No. 890,458. PATENTED JUNE 9, 1908.

G. B. SCHLEY.

SYSTEM OF MOTOR CONTROL.

APPLICATION FILED MAR. 29, 1907.

2 SHEETS—SHEET 1.

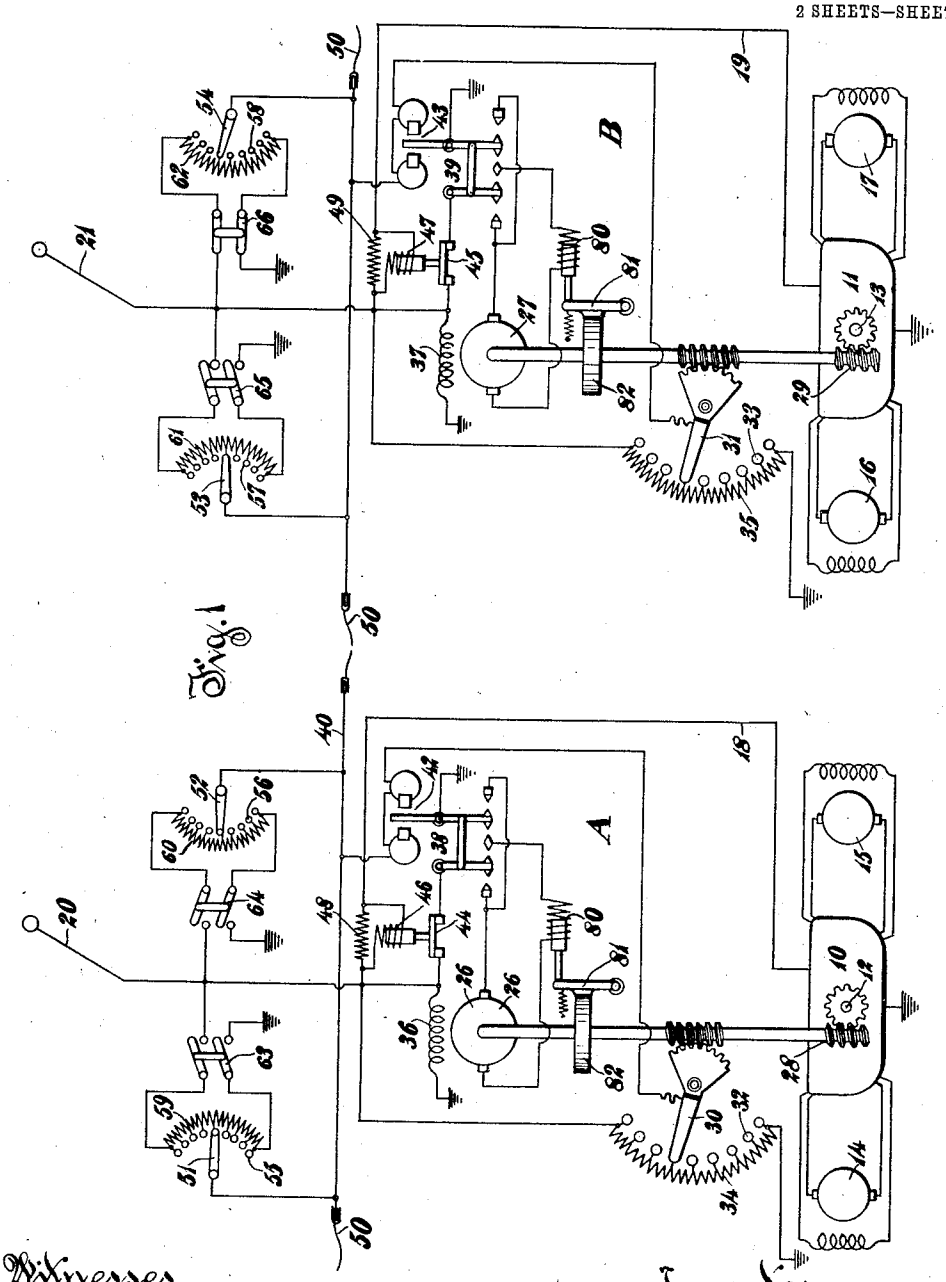

Fig. 1.

