No. 763,047. PATENTED JUNE 21, 1904.

F. B. COREY.

MOTOR CONTROL SYSTEM.

APPLICATION FILED DEC. 5, 1902.

NO MODEL. 2 SHEETS—SHEET 1.

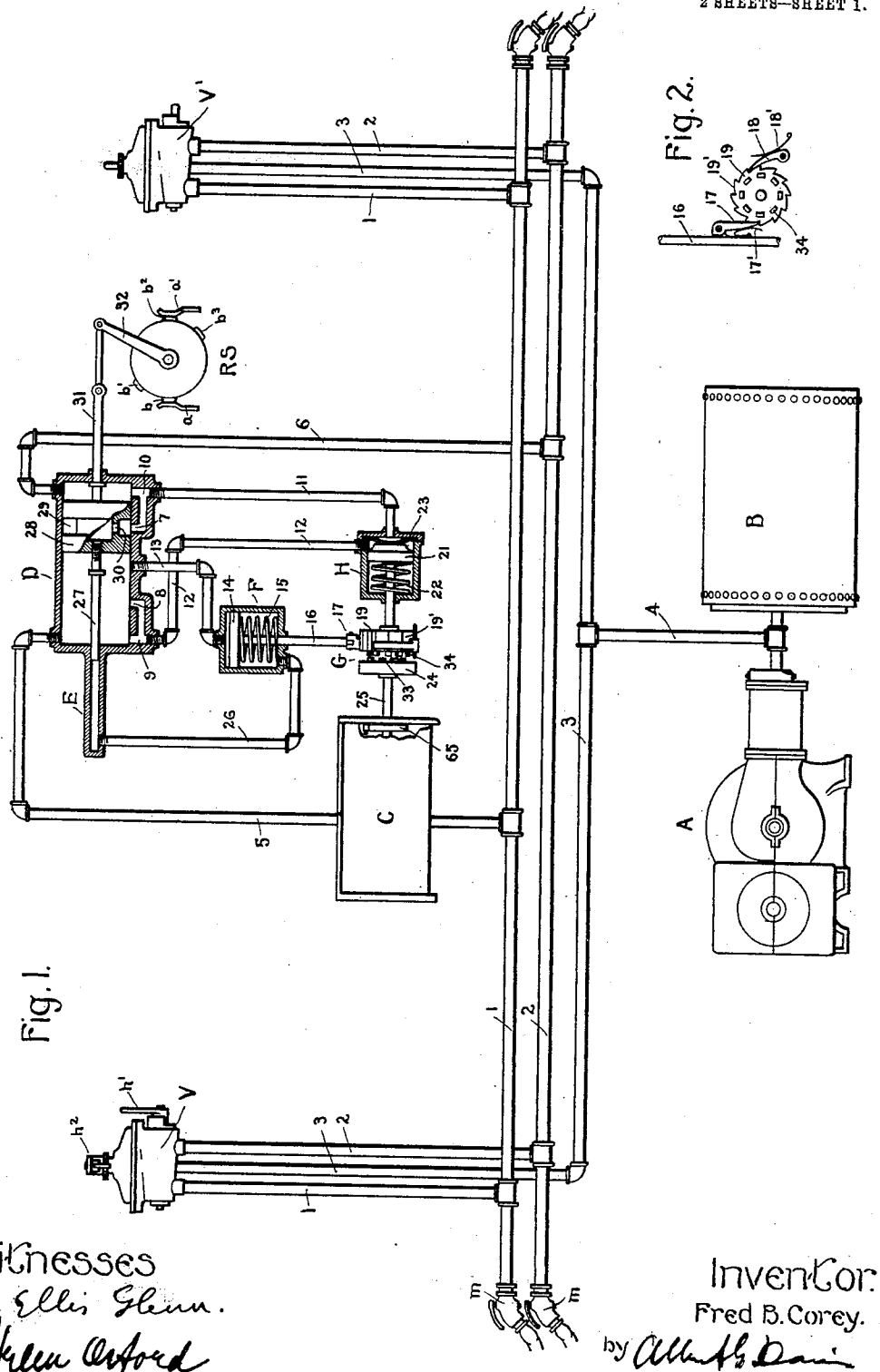


Fig. 1.

Fig. 2.

Witnesses
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NO MODEL. 2 SHEETS—SHEET 2.

