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RAILWAY TRAFFIC CONTROLLING APPARATUS

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2 Sheets-Sheet 1

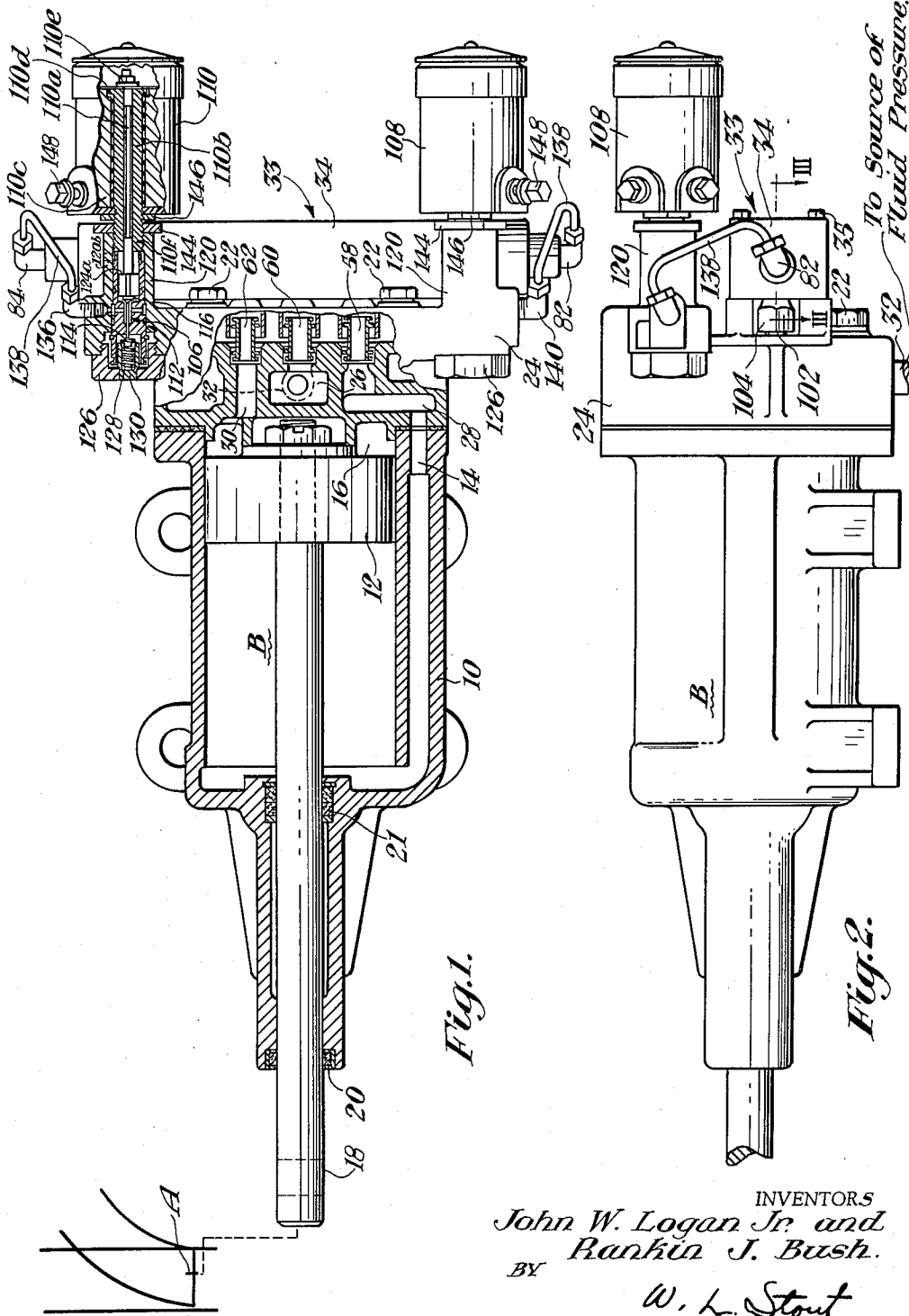


Fig. 1.

Fig. 2.

