No. 647,482. Patented Apr. 17, 1900.

F. L. DODGSON.

RAILWAY SIGNAL AND SWITCH APPARATUS.

(Application filed Nov. 14, 1898.)

(No Model.) 8 Sheets—Sheet 1.

Fig. 1.

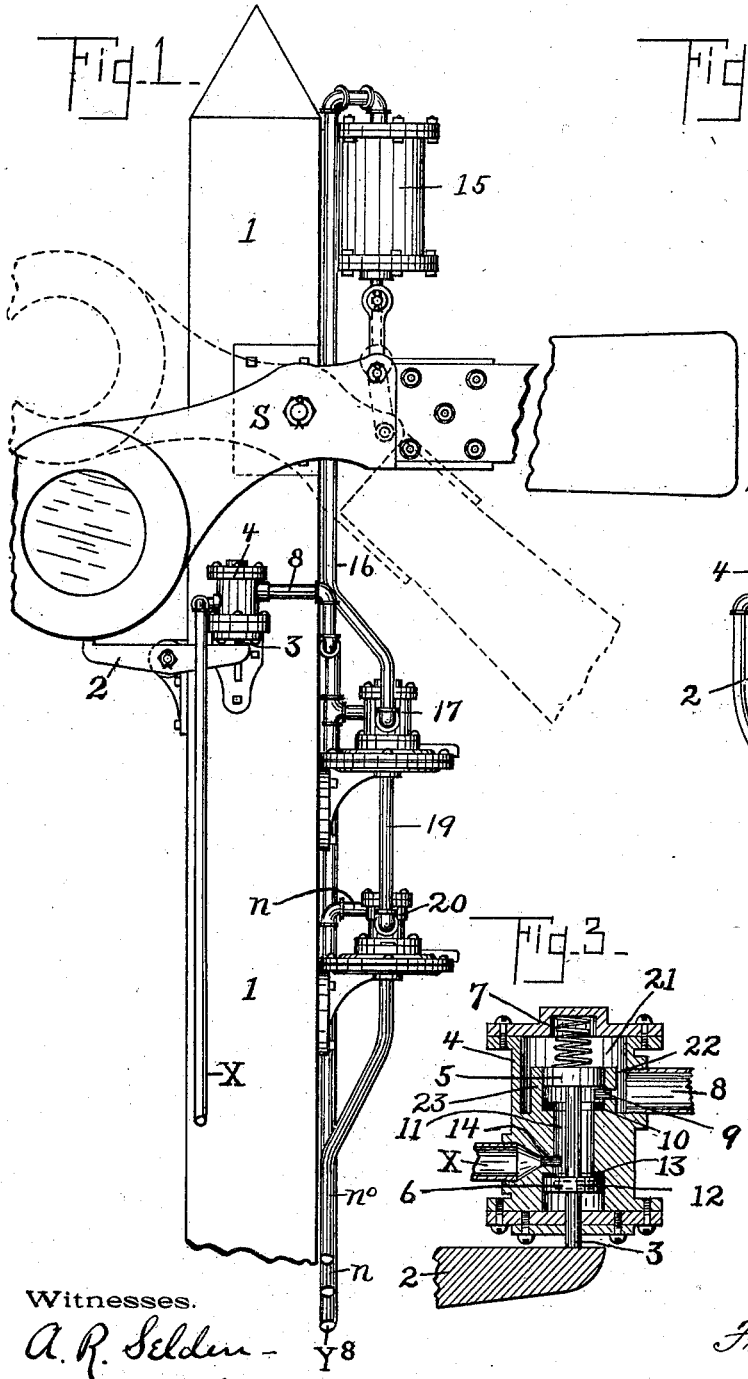

Fig. 2.

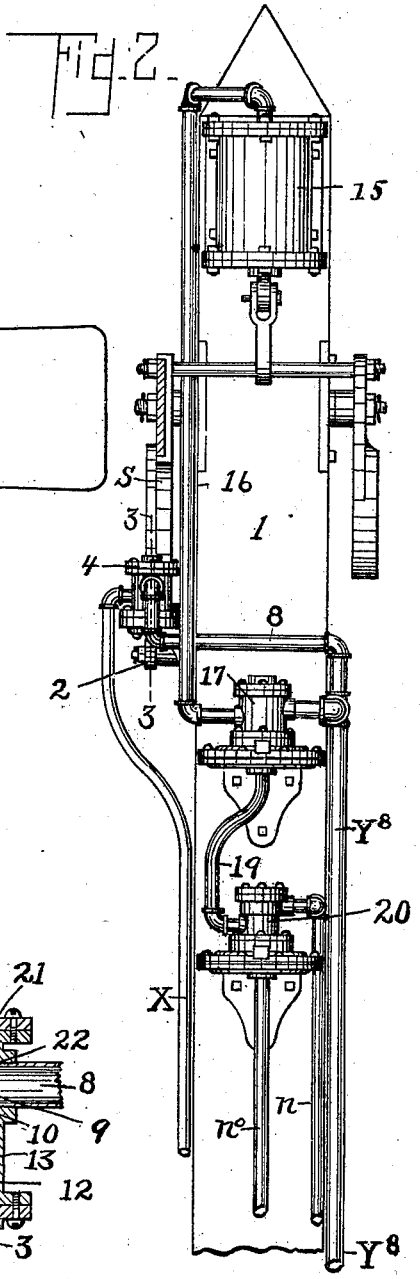

Fig. 3.

Witnesses.

A. R. Selden.

C. R. Osgood.

Inventor.

Frank L. Dodgson.

by Osgood & Davis

Attorneys.

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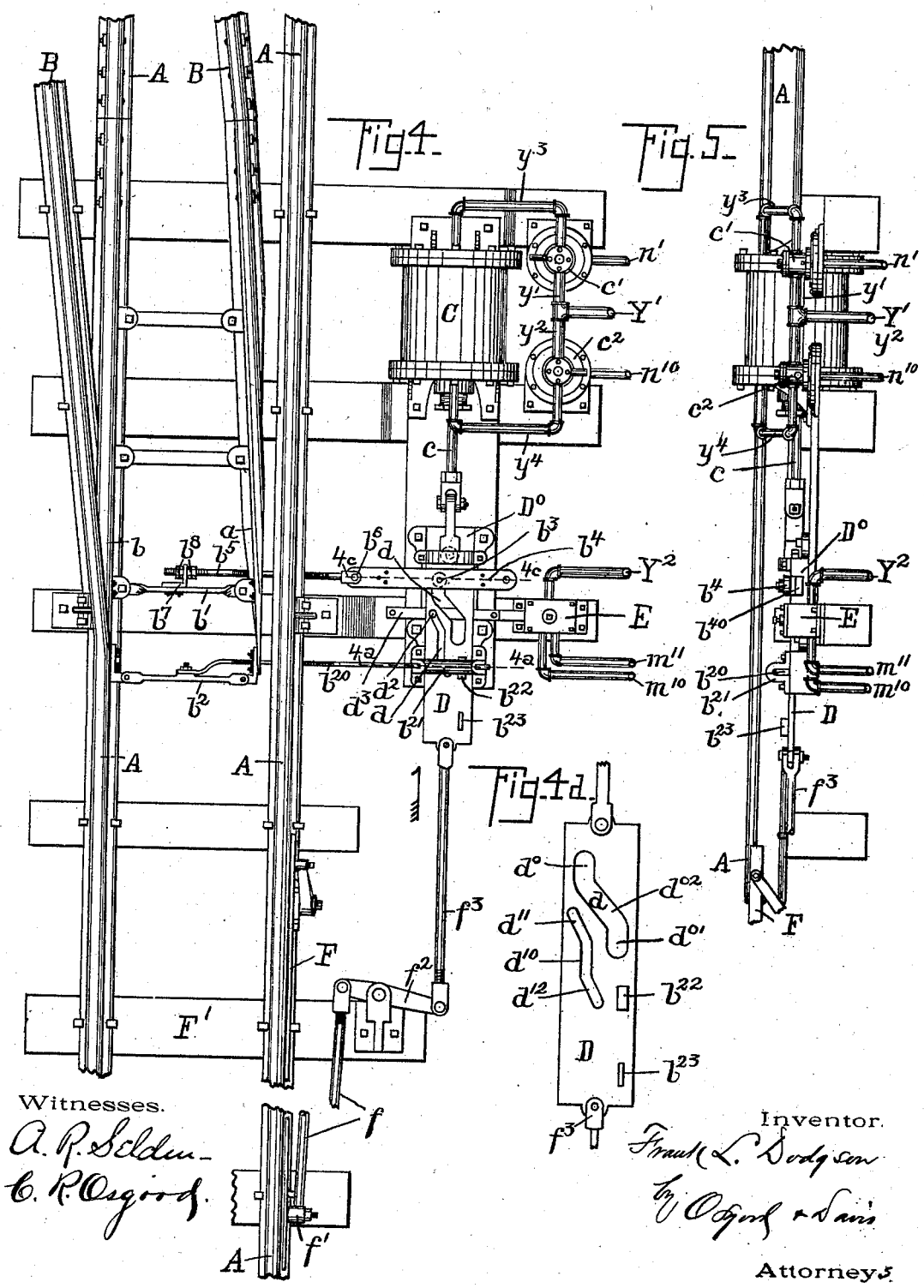
8 Sheets—Sheet 2.



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RAILWAY SIGNAL AND SWITCH APPARATUS.

(Application filed Nov. 14, 1898.)

(No Model.) 8 Sheets—Sheet 3.

Fig. 3.

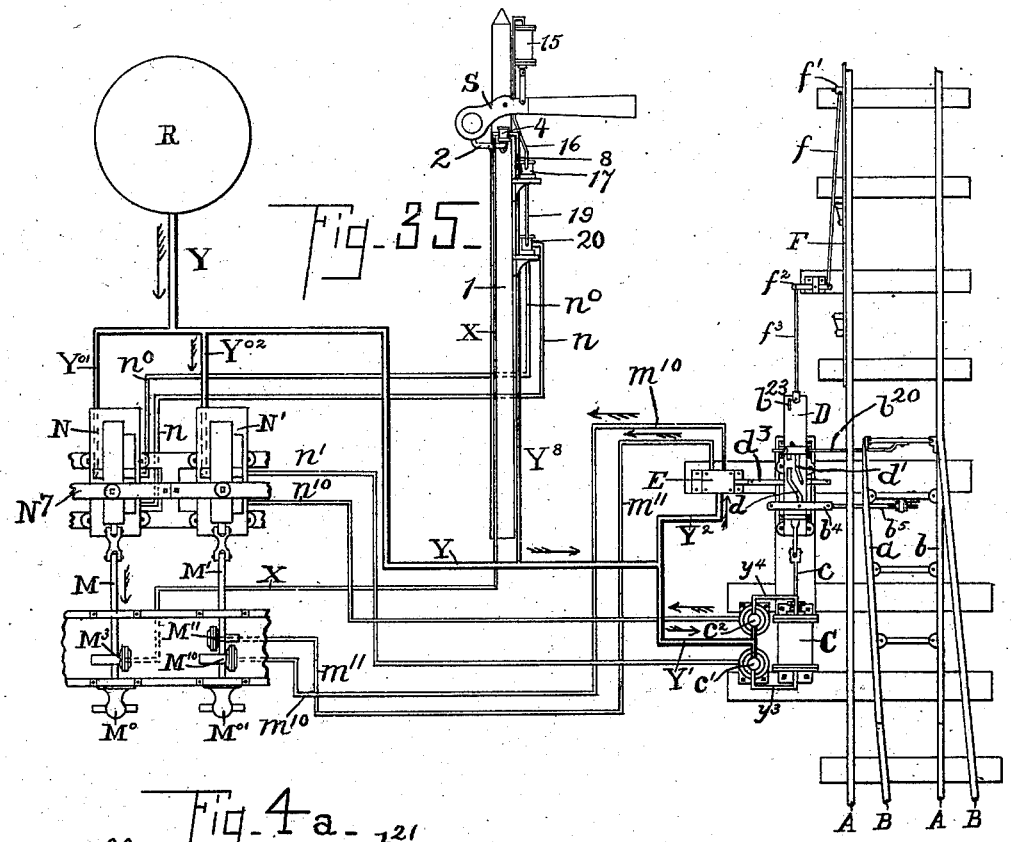


Fig. 4a.

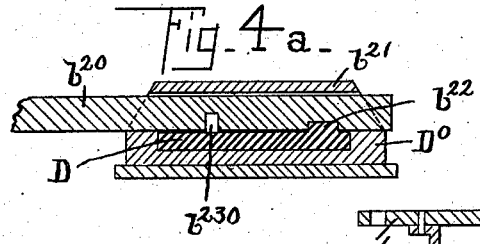


Fig. 4c.

