No. 757,019. PATENTED APR. 12, 1904.

F. L. BUTLER.

SYSTEM OF MOTOR CONTROL.

APPLICATION FILED SEPT. 13, 1902.

NO MODEL. 2 SHEETS—SHEET 1.

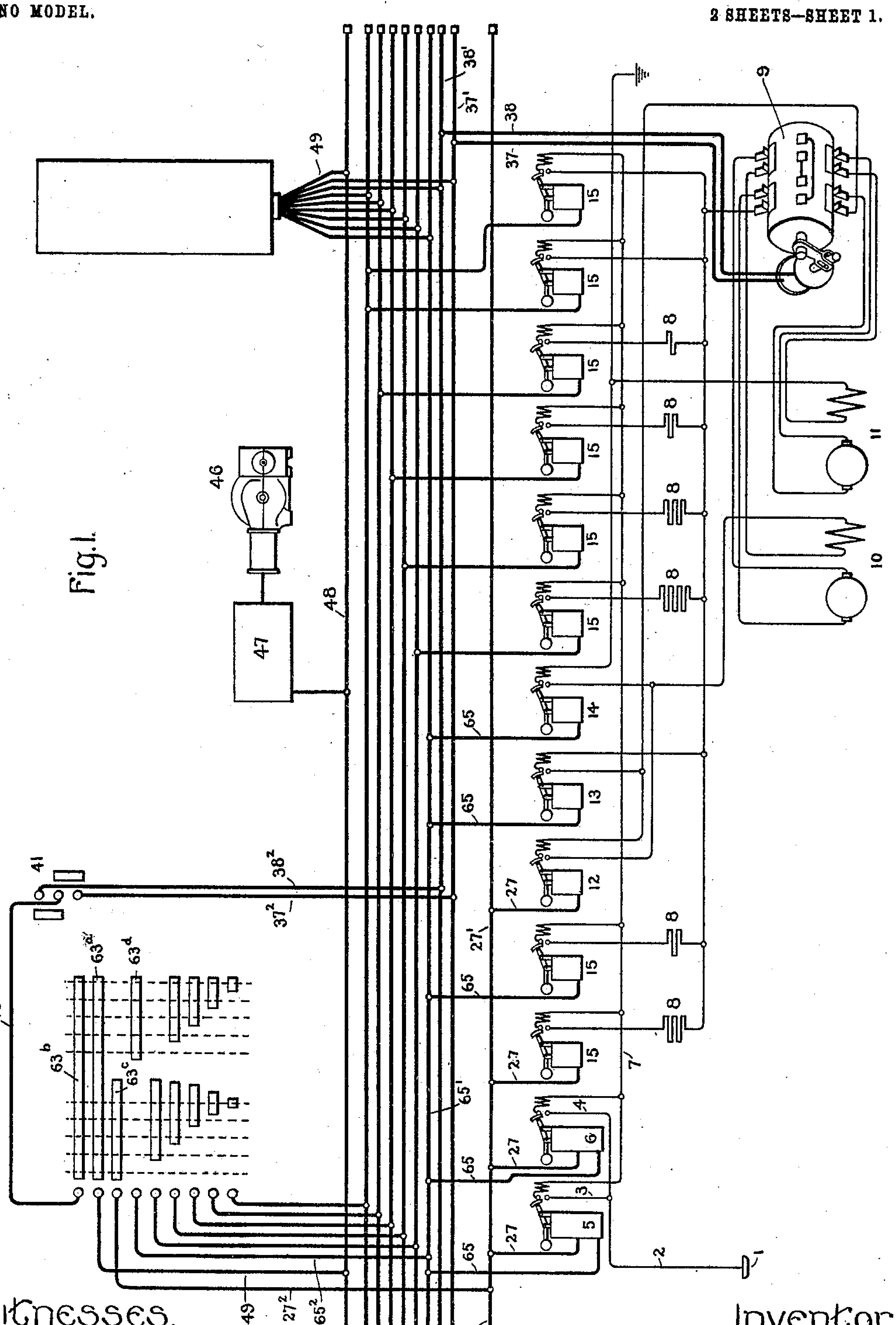

Fig. 1.