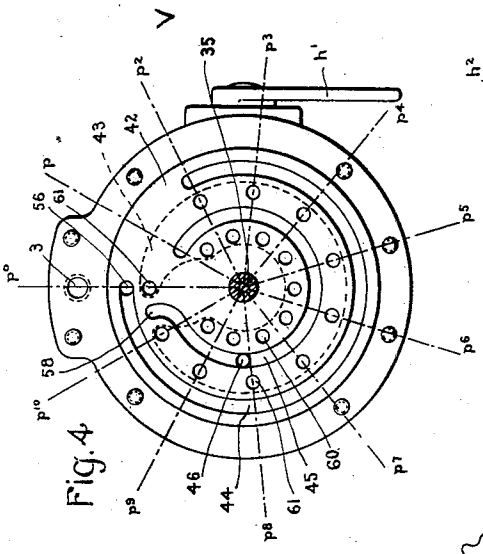


Fig. 4

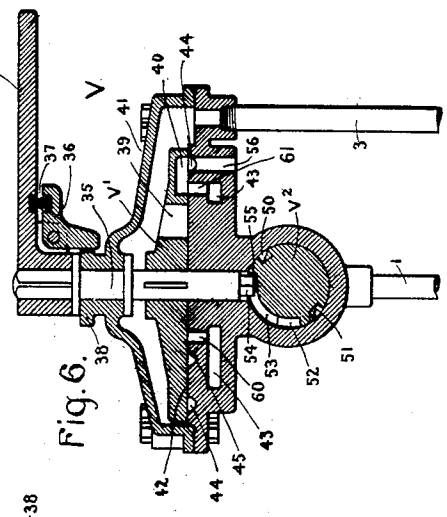


Fig. 6.

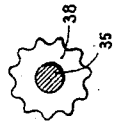


Fig. 7.

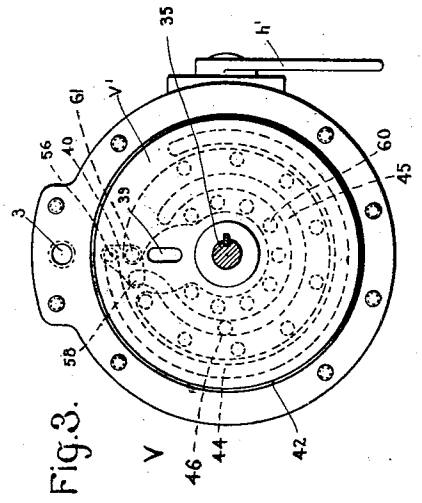


Fig. 3.

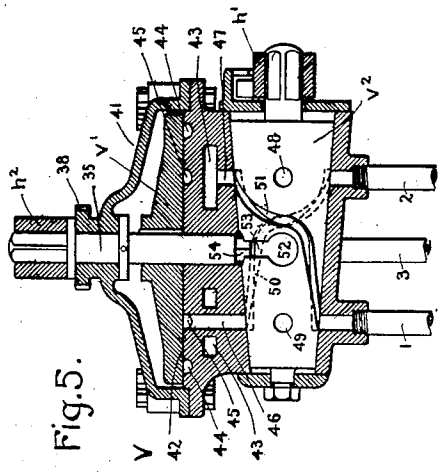


Fig. 5.

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No. 763,047. Patented June 21, 1904.

UNITED STATES PATENT OFFICE.

FRED B. COREY, OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

MOTOR-CONTROL SYSTEM.

SPECIFICATION forming part of Letters Patent No. 763,047, dated June 21, 1904.

Application filed December 5, 1902. Serial No. 133,930. (No model.)

To all whom it may concern:

Be it known that I, FRED B. COREY, 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 Motor-Control Systems, of which the following is a specification.

My present invention relates to systems of motor control, and more particularly to systems of train control in which a plurality of motor-controllers located on electrically-propelled vehicles coupled together to form a train are operated simultaneously by pneumatic pressure, the compressed fluid used for actuating said controllers being controlled from any desired point on the train.

In systems of train control it is desirable to reduce as much as possible the number of wires or pipes which run throughout the train, so as to avoid danger of mistake when coupling the corresponding wires or pipes of adjacent cars together and also to save time when making up the train. It is also very desirable to place the motors and the motor-controllers throughout the train under the complete control of the motorman, so that they may be moved with absolute synchronism from one operative position to the next when the master-controller or operating-valve is moved into the corresponding operative position and may be maintained in said position as long as the operator desires. In the majority of complex train-control systems now in use either a large number of train wires or pipes are used to produce a forward or reversed step-by-step movement of the controllers on the train or a small number of train wires or pipes are used to produce a continuous forward movement of the train-controllers. In the last-mentioned type of train control it is impossible to get a step-by-step movement through the various contact positions of the controllers in forward or reversed directions.