Witnesses

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2 SHEETS—SHEET 2.

Fig. 2

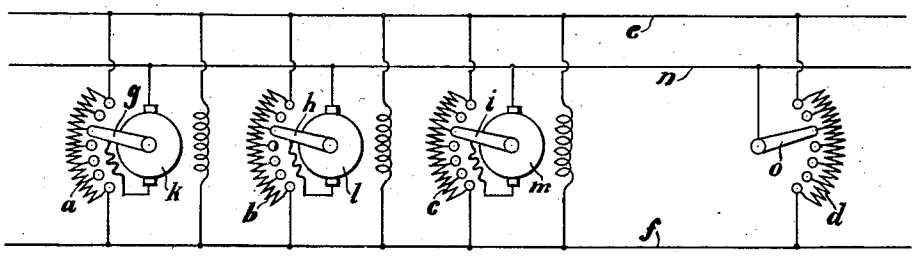


Fig. 3

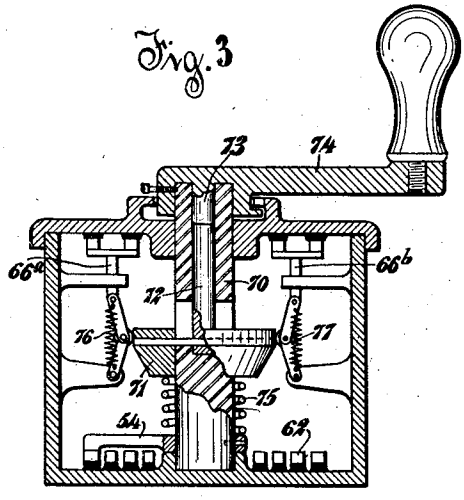
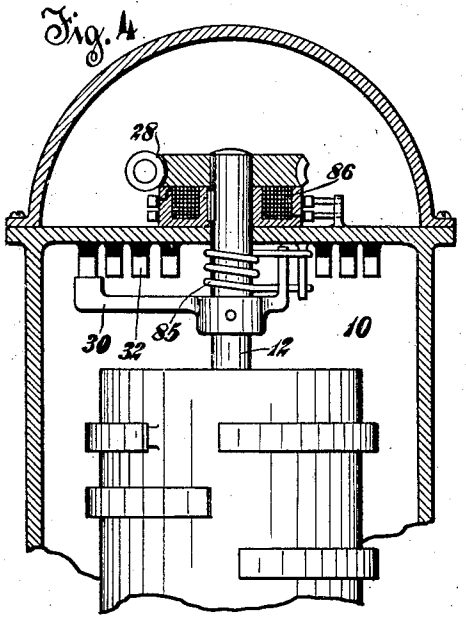


Fig. 4



Witnesses

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UNITED STATES PATENT OFFICE.

GEORGE B. SCHLEY, OF NORWOOD, OHIO, ASSIGNOR TO ALLIS-CHALMERS COMPANY, A CORPORATION OF NEW JERSEY, AND THE BULLOCK ELECTRIC MANUFACTURING COMPANY, A CORPORATION OF OHIO.

SYSTEM OF MOTOR CONTROL.

No. 890,458. Specification of Letters Patent. Patented June 9, 1908.

Application filed March 29, 1907. Serial No. 365,355.

To all whom it may concern:

Be it known that I, GEORGE B. SCHLEY, citizen of the United States, residing at Norwood in the county of Hamilton and State of Ohio, have invented certain new and useful Improvements in Systems of Motor Control, of which the following is a full, clear, and exact specification.

My invention relates to systems of motor control and particularly to multiple unit systems of train control.

All or most of the multiple unit train control systems now in use require either a plurality of train wires or a plurality of train pipes in order to obtain the desired movements of the main controllers on the different cars from any desired point or points on the train. These train wires or pipes and especially the connections between corresponding wires or pipes on the different cars of the train are a source of considerable trouble and expense, a derangement of the whole system often being caused by a single connection being out of order.

