controller. In order to operate the pilot-motor A in one direction or the other, a switch R is provided for reversing the connections of two of the alternating-current leads through which current is supplied to the motor. This reversing-switch is actuated by means of the electromagnets D and D′ and is locked in one or the other of its operative positions by means of the latches G and G′, carried by the armatures of the electromagnets F and F′.

In the particular system shown in Fig. 1 of the drawings the source of supply is supposed to be three phase, and three-phase currents are supplied to the system through the two trolley-shoes T' T^2 and the ground connection G. Conductors *a*, *b*, and *c* lead from the trolley and ground connections to the controller C, through which current is supplied to the motors M' M^2. In order to supply current to the pilot-motor A, a permanent connection between one of the terminals of said motor and ground is established through the conductor 4, and the other terminals are connected to the trolley-shoes through the reversing-switch R and the conductors 1 and 2. A transformer T, the function of which will be hereinafter explained, is also supplied with three-phase current through the conductors 1 2 and a ground connection through the conductor 3.

The operating-circuits for the electromagnets D D′, F F′, and H H′, by means of which the operation of the controller C is controlled, are connected to a system consisting of three conductors 11, 12, and 13. These conductors, as shown in the drawings, are represented as of a length suitable for a single car of a train and in a train system would be connected with the corresponding conductors of the other cars, so that all the controller-operating devices would be connected to the conductors 11, 12, and 13 or continuations thereof, and therefore in multiple with each other.

In order to operate the controlling devices of the several motor-controllers, master-controllers are located at any desired points on the train, (usually one at each end of each motor-car,) and these master-controllers are so connected to the system comprising the conductors 11, 12, and 13 that whenever any one master-controller is operated the controlling devices for all the motor-controllers on the train will be correspondingly operated. One of these master-controllers is shown at M and is connected to the train-conductor system by means of the leads 8, 9, and 10. It comprises a U-shaped core of magnetic material, *m*, mounted on the end of a pivoted arm B and arranged in coöperative relation with a member *m′*, of magnetic material, shaped in the arc of a circle having its center at the pivot from which the member *m* is supported and provided with a series of notches corresponding to the U-shaped notch in the member *m*. The controlling devices of the several motor-controllers are operated by current generated in secondary windings on the member *m′*. Each of the notches of this member constitutes a slot, within which a coil is wound, and these coils connected in two series, each comprising every alternate winding, are joined to the conductors 11, 12, and 13 through the conductors 8 and 10 and the common conductor 9. These windings are normally inoperative; but current is caused to flow in one of the series whenever the primary winding *l*, mounted on the member *m*, is brought into inductive relation with any one of the said secondary windings. The primary winding is supplied with current from the single-phase secondary winding of the transformer T, the primary of which, as already described, is connected to the three-phase source through the conductors 1, 2, and 3, leading to the trolley-shoes T' T^2 and ground connection G.

The terminals of the secondary winding of the transformer T are connected the one to the segment *f* and the other through the arm B to one terminal of the primary winding *l*, the other terminal of said winding being connected to an arm *e*, mounted to turn with the arm B, but insulated therefrom. The arm *e* carries at each end a contact device *d* in the shape of a roller, having a portion of its cylindrical surface of insulating material, as shown at *d′* in Fig. 2. These rollers are mounted in suitable bearings on the end of the arm *e* and have a limited rotary movement, the extent of such movement being determined by the projections *h* *h′*, which, as the roller is revolved in one direction or the other, engage with a pin *g* in the shaft upon which the roller rotates.

With the parts in the position shown in Fig. 1 of the drawings each of the rollers *d* has its insulated portion resting on the segment *f*, and therefore the circuit leading from the secondary of the transformer T to the primary winding *l* on the member *m* is broken. If, however, the handle B is turned either to the right or to the left to bring the primary winding *l* into coöperative relation with one of the secondary windings *i* or k^4, one of the rollers will pass off from the end of the segment *f* and the other will turn on its bearing until its conducting portion is brought into contact with the said segment. Suppose, for example, that the arm B is moved left-handedly until the primary winding *l* is brought opposite the secondary winding *i*. The initial movement of the arm causes the roller *d* on the right to pass off the segment *f*, while the roller *d* on the left is caused to rotate until the abutment *h* comes into contact with the pin *g*, after which any further movement of the arm left-handedly will cause the roller *d* to slide over the segment *f* with its conducting portion in contact with the said seg-

ment. Current will then be supplied from the secondary winding of the transformer T through the conductor 5 and a portion of the arm B to one terminal of the primary winding *l*, the other terminal of the primary winding being connected to the other terminal of the secondary of the transformer T through the arm *e*, the roller *d* on the left, the segment *f*, and the conductor 7.