In my present invention I have produced a train-control system which is simple in construction and effective in operation, using but two train-pipes and a simple pneumatically-actuated mechanism adapted to produce a simultaneous step-by-step movement of the controllers through their various operative positions, so as to operate the motors at any desired speed in either the forward or reversed direction. This mechanism can be applied readily to any of the various types of controllers now in use.

More specifically stated, my invention consists of a pneumatic train-control system for a plurality of electrically-propelled vehicles coupled together to form a train, said system comprising a master or motor controller mounted on each motor-car, a pneumatically-actuated device adapted to operate said controller by a step-by-step forward movement, a pneumatically-actuated clutch mechanism adapted to connect said controller-actuating device to said controller, a pneumatically-actuated reversing-switch-operating mechanism, and a source of compressed-fluid supply operatively connected through an operating-valve and two train-pipes to said pneumatically-actuated mechanisms. The system is so constructed and arranged that compressed fluid is admitted from a source of supply, such as an air-compressor, to one of said train-pipes in order to move the reversing-switches throughout the train into the desired operative position and also to operate said clutches, immediately thereafter operating said controller-actuating mechanisms to move said controllers into the first operative position. The train-pipe into which compressed fluid is first introduced determines the position of the reversing-switches, and consequently the direction of movement of the car or train. The compressed fluid is then alternately admitted to and exhausted from the second train-pipe, while the pressure is maintained in the first-mentioned pipe in order to move the controllers forward step by step simultaneously through the successive operative positions.

My invention further consists of details of construction and combination of parts, which will be fully described in the following specification and more specifically stated in the appended claims.

Referring now to the accompanying drawings, which illustrate the preferred embodi-

ment of my invention, Figure 1 represents diagrammatically a single car equipment of a pneumatic train-control system in which the controller is adapted to be operated with a step-by-step forward movement from any point on the car or train by compressed fluid. Fig. 2 illustrates a detail of the mechanism for producing a step-by-step forward movement of the controller-cylinder. Fig. 3 is a plan view of the controlling or motorman's valve with the said valve in position on its seat, the upper part of the valve-casing being removed. Fig. 4 is a view similar to Fig. 3 with the controlling-valve removed from its seat, so as to show the ports in said valve-seat. Figs. 5 and 6 represent vertical sections of the controlling or motorman's valve, the section shown in Fig. 5 being taken through the axis of the reversing plug-valve, while the section shown in Fig. 6 is taken perpendicular to said axis; and Fig. 7 is a plan view of the notched collar which is used to indicate to the motorman or operator the proper positions in which to stop the operating disk valve to correspond to the proper operative position of the controller.

Referring now to Fig. 1, the train-pipes are represented by 1 and 2, and the means for connecting the said train-pipes to the corresponding train-pipes on the adjacent cars are indicated by *m*. The source of compressed-fluid supply, here shown as an electrically-driven air-compressor, is indicated by A, and the compressed fluid from said compressor is received and stored in the reservoir B. Leading from the reservoir B is a connecting-pipe 4, which communicates with the supply-pipe 3, connected with the motorman's valves V and V′. Leading from the train-pipes 1 and 2, respectively, are pipes 5 and 6, which connect with the cylinder D, containing the reversing-switch-operating piston 28, which is connected with the reversing-switch RS through the piston-rod 31 and crank 32. The controller is indicated by C, and its shaft 25 is provided with a spring 65, which returns the controller to the "off" position whenever it is released in any of its operative positions. Attached to the end of the controller-shaft 25, is one member, 24, of a clutch G. The other member, 19, of the said clutch G is integrally formed with or otherwise attached to a ratchet-wheel 19′. The said ratchet-wheel is adapted to be rotated with a step-by-step forward movement by means of the controller-actuating piston 14, which is operatively connected to said member 19 through the piston-rod 16, carrying the spring-pressed pawl 17. The controller-actuating piston 14 is operated within the cylinder F in one direction by means of the compressed fluid and in the opposite direction by the spring 15. In addition to the rotary movement above described the said clutch member 19 is adapted to be reciprocated by means of the compressed fluid acting on the spring-pressed piston 21, contained within the cylinder H. The members 19 and 24 of the clutch G are provided with teeth 34 and 33, respectively, which are adapted to engage when the member 19 is moved toward the member 24. The said cylinder H is connected to both ends of the cylinder D by means of the pipes 11 and 12, respectively. Located within the said cylinder H is a flexible diaphragm 23, which prevents communication between the said pipes 11 and 12. The cylinder F is connected to the said cylinder D by means of the pipe 13, which communicates with said cylinder F above the piston 14. The cylinders F and D are also connected through the pipe 26, which communicates with said cylinder F below the piston 14 and is connected with the interior of the hollow piston 28 through the pipe 27 and connecting-sleeve E. The sleeve E may be formed integrally with or otherwise attached to the cylinder D. The piston 28 is provided with an annular groove 29, which is adapted to register with either of the ports 7 and 8 in cylinder D. The passage-way 30 leads from the annular groove 29 to the interior of the hollow piston 28.