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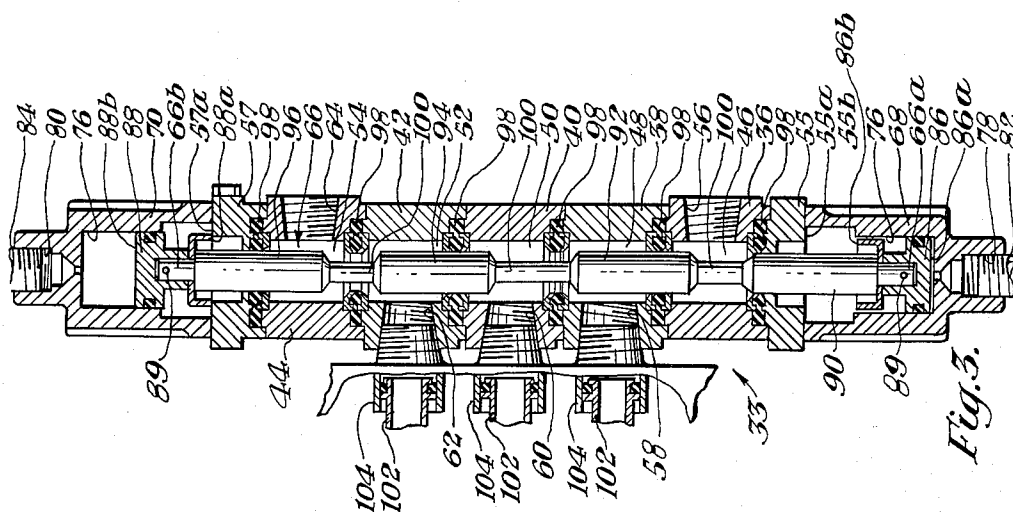
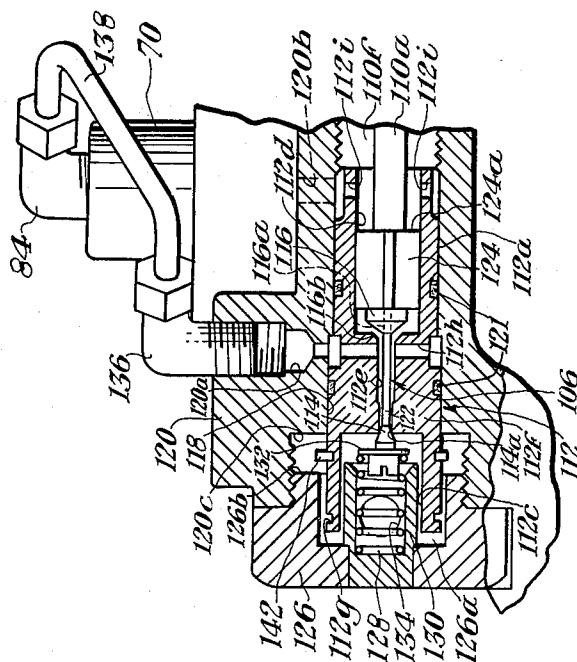
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RAILWAY TRAFFIC CONTROLLING APPARATUS
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Our invention relates to railway traffic controlling apparatus, and particularly to traffic controlling apparatus including a reversible fluid pressure-actuated motor controlled by means of a reciprocable valve member which, in turn, is controlled by electromagnetically-operated valves. More particularly, our invention relates to new and novel improvements in the electromagnetically-operated valves.

This invention is especially suitable for use in connection with track switches in a railway classification yard in which the switches are operable to either of two positions for controlling the movements of railway cars into turnout tracks leading to a number of classification tracks in the yard. In a railway classification yard, a track circuit, conveniently termed a detector track circuit, is provided for locking its associated track switch from movement during the period of time a railway car is passing over the switch and to a large extent, the minimum spacing between two successive cars routed to pass over the same switch is determined by the length of the track circuit with the allowable spacing becoming smaller as the length of the track circuit is reduced. In some cases, the track switch is located closer to the exit end of the car retarder than in others and in order to obtain the required track circuit length it is sometimes necessary to locate the insulating joints which define the entrance to the track circuit at a predetermined point in the car retarder. Generally speaking, however, although this arrangement is satisfactory in certain respects in a functional sense, it increases the complexity of the track arrangement and introduces inherent mechanical problems. For more economical operation of the yard it is therefore desirable that the track circuit be kept entirely out of the retarder and in one desired expedient the entrance of the track circuit is located beyond the exit end of the car retarder which shortens the track circuit length and accordingly minimizes the required spacing between successive cars. Reducing the length of a particular track circuit will, however, usually be accompanied by the undesirable consequence that when a second car closely spaced from a leading car is traveling at a relatively high speed, it may enter the track circuit and effect locking of the switch before movement of the switch from one to the other of its positions can fully be completed, thereby possibly causing the second car to be misrouted. To compensate for the reduced track circuit length it has been found expedient to lower the amount of time required by the switch machines in the yard for operating their associated track switches to prevent the possible misclassification of humped cars.

One object, therefore, of our invention is to provide a fast direct acting railway switch machine whose speed of operation is such that the amount of time required to complete a switching movement in response to a control signal is appreciably reduced.