The operation of the entire apparatus is as follows: Supposing the arm B to be moved in left-handed rotation, as above described, until the primary winding on the member *m* is brought into coöperative relation with the secondary winding *i*, a current will be generated in said secondary winding which will flow through the windings i' and i^2, connected in series with the winding *i*, to the conductor 10 and thence to the train-conductor 13, from which it will flow to each of the controller-operating devices as follows: through the winding of the electromagnet D, through a winding on each of the electromagnets F F′ to the winding of the electromagnets H, returning by way of conductor 15 to the conductor 12 of the train system, from whence it will flow through the conductor 9 and the secondary windings i^3 and i^4 of the master-controller to the other terminal of the secondary winding *i*. Current flowing through this circuit causes the electromagnet D to throw the reversing-switch lever L to the left against the tension of its centering-springs s' s', in which position it is held by the latch G, actuated by the electromagnet F, to engage the end of the lever L. At the same time the electromagnet H causes the escapement E to be drawn over until the left-hand tooth of said escapement engages the notched wheel W. As soon as the reversing-switch lever L is thrown the motor A is supplied with current through the conductors 1, 2, and 4. It therefore starts in operation and turns the movable element of the controller C until the edge of one of the notches in the wheel W is brought into contact with the tooth of the escapement, at which time the controller C reaches its first operative position. If now it is desired to move the controller into its second operative position, the master-controller will be moved forward until its primary winding *l* is brought into coöperative relation with the secondary winding *k*, when the current will flow as follows: starting from one side of the secondary winding *k*, through the secondary winding k', by way of conductor 9 to conductor 12 of the train-control system, whence it will flow through the conductor 15 to the electromagnet H′, actuating the escapement, so as to throw its right-hand tooth into engagement with the notched wheel W, through the lower windings on the electromagnets F and F′, and thence through the electromagnet D′ to the train-conductor 11, conductor 8, secondary windings k^2, k^3, and k^4 back to the other terminal of the secondary winding *k*. Although by this movement of the master-controller the circuit through the electromagnet D is broken and that through the electromagnet D′ completed, the reversing-switch lever will not be operated to reverse the terminals of the motor A, for the reason that the locking device G will still hold the reversing-switch lever in the position into which it was first thrown, the sum of the currents in the two windings of the magnets F and F′ remaining substantially constant while the system is supplied with current. The escapement E will, however, be thrown in the manner above described and the motor A permitted to revolve until the edge of a second notch has come in contact with the right-hand tooth of the escapement, thereby bringing the controller C into its second operative position.

In order to bring the motor-controller into its third operative position, the master-controller will be moved until the primary *l* is in coöperative relation with the secondary i', when current will be supplied to the electromagnet H through one of the circuits already described and the escapement caused to engage the notched wheel W at the left. It will thus be seen that so long as the handle of the master-controller is moved forward step by step in the same direction the escapement E will be actuated so as to permit the motor A to move the motor-controller C forward one step for each different position of the master-controller. As soon, however, as the master-controller handle is turned in the opposite direction the circuit of the primary winding *l* will be broken at the roller *d* on the left and during the further backward motion of the controller-handle will remain broken. All the controlling devices of the motor-controller will be deënergized, the reversing-switch opened, and the spring S will return the controller to its off position.

In order to operate the motor-controller in the opposite direction, the handle of the master-controller will be turned in right-handed rotation, when the roller *d* at the left will pass off from the segment *f* and the roller *d* on the right will turn until its abutment *h* comes into contact with the pin *g*, after which it will slide along its segment *f* with its conducting part in contact with the said segment. As the handle is moved forward the primary winding *l* will be brought successively into coöperative relation with the secondary windings k^4, i^4, k^3, i^3, and k^2, thereby first throwing the reversing-switch lever L to the left, in which position it will be locked by the latch G′ and in the successive positions of the master-controller operating the escapement E, so as to permit the motor A to move the controller C forward in the opposite direction one step for each movement of the master-controller.