In Fig. 2 I have indicated the means for producing a step-by-step forward movement of the controller-shaft, said means comprising the ratchet-wheel 19′, with which the pawl 17 engages, said pawl being pivoted to the piston-rod 16 and pressed against the teeth of said ratchet-wheel 19′ by means of the spring 17′. In order to prevent the said ratchet-wheel 19′ from rotating in a reverse direction when the piston-rod 16 is moved backward by the spring 15, I have provided a second pawl 18, which is forced against the teeth of said ratchet-wheel 19′ by means of the spring 18′.

Referring now to the means for admitting the compressed fluid to the train-pipes 1 and 2, Figs. 3 to 6, inclusive, illustrate my preferred form of motorman's valve, v' indicating the controlling or operating valve, which is operated by means of the handle h^2, and v^2 indicating the reversing plug-valve, which is operated by means of the handle h'. The reversing plug-valve v^2 is provided with a groove or slot 53, having enlarged ends 52 and 55, in which the elongated key or pin 54, carried by the valve-spindle 35, is adapted to operate. The pin or elongated key 54 is so constructed that it coöperates with said slot to form an interlock between the operating-valve and the reversing-plug and allows the reversing-plug v^2 to be moved from one of its operative positions to the other only when the valve-handle h^2 has been moved into the position corresponding to the off position of the controller, and while the reversing plug-valve v^2 is being moved from one of its operative positions to the other it prevents a movement of the valve v'. The operating-valve v' rests upon the valve-seat 42 and is inclosed within

a casing 41, which is bolted or otherwise fastened to said valve-seat, a space or chamber being formed between the said valve v' and the casing 41, into which the compressed-fluid-supply pipe 3 leads. The valve v' is supplied with the port 39 and also with the triangular-shaped undercut portion 40. The port 39 is adapted to register with the circular groove 45 in the valve-seat and the ports 60 through said valve-seat. The groove 45 is connected with the passage-way 46 through said valve-seat, while the ports 60 are connected with the annular chamber 43 beneath said valve-seat. The said annular chamber 43 is also in communication with the ports 61, which are adapted to be connected, by means of the triangular undercut portion 40, with the annular groove 44, leading to the exhaust passage-way 56 when the controlling-valve v' is in its off or in any one of its operative positions except the first operative position. The positions assumed by the port 39 and undercut portion 40 of said valve v' are indicated by radial lines on Fig. 4, the position corresponding to the off position of the controller being indicated by p^0 and the operative positions by the radial lines p' to p^{10}, inclusive, the said positions being indicated to the motorman by means of the notches or serrations in the periphery of the collar 38, integrally formed with or otherwise attached to the valve-casing and with which the dog or detent 36, actuated by the spring 37, is adapted to engage. The reversing plug-valve v^2 is also provided with the ports 48 and 49, which pass completely through the plug, and with the slots or grooves 50 and 51, the function and operation of which will be hereinafter described.