It is the object of my present invention to provide a system of train control in which only a single train wire is used. With this single train wire the main controllers on the different cars may be caused to move to any operative position for either forward or backward movement by operating any one of a number of master controllers throughout the train. The master controllers are so arranged that when one is in use, the others are inoperative.

My invention consists of a system of motor control comprising a main motor, a main controller therefor, a master controller for the main controller, a single connection between the main controller and the master controller, and means whereby movement of the master controller varies the potential of one end of said connection to cause the main controller to move in one direction or the other until by its movement in the direction determined by the difference of potential between the two ends of the connector it has brought the other end of said connection to the same potential.

More specifically my invention consists of a system of train control comprising a plurality of motor cars, a main controller for the motor or motors on each car, a pilot motor for operating each of said main controllers, a single train wire, an arm on each car arranged to be connected to contact points of different potential by movement of said pilot motor, connections between said respective arms and said train wire for determining the direction of rotation of said pilot motors in accordance with the direction of the potential difference between said train wire and said respective arms, and manually operated means for varying the potential of said train wire.

In another aspect my invention comprises the combination of a translating device, a controller therefor, a removable handle for the controller, means whereby the removal of the handle from the controller disconnects said controller.

Other features of my invention will appear from the description and drawings and will be pointed out in the claims.

Figure 1 shows diagrammatically a multiple unit train control system embodying my invention; Fig. 2 shows a simple connection diagram illustrating the principle of my invention; Fig. 3 is a sectional view of the master controller; and, Fig. 4 is a partial sectional view of the motor controller.

If, as shown in Fig. 2, a number of resistances *a*, *b*, *c* and *d* are each connected between two wires *e* and *f*, maintained at a constant difference of potential, and the arms *g*, *h* and *i* are movable over the resistances *a*, *b* and *c* by means of motors *k*, *l* and *m*, one element of each of said motors, say the field coils, being properly connected directly between the wires *e* and *f* while the other elements of said motors, say the armatures, are connected between a third wire *n* and the respective arms *g*, *h* and *i*, another arm *o* being also connected to said third wire and manually movable over the resistance *d*, the arms *g*, *h* and *i* will automatically follow the movement of the arm *o*. This takes place because the movement of the arm *o* varies the potential of the wire *n* within limits determined by the potentials of the wires *e* and *f*, thereby impressing a difference of potential in one direction or the other upon the armatures of the motors *k*, *l* and *m*, and causing said motors to rotate in the direction determined by the direction of this difference of potential until the arms *g*, *h* and *i* have

been brought to the same potential as the wire *n*. This operation is on the principle of the Wheatstone bridge. The resistance *d* and any one of the resistances *a*, *b* and *c* correspond to the two sides of the bridge, while the arm *o*, wire *n* and any one of the armatures *k*, *l* and *m* with its corresponding arms *g*, *h* or *i* correspond to the bridge or balancing wire. By applying this arrangement of connections to a train control system, the wires *e* and *f* being replaced by the trolley wire and the ground, it is possible to obtain a train control system with a single train wire corresponding to the wire *m*. In the practical installation of the system, the armature of the motors *k*, *l* and *m* are not connected directly between the arms *g*, *h* and *i* respectively and the train wire because of the decreased speed which the motors would then have as the potential of said arms approached that of the train wire, but are controlled by reversing switches operated by polarized relays, the magnet coils of which are so connected. The motors *k*, *l* and *m* are used to operate the main motor controllers of the cars. There may be any number of master controllers corresponding to the resistance *d* and the arm *o*, only one of these master controllers however, being operatively connected at any one time.

The two units A and B, illustrated in Fig. 1, represent any convenient units of control such as the different cars of a train. On each car there may be one or more master controllers and a main controller, the latter comprising a controlling part proper or motor controller and operating mechanism therefor. The motor controlling parts 10 and 11, may be of any desired type in which the main motors are controlled for forward or backward movement according as the controller shafts 12 and 13 are moved in one direction or the other from the neutral or off position. The motor controllers shown each control two motors, 14 and 15, and 16 and 17, respectively, preferably by series-parallel control, and have the usual connections 18 and 19 respectively to the trolleys 20 and 21 respectively and to the ground.