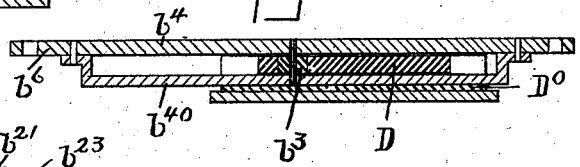
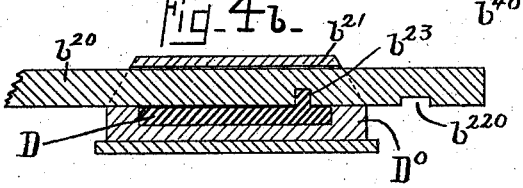


Fig. 4b.



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(No Model.) (Application filed Nov. 14, 1898.) 8 Sheets—Sheet 4.

Fig. 6.

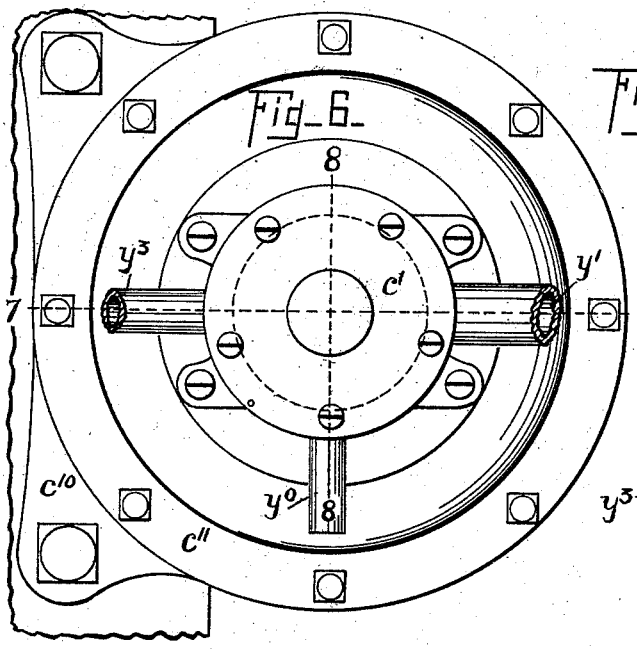


Fig. 9.

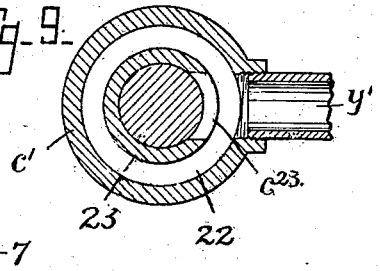


Fig. 10.

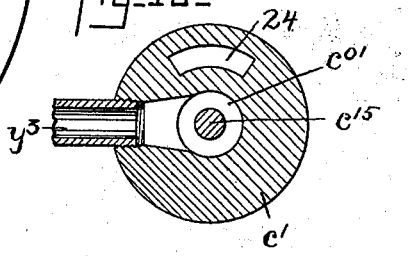


Fig. 7.

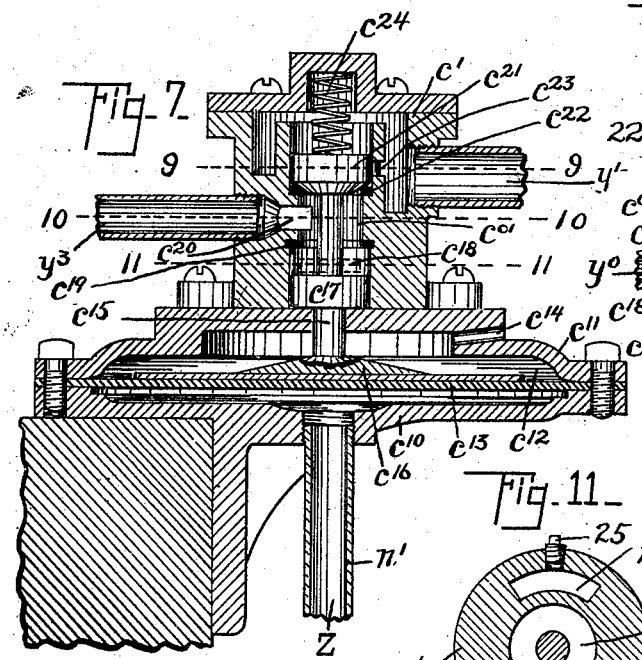


Fig. 8.

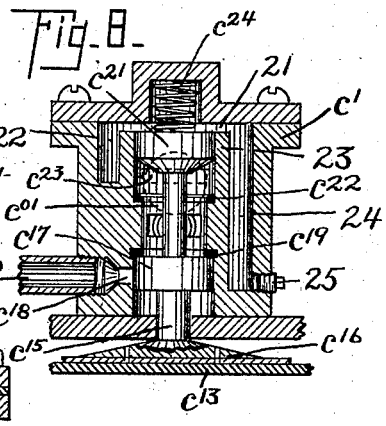
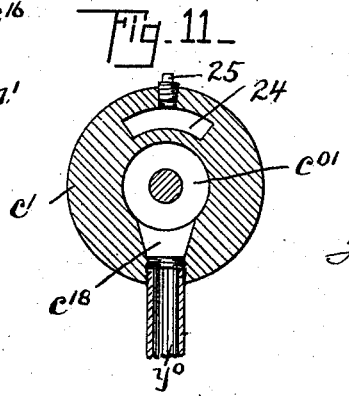


Fig. 11.



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(No Model.) (Application filed Nov. 14, 1898.)

8 Sheets—Sheet 5.

Fig. 12.

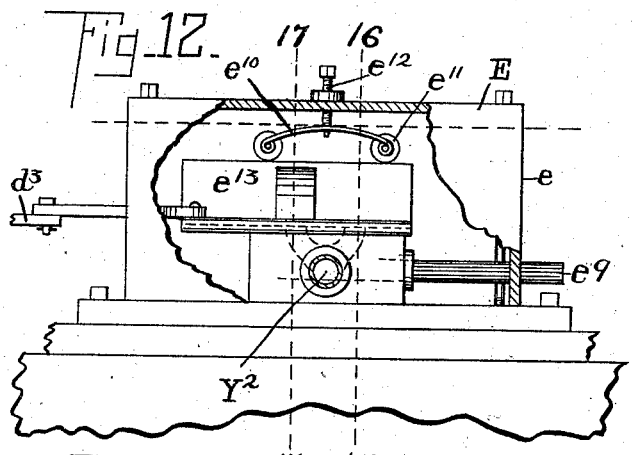


Fig. 16.

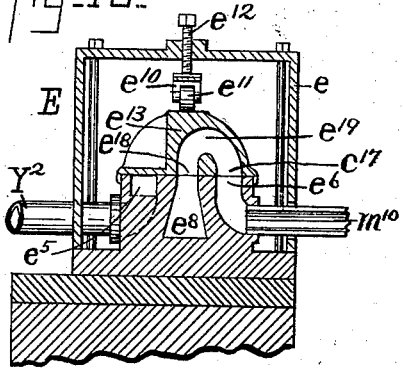


Fig. 13.

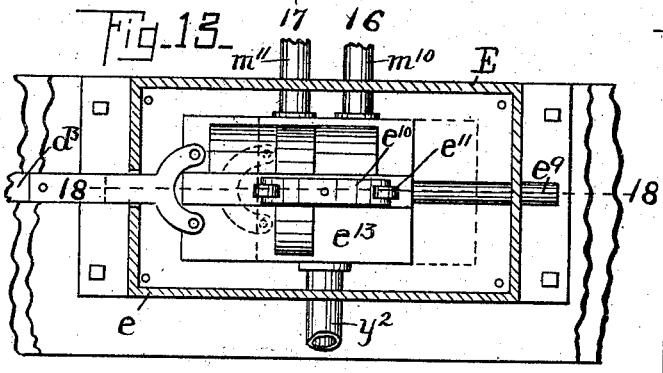


Fig. 17.

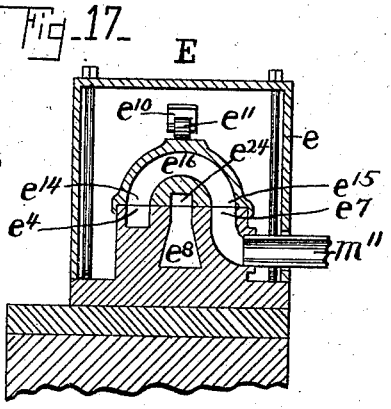


Fig. 14.

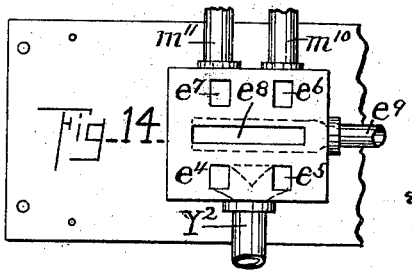


Fig. 18.

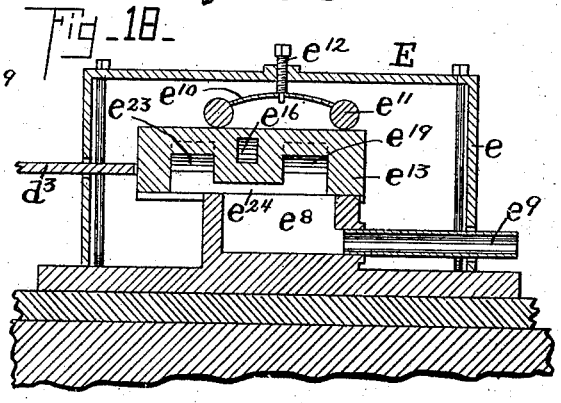
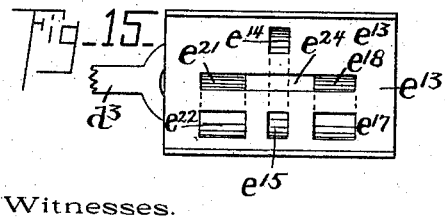


Fig. 15.



Witnesses.

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Inventor.

Frank L. Dodgson

by Osgood & Davis

Attorneys

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RAILWAY SIGNAL AND SWITCH APPARATUS.

(Application filed Nov. 14, 1898.)

(No Model.) 8 Sheets—Sheet 6.

Fig. 19.

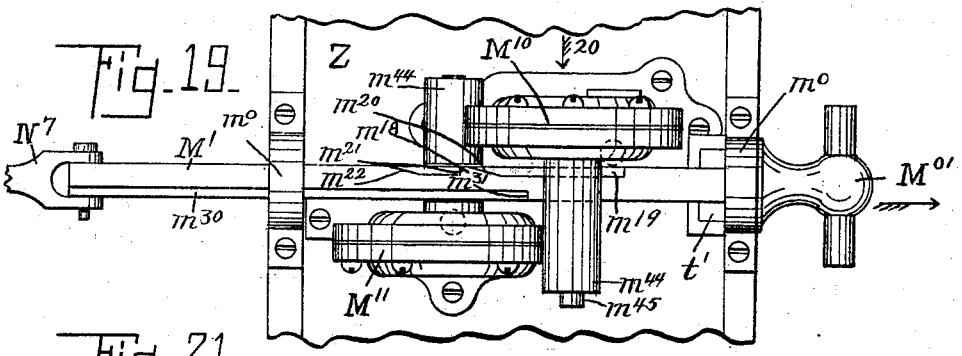


Fig. 21.

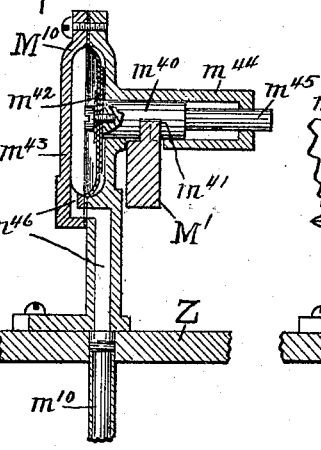


Fig. 20.

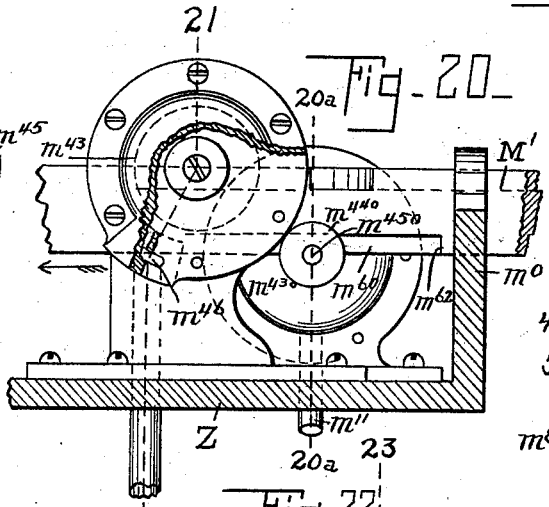


Fig. 22a.