The operation of the system is as follows: When the operating-valve v' is in the position indicated in Fig. 4 by p^0, the triangular undercut portion 40 of said valve is in register with one of the ports 61, the end 58 of the annular groove 45, and also with the exhaust passage-way 56, as indicated in Figs. 3 and 6, thereby exhausting both train-pipes to atmosphere. When in this position, the port 39 in the valve v', as indicated in each of said Figs. 3 and 6, is not in communication with any port or ports leading to either of said train-pipes. When the controlling-valve v' is moved into its first operative position, (indicated by the radial line p' in Fig. 4,) the port 39 is brought into register with the annular groove 45 and the compressed fluid is admitted from the supply-pipe 3 to train-pipe 2 through the port 39, annular groove 45, and its communicating passage-way 46 and through the passage-way or groove 50 in the reversing plug-valve v^2, the valve v^2 being in the position shown in Figs. 5 and 6. The compressed fluid then passes through the train-pipe 2, through the connecting-pipe 6, and into the right-hand end of the cylinder D, thence through the port 10 and connecting-pipe 11 to one end of the cylinder H. The diaphragm 23 in the cylinder H is made of flexible material, so that when pressure is applied to one side thereof it yields sufficiently to allow the piston 21 to be moved forward against the action of its spring 22 and also serves to prevent the admission of compressed fluid from the pipe 11 to the pipe 12. The forward movement of the piston 21 against the action of the spring 22 causes the teeth 34 of the reciprocating member 19 of the clutch G to be brought into engagement with the teeth 33 of the member 24, which is attached to the controller-shaft 25. Simultaneously with the movement of the piston 21, which causes the said clutch members to engage, the piston 28 in the cylinder D is moved to the left by the compressed fluid, thereby causing the reversing-switch RS to move into a position which is the reverse of that shown in Fig. 1—that is, so that the contact-fingers a and a' will engage the contact-segments b' and b^3 instead of the segments b and b^2, as shown in Fig. 1. When the piston 28 has moved sufficiently far enough to uncover the port leading to the pipe 13, the compressed fluid is admitted through said pipe 13 to the cylinder F above the controller-actuating piston 14, thereby moving said piston against the action of its spring 15 and rotating the ratchet-wheel 19 one notch forward. The teeth on the ratchet-wheel are so proportioned that the movement of said ratchet-wheel forward one tooth corresponds to a movement of the controller C from its off to its first operative position or from one operative position to the next. The controller may be retained in any one of its operative positions so long as the necessary pressure is maintained in train-pipe 2.

In order to move the controller C into its second operative position, it is necessary to admit the compressed fluid to train-pipe 1 and equalize the pressure within the cylinder F on both sides of the controller-actuating piston 14, so as to allow the spring 15 to return the piston 14 to its initial position, then exhaust the compressed fluid from said train-pipe 1, while maintaining the pressure in the train-pipe 2. This is accomplished by a movement of the controlling-valve v' into the position indicated by the radial line p^2 in Fig. 4. In moving from the position indicated by p' to the position indicated by p^2 the port 39 in the valve v' is brought into register with the first of the ports 60, leading through the valve-seat into the annular chamber 43, the said port 39 maintaining its registry with the groove 45 in all the operative positions of the controlling-valve. It will be seen that when the valve v' is in the position just referred to compressed fluid will be admitted to train-pipe 1 through the said port 39, port 60, annular chamber 43, passage-way 47, (see Fig. 5,) and the passage-way 51 in the reversing plug-valve v^2. From said train-pipe the compressed fluid passes

through pipe 5 into the left-hand end of the cylinder D, thence through the port 9 and connecting-pipe 12 into the cylinder H on the opposite side of the diaphragm 23, where it assists the compressed fluid already admitted to said cylinder through the pipe 11 to maintain the members of the clutch G in register. The compressed fluid also passes through the port 8 from the port 9, through the annular groove 29 in the hollow piston 28, thence through the passage-way 30 in said piston, through the pipe 27, which is fastened to the piston 28, and passes through the end of the cylinder D into the sleeve E. Thence the compressed fluid flows through the pipe 26 into the cylinder F below the piston 14. It will be understood that the piston 28 is now at the left-hand end of the cylinder D—that is, the end opposite from that shown in Fig. 1. Since the pressure above and below the piston 14 within the cylinder F is the same, the spring 15 will act to move the said piston 14 back to its initial position, thereby retracting the piston-rod 16 and moving the pawl 17 so that it will be in position to act upon the next succeeding tooth of the ratchet-wheel 19'. When the valve v' reaches its second operative position, (indicated by p^2,) the communication between the port 60, through the valve-seat, and the port 39, through the valve v', is cut off, and the triangular-shaped undercut portion 40 in said valve is brought into register with the first of the ports 61, leading to the said annular chamber 43, and also into register with the circular groove 44, leading to the exhaust-port 56. It will be seen that the said train-pipe 1, which is charged with the compressed fluid while the valve v' is moving from its first operative position to its second operative position, is exhausted to atmosphere when the said valve reaches its second operative position. When the fluid-pressure is exhausted from said train-pipe 1 in the second position of the valve v', the pressure above the piston 14 in the cylinder F causes the said piston 14 to move forward against the action of the spring 15, thereby moving the controller C forward into its second operative position.

The operation as above described is repeated when the controlling-valve is moved from each operative position to the next. It will be seen that the controller C can be held for an indefinite length of time in any one of its operative positions and that no matter how many controllers are connected to be operated from the said train-pipes 1 and 2 the said controllers will be moved forward step by step simultaneously through their respective operative positions.