In order to reduce the self-induction of the several secondary coils of the master-controller which are included in circuit with the active coil, but are not generating current, two copper segments are arranged, one on

each side of the primary member m, so that they will be in close inductive relation to all of the secondary windings, save the one which is for the time being generating current. The primary member of the master-controller will be drawn with considerable force into each one of its operative positions as the arm B is rotated, by reason of the fact that the magnetic attraction is strongest at these positions. Therefore it will not be necessary, ordinarily, to make use of a star wheel and roller for determining the various operative positions of the master-controller; but such an agreement may of course be used, if desired.

In Fig. 3 I have illustrated a modified system of control, in which instead of using the form of limiting device shown in Fig. 1 for determining the extent of motion of the motor-controller C, I have provided a plurality of electromagnets having movable cores adapted to be projected so as to operate as stops for an arm O, mounted on the upper end of the controller-shaft. In general the system shown in this figure is similar to that illustrated in Fig. 1. This system, however, requires a train-conductor system comprising at least as many train-conductors as there are operative positions in the motor-controller and employs a master-controller having each of its windings connected in a separate circuit. Since in this system only one of the secondary windings of the master-controller is connected in circuit at a time, the copper segments are unnecessary and have been omitted. Supposing the master-controller in Fig. 3 to be moved into its first operative position to the right, bringing its primary winding l into inductive relation to the secondary winding 6^a, current will flow from the said secondary winding to the conductor 6 of the train system and thence through the winding of the electromagnet D', thereby actuating the reversing-switch R through the winding of the electromagnet 6^b to the common return through the electromagnets F' and F and the train-conductor 11 and thence back to a common return for all the secondary windings of the master-controller. The current flowing in the circuit above described causes the lever L of the reversing-switch R to be thrown to the left, in which position it is held by the latch G', and also projects the core p of the electromagnet 6^b against the tension of its retaining-spring, so as to bring its outer end r into the path of movement of the arm O. The pilot-motor A will start into operation as soon as the reversing-switch R is closed and will turn the motor-controller C until the arm O strikes the end of the core of the electromagnet 6^b, at which point it will be stopped, this being the first operative position of the controller C. If now the master-controller is moved into its second operative position to the right, the electromagnet 6^b will be deënergized and the electromagnet 7^b energized, so as to project its core, and the motor A will be permitted to operate the controller until it reaches its second operative position, when the arm O will be stopped by the projecting end of the core of the electromagnet 7^b. As before, the reversing-switch lever L will be held in the position to which it has been first thrown until the handle of the master-controller is turned backward, when all the controlling devices will be released and the motor-controller returned to its off position by the spring S. In order to operate the motor-controller in the reverse direction, the master-controller will be turned to the left and in its first position. When the primary winding l is in inductive relation to the secondary winding 5^a, the electromagnet D will be operated to throw the reversing-switch in the opposite direction, in which position it will be held by the latch G, operated by the electromagnet F, and will also project the core of the electromagnet 5^b into the path of the arm O. The motor A will be started in the opposite direction and will rotate the controller C until the arm O is stopped by the projecting core of the electromagnet 5^b. During the further movement of the master-controller in this direction the reversing-switch will be held in the position to which it was first thrown in the manner above described, and the cores of the successive electromagnets will be projected to stop the operation of the controller C when it reaches a position corresponding to the position into which the master-controller has been moved.

Instead of causing the arm O to positively engage a core projected from one of the electromagnets in order to stop the movement of a controller at the desired point I may use the construction indicated in Fig. 4 of the drawings. In this figure the core v, with its winding w', takes the place of the electromagnet shown in Fig. 3, the cores v, with their associated windings, being arranged in a circle around the controller-shaft in the same way as the electromagnets 1^b to 10^b are arranged, and the arm O carries at its end a winding short-circuited on itself and arranged to surround a core interposed between two projecting portions of the arm O, which pass into close proximity to the projecting portions of the cores v. With such a construction when current is supplied to the winding w' of any of the members b and the motor A is started in rotation the controller C will be moved until the projecting portions on the arm O are brought into proximity with the projecting portions of the core v, the winding of which is energized, when the secondary current set up in the short-circuited winding on the arm O will cause the said arm to be held in this position until the winding w' is deënergized.