Another object of our invention is to provide a direct acting railway switch machine which ensures rapid operation of the switch or mechanism to be controlled from its one position to its other position.

Still another object of our invention is the provision in a railway switch machine of improved electromagnetically-operated valves which are designed for conven-

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ient installation and removal for inspection, maintenance and the like.

Yet another object of our invention is to provide a valve arrangement for use in connection with a railway switch machine, which valve arrangement is effective to materially reduce the amount of time required for performing major shop overhauls and other maintenance work.

Another object of our invention is the provision in a railway switch machine of an improved electromagnetically-operated valve for controlling fluid under pressure, means normally being provided to enclose the valve within said machine, but which means can readily be removed to permit removal of the valve from the machine.

A general object of our invention is to provide a railway switch machine of the type described which allows field emergency repairs of essential parts without necessitating removal of the machine from its location in the track.

Other objects and characteristic features of our invention will become apparent as the description proceeds.

To attain the aforementioned objects of our invention we provide a conventional railway traffic controlling device, a fluid pressure-actuated motor for controlling the device, and a spool-type slide valve arranged to control the admission of fluid under pressure from a suitable source to one or the other side of the motor piston. Two valve structures, each of which comprises cooperating pin and magnet valves adapted for concurrent movement in a suitable bushing, and operable by an electromagnet in a conventional manner, are provided for controlling the supply of fluid under pressure to the slide valve. By means of our invention, the making of electrical connections to the coil terminals of the electromagnets is appreciably facilitated by adjustably rotatably mounting each electromagnet in a manner to enable it to be rotated to any desired position.

We shall describe one form of apparatus embodying our invention, and shall then point out the novel features thereof in claims.

In the accompanying drawings:

FIG. 1 is a plan view partially in section showing a railway switch machine embodying our invention operatively connected with a railway switch.

FIG. 2 is an elevational view of the switch machine shown in FIG. 1.

FIG. 3 is a cross-sectioned view taken substantially along line III-III of FIG. 2 showing, to better advantage, the slide valve incorporated in the railway switch machine embodying our invention.

FIG. 4 is an enlarged view, partly in section, with certain of the parts removed, of the improved electromagnetically-operated valve structure embodying our invention.

Similar reference characters refer to similar parts in each of the several views.

Referring to FIG. 1 of the drawings, the reference character A designates a railway traffic controlling device, here shown as a railway switch. The switch is operated by a fluid pressure-actuated motor B, which motor, as here shown, comprises a cylinder 10 and a reciprocable piston 12 operable therein. Fluid under pressure, usually compressed air, is at times applied to one end or the other of cylinder 10 through passages 14 and 16 from a suitable source to be described. Secured to piston 12 at its one end is a piston rod 18 slidably mounted in suitable packing rings 20 and 21, and operatively connected at its other end to switch A for moving switch A between normal and reverse positions.

As seen in FIGS. 1 and 2, cylinder 10 of motor B is connected by means of bolts 22 with a cylinder head 24 provided with three fluid passages 26, 28 and 30. The passage 26 is connected by means of a fluid passage, not

shown, internally extending from passage 26 through the cylinder head to a pipe 32 (FIG. 2). The pipe 32 is connected to a suitable source of fluid under pressure, from which source the fluid under pressure for operating motor B is taken, and in a manner to be described in detail hereinafter. Passages 28 and 30 are directly connected, respectively, with passages 14 and 16 of motor B.

The passages 28 and 30 of cylinder head 22 are arranged to be opened and closed to fluid under pressure by a valve device 33, the housing 34 of which is secured directly to cylinder head 24 by means of bolts 35.

The valve device 33 is of the pneumatically-operated type, and is preferably of the type disclosed and claimed in Letters Patent of the United States No. 2,747,611, issued May 29, 1956, to Ellis E. Hewitt. This valve device, as shown in FIGS. 1 and 2, and particularly as shown in FIG. 3, comprises a plurality of identical adjoining casing sections designated by reference numerals 36, 38, 40, 42, and 44, each being provided with a chamber or bore, designated by the numerals 46, 48, 50, 52 and 54, respectively, the chambers all being aligned in coaxial relation with each other.

The casing sections 36, 38, 40, 42 and 44 are provided with screw-threaded ports or pipe-connecting bores 56, 58, 60, 62 and 64, respectively, connecting chambers 46, 48, 50, 52 and 54, respectively, to an external surface of the respective casing section.