As the train-pipe into which the compressed fluid is first admitted determines the position of the reversing-switch RS, and thereby determines the direction of translation of the train, it is necessary to maintain the pressure in the train-pipe into which the pressure is first introduced throughout all the operative positions of the controller. As an additional precaution to prevent the reversing-switch from moving into its reverse operative position an interlock may be used between the controller and the reversing-switch, which will prevent said reversing-switch from being moved from one of its operative positions to the other while the controller-cylinder is in any one of its operative positions.

When it is desired to allow the controllers to move back to their off or initial positions, the controlling-valve v' is moved into the position indicated by p^0 in Fig. 4, and each of the train-pipes is exhausted to atmosphere, as above described. The reduction of pressure caused by the exhausting of the train-pipes 1 and 2 to atmosphere allows the pistons 14 and 21 to be moved into their initial positions by the springs 15 and 22, respectively, thereby retracting the piston-rod 16 and causing the clutch members 19 and 24 of the clutch G to become disengaged and the controller C to return to its initial or off position by the action of the spring 65 or other means preferably located within the controller-casing.

If it is desired to move the reversing-switch RS into its reverse position, so as to reverse the movement of the train, the reversing plug-valve v^2 is turned so as to bring the port 49 in said plug-valve into register with the passage-way 46 and train-pipe 1 and also to bring the port 48 into register with the passage-way 47 and the train-pipe 2. Then as the controlling-valve v' is moved into its first operative position the compressed fluid is admitted to the train-pipe 1 and moves the piston 28 in the cylinder D to the right-hand end of the said cylinder, as shown in Fig. 1, and the operation of moving the controller forward step by step by admitting compressed fluid to and exhausting the same from train-pipe 2, as above described with respect to train-pipe 1, is repeated. In the operation of the system in the reverse direction—that is, with the reversing-switch-actuating piston 28 in the position shown in Fig. 1—the compressed fluid passes from train-pipe 2 through the connecting-pipe 6 into the right-hand end of the cylinder D, through passage-ways 10 and 7 into the annular groove 29, through passage-way 30 into the pipe 27 to the sleeve E, and from thence through the pipe 26 into the lower end of the cylinder F. In this position the compressed fluid is admitted to the cylinder H to actuate the piston 21 through the pipe 12 on the side of the diaphragm 23 opposite from that in which it was admitted when the train-pipe 2 received the compressed fluid first. Otherwise the operation of the clutch-actuating mechanism and the controller-actuating mechanism is the same as has already been described.

Although I have shown and described my

invention as applied to a train-control system, it is quite evident that the same system could be used in a number of cases where it is desired to control a motor or a plurality of motors from a single point or a number of points. I do not wish to be considered as limiting my invention to the specific system herein shown and described, as many modifications may be made by persons skilled in the art 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 a motor-control system, a controller, pneumatically-actuated means for operating said controller, means for maintaining said operating means normally disconnected from said controller, and means controllable independently of said controller-operating means for connecting said operating means to said controller.

2. In a motor-control system, a controller, means for operating said controller, means for maintaining said operating means normally disconnected from said controller, and pneumatically-actuated means for connecting said operating means to said controller.

3. In a motor-control system, a controller, pneumatically-actuated means for operating said controller, means for maintaining said operating means normally disconnected from said controller, and pneumatically-actuated means for connecting said operating means to said controller.

4. In a motor-control system, a controller, pneumatically-actuated means for operating said controller step by step through its successive operative positions, means for maintaining said operating means normally disconnected from said controller, and means for connecting said operating means to said controller.

5. In a motor-control system, a controller, pneumatically-actuated means for operating said controller step by step through its successive operative positions, means for maintaining said operating means normally disconnected from said controller, means for connecting said operating means to said controller, and means for returning said controller to its initial or "off" position when said connecting means becomes inoperative.

6. In a motor-control system, a controller, pneumatically-actuated means for operating said controller, means for maintaining said operating means normally disconnected from said controller, pneumatically-actuated means for connecting said operating means to said controller, a source of compressed-fluid supply, two pipes connected to said pneumatically-actuated means, and means for controlling the admission of compressed fluid to said pipes from said source of supply.

7. In a motor-control system, a plurality of controllers, means for operating said controllers simultaneously, means for disconnecting said operating means from said controllers, and pneumatically-actuated means for simultaneously connecting said operating means to said controllers.

8. In a motor-control system, a plurality of controllers, pneumatically-actuated means for operating said controllers, means for disconnecting said operating means from said controllers, pneumatically-actuated means for simultaneously connecting said operating means to said controllers, pipes connected with said pneumatically-actuated means, a source of compressed-fluid supply, and means for controlling the admission of compressed fluid to said pipes from said source of supply.