While I have described my invention with particular reference to a motor-control system operated by means of alternating currents, it will be evident that in certain of its features my invention is applicable alike to

direct and alternating current systems, while certain of the structures devised by me are of general application and are covered in the appended claims without reference to any particular use to which they may be applied. Further, it is not necessary that a system arranged according to my invention should contain all of the elements shown in Figs. 1 and 3 of the drawings. The component parts of my system may be used each in connection with devices other than those shown in the drawings, or, if desirable, some of them may be entirely omitted. For example, the particular type of master-controller devised by me may be used in any motor-control system having any suitable controlling devices for the motor-controllers, whether substantially similar to the controlling devices shown in the drawings or not, and the particular controlling devices shown by me may be used in connection with any suitable master-controller. The switch which I have devised for controlling the circuit connections of the winding on the movable element of the master-controller is evidently not essential, and it may be omitted and this winding left permanently in circuit whenever the system is supplied with current.

It is not intended to specify all or even a considerable part of the changes that might be made in my system or its constituent elements; but from the above it will be evident that material changes in the system and its component parts and material modifications in the construction of the several elements going to make up my system may be made without departing from the spirit and scope of my invention.

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

1. In combination, a controller, a motor for operating said controller, means for returning said controller to its off position, a limiting device for controlling the operation of said motor, a switch in circuit with said motor, and a master-controller for controlling the operation of the motor-switch and the limiting device.

2. In combination, a controller, a motor for operating said controller, means for returning said controller to its off position, a limiting device for controlling the operation of said motor, a switch in circuit with said motor, a master-controller for controlling the operation of the motor-switch and the limiting device, and means operating to release the limiting device and open the motor-switch as soon as the direction of movement of the handle of the master-controller is reversed.

3. In combination, a controller, a motor for operating said controller, a switch for said motor, a limiting device for controlling the operation of said motor, electromagnetic means for operating said motor-switch, electromagnetic means for locking said switch when operated, electromagnetic means for actuating said limiting device, and means for simultaneously supplying current to the switch-operating means, the locking means and the means for actuating the limiting device.

4. In combination, a controller, a motor for operating said controller, means for limiting the operation of said motor, a reversing-switch in said motor-circuit, electromagnetic means for operating said limiting means, electromagnetic means for operating said reversing-switch, a controller for controlling the operation of said reversing-switch and said limiting means, and means for locking said reversing-switch after it has been once thrown.

5. In combination, a controller, a motor for operating said controller, means for limiting the operation of said motor, a switch in said motor-circuit, a plurality of circuits for operating said limiting means and said switch, means for sending current through said circuits successively, and means for maintaining said switch in the position to which it is first thrown as long as current is flowing in any one of said circuits.

6. In a system of motor control, in combination, a controller, control-circuits therefor, and a master-controller consisting of a transformer having a plurality of secondary windings and a primary winding movable with respect thereto connected to said control-circuits.

7. In a system of motor control, in combination, a controller, means for controlling the operation of said controller, control-circuits for said controlling means, and a master-controller consisting of a transformer having a plurality of secondary windings and a primary winding movable with respect thereto connected to said control-circuits.

8. In a system of motor control, in combination, a controller, means tending to maintain said controller in its off position, a motor for operating said controller, electromagnetic means for limiting the operation of said motor, and a master-controller consisting of a transformer having a plurality of secondary windings and a primary winding movable with respect thereto for controlling the operation of said electromagnetic limiting means.

9. In combination, a controller, a motor for operating said controller, a reversing-switch for throwing said motor into circuit in either direction, electromagnets for operating said reversing-switch, other electromagnets for locking said reversing-switch when operated, electromagnets for limiting the rotation of said controller, and a master-controller comprising a plurality of secondary windings and a primary winding movable with respect thereto for controlling the operation of all of said electromagnets.

10. In combination, a controller, a motor for operating said controller, a reversing-switch for throwing said motor into circuit in either direction, electromognets for operating said reversing-switch, other electromagnets for locking said reversing-switch when operated, electromagnets for limiting the rotation of

siad controller, and a master-controller for controlling the operation of all of said electromagnets.

11. In combination, in an alternating-current train-control system, controllers located on the motor-cars, means for operating said controllers, means for limiting the operation of each controller, electromagnetic devices for controlling said limiting means, train-conductors to which said electromagnetic devices are connected, and a master-controller consisting of a transformer having a plurality of secondary windings and a primary winding movable relatively thereto for operating said electromagnetic devices.