The motor controllers are arranged to be operated by pilot motors 26 and 27 respectively, as through worm gears 28 and 29. Pivoted arms 30 and 31 are also moved by the two pilot motors, traveling respectively over series of contacts 32 and 33 of graduated potential. These potentials may be obtained by connecting the contacts 32 and 33 to different points on resistances 34 and 35 respectively, connected between the trolley and the ground. The field coils 36 and 37 of the pilot motors are permanently connected between the trolley and the ground, while the direction of current in the armatures thereof is reversible by reversing switches 38 and 39 respectively. These reversing switches are operable by sensitive polarized relays 42 and 43 respectively. The magnet coils of the relays are connected between the arm 30 and 31 respectively and the single train wire 40. In the circuit of the armatures 26 and 27 are switches 44 and 45 respectively, these switches being normally closed but arranged to be opened by solenoids 46 and 47 respectively, preferably connected in shunt to resistances 48 and 49 respectively in the connections 18 and 19.

The single train wire 40 extends throughout the train, the different parts of this wire on the different cars being joined by connectors 50. The different master controllers are provided with arms 51, 52, 53 and 54 respectively, which are manually movable over series of contacts 55, 56, 57 and 58 respectively of graduated potentials similar to those of the series of contacts 32 and 33. These graduated potentials may also be obtained by having the contacts 55, 56, 57 and 58 connected to different points on resistances 59, 60, 61 and 62 respectively which may be connected between the trolley and the ground by means of normally open switches 63, 64, 65 and 66. The switch of the master controller which is to be used to control the train is closed while the remaining switches are open.

In Fig. 3 I have shown a master controller in which the closing of this switch is accomplished by putting on the controller handle, the switch being automatically opened when the controller handle is removed. The hollow shaft 70 of the controller carries an arm, as 54, movable over the series of contacts, as 62. A frustum of a cone 71 is rotatable with the shaft 70 but is slidable longitudinally thereof, this frustum being rigidly fastened to a rod 72 fitting in the hollow shaft 70 and arranged to be depressed by a projection 73 of the operating handle 74 when the latter is put in place on the shaft 70. When the frustum 71 is depressed by putting the handle 74 in place on the shaft 70 it forces outwardly the lever of the toggle joint of the switches 66^a and 66^b, the two parts of the switch, as 66, being shown separate in this figure. When the handle 74 is removed from the shaft 70 the spring 75 forces the frustum 71 upward to allow the springs 76 and 77 to open the switches 66^a and 66^b.

The operating handle 74 is placed on any desired master controller, usually the one at the forward end of the train. Suppose that it is attached to the arm 54, closing the switch 66 in being so attached. The parts are preferably so arranged that the handle can be attached to or removed from the master controller only when the rheostat arm of said controller is in the middle or off position. With the various parts in off position, the arms 54, 30 and 31 are connected to the middle points of the resistances 62, 34 and 35

respectively and the motors 14, 15, 16 and 17 are disconnected. The arms 51, 52 and 53 are also all in off position, but as the resistances 59, 60 and 61 are disconnected the position of these arms is immaterial. Because the arm 54 is in its neutral position, that is, connected to the middle point of the resistance 62, the train wire 40 is at a potential half way between the potentials of the trolley wire and the ground, and no current flows through the magnets of the polarized relays 42 and 43. Consequently the reversing switches 38 and 39 are in off position and the armatures 26 and 27 of the pilot motors are disconnected. By moving the arm 54 upward as shown, the potential of the train wire 40 is raised, thus because of the resultant difference of potential between the terminals of the magnets of the relays 42 and 43 causing said magnets to operate the reversing switches 38 and 39 to admit current to the armatures 26 and 27. These armatures now rotate to operate the motor controllers 10 and 11 in the desired direction and to also move the arms 30 and 31 upward to increase the potential of said arms and diminish the difference of potential between said arms and the train wire 40. This movement continues until the arm 30 has reached substantially the same potential as the train wire 40, thus deënergizing the magnets of the relays 42 and 43 to allow the switches 38 and 39 to move to off position to disconnect the armatures 26 and 27 and to stop their further rotation. If desired a brake of any type may be applied at this point to prevent continued movement of the main controller by its momentum. Such a brake may comprise a solenoid 80 in the circuit of each of the armatures 26 and 27 and arranged when energized to lift a brake 81 from a brake disk 82 on the shaft of each of said motors.