9. In a motor-control system, a plurality of controllers, pneumatically-actuated means for operating said controllers, means for disconnecting said operating means from said controllers, pneumatically-actuated means for simultaneously connecting said operating means to said controllers, pipes connected with said pneumatically-actuated means, a source of compressed-fluid supply, and means for controlling the admission of compressed fluid to said pipes from said source of supply so as to produce a simultaneous step-by-step movement of said controllers through their successive operative positions.

10. In a motor-control system, a controller, pneumatically-actuated means for operating said controller step by step through its successive operative positions, a pneumatically-actuated clutch for connecting the controller-operating means to said controller, and means for controlling the operation of said clutch and said controller-operating means.

11. In a motor-control system, a controller, pneumatically-actuated means for operating said controller step by step through its successive operative positions, a pneumatically-actuated clutch for connecting said controller-operating mechanism to said controller, and an operating or motorman's valve for controlling the admission of compressed fluid to and the exhaust of the same from said clutch and said controller-operating means.

12. In a motor-control system, a controller, a pneumatically-actuated clutch one member of which is operatively connected with said controller and the other member of which is adapted to be reciprocated into and out of engagement with said first-mentioned clutch member, and pneumatically-actuated means for rotating said clutch by a step-by-step forward movement.

13. In a motor-control system, a controller, a pneumatically-actuated clutch one member of which is operatively connected with said controller and the other member of which is adapted to be reciprocated into and out of engagement with said first-mentioned clutch member, and pneumatically-actuated means for rotating said clutch by a step-by-step for-

ward movement said means comprising a ratchet-wheel connected with said reciprocating member and a pawl operatively connected to a piston capable of a reciprocatory movement.

14. In a motor-control system, a controller, a pneumatically-actuated means for operating said controller step by step through its successive operative positions, pneumatically-actuated means for connecting said controller-operating means to said controller, a pneumatically-actuated reversing-switch, and means for controlling the operation of said controller-actuating means, said connecting means and said reversing-switch.

15. In a motor-control system, a controller, pneumatically-actuated means for operating said controller step by step through its successive operative positions, pneumatically-actuated means for connecting said operating means to said controller, a pneumatically-actuated reversing-switch, and a means for preventing the operation of said controller until said reversing-switch is thrown into the desired position.

16. In a motor-control system, a controller, pneumatically-actuated means for operating said controller step by step through its successive operative positions, pneumatically-actuated means for connecting said operating means to said controller, a pneumatically-actuated reversing-switch, means for preventing the operation of said controller until said reversing-switch is thrown into the desired position, two pipes operatively connected with said pneumatically-actuated devices, and means for controlling the admission of compressed fluid to said pipes.

17. In a motor-control system, a controller, pneumatically-actuated means for operating said controller step by step through its successive operative positions, a pneumatically-actuated clutch for connecting said controller-operating means to said controller, a pneumatically-actuated reversing-switch, and an operating or motorman's valve for controlling the admission of compressed fluid to and the exhaust of the same from the means for operating said clutch, said reversing-switch and said controller.

18. In a train-control system, a controller, pneumatically-actuated means for operating said controller step by step through its successive operative positions, a pneumatically-actuated clutch for connecting said controller-operating means to said controller, a pneumatically-actuated reversing-switch, two train-pipes operatively connected with the means for operating said controller, clutch and reversing-switch, and means for controlling the admission of compressed fluid to said train-pipes.

19. In a train-control system, a controller, pneumatically-actuated means for operating said controller, a pneumatically-actuated clutch for connecting said controller-operating means to said controller, a pneumatically-actuated reversing-switch, two train-pipes operatively connected with the means for operating said controller, clutch and reversing-switch, and an operating or motorman's valve for controlling the admission of compressed fluid to and the exhaust of the same from said train-pipes to move said reversing-switch into the desired position and to produce a step-by-step forward movement of the controller.

20. In a train-control system, a controller, pneumatically-actuated means for operating said controller, a pneumatically-actuated clutch for connecting said controller-operating means to said controller, a pneumatically-actuated reversing-switch, two train-pipes operatively connected with the means for operating said controller, said clutch and reversing-switch, and means for controlling the admission of compressed fluid to said train-pipes in such a manner that by admitting compressed fluid to one of said train-pipes the position of the reversing-switch is determined and by admitting compressed fluid to and exhausting the same from the other of said train-pipes while maintaining the pressure in said first-mentioned pipe the controller-cylinder will be moved forward with a step-by-step movement through its operative positions.