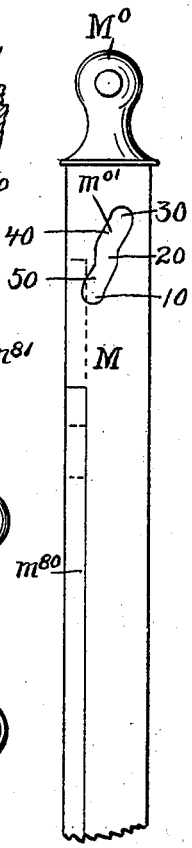


Fig. 23.

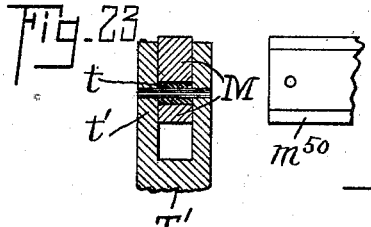


Fig. 22.

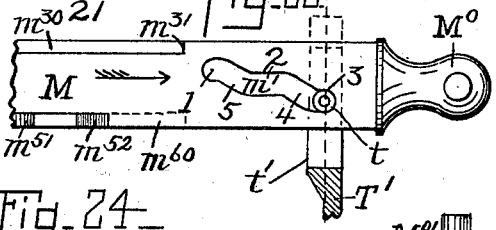


Fig. 24.

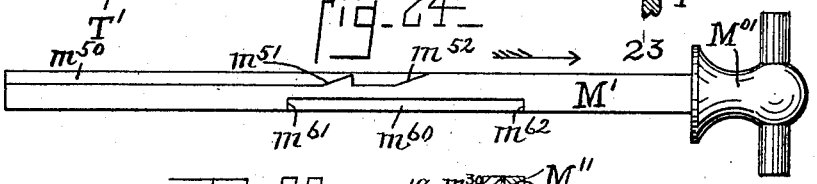
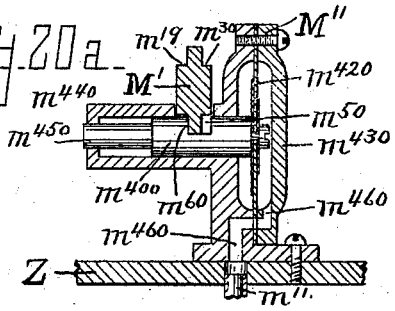


Fig. 20a.



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RAILWAY SIGNAL AND SWITCH APPARATUS.

(Application filed Nov. 14, 1898.)

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Fig. 25.

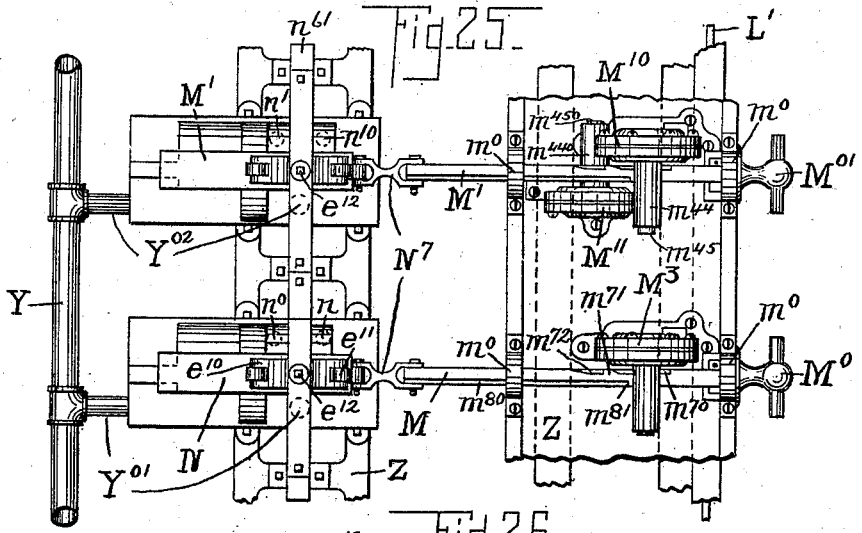


Fig. 26.

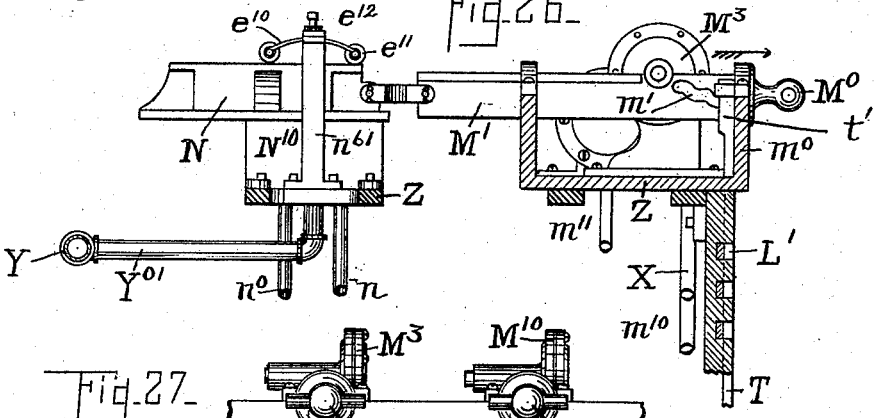
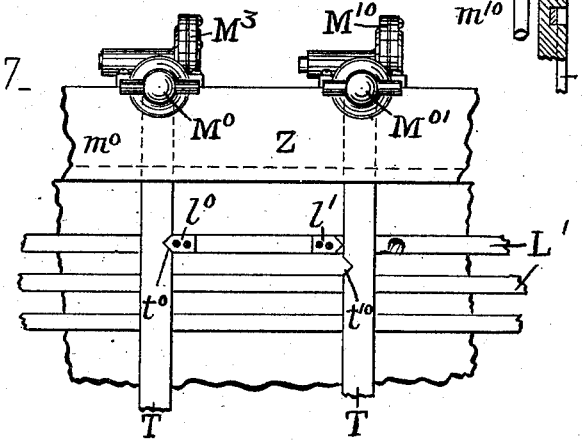


Fig. 27.



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RAILWAY SIGNAL AND SWITCH APPARATUS.

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(No Model.) 8 Sheets—Sheet 8.

Fig. 28.

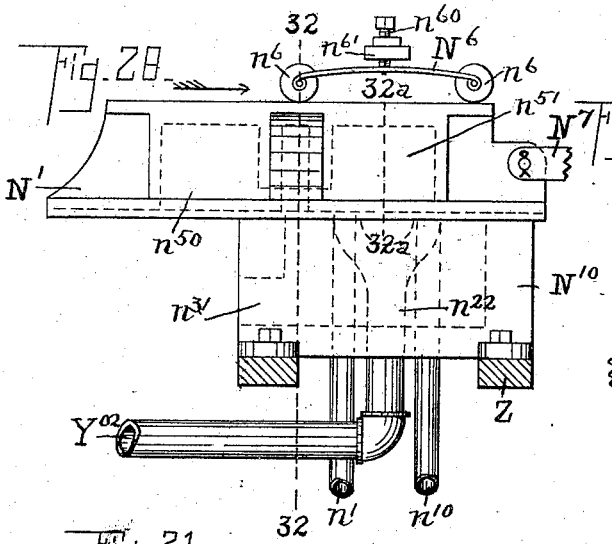


Fig. 29.

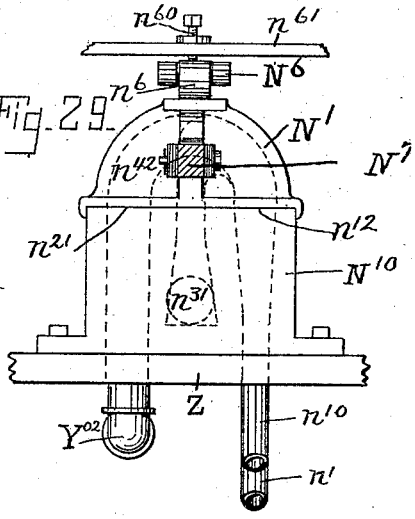


Fig. 31.

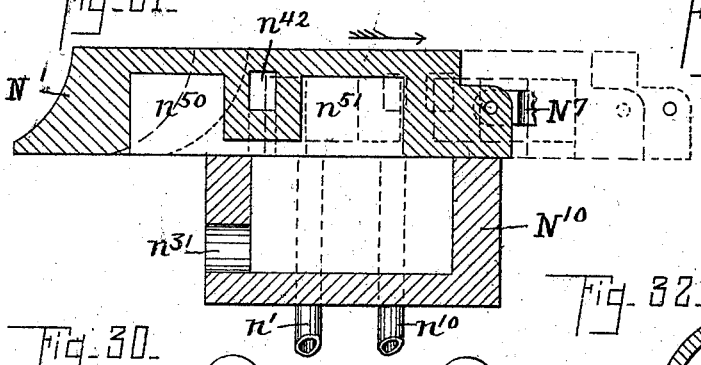


Fig. 32a.

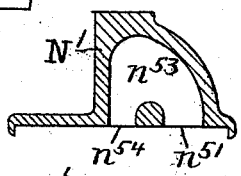


Fig. 30.

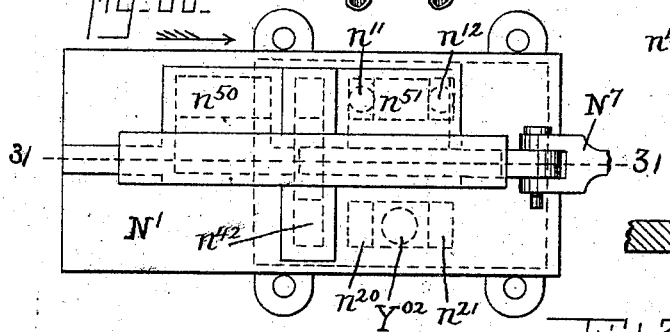


Fig. 32.

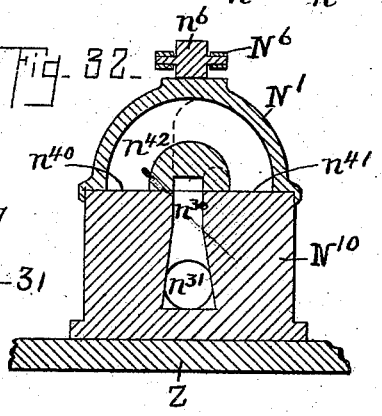


Fig. 33.

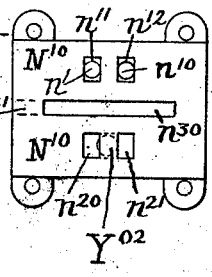
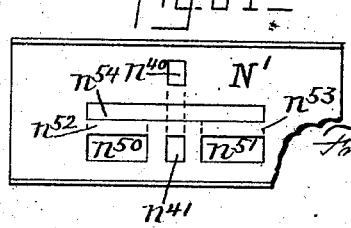


Fig. 34.



Witnesses.
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C. R. Osgood.

Inventor.
Frank L. Dodgson
by Osgood & Davis
Attorneys.

UNITED STATES PATENT OFFICE.

FRANK L. DODGSON, OF ROCHESTER, NEW YORK, ASSIGNOR TO THE PNEUMATIC RAILWAY SIGNAL COMPANY, OF SAME PLACE.

RAILWAY SIGNAL AND SWITCH APPARATUS.

SPECIFICATION forming part of Letters Patent No. 647,482, dated April 17, 1900.

Application filed November 14, 1898. Serial No. 696,431. (No model.)

To all whom it may concern:

Be it known that I, FRANK L. DODGSON, a citizen of the United States, and a resident of Rochester, in the county of Monroe and State of New York, have invented certain new and useful Improvements in Railway Signal and Switch Apparatus, of which the following is a specification.

This invention relates to a combined switch and signal system for railways involving means for return signaling to the operating-station, showing when the signals and the switches are set to certain positions; also, means for locking the parts in order to secure the occurrence of the proper series of operations, involving certain preliminary lockings, which are prerequisite to the operation of an interlocking mechanism; also, novel devices and features of construction in both the switch and signal mechanisms; also, pneumatic devices for performing many of the operations occurring in the system.

The object of my invention is to provide an efficient switch mechanism and semaphore mechanism which may be employed either separately or in combination, in which low pneumatic pressure may be employed for operating the mechanisms, and which may be employed for action at considerable distances from the source of pressure.

My invention consists in the devices and combinations hereinafter described and claimed.