The arm 54 may be moved to any desired position for forward or reverse movement of the train and the pilot motors 26 and 27 will operate the motor controllers 10 and 11 and the arms 30 and 31 in the proper direction until said arms are brought to the same potential as the arm 54 and the train wire 40. The resistances of the magnets of the relays 42 and 43 are preferably great as compared with the resistances 34, 35, 59, 60, 61 and 62.

In case the motors 26 and 27 operate so rapidly that too great currents are supplied to the motors 14, 15, 16 and 17, the solenoids 46 and 47 will open their respective switches 44 and 45 to interrupt the current to the armatures 26 and 27 and thus prevent further movement of said armatures until the main motors 14 to 17 shall have increased in speed sufficiently to bring the motor currents down to normal.

Although in the diagram of Fig. 1 the arms 30 and 31 are shown as being actuated by worm gears which are independent of the worm gears actuating the motor controllers 10 and 11, in practice these arms would generally be combined with the respective motor controllers as by being mounted on the shafts 12 and 13 as shown in Fig. 4. It is also desirable to provide means whereby in case the current supply from the line should fail, the controllers 10 and 11 together with the arms 30 and 31 would be automatically returned to their off or neutral positions. This may be accomplished as shown in Fig. 4, where a spring 85 of proper strength tends to move the motor controller shaft to its middle position whenever the latter is away from said position, and will do so whenever the winding 86 of a magnetic clutch which connects said shaft to the worm gear is deënergized. The clutch winding 86 is connected in any desired manner, as by forming one of the sections of the resistance 32 or by being in circuit with the pilot motor field winding, so as to be supplied continuously with current from the line when the latter is alive to maintain the connection between the shaft 12 and the worm gear 28.

Many modifications may be made in the construction and connections here shown and described and all such which do not involve a departure from the spirit and scope of my invention I aim to cover in the following claims.

What I claim as new is:

1. In combination, a translating device, a controller therefor, a removable handle for the controller, and means whereby the removal of the handle from the controller disconnects said controller.

2. In combination, a motor, a main controller therefor, a master controller for the main controller, a removable handle for the master controller, and means whereby the removal of said handle disconnects said master controller.

3. In combination, a motor, a plurality of controllers therefor, said controllers being normally disconnected, a removable handle for said controllers, and means whereby putting said handle in place on any one of the controllers connects that controller.

4. In combination, a motor, a main controller therefor, a plurality of normally disconnected master controllers for said main controller, a removable handle for said master controllers, and means whereby putting said handle in place on any one of said master controllers connects that controller.

5. In combination, a plurality of motors, a plurality of normally disconnected controllers any one of which can control all of said motors, an operating handle which may be placed on any of said controllers, and means whereby putting said handle on any one of said controllers connects that controller.

6. In combination, a plurality of motors, a plurality of main controllers for the motors, a

plurality of normally disconnected master controllers any one of which can control all of said main controllers, an operating handle which may be attached to any of said master controllers, and means whereby attaching said handle to any one of said master controllers operatively connects that master controller.

7. A system of motor control comprising a motor, a main controller therefor, said main controller including a pilot motor for operating it, a master controller for the main controller, and a conductor leading from the master controller to the main controller, the direction of movement of said pilot motor being determined by the direction of current in said conductor, said conductor being arranged to have the potential at one of its ends varied by movement of the master controller and the potential at its other end by movement of the main controller.

8. A system of motor control comprising a main motor, a main controller therefor, said main controller including a pilot motor for operating it, a master controller, and a conductor leading from the main controller to the master controller, the movement of said pilot motor being in a direction determined by the direction of current in said conductor and continuing while there is current in said conductor, said conductor being arranged to have the potential of one of its ends varied by the master controller, and its other end brought to the same potential by movement of the main controller.