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THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

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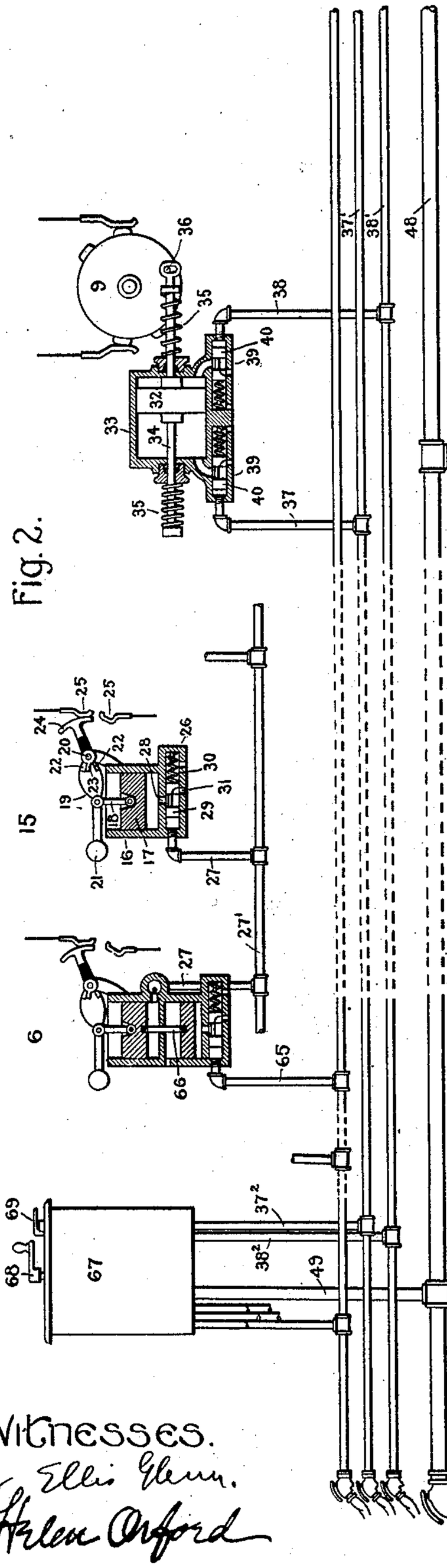

Fig. 2.

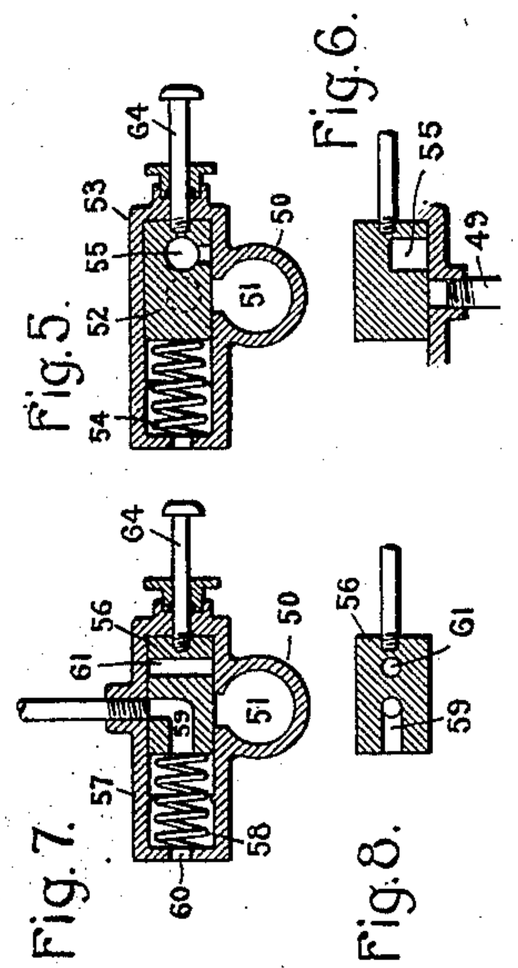

Fig. 5. Fig. 6. Fig. 7. Fig. 8.