A spool-type slide valve 66 extends coaxially through the several chambers 46, 48, 50, 52 and 54, and through a pair of cap portions 55 and 57. The valve 66 is provided with end portions 66a and 66b which project into cylindrical end caps 68 and 70, respectively, which end caps, cap portions, and casing sections are secured in any conventional manner herein not shown in abutting contact with each other. The end caps 68 and 70 are each formed interiorly with a concentric bore or chamber 76 and terminate, at one end of their respective bores 76, in screw-threaded ports 78 and 80, respectively. The screw-threaded portions 78 and 80 are shown connected with suitable pipe fittings 82 and 84, and the connections with the corresponding opposite ends of pipe fittings 82 and 84 will be described as the specification proceeds. Respectively located within bores 76 of end caps 68 and 70 for sliding movement therein are two pistons 86 and 88 fixedly attached, respectively, to the end portions 66a and 66b of valve 66 by any suitable means such as, for example, by passing a cotter pin or roll pin 89 through aligned holes provided in the pistons and the corresponding ends, as herein shown. The lower position of valve 66, as viewed in FIG. 3, is defined by the engagement of one side 88a of piston 88 with a surface 57a of cap portion 57, in which position a face 86a of the other piston 86 substantially abuts against the bottom of the bore 76 in end cap 68. Similarly, the upper position of valve 66, as seen in FIG. 3, is defined by engagement of one side 86b of piston 86 with a surface 55a of cap portion 55, in which position a face 88b of the other piston 88 will substantially abut against the bottom of bore 76 in the other end cap 70. It will be understood, of course, that when the railway switch machine embodying our invention is installed adjacent a trackway for operation, valve device 33 and, consequently, valve 66 will be disposed in a horizontal plane.

The valve 66 comprises four land portions 90, 92, 94, and 96 disposed for sliding and sealing contact in resilient O-rings 98 which are located between adjoining casing sections, and which are also located between cap portions 55 and 57 and the two outer casing sections 36 and 44 adjacent thereto, respectively. The land portions 90, 92, 94 and 96 are connected by reduced portions or grooves 100. Land portions 92 and 94 are of such length that when valve 66 is operated to its lower position, as described hereinabove, land portion 92 remains disposed in an interfering position between casing sections 36 and 38 for closing communication between

chambers 46 and 48. At the same time, land portion 92 opens communication between chambers 48 and 50. Land portion 94 meantime is moved to a position to open communication between chambers 52 and 54, and to close communication between chambers 50 and 52. When valve 66 is operated to its upper position, as described hereinabove, the land portion 92 will move from its previous position between casing sections 36 and 38 and thereby now open communication between chambers 46 and 48 while, at the same time, moving to an interfering position in which communication will now be closed between chambers 48 and 50. Land portion 94 will simultaneously move to a position to open communication between chambers 50 and 52, and to close communication between chambers 52 and 54. Hence, it can be seen that operating the valve 66 to its other end position closes the chambers that were open and opens the chambers that were closed. Due to the sliding friction between the land portions of valve 66 and the O-rings 98, valve 66 remains, when operated, in its upper and lower positions according as a fluid pressure force, preferably compressed air, acts, in a manner to be described in detail hereinafter, against piston 86 or 88, respectively.

The screw-threaded ports 56 and 64 of valve device 33 are merely open to atmosphere; ports 58 and 62 communicate respectively with passages 28 and 30 of cylinder head 24 by means of grommets sleeves 102 which extend inside one end of threaded adapters 104, the adapters 104 in turn being screwed at their other end into ports 58 and 62; and port 60 communicates with passage 26 of cylinder head 24 by means of a similar sleeve and adapter. Thus, when valve 66 occupies the position in which it is shown in FIG. 3, fluid communication is established between passage 26 of cylinder head 24, port 60, chambers 50 and 48, and port 58 of valve device 33, and passage 28 of cylinder head 24 and passage 14 of motor B to admit fluid under pressure to the left-hand side of piston 12. At the same time, the right-hand side of piston 12 is directly connected with atmosphere through a fluid passageway including passage 16 of motor B, passage 30 of cylinder head 24, and port 62, chambers 52 and 54, and port 64 of valve device 33. It will be appreciated that by exposing directly to atmosphere that side of piston 12 opposite to the side to which fluid under pressure is applied each time a movement of switch A is effected, piston 12 encounters no appreciable fluid pressure resistance as it moves between the ends of cylinder 10 of motor B, thereby greatly reducing the time required for such movements of piston 12 to consequently reduce the time required to operate switch A from one to the other of its positions.