In the drawings, Figure 1 is a side elevation of a signal-post, showing the semaphore in two positions, together with the valves upon said post. Fig. 2 is a front elevation of the same devices. Fig. 3 is a vertical section on the line 3 of Fig. 2 through the indicator-valve and a portion of its lever. Fig. 4 is a plan view of the mechanisms at a switch. Fig. 4^a is a section on the line 4^a of Fig. 4 through the locking-bar, its guide, the motion-plate, and its base-plate. Fig. 4^b is a section on the same line with the parts in other positions. Fig. 4^c is a section on the line 4^c of Fig. 4 through the switch-moving bar, its guide-bar, the motion-plate, and its base-plate. Fig. 4^d is a plan view of the motion-plate. Fig. 5 is a side elevation of a portion of the same mechanisms at a switch. Fig. 6 is a top plan view of a cylinder-valve at a switch. Fig. 7 is a vertical section on the line 7 7 of Fig. 6. Fig. 8 is a vertical section on the line 8 8 of Fig. 6. Figs. 9, 10, and 11 are cross-sections on the lines 9 9, 10 10, and 11 11 of Fig. 7. Fig. 12 is an elevation of the slide-valve at a switch, a portion of the casing being removed. Fig. 13 is a top plan view of the same valve, the top of the casing being removed. Fig. 14 is a top plan view of the slide-valve seat. Fig. 15 is a bottom plan view of the slide-valve. Fig. 16 is a vertical section on the line 16 16 of Fig. 12. Fig. 17 is a vertical section on the line 17 17 of Fig. 12. Fig. 18 is a vertical section on the line 18 18 of Fig. 13. Fig. 19 is a top plan view of the operating-bar relating to a switch, with its indicating and locking devices. Fig. 20 is a side elevation of a portion of the same bar, parts being removed to exhibit construction and seen as indicated by the arrow marked 20 in Fig. 19. Fig. 20^a is a section on the line 20^a 20^a of Fig. 20. Fig. 21 is a section on the line 21 21 of Fig. 20. Fig. 22 is a side elevation of a switch-operating bar, showing its connection with a tappet-bar of the interlocking mechanism. Fig. 22^a is a side elevation of a signal-operating bar. Fig. 23 is a vertical section on the line 23 23 of Fig. 22. Fig. 24 is the bottom plan of a switch-operating bar. Fig. 25 is a top plan view of a switch-operating device and a signal-operating device at the operating-station. Fig. 26 is a side elevation of the same devices shown in Fig. 25. Fig. 27 is a front elevation of the same device shown in Figs. 25 and 26, showing also the interlocking devices between the switch mechanism and the signal-operating mechanism. Fig. 28 is a side elevation of a valve of the switch-operating and signal-operating devices. Fig. 29 is a front elevation of said valve. Fig. 30 is a top plan of said valve, omitting the devices for holding it upon its seat. Fig. 31 is a vertical section on the line 31 31 of Fig. 30. Fig. 32 is a vertical section on the line 32 32 of Fig. 28. Fig. 32^a is a vertical section through the slide-valve (without its seat) on the line 32^a 32^a of Fig. 28. Fig. 33 is a top plan view of the valve-seat of the valve shown in Figs. 28 to 32. Fig. 34 is a

bottom plan view of the slide-valve of the same valve, and Fig. 35 is a diagrammatic view of a complete switch and signal apparatus.

The signal or semaphore operating devices are the same as those shown in my pending application, Serial No. 656,856, filed October 29, 1897. They include a counterweighted semaphore-arm S, adapted to rest normally in the danger position and to be moved to the safety or abnormal position by pneumatic pressure acting in a cylinder 15, having a piston connected to said semaphore-arm. It is unnecessary to describe the valves and the valve-operating mechanism by which the movements of this arm are produced, for the reason that these parts constitute the subject-matter of my said application. I add thereto a return-signaling device which indicates to the operator at the operating-station the return of the semaphore to the danger position and which operates also as a locking device when a correlated switch or signal is employed. For this purpose there is pivoted upon the signal-post 1 a lever 2, one of the arms of which is placed in the path of movement of the semaphore-arm S (or obviously in the path of a part moving with said semaphore-arm) and in such a position in said path that when the semaphore-arm has returned to the danger position the lever at the very end of the return movement of said arm is tilted or actuated. The other arm of the lever 2 is adapted to move a valve mechanism which admits air under pressure to a pipe X, leading to the operating-station, and by suitable devices at that point indicates the return of the semaphore-arm to its normal or danger position and also acts, as hereinafter explained, in connection with the switch-operating device. The valve just mentioned is set within a valve-casing 4, which is fixed upon the signal-post 1. The valve-stem 3 extends into the casing and carries two valve-heads 5 and 6, which are normally pressed against the action of the lever 2 by a spring 7 in the casing. An inlet-pipe 8 leads into said valve-casing, and the pipe X leads out therefrom back to the operating-station. The pipe 8 is connected by a pipe Y^8 with the principal air-main Y of the system, in which there is always air under pressure derived from a reservoir R or other source of air-pressure. The valve-head 5 is adapted to move downward from the position in which it is held by the semaphore-arm when at "danger" to cover an inlet-port 9 and cut off pressure from the valve-casing and to rest upon a valve-seat 10, which may be packed, if desired. This downward motion is produced by the spring 7, assisted by the air-pressure coming from the pipe 8 on the top of the head 5. The head 6, when held in position by the semaphore-arm at "danger," covers an exhaust-port 12 (shown in dotted lines in Fig. 3) and rests against a seat 13, which may have a packing, if desired. An outlet-port 14 connects with the pipe X. The operation of this device is as follows: When the semaphore-arm is in the normal or danger position, the lever 2 is tilted and strikes the projecting stem 3, lifting the valve-head covering the exhaust-port 12 and opening the inlet-port 9, which, through the connecting-cavity 11 between the heads 5 and 6, leads air under pressure from the pipe 8 through the casing into the pipe X and creates a pressure in said pipe which is communicated to suitable signaling or locking devices at the operating-station. When the semaphore-arm is in the safety position, the lever 2 is relieved and the spring 7 and air-pressure from the pipe 8 press the valves 5 and 6 downward, closing the inlet-port 9 and opening the exhaust-port 12, thus permitting the exhaust of the air from the pipe X through the port 14 and the exhaust-port 12, which is at this time open to the air. The character of these signaling or locking devices at the operating-station that are operated by these means is hereinafter explained.

Through suitable interlocking devices I produce conjoint and correlative movements of the semaphore with the movements of a pneumatically-operated switch, as will be fully explained later on in this specification. In Fig. 4 the switch is shown as set for the main track A A. The rails of the siding are B B. The movable switch-points a b are connected by suitable bars b' b^2. The main air-pipe Y', leading from the reservoir, divides in the two branches y' y^2, passing through suitable valve devices, hereinafter explained, and into the opposite ends of a cylinder C, having a suitable piston therein. The piston-rod c is connected to a motion-plate D, which slides in suitable guides on a base D^0. The motion-plate has a cam-slot d therein, having two end portions d^0 d^{01}, each parallel to the line of movement of the plate, and a diagonal portion d^{02}, connecting said two end portions. A pin bearing a friction-roller b^3 rests in the slot d, and when the middle diagonal portion d^{02} of the slot acts upon said roller it moves it transversely with reference to the line of movement of the plate. The roller b^3 is fixed upon a bar b^4, which is connected to a rod b^5 by a pivot b^6. The bar b^4 carries a supplementary guide-rod b^{40}, passing through a suitable guide-slot in the base-plate D^0, as shown in Fig. 4^c. An arm b^7, rigidly fastened upon the bridle or bar b', connecting the movable switch-points, is perforated, and the bar b^5 passes through it, and by means of setting and locking nuts b^8 the position of the switch-points with reference to the slot d of the motion-plate may be properly adjusted. As shown in the drawings, the movements of the piston-rod and of the motion-plate are transverse to the direction of the motion of the movable switch-points, and it will now be seen that a complete longitudinal movement of the motion-plate D in the direction of the arrow in Fig. 4 will set the switch for the siding instead of for the main track.

From the bridle or bar b^2, connecting the movable switch-points a b, there extends a locking-rod b^{20}, preferably set transversely to the track and to the motion-plate. The locking-rod passes over said motion-plate and runs in a box or guide b^{21}, set on the bed-plate D^0. Upon the motion-plate are two lugs b^{22} and b^{23}, having different shapes or sections, as shown in Figs. 4^a, 4^b, and 4^d. Corresponding slots or perforations b^{220} and b^{230} are made transversely across the bar b^{20}, and the perforations are of such forms that the lug b^{22} cannot pass into the slot b^{230}, provided for the lug b^{23}, nor can the lug b^{23} pass into the slot b^{220}, provided for the lug b^{22}. For example, the lug b^{22} and its slot b^{220} are low and wide, while the lug b^{23} and its slot b^{230} are high and narrow. The slots for said lugs are set in the bar b^{20} in different positions along the bar, so that when the motion-plate is in the position shown in Fig. 4 the lug b^{22} is inserted through its slot b^{220}, and thus locks the bar b^{20} and the movable switch-points in position for a clear main track; but when the motion-plate D is at the other limit of its motion and the switch-points are set for the siding the lug b^{23} is inserted through its slot b^{230} and the parts are locked in safe position for taking a train upon the siding. The lengths of the straight end portions of the slot d in the motion-plate are such as to permit the lug b^{22} or b^{23}, as the case may be, to be moved out of or into their respective slots or perforations in the bar b^{20} while the switch-moving bar b^4 is stationary, and thus the switch-points are unlocked before they can be moved and are locked immediately after they have been set. The effect of making the perforations in the bar b^{20} and the lugs b^{22} and b^{23} of different shapes, as described, is that if the motion-plate does not move the switch-points or does not move them completely the locking-lugs b^{22} and b^{23} on the plate cannot enter the slots in the bar, and a complete movement of the motion-plate is thus prevented, because the lugs will strike against the side of the bar b^{20} and cannot pass through it, and the failure of the motion-plate to make its complete stroke will be discovered by the operator at the operating-station, as hereinafter explained. In the motion-plate D is another slot d', having a middle portion d^{10} in the line of movement of the plate and end portions d^{11} d^{12} extending in opposite directions on either side of the slot and at oblique angles to the middle portion of the same. This slot is therefore of a form that may be called "converse" to the form of the switch-moving slot d, for while it is the central portion of the slot d that gives motion it is the end portions only of the slot d^{10} that do so. A pin d^2 on a bar d^3 sets in said slots d', whereby the bar is caused to move whenever the pin is in the angularly-disposed end portions d^{11} d^{12} of the slot, but is held stationary in the middle of its travel while the pin is in the central portion d^{10} of said slot. This slot d' determines the movements of a valve E, governing certain safety devices and signaling or locking devices at the operating-station or at any other suitable point. The movement of the motion-plate D and of the switch operates the valve E through the bar d^3, which moves at right angles to the movement of the motion-plate D, as just described. The straight portions d^{01} d^0 of the slot d, whereby the switch is moved, correspond in the timing of the movements of the parts with the angular end portions d^{11} d^{12} of the slot d', which governs the valve E, and the setting of the valve E occurs while the angular portions of the slot d' are acting upon the pin d^2, the period of rest of the valve E being determined by the length of the straight middle portion d^{10} of the slot d'. The locking and unlocking of the bar b^{20} by means of the lugs b^{22} and b^{23} occur while the switch is stationary, but while the valve E is being set.

The motion-plate D is connected to a detector-bar F, of any suitable construction, which is located in such proximity to the rails as to be acted on by a moving car or train. As long as a wheel of a train is upon said detector-bar the motion-plate cannot be moved. As a convenient method of connecting the detector-bar with the motion-plate I provide a rod f, which is pivoted to the detector-bar at f' and at its opposite end to a lever f^2, pivoted in a suitable bracket upon a stationary base, such as a tie F'. The other arm of the lever f^2 is connected to the motion-plate by a rod f^3. The detector-bar swings upward and then downward with each complete movement of the motion-plate and in its swing rises above the level of the top of the rail at all positions of the motion-plate, except its extreme positions, in a manner well known.