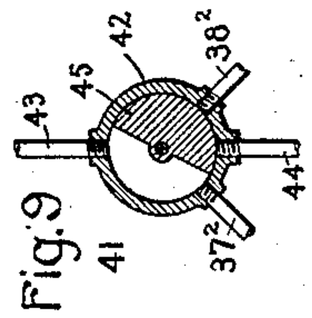

Fig. 9

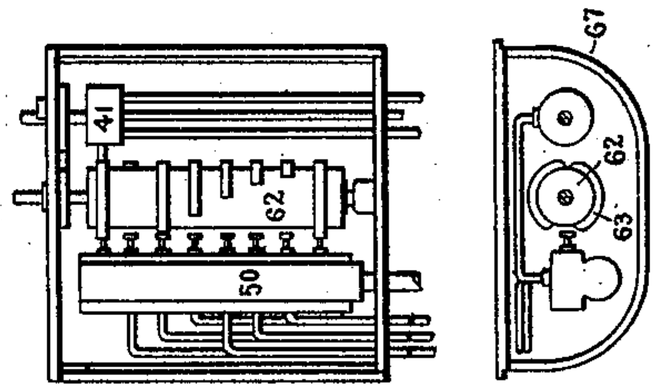

Fig. 3. Fig. 4.

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No. 757,019. Patented April 12, 1904.

UNITED STATES PATENT OFFICE.

FRANK L. BUTLER, 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. 757,019, dated April 12, 1904.

Application filed September 13, 1902. Serial No. 123,306. (No model.)

To all whom it may concern:

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

This invention relates to an electric-motor-control system in which the motor-controllers comprise a plurality of separately-actuated contacts or "contactors." This system is now well known, having been set forth in many prior patents—such, for example, as that to Elihu Thomson, No. 617,546, dated January 10, 1899. Ordinarily the individual contactors are actuated by electromagnets. The object of my invention is to actuate said contactors by fluid-pressure, preferably compressed air supplied from the air-brake reservoirs, or from a special air-compressor, as may be found most convenient. In this way I am enabled to keep the electric conductors comprising the motor-circuits beneath the floor of the car, the pipes for connecting the pneumatic master-controller with the contactors being the only parts of the system which extend up into the car. The arrangement of pipes is very similar to the electric conductors of an electric-control system, as appears from the accompanying drawings, in which—

Figure 1 is a diagram of my improved pneumatic control system. Fig. 2 is a view of the air-compressor, the master-controller, the reverser, and two of the contactors. Fig. 3 is a front elevation of the master-controller with the front cover removed. Fig. 4 is a top plan view of the master-controller with the top plate removed. Fig. 5 is a horizontal cross-section of the valve which admits the air to the controller-casing. Fig. 6 is a vertical section of the same. Fig. 7 is a horizontal cross-section of one of the valves which admits air from the controller-casing to the contactor-pipes. Fig. 8 is a vertical section of the same, and Fig. 9 is a horizontal cross-section of the master reversing-valve.

In the diagram, Fig. 1, the pipes or conduits are shown by heavy black lines, while the electric conductors are shown by light lines. The system shown involves nothing new so far as the arrangement of the circuits is concerned. In brief, it comprises a contact-shoe 1, through which current is taken from a third rail or other working conductor. The power lead 2 has two branches 3 4, terminating in contacts adjacent to two contactors 5 6, by means of which the branch power leads are placed in connection with a lead 7 from which current is taken through suitable resistances 8 and a reverser 9 to the motors 10 11. Provision is made for connecting the motors in series by means of a contactor 12 or in parallel by means of contactors 13 and 14. The remaining contactors 15 control the flow of current through the resistances 8.

The novelty of my invention resides in the fact that I employ compressed air or other fluid-pressure to operate the contactors and the reverser. In Fig. 2 the specific construction of these parts is illustrated. It will be seen that in its simplest form the contactor consists of a cylinder 16, open at its upper end and containing a piston 17, connected by a short rod 18 with a lever 19, pivoted at 20 and provided with a weight 21, which tends to keep the piston at or near the bottom of the cylinder. The lever carries small lugs 22, adapted to strike a short arm 23 on the end of a switch-lever 24, pivoted at 20 and arranged to bridge a pair of stationary contacts 25 when the piston is moved to the upper part of the cylinder. The lugs 22 allow the lever 19 to have a certain amount of play or lost motion, so that its movement is communicated to the switch-arm 24 by a sudden blow, and thus the switch is opened and closed quickly. The portion of the switch-arm which forms the bridging contact is insulated, as indicated in the drawings.