A control over the speed of switch A may be desired to slightly retard the movement of switch A immediately prior to the time a reverse movement of the switch has fully been completed to avoid slamming the switch to thus protect the points thereof from damage. Hence, a choke device (not shown) may be provided and screwed into ports 56 and 64 of valve device 33 to regulate the flow of fluid under pressure from either side of piston 12 to atmosphere during movement of piston 12 in either direction of its stroke. The choke device may assume various forms well known in the art and may, for example, as herein contemplated, comprise a bored plug (not shown) screwed into the ports 56 and 64, with the diameter of the bore in the plugs determining the rate of escape of fluid under pressure to atmosphere from the chambers 46 and 54 of valve device 33.

In accordance with a principal object of our invention, the admission of fluid under pressure to valve 66 is controlled by two identical valve structures, only one of which, herein designated 106, is illustrated, which valve structures are operated, respectively, by identical electromagnets 108 and 110, one or the other of which is energized according to the desired position of switch A. Inasmuch as the valve structures and their associated elec-

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tromagnets are identical in operation and construction, we have chosen only to describe that valve structure and associated electromagnetic which appears in the upper part of FIG. 1, which valve structure and a portion of the associated electromagnet we have for purposes of simplicity more clearly illustrated in FIG. 4.

Referring now to FIG. 4, the valve structure 106 is housed in a substantially cylindrical bushing 112 and includes detachably connected valves 114 and 116 which operate respectively as inlet and exhaust valves. The bushing 112 and the valves 114 and 116 when assembled together form a valve subassembly which can be regarded as a replaceable unit, as will be described hereinafter. Furthermore, it will be understood that in practice either one of the pair of valves 114 and 116 may serve as the inlet valve with the remaining one serving as the outlet valve depending upon the desired arrangement of the external connection to the ports controlled by the valves. The bushing 112 is mounted in an annular opening 118 provided in a housing or enclosure member 120 formed integrally with cylinder head 24 at one end thereof and is movable laterally within the opening for a purpose which will be made clear as the specification proceeds. The outer surface 112a of bushing 112 is provided with two spaced annular grooves in which O-rings 121 for sliding and fluid pressure sealing purposes are located. The bushing 112 is formed at one end with a longitudinal hole 112c, and is slightly reduced in diameter at its other end, which other end is provided with another longitudinal hole 112d in axial alignment with the hole 112c. The bases of holes 112c and 112d are communicably connected by an aperture 112e extending through an intermediate portion 112f of bushing 112, which aperture is considerably smaller in diameter than either hole 112c or 112d and concentric therewith. The aperture 112e is suitably proportioned to loosely receive a stem 122 having its one end connected to pin valve 114. The other end of stem 122 fits into a recess 116a provided centrally in valve 116. It will be understood that stem 122 may instead be provided on valve 116, and a recess for receiving the stem then be provided in valve 114. In either case, such an arrangement, whereby valves 114 and 116 are detachably connected to each other, permits the most troublesome parts of the switch machine embodying our invention to be independently examined and inspected when valves 114 and 116 are detached from each other, as will be described.

The valves 114 and 116, as shown in FIG. 4, are in their respective normal positions, and cooperate respectively with valve seats 114a and 116b at the opposite ends of the aperture 112e such that when one valve is seated the other is unseated. Guided by the inner surface of hole 112d, and formed integrally with valve 116, is a generally triangular shaped member 124 which allows air to pass along its sides against a plane surface 124a of which a tapered armature stem 110a of electromagnet 110 abuts.

Referring now specifically to FIG. 1, the electromagnet 110 is of standard construction and comprises briefly a hollow core 110b surrounded by a winding 110c. An armature 110d cooperates with armature stem 110a, the armature being held in juxtaposition to the armature stem by a lock nut 110e. The core 110b is provided outside the main body of the electromagnet with a threaded extending portion 110f, one end of which is threadably connected with one end of housing 120 to close one end of opening 118. The other end of opening 118 is closed by a cap nut or plug 126 screwed into housing 120. To bias valves 114 and 116 to their respective normal positions, a coil spring 128 contained in a cup 130 secured to cap nut 126 acts against an annular shoulder 132 on valve 114 in a direction to normally seat valve 114 and to unseat valve 116, substantially as shown in FIG. 4. When electromagnet 108 becomes energized, valves 114 and 116 are operated, in opposition to the bias of spring

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128, to positions in which they become unseated and seated, respectively, as shown in FIG. 1.

In order to gain access to valves 114 and 116, cap nut 126 is unscrewed and removed from housing 120, and a screw driver or similar conventional tool, not shown, is applied to a groove 112g (FIG. 4) provided on one end of bushing 112. To completely withdraw bushing 112 and the valves 114 and 116 mounted therein from within opening 118, a relatively light force is then applied to the screw driver, in a direction away from electromagnet 110. With such an arrangement, both valves 114 and 116 are immediately accessible and when removed from the bushing they may be detached from each other, as previously mentioned. If the valves are found to be excessively worn due to their repeated operation, either valve may be restored to condition for service or replaced, or discarded at the end of a predetermined duration of active service. Such an arrangement obviously simplifies maintenance procedure to correspondingly reduce the cost of maintenance. Furthermore, removably mounting the bushing as embodied in our present invention enables the bushing, and the valves therein, as a unit, to be used to replace, for example, a defective unit, thus making it possible to conveniently correct any valve problem without detaching the electromagnet from housing 120.