The cylinder C, heretofore referred to, is connected by pipes y^3 y^4 with valves c' c^2. (Shown more clearly in Figs. 6 to 11.) The inlet-pipes y' y^2 connect these valves to a common supply-pipe Y', communicating with the principal air-main Y, whereby air-pressure from the reservoir R is admitted to one end or the other of the cylinder for producing motion of the piston and of the motion-plate D, according as one valve or the other is opened for inlet of air. In order to operate one valve or the other, as may be necessary, air-pipes n' n^{10} communicate with valves c' c^2, respectively. The two valves are identical, and each consists of a bed-plate c^{10} and an upper plate c^{11}, between which is a cavity c^{12}, and across the cavity is set a flexible diaphragm c^{13}, separating the cavity c^{12} into two chambers. Into the chamber under the diaphragm the pipe n' or n^{10} is led, and it is obvious that pressure of air in either of the pipes must bend the flexible diaphragm and raise it. The chamber above the diaphragm is constantly open to the air through the port or passage c^{14}. The center of the diaphragm, as shown in the drawings, bears a supporting-piece c^{16} of suitable material, and this supporting-piece rests upon or is fastened to a

valve-stem c^{15}. The stem c^{15} passes through the upper plate c^{11} and carries a valve-head c^{17}, which is a piston that slides in a cylindrical valve-casing c^{01} to open or close an exhaust-port c^{18}. (Shown in dotted lines in Fig. 7.) When the valve-piston c^{17} is raised to the full limit of its movement, it closes the port c^{18}, as shown in Fig. 8, and rests against a valve-seat c^{19}, which may be provided with packing, if desired. The stem c^{15} continues upward through the valve-cavity c^{01}, and the casing at or about its middle is provided with the outlet-port c^{20}, connecting with the pipe y^3. The upper end of the stem c^{15} bears another valve-piston c^{21}, which slides in the casing and when in the lower position rests against a valve-seat c^{22}, which may be packed, and closes an inlet-port c^{23}. When the valve-piston c^{21} is raised, it opens said port c^{23} and admits air into the interior valve-cavity c^{01} from the branch inlet-pipe y' through the outlet-port c^{20} and pipe y^3 with one end of the cylinder, whereby motion of the piston is produced. In the upper part of the valve-casing c' is a spring c^{24}, which tends to press the valve downward and to retain the parts in the position shown in Fig. 7 whenever there is a reduced air-pressure in the pipe n' or n^{10}. The pipe Y', as above stated, is in open communication with the reservoir R by the principal air-main Y, and the admission of air-pressure into the pipe n' or n^{10} is controlled by suitable devices at the operating-station, to be hereinafter described. In their normal condition the parts are in the position shown in Fig. 7, and the air-pressure to the cylinder C is cut off from the supply-pipe Y' by the closing of the port c^{23}. The valves c' c^2, leading to opposite ends, respectively, of the cylinder, are normally open to the exhaust through the port c^{18}, so that when either valve is operated, so as to shut off its exhaust and admit air-pressure to its end of the cylinder, free movement of the piston may occur by reason of the other end of the cylinder being connected to the open exhaust of the opposite valve. If air-pressure be admitted to the pipe n' or n^{10} by means of suitable controlling devices at the operating-station, the diaphragm controlled by said pipe rises and the valves c^{17} and c^{21} are moved into the positions shown in Fig. 8, and thus air-pressure is admitted from the pipe Y' into the cylinder. The same movement of the valves c^{17} and c^{21} cuts off the exhaust-port c^{18} and compresses the spring c^{24}. The piston now moves to the opposite end of the cylinder from which it started, driving the motion-plate, unlocking the locking-bar b^{20}, throwing the switch-points, and when the extreme limit of movement of the piston has occurred relocking said bar. The latter part of the same movement operates the valve E and transmits an air-pressure for signaling and for other purposes back to the operating-station. As soon as the air-pressure in the pipe n' or n^{10} is relieved the spring c^{24}, assisted by air-pressure from the inlet, moves the valves c^{21} and c^{17} back to their original positions, cutting off the inlet-port c^{23} and opening the cylinder C through the pipe y^3 to the exhaust c^{18} in the valve.

The valves 4, c', and c^2 are alike in their general construction, the valve 4, however, being operated without air-pressure, while the valves c' and c^2 are operated by air-pressure. In the upper part of the valve-casing in each of these valves is a chamber 21, extending downward in an annular chamber 22, which latter chamber surrounds and forms the comparatively-thin cylinder 23 for the upper valve 5 or c^{21}. The inlet-port 9 or c^{23} leads through the wall of this cylinder 23. Hence the air-inlet pipe 8 or y' or y^3, as the case may be, always communicates with the chambers 21 and 22. The bottom of the chamber 22 has a downward extension 24 within the valve-casing, (see Figs. 8 and 11,) which may have an outlet closed by the plug 25. If water of condensation collects in the chambers 21 and 22, it runs into the passage 24 and may be drawn off or blown out by removing the plug 25. In case the outside air is colder than the air in the valve-casing moisture condenses upon the inner wall of the valve-casing, but does not condense on the inner surface of the cylinder 23, because the air in the valve-casing maintains the inner and outer surfaces of the relatively-thin cylinder at substantially the same temperature. Hence in frosty or freezing weather there is no accumulation of ice-crystals or of ice within the cylinder that might impede the movements of the piston. If any water should have dripped on the upper piston-valve in the cylinder, it will, when the piston rises to its uppermost position, be discharged over the upper edge of the cylinder into the chamber 22 and be conducted by the extension 24 to the outlet, because the upper piston is so set that its upper face rises to the level of the upper edge of the cylinder.

The valve E at the switch is shown in Figs. 12 to 18, and consists of a casing e, set upon a suitable stationary support and preferably upon the same support as the bed-plate D^0 of the cylinder C and the motion-plate D in order that the relative positions of these parts may not be disturbed in ordinary use. The valve-seat has a port which communicates with the branch pipe y^2 of the main Y and has two outlet-pipes m^{10} m^{11}. The pressure-pipe Y^2 is connected by forked passages with two inlet-ports e^4 e^5 in the face of the valve-seat. The pipe m^{10} is connected by an independent passage with a port e^6, and the pipe m^{11} is connected with a port e^7 by a passage of its own, both of said ports being in the face of the valve-seat. In the middle of the valve-seat is a long port e^8, which communicates with an exhaust-pipe e^9. (See Figs. 14 and 18.) The ports e^4, e^5, e^6, and e^7 are arranged substantially at corners of a rectangle, and the port e^8 is arranged longitudinally between the ports e^4 e^5 on one side and the ports e^6 and e^7

on the other side. The slide-valve e^{13} slides upon the valve-seat and is held down by the pressure of a spring e^{10}, having on its ends rollers e^{11}, which roll upon the back of the slide-valve. The spring is held in place and is adjusted as to tension by a screw e^{12}, passing through the valve-casing e. The slide-valve is of peculiar form and has in it six ports arranged as shown in Figs. 15 and 16 and connected as shown in dotted lines in said figures. The valve-ports are normally in the positions shown in Figs. 12, 13, and 18. In the face of the slide-valve is a port e^{14}, adapted to register with the inlet-ports e^4 e^5 of the valve-seat. The port e^{14} is connected by an arched passage e^{16} in the body of the slide-valve (shown in Fig. 17) with a port e^{15}, which is in a position to be moved to register with either of the ports e^7 or e^6. On the side of the ports e^7 and e^6 in the slide-valve are two ports e^{17} and e^{22} in line with the port e^{15} and which are thus adapted, in the motion of the slide-valve e^{13}, to register with the ports e^7 or e^6, as the case may be. The port e^{15} is of substantially the same area as either of the ports e^6 or e^7; but the ports e^{17} and e^{22} are substantially twice as large in area as the ports e^6 or e^7. The distances separating the ports e^{17} and e^{22} from the port e^{15} are such that when the port e^{15} registers with the port e^7 the port e^6 registers with the port e^{17} at about the middle point of the latter and when the port e^{15} registers with the port e^6 the port e^7 registers with the port e^{22}. The ports e^{17} and e^{22} are connected with the ports e^{18} and e^{21}, respectively, by arched passages e^{19} and e^{23} in the body of the slide-valve e^{13}. The ports e^{18} and e^{21} are adapted to register with the exhaust-port e^8 at all times and are connected with each other by a slot e^{24} in the face of the valve, as shown in Fig. 18. If when the valve is in the position shown in Fig. 12 the switch be moved, the bar d^3 moves the slide-valve, so that the port e^{14} is cut off by that portion of the face of the valve-seat between the ports e^4 e^5, and at the same time both ports e^6 and e^7 are connected with the exhaust, thus exhausting the air from the pipes m^{10} and m^{11}. When the switch has been fully thrown, the port e^{14} registers with the port e^5 and the valve connects the ports e^5 and e^6, thus throwing an air-pressure from the pipe Y^2 into the exhausted pipe m^{10}. In this last position of the parts the port e^7 is connected with the exhaust e^8 and remains fully exhausted; but the air-pressure continues from the pipe Y^2 into the pipe m^{10} as long as the parts remain in the position last described. In this way an impulse by means of compressed air is carried from the reservoir through the pipe Y^2 and the pipe m^{10} back to the operating-station, indicating to the operator at that point that the switch has been thrown. If, however, any failure of the parts has occurred which has prevented a proper movement of the switch and the locking of the same in its thrown position, no impulse occurs, because the throw of the valve and the position of the ports is such that the impulse occurs only at the end of the stroke of the motion-plate and after the locking-lugs on the motion-plate have begun to enter the slots in the locking-bar b^{20}. When the slide-valve e^{13} is returned again to the position shown in Figs. 12 to 18, the first movement causes the pipe m^{10} to be exhausted, and then the pipe m^{11} is connected with the supply-pipe Y^2 and receives air-pressure therefrom, whereupon the parts are in position for a new operation.

In the operating-station (which may be at a considerable distance from the semaphore or switch) is an interlocking board, a portion of which (if of the usual Saxby and Farmer form) is shown in Fig. 27, provided with the usual tappets T T′ and locking-bars L′. Interlocking devices are so well known that it is unnecessary to describe them further; but they are essential features in my complete system in order to compel operation of the mechanisms in a prescribed order. In the drawings only one pair of tappets is shown, one of which, T, is operated by the signal-operating device, and the other, T′, is operated by the switch-operating device. These operating devices are identical in many respects and are composed, in the switch-operating device, of a sliding bar M′, having a handle $M^{0\prime}$. The bar slides in guides M^0, properly supported on a table Z, and through the operating-bar M′ in a suitable position is cut a slot m', in which rests a roller t, set in the forked end t' of the tappet T′. The slot m' has three portions, numbered 1, 2, and 3, (see Fig. 22,) each of which has sides parallel to the line of movement of the bar. These parallel portions of the slot are connected by diagonal portions, (marked 4 and 5 in said Fig. 22.) Said portions 1, 2, and 3 are on successively-lower levels, as shown. If now the bar M′ is moved in the direction of the arrow in Fig. 22 or Fig. 26, it is obvious that the action of the bar through the roller t will not be such as to move the tappet T′ while the roller is in the portions 1, 2, or 3, but that the tappet T′ will be raised when the roller is in either of the portions 4 or 5 and will be lowered when in the same portions if the movement of the bar is opposite to that of the arrow. The purpose of the straight portions 1 and 3 of the slot m' is to prevent the weight of the tappet from having any tendency to move the operating-bar at the ends of its stroke. The straight portion 2 has the same purpose, but is also made long enough to permit a longitudinal movement of the operating-bar sufficient to allow the valve N′ to connect the inlet Y^{02} with either one pipe n' or n^{10}, thus providing for an incomplete movement of the tappet until a proper port connection is made. The slot m^{01} for the tappet-roller in the signal-operating bar M (see Fig. 22^a) is shorter than the slot m' in the switch-operating bar M′. It has an end portion 10, a middle portion 20, and an end portion 30, all parallel with the line of movement of the bar and at successive

levels, and when the roller is in either of these straight portions the tappet is supported therein without tendency to move the bar. These straight portions are connected by diagonal portions 40 and 50, which act on the roller to move the tappet-bar. The stroke of the signal-valve N is less than that of the switch-valve N′, because the signal-valve is only moved sufficiently forward to make the necessary port connections to operate the cylinder one way and is not moved forward farther, as the switch-valve is, in order to close the inlet. The operating-bars M and M′ are connected by links N^7 with slide-valves N N′, which rest upon valve-seats N^{10}. These valves are substantially identical with the valve at the switch above described, and shown in Figs. 12 to 18, except that their proportions and throw are somewhat different and no casing is necessary, because they are not exposed to the weather. The valve N′, relating to the switch, is adapted to pass the ports in such a manner that at each end of its stroke the inlet-port is cut off and both outlet-ports are open to the exhaust. The valve N, relating to a signal, is adapted in its normal position of rest to cut off the inlet and to connect both outlets to the exhaust; but on its forward stroke for setting the semaphore to "safety" the inlet-port is connected with an outlet-port, and the valve cannot pass this position. The pipe connections in the valves in the operating-station are slightly different from those at the switch. In Figs. 28 to 34 is shown one of these valves in the operating-station. The valve-seat N^{10} has a pair of ports n^{20} n^{21}, connected by a forked passage n^{22} with the inlet-pipe Y^{02} or Y^{01}, and two outlet-ports n^{11} n^{12}, connected, respectively, with the outlet-pipes n' and n^{10}. The ports n^{12} and n^{21} are opposite each other, and the ports n^{11} and n^{20} are opposite each other, and the pairs of ports n^{11} n^{12} and n^{20} n^{21} are respectively on opposite sides of the middle longitudinal line of the valve-seat. In the middle of the valve-seat and longitudinally arranged therein is a long exhaust-port n^{30}, which communicates freely with the atmosphere through an opening n^{31}. The slide-valve N′ has a pair of ports n^{40} n^{41} on opposite sides of its middle line, which are adapted to connect the inlet-port n^{22} with the outlet-port n^{11} or the inlet-port n^{21} with the outlet-port n^{12} by means of a transverse arched passage n^{42} in the body of the slide-valve. On either side of the port n^{41}, toward the ends of the slide-valve, run large ports n^{50} n^{51}, which are connected by arched passages n^{52} n^{53} in the body of the slide-valve with a long exhaust-port n^{54}, extending in the middle line of the slide-valve, so that the port n^{40} is on one side thereof and the ports n^{50}, n^{41}, and n^{51} are on the other side thereof. Each of said exhaust-ports is adapted to register with both of the outlet-ports n^{11} n^{12} at the same time. The exhaust-ports are also so arranged that when the ports n^{40} n^{41} connect the inlet Y^{02} with one outlet-port, as n^{11}, an exhaust-port, as n^{51}, is connected with the outlet-port. The face of the valve extends beyond the ports n^{50} n^{51}.