12. In combination, in an alternating-current train-control system, controllers located on a plurality of cars, motors for operating said controllers, a reversing-switch for each of said motors, an escapement for limiting the operation of each motor, a plurality of electromagnetic devices for controlling said escapement, a plurality of electromagnetic devices for controlling the operation of said reversing-switch, and a master-controller consisting of a transformer comprising a primary winding and two series of secondary windings for controlling the operation of said escapement and said reversing-switch.

13. In combination, a core of magnetic material, a plurality of secondary windings thereon, a primary winding adapted to be moved into inductive relation with any one of said secondary windings, and means for reducing the self-induction of the secondary windings not in inductive relation to said primary winding.

14. In combination, a core of magnetic material, a plurality of secondary windings mounted thereon and alternately connected in series, a primary winding adapted to be moved into inductive relation with any one of said secondary windings, and means for reducing the self-induction of the other secondary windings in the same series.

15. In combination, a plurality of secondary windings, each provided with a core constituting a partially-closed magnetic circuit, a primary winding provided with a core adapted to complete the magnetic circuit of any one of said secondary windings, and means movable with said primary winding for reducing the self-induction of the other secondary windings.

16. In combination, a plurality of secondary windings arranged in two sets, a primary winding normally positioned between said sets and movable in either direction, the said windings being alternately connected in series and so arranged that when the primary winding is in its first operative position in one direction a winding in one of said series will be energized, and when it is in its first operative position in the other direction a winding in the other of said series will be energized.

17. In combination, two relatively movable members provided with primary and secondary windings respectively, a source of current-supply, and means operating to close a circuit between the source of supply and the said primary windings upon movement of the movable member and to open said circuit upon a reversal of said movement.

18. In combination, two relatively movable members provided with primary and secondary windings respectively, a source of current-supply, and means for closing a circuit between the source of supply and the said primary windings whenever the windings on the said members are brought into inductive relation with each other, and for opening said circuit when the direction of the movement of the movable member is reversed.

19. In combination, a secondary member provided with a plurality of secondary windings, each having a partially-closed magnetic circuit and all arranged in the form of an arc of a circle, a primary member having a primary winding surrounding a core constituting a partially-closed magnetic circuit, a support upon which said primary member is pivoted for movement in either direction, a fixed contact connected to a source of supply, and an arm on said support connected to one end of said primary winding and having contacts normally out of engagement with said fixed contact, said contacts being so arranged that when the primary member is moved in either direction from its zero position a circuit will be closed from the source to said primary winding, and when the direction of movement of said primary member is reversed, said circuit will be broken.

20. The combination with an extended fixed contact of a movable contact adjustably mounted on an actuating-lever and so arranged that a movement of the actuating-lever in one direction will maintain the contacts in engagement and a reversal of such movement from any point will separate the same.

21. In combination, a lever, a contact carried by said lever and movable thereon, a stop for limiting the movement of said contact, a fixed contact extending throughout the limit of movement of said lever, said stop and said movable contact being so arranged that when said lever is moved in one direction the said contacts will be maintained in engagement, and when the direction of motion of said lever is reversed said contacts will be disengaged.

22. In combination, a lever, a contact carried by said lever having a limited rotary movement thereon, a fixed contact, and means for maintaining said movable contact in engagement with said fixed contact when the lever is moved in one direction and for disengaging and maintaining said contacts disengaged upon movement in the opposite direction.

23. In combination, a lever, a cylindrical contact pivoted on said lever and having a portion of its surface composed of insulating

material, a fixed contact extending throughout the limit of movement of said lever and adapted for engagement with said cylindrical contact, and means for limiting the rotation of the cylindrical contact on the lever.

24. In combination, a reversing-switch, electromagnetic actuating means for operating said switch, electromagnetic means for retaining said switch in the position to which it has been thrown, and circuit connections such that after the switch is once thrown, it will be locked against movement so long as current is flowing in the circuit of either of said electromagnetic actuating means.

25. In combination, in a motor-control system, a controller, a motor for operating said controller, a reversing-switch, electromagnetic means for operating said switch, electromagnetic means for locking said switch in the position to which it is thrown, a master-controller, and control-circuits so arranged that when the master-controller is moved in one direction or the other, the reversing-switch will be correspondingly thrown and locked in position until the direction of motion of the master-controller is changed.

In witness whereof I have hereunto set my hand this 13th day of June, 1900.

ALBERT H. ARMSTRONG.

Witnesses:

BENJAMIN B. HULL,

MABEL H. EMERSON.