The cap nut 126 closes a cavity 126a to which fluid under pressure is constantly supplied by means of a pipe connection 134, best shown in FIG. 4, which may be coupled by any suitable means, not shown, to the source of fluid under pressure indicated in FIG. 2. The fluid under pressure for operating valve 66 is taken from this cavity and is intended to be applied through aperture 112e and a port 112h which extends through the intermediate portion 112f of bushing 112 to a transverse hole 120a bored in housing 120, the aperture 112e, port 112h, and hole 120a all being connected in direct fluid communication with each other. This hole 120a receives one end of a pipe fitting 136, which pipe fitting is clearly illustrated in FIG. 4, and at the upper part of FIG. 1. The other end of pipe fitting 136 is connected by means of a pipe or tubing 138 with one end of pipe fitting 84. It will be recalled that pipe fitting 84 has its other end connected with the port 80 in end cap 70 of valve device 33. Moreover, a pipe fitting 140, shown in the lower part of FIG. 1 connecting with the other housing 120, is connected by a similar pipe or tubing 138, and pipe fitting 82 with port 78 in end cap 68 at the other end of valve device 33. The housing 120 is further provided adjacent its other end with another transverse hole 120b continually connected with atmosphere. With valves 114 and 116 in their respective normal positions, fluid communication is established between hole 120b and aperture 112e by means of holes 112i aligned with hole 120b and bored through the wall of bushing 112.

The fluid under pressure charging cavity 126a may tend to force bushing 112 deeper into opening 118. If the movement of bushing 112 in this direction is not arrested after a certain relatively small extent, the O-ring 121 nearest to the cap nut 126 may be displaced from its present position to a position in which it becomes entangled in hole 120a in extension 120 and perhaps forced from its groove. To avoid the obvious consequent damage to the O-ring, bushing 112 is provided with a snap ring 142 (FIG. 4) which by its engagement with a flat inner surface 120c of housing 120 limits movement of the bushing 112 into opening 118. Moreover, movement of bushing 112 in response to an oppositely directed force, such as, for example, a force produced by the impact of valve 116 against its seat, is also limited due to the other side of the snap ring acting against an inner surface 126b of cap nut 126.

To secure electromagnet 110 firmly in place against the housing 120 of cylinder head 24, the extending portion 110f of core 110b of the electromagnet 110 is pro-

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vided with an adjustable lock nut 144. Initially, as extending portion 110f is screwed into opening 118, lock nut 144 is backed off to a position in which it abuts against a second lock nut 146, which lock nut 146 is also mounted on the extending portion 110f. Eventually, as the rotation of electromagnet 110 is continued, lock nut 144 in its backed-off position strikes extension 120 and the rotation of electromagnet 110 is arrested. Before the electromagnet is rigidly locked against movement, adjustment of the armature stem 110a relative to member 124 will generally be required to insure a suitable working relationship between valves 114 and 116 and their respective valve seats when they are operated. To accomplish this adjustment, lock nut 110e securing stem 110a to armature 110d is somewhat loosened and the armature stem is moved along its longitudinal axis until the valves occupy the position in which they are shown in FIG. 4, whereupon lock nut 110e is retightened. Should it be necessary, electromagnet 110 is thereupon rotated in a reverse direction until terminals 148 are in positions best suited for connection with lead-in wires not shown. Because of the reverse rotation of the electromagnet a relatively slight separation will occur between the inner end of the armature stem and member 124 but the abutment between the armature stem and member 124 will immediately be reestablished since the bushing 112, in response to the fluid under pressure at its one end in cavity 126a, will move axially toward core extension 110 as the electromagnet is backed off. That is, when the positions of the terminals 148 relative to the lead-in wires are adjusted, bushing 112 will move linearly an extent proportional to the angular distance of the electromagnet during its reverse rotation and the armature stem adjustment will remain unchanged. It will readily be appreciated, therefore, that by the expedient of allowing the bushing to float within its enclosure, contact between the actuating member of the electromagnet and the valve assembly will absolutely be assured regardless of any slight angular adjustment of the electromagnet. It will further be appreciated that this mounting arrangement, and the ability of the bushing to drift freely within the limits hereinabove described, provides a convenient means for gaining access to the coil terminals of the electromagnet with lead-in wires whose length, for instance, may be so short that connection to the coil terminals would otherwise be difficult. After connection to terminals 148 of such lead-in wires, lock nut 144 is tightened against housing 120 to firmly lock the electromagnet in place.