The operation of the valve is as follows: Ordinarily it stands in the position shown in Figs. 28, 30, and 31, with its handle pushed in to the extreme position, as shown in Figs. 25 and 26. In this position the exhaust-port n^{51} registers with both of the outlet-ports n^{11} and n^{12} in the face of the valve-seat, and the pipes n' n^{10} are freely connected with the exhaust-port n^{30}; but a solid portion of the face of the slide-valve covers the inlet-ports n^{20} n^{21}. If the handle attached to said valve is pulled, mechanisms coöperating therewith are so arranged that the ports n^{40} n^{41} may pass over the ports n^{20} and n^{11} and connect the ports n^{21} and n^{12}, thus conducting an air-pressure from the inlet-pipe Y^{02} into the outlet-pipe n^{10}. The port n^{50} now connects the pipe n' with the exhaust. Stopping devices, hereinafter described, permit this movement across the pair of ports n^{11} n^{20} and stop the slide-valve in position to connect the pair of ports n^{12} and n^{21}. This is the full forward stroke in the case of a signal-operating valve, as N of Fig. 35; but in the case of a switch-operating valve the handle and slide-valve are capable of still further movement from the position last described in the direction of the arrow in Figs. 28, 30, and 31, and after the stopping or locking device has been released in the manner to be described the valve must be pulled still farther forward in the direction of the arrow until it rests in the position shown in the dotted lines farthest to the right in Fig. 31. In this position the outlet-pipes n' and n^{10} are open to the exhaust through the port n^{50} and the inlet-ports n^{20} and n^{21} are closed by a solid portion of the face of the slide-valve. On the return movement of both valves (signal and switch) the first movement of the valve causes the ports n^{40} and n^{41} to pass the ports n^{21} and n^{12} and connects the ports n^{20} and n^{11} by means of the passage n^{42}, the slide-valve having passed directly from the extreme forward position to a position producing this connection. The exhaust-port n^{51} now registers with the port n^{12} and exhausts the pipe n^{10}. This connection permits air-pressure from the inlet-pipe Y^{02} to pass into the pipe n', and the parts are stopped and locked in this position, as hereinafter described, until the switch has been moved or reset or the signal has been reset, whereupon the lock is released and the slide-valve may be moved back to the initial position.

In the case of the switch-valve the locking mechanisms prevent movement of the valve in either direction when a connection is made from an inlet-port to an outlet-port until an indication has returned from the switch showing that it has been fully thrown by the air-pressure produced by the port connections.

In the case of the signal-valve the locking occurs during the return movement of the valve at the point where the ports n^{20} and n^{11}

are connected until a return indication is received from the semaphore, showing that the semaphore has been reset to "danger," whereupon the valve may be returned to its initial position.

A spring N^6, provided at its ends with rollers n^6, is adjustably supported over each slide-valve and the rollers press on the back of the valve to hold it on its seat. The spring is supported and is adjusted for pressure against the valve by a set-screw n^{60}, carried by a stationary frame-piece n^{61}, supported on the same table Z which bears the valves N and N'. Each slide-valve is conveniently connected to its operating-bar M or M' by a link N^7. These details while at present my preferred form may of course like many other details or constructions in my switch and signal devices be varied to suit the requirements of particular cases or the convenience or taste of the constructor.

The mechanisms whereby the indications and the lockings just mentioned are produced are now to be described.

The operating-bars M and M' relate to the slide-valves for controlling the semaphore and the switch, respectively, and are provided with indicating and locking devices operated, respectively, by the valve 4 at the semaphore and by the valve E at the switch. These operating-bars and the devices immediately connected therewith are shown in Figs. 19 to 24, both inclusive.

In the case of the signal only one locking and signaling device is employed, but with the switch two are employed, for the reason that with a signal it is necessary for the operator to know only that the signal is reset to "danger;" but with a switch the operator must know that the switch is set to either one of its positions. The operation of the switch mechanisms is such that when the operating-bar has been partially pulled—say to about half of its stroke in either direction—it is locked against further movement sufficient to reverse the port connections, and thus to change the movements of the switch until an impulse is received from the switch through the air-pipes, which releases the locking device and also displays a visual signal to the operator when the lock has been released, whereupon the bar may be moved for the remainder of its stroke. In order to produce this result, a particular mechanism, which is the present embodiment of my invention, will now be described, first, as applied to a switch-operating bar and then as applied to a signal-operating bar.

The switch-operating bar M' is cut away along one of its top edges by the groove m^{19}. This groove has in it a wedge-like locking-point m^{18}, having an inclined face m^{20} on the side of the outward movement of the operating-bar and an abrupt or rectangular face m^{21} on its other side. The groove m^{19} ends in an inclined face m^{22}, substantially parallel to the face m^{20}, leading from the bottom of the groove m^{19} to the side of the operating-bar. The other top edge of the operating-bar has a groove m^{30}, provided with an abrupt shoulder m^{31} at its front end. The width from the upper edge of the groove m^{19} to the opposite edge of the bar M' is the same as the width from the upper edge of the groove m^{30} to the opposite upper edge of the operating-bar. The shoulder m^{31} of the groove m^{30} is slightly forward from the position of the wedge m^{18} in the groove m^{19}. The upper edge of the bar rests in a slotted rod m^{40}, having in its lower side a slot m^{41}, wide enough to fit upon the narrowed portions of the upper edge of the bar. The rod m^{40} is attached to a flexible diaphragm m^{42}, which is fixed in a casing m^{43}, so that said diaphragm may vibrate within said casing. The rod m^{40} slides in a housing m^{44}, which may, as shown, be continuous with the casing m^{43}, and through the end of said housing there projects a pin m^{45} in continuation of the rod m^{40} whenever the diaphragm is moved toward the right in Fig. 21. A pipe m^{10} leads from the valve E through an inlet m^{46} into the casing m^{43} on the side of the diaphragm opposite to the side thereof that is attached to the rod m^{40}. Air-pressure in the pipe m^{10}, which is introduced through the valve E when the switch is being reset, moves the diaphragm and the rod m^{40} toward the right in Fig. 21, provided the rod is free to move into the groove m^{19}. The normal position of the parts of the locking and indicating valve M^{10} is such that the rod rests across the upper edge of the bar M' and in the forward end of the groove m^{19}. The pin m^{45} projects from the housing and shows that the rod m^{40} and its diaphragm are in the proper positions. The locking and indicating valve M^{11} engages the under side of the operating-bar M', which is provided with a groove m^{50}, (see Fig. 24,) in which there is a latching and locking wedge m^{51}, having its abrupt shoulder facing in the opposite direction to that of the wedge m^{18} and toward the front end of the operating-bar, and said groove ends in the sloping face m^{52}, leading to the side face of the operating-bar and in front of the wedge. This groove m^{50} is directly underneath the groove m^{30}. The other lower edge of the bar has a groove m^{60}, having the abrupt or rectangular ends m^{61} and m^{62}. The groove m^{60} extends farther forward than the groove m^{50}, and said groove m^{60} extends backward along the bar so far as to pass the position of the wedge m^{51}. The latching device M^{11} is similar in all respects to the latching device M^{10} and has a slotted rod m^{400}, a pin m^{450}, a diaphragm m^{420}, a housing m^{440}, and a casing m^{430}, and is connected to the air pipe m^{11} by the inlet m^{460}; but said latching device M^{11} acts upon the lower edge of the bar M' and oppositely to the latching device M^{10} and the two latching devices act alternately. From this description it will be seen that the groove m^{19}, with its wedge m^{18} is upon the edge of the rod M' diagonally opposite to the edge which has the groove m^{50} and latching-wedge m^{51}, and that

said latching-wedges m^{18} and m^{51} are directed in opposite directions. The groove m^{30} on the upper edge of the bar M′ is on the diagonally-opposite edge of the operating-bar from the edge which has the groove m^{60}.

In the normal position of the parts, as shown in Figs. 19 and 25, the rod m^{40} of the valve M^{10} rests in the forward part of the groove m^{19} and against the opposite side face of the operating-bar M′, while the slotted rod m^{400} of the valve M^{11} rests in the groove m^{60}, but does not extend into the groove m^{50}. (See Fig. 20^a.) If the rod M′ is pulled in the direction of the arrows in Figs. 19, 20, and 24, the bar can be moved until the face m^{61} of the groove m^{60} strikes the pin m^{400} of the latching device or valve M^{11}, whereupon the bar is stopped and cannot move farther. The same motion pulls the wedge m^{18} of the groove m^{19} through the slot in the rod m^{40}, and because a portion of the groove m^{30} is opposite to said wedge the rod is moved by the wedge m^{18} in the direction opposite to the arrow marked 20 in Fig. 19; but because air-pressure continues in the casing, tending to force the rod outward, the air-pressure acts as a spring, which causes the rod to spring into the groove m^{19} behind the wedge m^{18}. In this position the rod is locked against further movement in either direction, because the pin m^{400} of the valve M^{11} rests in front of the face m^{61}, while the pin m^{40} of the valve M^{10} rests behind the face of the wedge m^{18}. This position of the operating-bar causes a connection through the slide-valve N′ between the inlet Y^{02} and the outlet n^{10}, transmitting an air impulse to the valve c^2 and causing a movement of the motion-plate D, which sets the switch for the siding. This movement of the motion-plate sets the valve E and transmits an air-pressure from the supply-pipe Y^2 through the pipe m^{11} to the latching device or valve M^{11} and at the same time opens the pipe m^{10} to the exhaust. The air-pressure in the latching device M^{11} moves the pin m^{400} out of the groove m^{60} and into the groove m^{50}, while the removal of air-pressure from the latching device M^{10} does not move it. Upon further movement of the bar M′ to the limit of its outward stroke the angular face m^{22} comes in contact with the pin m^{40} of the latching device M^{10} and moves the pin into the groove m^{30}, but in a position to be free from the action of the wedge m^{18} if the motion of the bar should be reversed. The bar is stopped by the end of the slot m' meeting the roller t of the tappet T′, and in this position of the bar the valve N′ has been moved to open the pipes n' n^{10} to the exhaust and to cut off the inlet-pipe Y^{02}. On the return stroke of the bar it may be moved until the face m^{31} of the groove m^{30} strikes the pin m^{40} of the latching device M^{10}, (thus passing the wedge m^{18},) and this movement brings the wedge m^{51} in contact with the pin m^{400} of the latching device M^{11}, and said wedge passes through the pin, which on account of the air-pressure in the latching device M^{11} immediately snaps back into position in front of the wedge m^{51}. In this position of the parts the operating-bar M′ is locked against either forward or backward movement by the action of the shoulder m^{31} on the pin m^{40} and the action of the abrupt face of the wedge m^{51} on the pin m^{400}. The same movement of the bar connects the inlet Y^{02}, through the slide-valve N′, with the pipe n' and the pipe n^{10} is opened to the exhaust. These slide-valve connections operate to introduce air through the valve c' to the switch-cylinder, and as the motion-plate is thrown back to its initial position for resetting the switch for the main track the position of the valve E is changed, so that the supply-pipe Y^2 is connected to the pipe m^{10}, while the pipe m^{11} is opened to the exhaust, and thus an air-pressure is introduced into the latching device M^{10} and exhausted from the latching device M^{11}. Pressure in M^{10} forces the pin m^{40} out of engagement with the shoulder or face m^{31} and into the groove m^{19} in front of the wedge m^{18}, and as there is no pressure in the latching device M^{11} at this time upon further return movement of the bar M′ the pin m^{400} of the latching device M^{11} is moved to its initial position by the action of the inclined face m^{52} and rests in the groove m^{60}. Thus the bar M′ is relieved from the locking action of both the latching devices in order to permit it to be moved back to its original position, cutting off the supply-pipe Y^{02} and opening both of the outlet-pipes n' and n^{10} to the exhaust, leaving the parts in a position ready for a new operation.

Whenever an air-pressure is transmitted into one of the latching devices, it forces its pin against the bar M′ and produces an audible click. This click is the audible signal or means for indicating the return of the valve to one of its locking positions, and this occurs as soon as the switch is either set or reset, as the case may be. Consequently these devices are both latching and indicating devices. The projection of the pins m^{45} or m^{450} from their housings m^{44} or m^{440} constitutes a visible indicator whereby the operator may know the position of the diaphragm and the corresponding position of the switch.