9. A system of motor control comprising a main motor, a motor controller, a pilot motor for operating said motor controller, two series of contact points of graduated potential, an arm movable over one of said series by hand, a second arm movable over the other series by said pilot motor, and a connection between said two arms, said pilot motor being arranged to move to diminish the current in said connection to substantially zero.

10. A system of motor control comprising a motor, a motor controller therefor, a reversible motor for actuating said motor controller, two series of contact points of similarly graduated potential, an arm movable over one of said series by said pilot motor, a second arm manually movable over the other of said series, and a connection between said two arms, the direction of current in said connection controlling the direction of movement of said pilot motor.

11. A system of motor control comprising a plurality of motors, a plurality of motor controllers therefor, a pilot motor for actuating each motor controller, an arm movable over a series of contact points of graduated potential by each pilot motor, a connection from all of said arms to a manually operated arm movable over a series of contact points of similarly graduated potential, the direction of movement of said pilot motor varying as the direction of current in said connection.

12. A system of motor control comprising a plurality of motors, a plurality of motor controllers, a reversible pilot motor for actuating each of said motor controllers, an arm movable over a series of contact points of graduated potential by each of said pilot motors, an arm manually movable over a series of contact points of similarly graduated potential, a single wire to which all of said arms are connected, and connections whereby when there is current in said wire said pilot motors move in the proper direction to decrease said current.

13. A system of train control comprising a plurality of motor cars, a motor controller for the motor or motors on each car, a pilot motor for operating each of said motor controllers, a single train wire, an arm on each car arranged to be connected to contact points of different potential by movement of said pilot motor, connections between said arms and said train wire for determining the direction of rotation of said pilot motors in accordance with the direction of the potential difference between said train wire and said respective arms, and manually operated means for determining the potential of said train wire.

14. A system of motor control comprising a main motor, a main controller therefor, a master controller for the main controller, a single connection between the main controller and the master controller, and means whereby movement of the master controller varies the potential of one end of said connection to cause the main controller to move in one direction or the other until by its movement in the direction determined by the difference of potential between the two ends of the connection it has brought the other end of said connection to substantially the same potential.

15. A system of motor control comprising a main motor, a main controller therefor, a master controller for the main controller, a single connection between the main controller and the master controller, means whereby movement of the master controller varies the potential of one end of said connection to cause the main controller to move in one direction or the other until by its movement in the direction determined by the difference of potential between the two ends of the connection it has brought the other end of said connection to substantially the same potential, and means for stopping the movement of the main controller when the two ends of said connection reach the same potential.

16. A system of motor control comprising a main motor, a main controller therefor, a master controller for the main controller, a single connection between the main controller and the master controller, means

whereby movement of the master controller varies the potential of one end of said connection to cause the main controller to move in one direction or the other until by its movement in the direction determined by the difference of potential between the two ends of the connection it has brought the other end of said connection to substantially the same potential, and means for automatically returning the main controller to off position upon failure of the supply of current.

17. In a multiple unit control system, a single pilot wire extending throughout the train, a master controller, a plurality of motor controllers on the different cars of the train having positions corresponding to the positions of the master controller, and means whereby each motor controller automatically takes the position corresponding to the position occupied by the master controller regardless of the number of other motor controllers which may be under the control of the master controller.

18. In combination, an electric motor, an electrically operated main controller therefor, a master controller for the main controller, a removable handle for the master controller, and means whereby the removal of said handle electrically disconnects said master controller.

19. In combination, an electric motor, a plurality of controllers therefor, said controllers being normally ineffective in any position, a removable handle for said controller, and means whereby putting said handle in place on any one of the controllers renders that controller effective.

20. In combination, an electric motor, a controller therefor, a removable handle for the controller, and means whereby the removal of the handle from the controller renders said controller ineffective in all positions.

21. In combination, an electric motor, a main controller therefor, a plurality of normally ineffective master controllers for said main controller, a removable handle for said master controllers, and means whereby putting said handle in place on any one of said master controllers renders that controller effective.

In testimony whereof I affix my signature, in the presence of two witnesses.

GEORGE B. SCHLEY.

Witnesses:

RUBY ROBINSON,

FRED J. KINSEY.