The operation of this arrangement is as follows: When neither electromagnet is energized, valve 66 occupies one or the other of its operated positions according as fluid under pressure was last admitted to either one or the other end of valve device 33, substantially as described hereinabove.

Assuming now that the electromagnet 110 becomes energized, valve 114 is moved in a direction to become disengaged from seat 114a, and valve 116 simultaneously moves in the same direction to engage seat 116a and thereby close communication between aperture 112e and atmosphere. The opening of valve 114 admits fluid under pressure to aperture 112e and to the previously traced fluid path including pipe fitting 136, pipe 138, and pipe fitting 84 to port 80 of valve device 33. The admission of fluid under pressure to port 80 of valve device 33 causes movement of valve 66 in such direction as to cause fluid under pressure to be admitted to passage 14 of motor B, as hereinabove explained. Piston 12 of motor B will thereupon move to the right, as viewed in FIG. 1.

Fluid under a relatively lower pressure and created at the right-hand side of piston 12 by the sudden movement of piston 12 to its right will meantime pass to atmosphere, substantially as described hereinabove.

One feature of the valve apparatus embodying our invention is that the electromagnetically-operated valves are accessible at all times for servicing or maintenance

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purposes. That is, it is possible with this construction to remove the cap nuts which enclose the valve structures within their respective housings merely by applying to the cap nuts a standard tool of the type generally carried by signal maintainers. It can be seen that once the cap nut is removed, the bushing and the valve structure mounted therein may be removed for immediate inspection, there being no fixed attachment between the valve structure and the armature stem of the electromagnet operatively associated with each valve structure. However, once the electromagnet is fixedly mounted for operation, and its terminals connected to the energizing source, it can be seen that the novel approach to the problem of simplifying valve adjustment removes the doubt that variations from the initial valve adjustment will occur.

Although we have herein shown and described only one form of railway traffic controlling apparatus embodying our invention, it is understood that various changes and modifications may be made therein within the scope of the appended claims without departing from the spirit and scope of our invention.

Having thus described our invention, what we claim is:

1. In combination, a fluid pressure-actuated motor comprising a cylinder having a piston reciprocable between a first and a second position, fluid pressure-actuated spool valve means reciprocable between a first and a second position for controlling the admission of fluid under pressure to said cylinder, and means for controlling the admission of fluid under pressure to said spool valve means and comprising first and second enclosure members each having an elongated opening therethrough screw-threaded at both ends, a first bushing slidably mounted in the opening in said first enclosure member, a second bushing slidably mounted in the opening in said second enclosure member, cap means in threaded engagement with said first and second enclosure members at one end of said openings for closing said one end of said openings, a first valve means slidably mounted in said first bushing for axial movement between a biased initial position and a second position for controlling the admission of fluid under pressure to one end of said spool valve means, a second valve means slidably mounted in said second bushing for axial movement between a biased initial position and a second position for controlling the admission of fluid pressure to the other end of said spool valve means, and valve actuating means secured to said first and second enclosure members at the other end of said opening and being operatively connected with said first and second valve means for moving said first and second valve means to their respective second positions.

2. In combination, a fluid pressure-actuated device comprising a cylinder having a reciprocable piston therein, a valve supporting member having an inlet port adapted for connection with a fluid pressure source and a pair of ports each one communicating with one end of said cylinder, first fluid pressure-operated valve means in said valve supporting member movable between first and second positions and effective in its first position for connecting said inlet port with one end of said cylinder and effective in its second position for connecting said inlet port with the other end of said cylinder, first and second enclosure members having relatively elongated first and second openings extending therethrough respectively, first and second bushings mounted in said first and second openings respectively, and each provided circumferentially with a resilient sealing member slidably engaging the inner surface of said openings, removable cap means for closing one end of said first and second openings whereby when said cap means are removed said bushings may independently be removed from said enclosure members; said first enclosure member having a first group of ports comprising an inlet port adapted for connection with a fluid pressure source, an outlet

port and an exhaust port; said first bushing having an outlet port in direct communication with the outlet port of said first group, a first passageway extending from the outlet port of said first group to one end of said first valve means, second valve means in said first bushing movable between one position for establishing communication between the outlet port and the inlet port of said first group, and another position for establishing communication between the outlet port and the exhaust port of said first group; said second enclosure member having a second group of ports comprising an inlet port adapted for connection with a fluid pressure source, an outlet port, and an exhaust port; said second bushing having an outlet port in direct communication with the outlet port of said second group, a second passageway extending from the outlet port of said second group to the other end of said first valve means, and third valve means in said second bushing movable between one position for establishing communication between the outlet port and the inlet port of said second group, and another position for establishing communication between the outlet port and the exhaust port of said second group.