In the signal-operating devices the latching and indicating device M^{11} is omitted and the same upper latching and indicating device, as M^{10}, is employed, but with a slight modification, as follows: The bar M is provided on its upper edge, adjacent to the casing of the valve M^3, with a groove m^{70}, having in it a wedge m^{71} and terminating in the inclined face m^{72}, and the other upper edge of the bar M has the groove m^{80}, having the shoulder m^{81}. (See Figs. 22^a and 25.) The upper edge of the bar M is therefore like the upper edge of the bar M′; but as no lower latching device M^{11} is employed it will be obvious that the bar M may be pulled outward to the full limit of its stroke without interruption, and hence in the case of a signal this full limit of

its outward pull connects the inlet Y^{01} with the pipe n, transmitting an air impulse which causes the admission of air to the cylinder 15 of the semaphore and the setting of the semaphore to "safety," cutting off the air-inlet to the pipe X, leading to the latching device M^3, and exhausting said pipe X. This exhaustion of the air does not occur until after the wedge m^{71} has passed through the slot in the pin and the inclined face m^{72} has forced the pin out of the slot m^{70} and into the slot m^{80}. Hence the bar M cannot be returned to its initial position until after the semaphore has been operated. In returning the bar M the pin is in the path of the shoulder m^{81}, and thus stops the return movement of the bar M until the pin is released from said shoulder. The engagement of the shoulder m^{81} with the pin stops the valve N in the position which opens the pipe n to the exhaust, connects the supply-pipe Y^{01} with the pipe n^0, and causes the transmission of an operative air-pressure to the valve 20, opens the pipe 19 to the exhaust, which opens the cylinder-pipe 16 to the exhaust, and permits the counterweighted semaphore-arm S to return to initial position. The semaphore-arm at the end of its stroke tilts the lever 2, moves the valve 4, connects the pipe X with the supply Y^8, and produces air-pressure in the latching and signaling device M^3. This moves the pin of said latching and signaling device out of the groove m^{80} and into the groove m^{70} on the opposite edge of the bar, whereupon the operating-bar M may be moved to return the valve N to its initial position, cutting off the air-inlet Y^{01} and opening both of the pipes n and n^0 to the exhaust.

In the signal device, just as in the switch device, the stroke of the pin in the latching device M^3 against the operating-bar M is an audible indicator, and the projection of the end of the pin from its housing and its retraction thereinto constitute a visible indicator. The effects of these movements are as follows: In the switch-moving mechanism the first outward movement of the operating-bar is such as to connect the air-pipes for operation of the switch and to lock the operating-bar against any movement until the switch has been thrown. One of the locks remains in position to prevent a return movement of the bar until its outward movement has reached its limit, when the bar can make a return stroke. Upon the return stroke the bar is locked against movement in either direction in a position which connects the air-pipes for throwing the switch, and it is retained in this position until the switch has been reset, and then only can the bar be returned to its original position, although it is still locked against an outward movement until so returned. These devices therefore compel a complete cycle of movements of the operating-bar without permitting its return or a reversal of its movement except at the proper time in said cycle.

In the signal device the outward movement of the bar is such as to set the semaphore to "safety," whereby the bar is latched against return movement until the semaphore-arm has moved. Thereupon the bar may be moved backward, but is stopped in its course until the semaphore-arm is returned to "danger," whereupon the backward movement of the operating-arm may be continued to its original position. In this case also the stop-and-lock cycle of movements is controlled by the latching device.

Now taking into account the interlocking device which connects the operating-bars of the related switch and semaphore it will be clear that until the switch has been fully thrown and its operating-bar has been pulled outward to its extreme position and the switch and its operating mechanism have been locked in place the signal-operating bar cannot be moved. After the switch-operating mechanism is in such position as to permit the signal-operating bar to be pulled the signal can be set. After the signal-operating bar has been pulled it can be returned to its initial position only after the signal has been reset to "danger," and the signal-operating bar must be returned to its initial position before the switch-operating bar can be moved to reset or operate the switch, or, in other words, the signal must be at its normal position of "danger" in order that its related switch may be moved. The signal-operating bar is also locked in its normal position of rest until the switch-operating bar has been fully returned to its original position. Thus my device necessitates a complete cycle of movements as between a switch and its related signal.

In Fig. 35 is shown a complete switch and signal system embodying my invention. A reservoir R contains air compressed to the proper degree and is in open communication with a principal air-main Y, having branches Y^{01} Y^{02}, leading to the valves N N′ at the operating-station which govern, respectively, the transmission of air-pressure to the semaphore and to the switch-moving device. A branch Y^8 from the principal air-main runs to the semaphore, a branch Y′ runs to the switch-moving device, and a branch Y^2 runs to the indicating-valve at the switch. The branch Y^8 runs to the inlet-valve 17 for the semaphore-cylinder 15 and said valve 17 controls the admission of air to the pipe 16, leading to said semaphore-cylinder. From the valve N at the operating-station run two pipes n^0 and n, the latter of which passes into the valve 20 and continues to the valve 17 by the pipe 19. The valve 20 controls the action of the valve 17 by the increase or reduction of pneumatic pressure. The operation of these parts is the same as shown in my application, Serial No. 656,856, above mentioned, but is here repeated in general terms for clearness. If the signal-bar M is pulled to the limit of its forward stroke in the direction of the arrow in Fig. 35, connection through the valve

N is made with the reservoir through the pipes $Y^{0'}$ and n. The air under pressure passes freely through the valve 20 and into the pipe 19, operating the valve 17 and connecting the supply-pipe Y^8 through the pipe 16 with the semaphore-cylinder 15. This sets the semaphore-cylinder to "safety" and permits the lever 2 to tilt, which closes the valve 4. As the valve 4 has heretofore been open and has connected the supply-pipe Y^8 with the pipe X, the air in the pipe X has been under pressure and has held the indicator and latch M^3 relating to the signal-operating bar M in operative position as a lock, but when the lever 2 has tilted the valve 4 moves and closes the inlet-pipe 8 and opens the pipe X to the exhaust. This operation brings the indicator and latch M^3 into latching position, and the operating-bar M cannot be moved backward to its initial position until the latch is relieved. If, now, the signal-bar is moved back to the latching-point, that operation connects the inlet-pipe $Y^{0'}$ with the pipe n^0, which admits air-pressure into the last-mentioned pipe and operates the valve 20, shutting off the inlet n to said valve and connecting the pipe 19 to the exhaust. This permits the valve 17 to move back to its initial position and connects the pipe 16 to the exhaust, which at the same time cuts off the air-pressure from the supply-pipe Y^8, whereupon the semaphore S may return to its initial position, and upon such return the semaphore strikes the lever 2, operating the valve 4, connecting it again with the inlet Y^8 through the pipe 8 and reëstablishing pressure in the pipe X, which operates the indicator and latch M^3 and releases the operating-bar M. As soon as this unlocking operation has occurred the valve N may be pushed back to its initial position, which cuts off the inlet $Y^{0'}$ and opens both pipes n^0 and n to the exhaust, relieving the pressure upon the valve 20 and allowing it to return to its initial position. Thereupon the semaphore and its related devices are in position for a new operation. The valve N' relating to the switch has an inlet-pipe Y^{02} and outlet-pipes n^{10} and n', which lead, respectively, to the valves c^2 c', controlling the operation of the switch-cylinder C. The operating-bar M' relating to the switch is controlled by the locking and indicating devices M^{10} M^{11}, and from said locking and indicating devices, respectively, the pipes m^{10} and m^{11} run to the indicating-valve E at the switch.

The operation of the switch-actuating devices is as follows: When the switch-operating bar M' is pulled, it can be pulled only part way, whereupon it is stopped by the indicating and locking device M^{11} in a position which, through the valve N', connects the inlet Y^{02} with the pipe n^{10}, and pressure in this pipe operates the valve c^2, which connects the supply-pipe Y' through the pipe y^4 with one end of the cylinder and causes a throw of the switch and of the switch-indicating valve E. In the normal position of rest of the switch-indicating valve E there is an air-pressure in the locking device M^{10} through the inlet Y^2 and through the pipe m^{10}; but the air in the pipe m^{11} running to the locking device M^{11} is normally not under pressure, but is open to the exhaust through the valve E. The switch-operating bar M' is locked by the locking device M^{11} as soon as it has made a stroke sufficient to connect the inlet Y^{02} with the pipe n^{10}, and in this position the bar is locked against movement in either direction by cooperation of the locks M^{11} and M^{10}. When the inlet of air to the switch-cylinder C through the valve c^2 and pipe y^4 has thrown the switch to its fully-operated position, the pipe m^{10} is connected to the exhaust through the valve E and the pipe m^{11} is connected with the supply Y^2. In this position air-pressure is put upon the lock M^{11} and is cut off from the lock M^{10}, whereupon the switch-operating bar M' may be pulled outward to its extreme position. As above described, this extreme position of the valve N' connects the pipes n' and n^{10} with the exhaust, thus cutting off the air-pressure through the pipe n^{10} upon the valve c^2. This position produces no effect upon the cylinder C and the switch remains in its set position. If, now, it is desired to return the switch to its original position, the switch-operating bar M' is pushed inward, but is stopped at a midway position by the lock M^{10} and is locked against movement in either direction by coöperation of the locks M^{10} and M^{11}. In this position the valve N' connects the inlet Y^{02} with the pipe n', which conveys air-pressure to the valve c' and opens said valve, thus connecting the cylinder with the supply-pipe Y' through the pipe y^3, whereupon the cylinder is moved and the switch is reset to its former position. The motion of the switch in being reset moves the valve E back to its original position, opening the pipe m^{11} to the exhaust, introducing pressure in the pipe m^{10}, and releasing the lock M^{10} from the operating-bar M', whereupon the operating-bar M' may be returned to its initial position, cutting off the air-supply to the pipe n' and opening both the pipes n' and n^{10} to the exhaust, thus relieving the valves c' c^2 from pressure and cutting off the air-supply to both ends of the cylinder. After these operations have occurred all the parts are in their original positions and ready for a new operation.

As above explained and shown in Fig. 27, the action of the operating-bars M M' is controlled by the interlocking mechanism. The slots in the operating-bars which operate the tappets T and T' are of such total length as to produce a stroke of said tappets sufficient to permit the locking and unlocking movements of the bars L'. For instance, upon actuating the switch-handle M^{01} the partial stroke of said handle and of its operating-bar M' is insufficient to raise the tappet T' high enough to permit the dog l' on the locking-bar L' to enter its notch T^{10} in the tappet T',

and consequently the tappet T of the related signal device cannot be raised, nor can the handle M^0 of the signal-operating mechanism be moved; but when the lock M^{11} is released the operating-bar M′ can be pulled outward to its extreme position, and the tappet T′ is then raised, so that the notch t^{10} stands opposite the dog l', and the bar L′ can be moved by the action of the notch t^0 in the tappet T upon the dog l^0 on the locking-bar L′. As long as the parts of the interlocking mechanism stand with the dog l' in the notch t^{10} and the tappet T raised, so that the dog l^0 rests against the edge of the tappet and not opposite to the notch t^0, it will be impossible to move the switch-operating bar M′ until the signal-operating bar M is pushed inward to its normal position and its tappet T is returned to the position shown in Fig. 27. The lock M^3 prevents the full return of the operating-bar M until the semaphore S has returned to the danger position, whereupon the bar M is unlocked and may be returned to its initial position, thus moving the tappet T downward until its notch t^0 is opposite to the dog l^0. The operating-bar M′ may now, and not until these operations have occurred, be moved back to its original position, forcing the dog l^0 into the notch t^0, whereby all the parts are brought again to their initial positions.

Having thus described the invention, what I claim is—

1. In a switch-operating apparatus, a cylinder and piston for throwing the switch, said cylinder having two operating-ports, a supply-main, a separate motor-valve controlling each port to admit air to said cylinder from said main and to exhaust air from said cylinder, a controlling-pipe for operating each motor-valve, and means for producing pressure in said controlling-pipes alternately and for reducing the pressure in both controlling-pipes simultaneously.

2. In a switch-operating apparatus, a cylinder and piston for throwing the switch, said cylinder having two operating-ports, a supply-main, a separate motor-valve controlling each port to admit air to said cylinder from said main and to exhaust air from said cylinder, a controlling-pipe for operating each motor-valve, and means for producing pressure in said controlling-pipes alternately and for exhausting both controlling-pipes simultaneously.

3. In a switch-operating apparatus, a cylinder and piston for throwing the switch, said cylinder having two operating-ports, a supply-main, a separate motor-valve controlling each port to admit air to said cylinder from said main and to exhaust air from said cylinder, a controlling-pipe for operating each motor-valve, and means for producing pressure in said controlling-pipes alternately and for reducing the pressure in both controlling-pipes simultaneously, a valve operated by the movements of said piston and connected with said supply-main, signal-pipes leading from said valve for operating indicating mechanism for the lever at the operating-station, said indicating mechanism, and ports in said valve at the switch which at mid-stroke in either direction opens both signal-pipes to exhaust and at each end of its stroke produces pressure in one signal-pipe and exhausts the other and vice versa.