The admission of compressed air to the lower end of the cylinder is governed by an automatic exhaust-valve contained in a valve-chest 26, integral with or attached to the cylinder. The air-pipe 27 enters one end of said chest, which communicates by a port 28 with the cylinder. Communication between the air-pipe and said port is normally prevented by means of a valve 29, capable of sliding longi-

tudinally in the valve-chest and held in its normal position by a spring 30. In this position there is free communication between the cylinder and the atmosphere through the port 28, a cut-away portion of the body of the valve, and an exhaust-port 31 in the valve-chest; but when the compressed air is admitted through the pipe 27 the valve is forced backward in its chest, compressing the spring 30. As soon as the valve passes the port 28 the compressed air can enter the cylinder and lift the piston and close the switch, the exhaust-port 31 being meanwhile closed by the valve 29. When the air-pressure is reduced, the spring restores the valve to its normal position and by opening the exhaust-port permits the air under the piston to escape quickly.

The reverser is actuated by a piston 32, reciprocated in the cylinder 33 and having a piston-rod 34 projecting through both heads of the cylinder in order to receive the balancing-springs 35, by means of which the piston is normally retained at the middle of the cylinder. One end of the piston-rod is connected with a crank-pin 36, by means of which the reverser can be given a partial rotation. Air is admitted to one end or the other of the cylinder 33, as may be desired, through the pipes 37 38, entering the valve-chest 39, containing spring-valves 40, similar in all respects to the valve 29 and operating in the same way to admit air to the cylinder and exhaust it quickly therefrom.

The pipes 37 and 38 communicate with two train-pipes 37′ and 38′, from which branches 37^2 and 38^2 run to the master reversing-valve 41, which is shown diagrammatically in Fig. 1. The preferred form of this valve is illustrated in cross-section in Fig. 9. It comprises a cylindrical casing 42, with which the pipes 37^2 38^2 communicate. The pipe 43 for supplying fluid-pressure to the casing 42 and the pipe 44 for conveying away the exhaust-air also communicate with the casing. The casing contains a rotating valve 45, adapted to put the supply-pipe 43 in communication with either of the pipes 37^2 38^2 or to place both of them in communication with the exhaust.

The compressed air may be furnished either by the air-brake system or by a special air-compressor. In Figs. 1 and 2 I have shown an electrically-driven air-compressor 46 delivering air to a reservoir 47, which communicates with a train-pipe 48.

At each end of each car is a master-controller communicating by a branch pipe 49 with the supply-pipe 48. The master-controller is shown in diagram in Fig. 1, and its preferred mechanical construction is indicated in Figs. 3 to 8, inclusive. It comprises a casing 50, containing an upright chamber 51, which can be placed in communication with the pipe 49 by means of a sliding valve 52, contained in a valve-chest 53, integral with or attached to the casing 50. The spring 54 keeps said valve normally in such a position that the air cannot enter the chamber; but when the valve is moved longitudinally a port 55 therein establishes communication between the pipe 49 and the chamber 51.

Compressed air or other fluid-pressure is admitted from the chamber 51 to a plurality of branch pipes connecting with their respective train-pipes and these in turn with the contactors. The admission of air to each pipe is controlled by a sliding valve 56, contained in a suitable valve-chest 57 and maintained normally by a spring 58 in such a position that a port 59 in said valve places the branch pipe which it controls in communication with the atmosphere through a port 60 in the end of the valve-chest 57. The valve contains a transverse port 61, which when the valve is moved longitudinally, so as to compress the spring, connects the chamber 51 with the branch pipe, the exhaust being at the same time closed.

In order to properly actuate the several valves, they are arranged in a tier, as shown in Fig. 3, and adjacent to them is rotatably mounted a cylinder 62, carrying segmental cams 63, which when the cylinder is rotated come in contact with the ends of stems 64, projecting from the valves. In this way the valves are moved by means of the cams to open communication with the chamber 51, and as soon as the cam-segment passes the end of the valve-stem the spring closes said valve.

In Fig. 1 is shown a development of the cams of one of the cylinders represented as though they were on a plane surface. The cam 63^a controls the admission of air from the supply-pipe 49 to the chamber 51. Cam-segment 63^b admits air from said chamber to the pipe 43, communicating with the casing 42 of the master reversing-valve. Cam 63^c admits air to a pipe 27′, communicating with the train-pipe 27′, which connects by branch pipes 27 with the two power-controlling contactors 5 6, the series contactor 12, and the first of the resistance-contactors 15. Cam-segment 63^d admits air to a pipe 65^2, communicating with a train-pipe 65′, from which branch pipes 65 convey air to the two power-controlling contactors 5 6, the two parallel contactors 13 14, and the second of the resistance-contactors 15. The other cam-segments, which need not be specifically referred to by letter, control the admission of air to the various train-pipes, which are connected, respectively, with the remaining resistance-contactors, so that they will be operated in succession to vary the speed of the motors.