3. A fluid pressure-actuated device comprising a cylinder having a piston reciprocable therein, the combination comprising a valve supporting member having a pair of ports each communicating with one end of said cylinder and an inlet port adapted for connection with a fluid pressure source, a valve member slidably mounted in said valve supporting member for movement between a first and a second position and effective in its first position for connecting one of said ports with said inlet port and effective in its second position for connecting the other of said ports with said inlet port, first and second enclosure members provided with first and second openings respectively, the openings each being in axial alignment with its associated enclosure member and being open at both ends to afford entry thereto, a first elongated bushing slidably mounted in said first opening and admitted thereto from one end of said first opening, first cap means for closing said one end of said first opening; said first enclosure member provided with a first inlet port at one end of said first bushing adapted for connection with a fluid pressure source, a first outlet port, and a first exhaust chamber at the other end of said first bushing communicating with atmosphere; first valve means slidably mounted in said first bushing in axial alignment therewith for movement between normal and operated positions for controlling communication between said first exhaust chamber and said first outlet port and between said first inlet chamber and said first outlet port respectively, means for connecting said first outlet port with one end of said spool valve, electromagnetic means secured to said first enclosure member at the other end of said first opening for actuating said first valve means to its operated position, a second elongated bushing slidably mounted in said second opening and admitted thereto from one end of said second opening, second cap means for closing said one end of said second opening; said second enclosure member provided with a second inlet port at one end of said second bushing adapted for connection with a fluid pressure source, a second outlet port, and a second exhaust chamber at the other end of said second bushing communicating with atmosphere; second valve means slidably mounted in said second bushing in axial alignment therewith for movement between normal and operated positions for controlling communication between said second exhaust chamber and said second outlet port and between said second inlet chamber and said second outlet port respectively, means for connecting said second outlet port with the other end of said spool valve, and other electromagnetic means secured to said second enclosure member

at the other end of said second opening for actuating said second valve means to its operated position.

4. In combination with a cylinder having a reciprocable piston therein to which the admission of fluid under pressure from a suitable fluid pressure source is controlled by a reciprocable spool valve means effective in one position for connecting one end of said cylinder with said source to operate said piston in one direction, and another position for connecting the other end of said cylinder with said source to operate said piston in the opposite direction, means for controlling the admission to said spool valve means of fluid under pressure and comprising first and second enclosure members each having therein an elongated annularly-shaped opening screw-threaded at both ends, first and second substantially cylindrical bushings respectively slidably mounted in the opening in said first enclosure member and in the opening in said second enclosure member, cap means in threaded engagement with said first and second enclosure members at one end of said openings for closing said openings at said one end, said first and second bushings each having adjacent to said one end of said openings a snap ring engageable with said enclosure members and effective when thus in engagement therewith for preventing further entry of said bushings into the openings receiving the same; said first enclosure member having a first group of ports comprising an inlet port adapted for connection with a fluid pressure source, an outlet port, and an exhaust port; said first bushing having a first outlet port in communication with the outlet port of said first group, a first passageway extending from the outlet port of said first group to one end of said cylinder, first valve means slidably mounted in said first bushing and axially movable between a normal position for establishing communication between the outlet port and exhaust port of said first group, and an operated position for establishing communication between the outlet port and inlet port of said first group, electromagnetic means removably secured to said first enclosure member at the other end of said first opening and operatively connecting with said first valve means for selectively actuating said first valve means to its operated position; said second enclosure member having a second group of ports comprising a second inlet port adapted for connection with a fluid pressure source, a second outlet port, and a second exhaust port, said second bushing having an outlet port in communication with the outlet port of said second group, a second passageway extending from the outlet port of said first group to the other end of said cylinder, second valve means slidably mounted in said second bushing and axially movable between a normal position for establishing communication between the outlet port and exhaust port of said second group, and an operated position for establishing communication between the outlet port and inlet port of said second group, and other electromagnetic means removably secured to said second enclosure member at the other end of said second opening and operatively connecting with said second valve means for selectively actuating said second valve means to its operated position.

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2,692,354	Fisher	Oct. 19, 1954
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2,752,895	MacDuff	July 3, 1956
2,821,997	Clay et al.	Feb. 4, 1958
2,853,976	Gerwig et al.	Sept. 30, 1958
2,861,592	Collins	Nov. 25, 1958