4. In a switch-operating apparatus, a cylinder and piston for throwing the switch, said cylinder having two operating-ports, a supply-main, a separate motor-valve controlling each port to admit air to said cylinder from said main and to exhaust air from said cylinder, a controlling-pipe for operating each motor-valve, and means for producing pressure in said controlling-pipes alternately for exhausting both controlling-pipes simultaneously, a valve operated by the movements of said piston and connected with said supply-main, pipes leading from said valve for operating a locking mechanism for the lever at the operating-station, said locking mechanism, and ports in said valve at the switch which at mid-stroke in either direction opens both signal-pipes to exhaust and at the two ends of its stroke produces pressure in one signal-pipe and exhausts the other and vice versa.

5. In a switch-operating and return-signaling device, a switch, a pneumatic supply-main, a valve controlling said supply-main, pipes connecting said valve with signaling apparatus at the operating-station, a motor, a main plate operated by said motor and having a slot-and-pin connection with the switch and a slot-and-pin connection with said valve, the slots being of such form as to produce converse movements of the switch and valve.

6. The combination of a switch and its operating-cylinder and piston, a motor-valve for controlling the movement of said piston in each direction, a pneumatic supply-main, an operating-valve for controlling both of said motor-valves, a controlling-pipe from said operating-valve to each motor-valve, said operating-valve being adapted to produce pressure or exhaust alternately in said controlling-pipes and to reduce the pressure in both controlling-pipes simultaneously.

7. The combination of a movable semaphore, a pneumatic motor for setting the same in safety position, an operating-bar at the operating-station for controlling the motor, a pneumatic locking device for the operating-bar, a valve at the semaphore operated by the movements of the semaphore-arm, and direct pneumatic connections between said valve and said locking devices, said locking devices being operated to lock said bar upon exhaustion of the air from said pneumatic connections and to unlock said bar when the semaphore has returned to danger position and has operated said valve to produce pressure in said pneumatic connections.

8. In a switch-operating apparatus, a pneu-

matic motor for throwing the switch, an operating-bar at the operating-station adapted to control the movements of said motor, a valve at the switch operated by the movements of the switch, a locking device for said operating-bar, direct pneumatic connections between said valve and said locking devices, said valve being adapted to release said locking devices alternately by pressure in said pneumatic connections when the valve is at the end of its stroke, and to set said locking devices when the valve is at its mid-stroke by exhausting said pneumatic connections.

9. In a switch-operating mechanism, the combination of an actuating-plate for moving the switch, a valve-operating rod for transmitting a signal indicating the position of the switch, the plate having two slots, the first slot having end portions parallel with the movement of the actuating-plate and a diagonal central portion, and the second slot having diagonal end portions set in parallel planes and the straight central portion parallel with the movement of the plate, a switch-operating rod coöperating with the first slot and a valve-operating rod coöperating with the second slot, whereby, in a movement of the actuating-plate in either direction the valve is partly set before the switch begins to move, the switch is moved while the valve is stationary, and the stroke of the valve is finished after the switch has been fully moved.

10. In a switch-operating mechanism, the combination of an actuating-plate for moving the switch, a valve-operating rod for transmitting a signal indicating the position of the switch, the plate having two slots the first slot having end portions parallel with the movement of the actuating-plate and a diagonal central portion, and the second slot having the diagonal end portions set in parallel planes and the straight central portion in the line of movement of the plate, the switch-operating rod coöperating with the first slot and the valve-operating rod coöperating with the second slot, a pair of lugs upon said actuating-plate and a locking-bar connected with the switch having slots in which said lugs engage at the ends of the stroke of said actuating-plate, whereby, in the movements of the actuating-plate in either direction the locking-bar is released and the valve is partly set before the switch begins to move, the switch is moved while the valve is stationary and the stroke of the valve is finished and the bar is locked after the switch has been fully moved.

11. In a pneumatic switch-operating apparatus, a cylinder, a piston for throwing the switch, said cylinder having two operating-ports, a supply-main, a separate motor-valve controlling each port to admit air to said cylinder from said main and to exhaust air from said cylinder, a controlling-pipe for operating each motor-valve from which air is normally exhausted, and means for producing pressure in said controlling-pipes alternately and for exhausting both controlling-pipes simultaneously.

12. In a pneumatic mechanism for operating switch and semaphore devices, the combination of a pneumatic motor, a valve controlling the same, an operating-bar for said valve, a lock for said bar, a pneumatic operating mechanism for said lock, pneumatic connections from said mechanism to a valve at the switch or semaphore, connections between the switch or semaphore and the valve thereat for operating said valve, and means for returning the lock to its initial position, actuated by the movement of said bar.

13. In a pneumatic mechanism for actuating switch and semaphore devices, a valve controlling the same, an operating-bar for said valve, said bar having a notched edge, a locking-rod for engaging said notched edge, a pneumatic actuating device for said rod, pneumatic connections from said device to a valve at the switch or semaphore, mechanism operated by the switch or semaphore for actuating the valve, the edge of the bar being so formed as to return the locking-rod to its initial position.

14. In a pneumatic mechanism for controlling the operating-bars of switch and semaphore devices, the combination of an operating-bar adapted to control the movements of the switch or semaphore, said bar having a notched edge, a rod adapted to engage said notched edge, a casing whereinto said rod extends, a flexible diaphragm in said casing, a valve at the switch or semaphore and operated by the movements thereof, a pneumatic connection from the valve at the switch or semaphore to said casing for operating said rod, and means upon the operating-bar for returning the said locking-bar positively to its initial position.

15. In a switch-operating device, the combination of an actuating-plate, connections therefrom to said switch for operating the same, a locking-bar movable with said switch and having grooves therein of different contours, lugs on said actuating-plate, one of said lugs being adapted to enter one of the grooves only and the other lug being adapted to enter the other groove only.

16. In a switch-operating device, the combination of an actuating-plate, connections therefrom to said switch for operating the same, a locking-bar movable with said switch and having two grooves therein of different contours, two lugs on the actuating-plate, each lug corresponding in contour to one of said grooves and having such a contour that it cannot enter the other of said grooves.

17. The combination of a movable switch, an operating-rod therefor, a rod-actuating plate, a bed-plate having ways in which said actuating-plate slides, a switch-locking rod, a keeper on the bed-plate in which the locking-rod works, a cam-slot and pin connection between the switch-rod and the actuating-plate, and a locking connection between said

plate and the locking-rod, the same consisting of grooves or slots of different contour on one of the parts, and lugs or detents on the other part, one of said lugs being adapted to enter one of the grooves only, and the other lug being adapted only to enter the other groove.

18. In a switch-operating mechanism, the combination of an actuating-plate for producing converse movements of a switch and a valve, oppositely-disposed pin-and-slot connections between the plate and the switch and valve-operating rods, a locking-bar coöperating with the actuating-plate and having grooves or slots therein of different contours, and lugs on the actuating-plate, one of said lugs being adapted to enter one of the grooves only, and the other lug being adapted to enter the other groove only.

19. In a valve mechanism for pneumatic switch and signal operating apparatus, the combination of a casing having an internal bore, a piston fitting in said bore, and ports controlled by said piston, said internal bore extending into a cylindrical portion of the casing and having an annular space around the same.

20. In a valve mechanism for pneumatic switch and signal operating apparatus, the combination of a casing having an internal bore, a pair of connected pistons working in said bore, an inlet-pipe at one end of the bore of the valve-casing, an exhaust-port at the opposite end of said bore, an outlet-pipe intermediate the inlet and exhaust, a pneumatic mechanism for operating the pistons in one direction, and a spring tending to move them in the opposite direction.

21. In a valve mechanism for pneumatic switch and signal operating apparatus, the combination of a casing having a cylindrical bore, a pair of connected pistons fitting in said bore, and ports controlled by said pistons, one end of the bore being within a cylindrical extension projecting into the chamber of the casing, and one of said valves being adapted to move in said cylindrical extension.

22. In a valve mechanism for pneumatic switch and signal operating apparatus, the combination of a casing having a cylindrical bore, a pair of connected valves fitting in said bore and ports in said casing controlled by said valves, one of said ports being in a cylindrical extension projecting into the chamber of the casing, means for moving the valves in one direction, and a spring tending to move them in the opposite direction.

23. In a valve mechanism for pneumatic switch and signal operating apparatus, the combination of a casing having an internal bore, a pair of connected pistons working in said bore, an annular chamber in the upper part of the casing surrounding and communicating with the upper part of said bore above the upper piston, an inlet-pipe communicating with the annular chamber, an exhaust-port leading from the lower part of said bore, an outlet-pipe connecting said bore between the inlet and the exhaust, a pneumatic device for operating the pistons in one direction, and a spring tending to operate it in the reverse direction.

24. In a valve mechanism for pneumatic switch and signal operating apparatus, the combination of a casing having a cylindrical bore, a pair of connected valves fitting in said bore, and ports controlled by said valves, one end of said bore being within a cylindrical extension projecting into the chamber of the casing, and one of said valves being adapted to move in said cylindrical extension, and a pneumatic mechanism for operating the valves.

25. In a valve mechanism for pneumatic switch and signal operating apparatus, the combination of a casing provided with a cylindrical bore, a pair of connected pistons fitting in said bore, ports controlled by said pistons, one end of said bore being within a cylindrical extension projecting into the chamber of the casing, and one of said valves being adjusted to move in said cylindrical extension, and a drip-chamber outside the cylindrical extension, said drip-chamber extending from the first-mentioned chamber downward in the body of the valve and having a plugged outlet.

26. In a valve mechanism for pneumatic switch and signal operating apparatus, the combination of a supply-pipe, a casing into which it leads, two inlet-ports connecting the supply-pipe with the casing, two outlet-pipes leading from the casing, outlet-ports connecting said outlet-pipes with the casing, and ports and passages in the fixed and movable parts of the valve whereby either of said outlet-pipes may be connected with the supply-pipe, and the air may be exhausted simultaneously from both the outlet-pipes.

27. In a valve mechanism for pneumatic switch and signal operating apparatus, the combination of a supply-pipe, a casing into which it leads, an exhaust-port, two inlet-ports connecting the supply-pipe with the casing, two outlet-pipes leading from the casing, outlet-ports connecting said outlet-pipes with the casing, and ports and passages in the fixed and movable parts of the valve whereby either of said outlets may be connected with the supply-pipe, the other outlet being meantime connected to the exhaust, and both of said outlets may be connected with the exhaust, the outlet-ports being at such time closed.

28. In a valve mechanism for pneumatic switch and signal operating apparatus, the combination of a supply-pipe, a casing into which it leads, two air-outlet pipes leading from the casing, a valve-seat having a medial exhaust-port, an inlet-port connected with the supply-pipe, an outlet-port connected with each outlet-pipe, said four ports being arranged symmetrically with reference to

said exhaust-port, a slide-valve having a single pair of ports adapted to connect one of the inlet-ports with one of the outlet-ports, a port constantly registering with the exhaust-port, and two ports connected with the last-mentioned port, each adapted to register with one or both of the outlet-ports in the seat.

29. In a pneumatic mechanism for operating switch and semaphore devices, the combination of a pneumatic motor, a valve controlling the same, an operating-bar for the valve, said bar having a groove on one edge provided midway of its length with a locking-wedge and having a sloping face at one end, a rod for locking the bar, said rod having a notch adapted to fit the grooved edge of the operating-bar, and pneumatic devices for operating said rod transversely to the bar, whereby on operating said locking-rod in one direction the operating-bar may pass through the notch and engage behind the wedge, thus preventing reverse movement of the bar, and upon releasing the rod from its actuating device it is returned to its original position by the sloping face of the groove in the operating-bar.

30. In a combined switch and signaling apparatus, the combination of a movable semaphore, a pneumatic motor therefor, an operating-bar for throwing the motor into action a movable switch, a pneumatic motor for working the switch, an operating-bar for this motor, mechanism for locking the switch-operating bar, and mechanism for locking the signal-operating bar, said latter mechanism being adapted to release the signal-operating bar only when the switch-operating bar has completed its movement.

31. In a combined switch and signaling apparatus the combination of a movable semaphore, a pneumatic motor therefor, an operating-bar for throwing the motor into action, a movable switch, a pneumatic motor for working the switch, an operating-bar for throwing this motor into action, interlocking mechanism connecting the two bars together so that neither can be actuated until the other has completed its movement, individual locking devices for each of said bars and mechanism for releasing said bar-locking devices by means of a return impulse from the semaphore and switch respectively.

FRANK L. DODGSON.

Witnesses:
C. M. PERKINS,
F. BISSELL.