21. In a train-control system, a controller, pneumatically-actuated means for operating said controller, a pneumatically-actuated clutch for connecting said controller-operating means to said controller, a pneumatically-actuated reversing-switch, two train-pipes operatively connected with the means for operating said controller, clutch and reversing-switch, means for admitting compressed fluid to one of said train-pipes to determine the position of said reversing-switch and for admitting compressed fluid to and exhausting the same from the other of said train-pipes while maintaining the pressure in said first-mentioned pipe to move the controller-cylinder forward through its successive operative positions with a step-by-step movement, and means for changing the pipe connections so that the other of said train-pipes will receive compressed fluid first and reverse the position of the reversing-switch.

22. In a train-control system, a controller, pneumatically-actuated means for operating said controller, a pneumatically-actuated clutch for connecting said controller-operating means to said controller, a pneumatically-actuated reversing-switch, two train-pipes operatively connected with the means for operating said controller, said clutch and said reversing-switch, an operating or motorman's valve provided with ports adapted to admit compressed fluid to one of said train-pipes to determine the position of said reversing-switch and to admit compressed fluid to and exhaust the same from the other of said pipes

while maintaining the pressure in said first-mentioned pipe to move the controller-cylinder forward through its operative positions with a step-by-step movement, a reversing-valve connected with said pipes and adapted to allow said last-mentioned train-pipe to receive compressed fluid first when the motorman's valve is operated and thereby reverse the position of said reversing-switch, and an interlock between said controlling-valve and said reversing-valve.

23. In a motor-control system, a plurality of controllers, pneumatically-actuated means for operating said controllers simultaneously through their successive operative positions, pneumatically-actuated means for connecting said controller-operating means to said controllers, pneumatically-actuated reversing-switches, and means under the control of the motorman and located at any desired point for controlling the operation of said controller-actuating means, said connecting means and said reversing-switches.

24. In a train-control system, a plurality of controllers, pneumatically-actuated means for operating said controllers step by step simultaneously through their successive operative positions, pneumatically-actuated clutches for connecting said controller-operating means to said controllers, pneumatically-actuated reversing-switches, two train-pipes operatively connected with the means for operating said controllers, clutches and reversing-switches, and means for controlling the admission of compressed fluid to said train-pipes to operate said pneumatically-actuated controllers, clutches and reversing-switches.

25. In a motor-control system, a plurality of controllers, pneumatically-actuated means for operating said controllers simultaneously step by step through their successive operative positions, pneumatically-actuated means for connecting said operating means to said controllers, pneumatically-actuated reversing-switches, and means for preventing the operation of said controllers until said reversing-switches are thrown into the desired position.

26. In a train-control system, a plurality of controllers, pneumatically-actuated means for operating said controllers simultaneously through their successive operative positions, pneumatically-actuated means for connecting said operating means to said controllers, pneumatically-actuated reversing-switches, means for preventing the operation of said controllers until the reversing-switches are thrown into the desired position, two train-pipes operatively connected with said pneumatically-actuated controllers, connecting means and reversing-switches, and means for controlling the admission of compressed fluid to said train-pipes to operate said pneumatically-actuated devices.

27. In a train-control system, a source of compressed-fluid supply, two train-pipes, and a motorman's valve having ports constructed and arranged to admit compressed fluid to one of said train-pipes and while maintaining the pressure in said train-pipe to admit compressed fluid alternately to and exhaust the same from the other of said train-pipes while moving through its successive operative positions and to exhaust both train-pipes to atmosphere when in its initial or "off" position.

28. In a train-control system, a source of compressed-fluid supply, two train-pipes, a motorman's valve having ports constructed and arranged to admit compressed fluid to one of said train-pipes and while maintaining the pressure in said train-pipe to admit compressed fluid alternately to and exhaust the same from the other of said train-pipes while moving through its successive operative positions and to exhaust both train-pipes to atmosphere when in its initial or "off" position, and means for reversing the connections between said valve and said train-pipes so that the order of admission of compressed fluid to said train-pipes will be reversed.

29. In a train-control system, a source of compressed-fluid supply, two train-pipes, a motorman's valve having ports constructed and arranged to admit compressed fluid to one of said train-pipes and while maintaining the pressure in said train-pipe to admit compressed fluid alternately to and exhaust the same from the other of said train-pipes while moving through its successive operative positions and to exhaust both train-pipes to atmosphere when in its initial or "off" position, a valve having ports adapted to reverse the connections between said valve and said train-pipes so as to reverse the order of admission of compressed fluid to said train-pipes, and an interlocking device between said valves.

In witness whereof I have hereunto set my hand this 4th day of December, 1902.

FRED B. COREY.

Witnesses:

ALEX. F. MACDONALD,

HELEN ORFORD.