Inasmuch as both the series and the parallel pipes 27 65 convey air to the power-controlling contactors 5 and 6 each of these contactors is made with two cylinders arranged tandem. so that the pistons can be connected by a rod 66, as shown in Fig. 2. It follows that these contactors will be actuated whether the

air is admitted to the upper or the lower cylinder, the upper being connected with the pipe 27 and the lower with the pipe 65. It is manifestly impossible to connect both of these pipes with one cylinder, since that would prevent the proper operation of the series and parallel contactors.

The casing 50, the cylinder 62, and the casing 42 are conveniently arranged adjacent to each other and protected by a cover 67, similar to that of the ordinary electric-railway-car controller. The cylinder 62 can be turned by means of a handle 68 and the reversing-valve 45 by means of a handle 69.

It will thus be seen that my invention provides for the control of a car-controller or a plurality of car-controllers comprising separately-actuated contacts as completely as in the case of systems where the contactors are actuated by electromagnets.

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

1. In a system of motor control, a motor-controller comprising a plurality of separately-actuated contacts, a pneumatic actuating device for each contact, and a master-controller comprising separate and independently-actuated valves for controlling said devices individually from a distance and mechanical means for actuating said valves in any predetermined order.

2. In a system of motor control, a motor-controller comprising a plurality of separately-actuated contacts, a pneumatic actuating device for each contact, a master-controller comprising separate and independently-actuated valves for controlling said devices individually from a distance, and a plurality of pipes for connecting the pneumatic actuating devices with their corresponding controlling-valves.

3. In a controller for electric motors, the combination with a plurality of separately-actuated contacts for controlling the motors, of a pneumatic actuating device for each contact, a pneumatically-actuated reversing-switch, a master reversing-valve, and a master-controller comprising a plurality of separately-actuated valves for controlling said contact-actuating devices and a valve for controlling the admission of compressed fluid to said master reversing-valve.

4. In a system of motor control, a motor-controller comprising a plurality of separately-actuated contacts, a pneumatic actuating device for each contact, a system of train-pipes, pipes connecting each pneumatic actuating device to its corresponding train-pipe, a master-controller comprising a plurality of separate and independently-actuated valves, and pipes connecting each of said valves to its corresponding train-pipe.

5. In a system of motor control, the combination of a plurality of electric motors, a resistance, separately-actuated contacts for controlling the amount of resistance inserted in circuit with said motors, separately-actuated contacts for connecting said motors in series and in parallel relationship, pneumatic actuating devices for each of said contacts, a plurality of separate and independently-actuated valves forming a master-controller for said pneumatic devices, and a series of cams for operating said valves so as to connect the motors in series with a resistance in circuit, then to cut out said resistance, then to connect the motors in parallel with resistance in circuit, and then to cut out said resistance.

6. In a system of train control, the combination of a plurality of motors, a plurality of motor-controllers each comprising a plurality of separate pneumatically-actuated contacts, a master-controller, pipes connecting the actuating means of corresponding contacts of said motor-controllers directly to said master-controller, and means in said master-controller for controlling the admission of compressed fluid to said pipes in any desired order, whereby the corresponding contacts of the several motor-controllers are operated simultaneously and the contacts in any one controller are operated in any desired order.

7. In a system of train control, the combination with an electric motor, of separately-actuated contacts for controlling the electric circuits, pneumatic actuating devices therefor, and a master-controller for said pneumatic devices comprising a casing containing a chamber, a plurality of pipes, valves for individually connecting said chamber and pipes, and a movable valve-controller provided with cams for operating said valves in a predetermined order.

8. The combination with a plurality of pneumatically-actuated electric contacts, of a casing containing a chamber, pipes connecting said casing with a source of fluid-pressure and with the contact-actuating devices, valves for individually connecting said chamber and pipes, and a cylinder carrying cam-segments for opening said valves.

In witness whereof I have hereunto set my hand this 12th day of September, 1902.

FRANK L. BUTLER.

Witnesses:

ALEX. F. MACDONALD,

HELEN ORFORD.