(No Model.) 9 Sheets—Sheet 1.

G. WESTINGHOUSE, Jr., & J. G. SCHREUDER.

SWITCH AND SIGNAL APPARATUS.

No. 446,159. Patented Feb. 10, 1891.

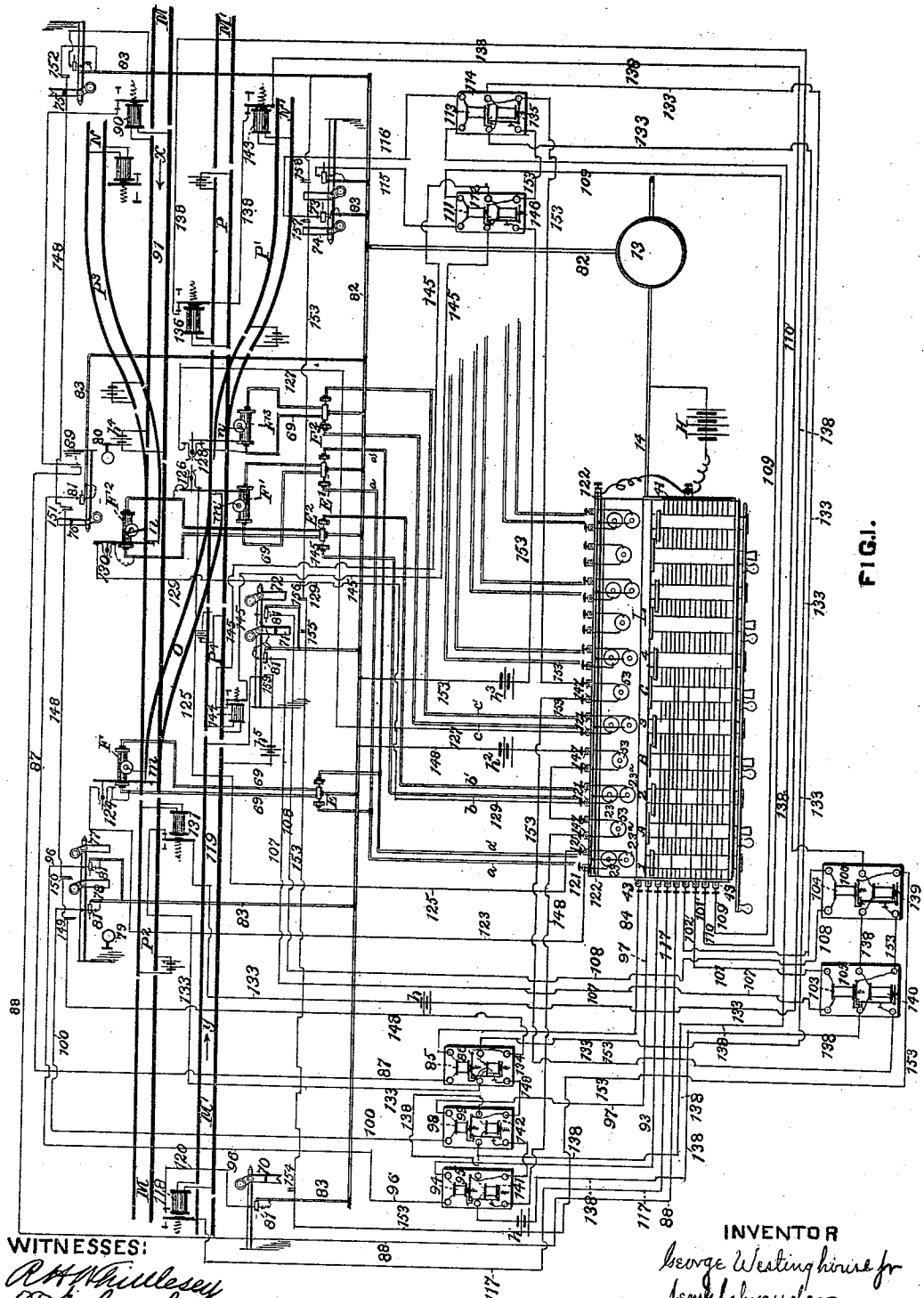

FIG. 1.

WITNESSES:

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(No Model.) 9 Sheets—Sheet 2.

G. WESTINGHOUSE, Jr., & J. G. SCHREUDER.

SWITCH AND SIGNAL APPARATUS.

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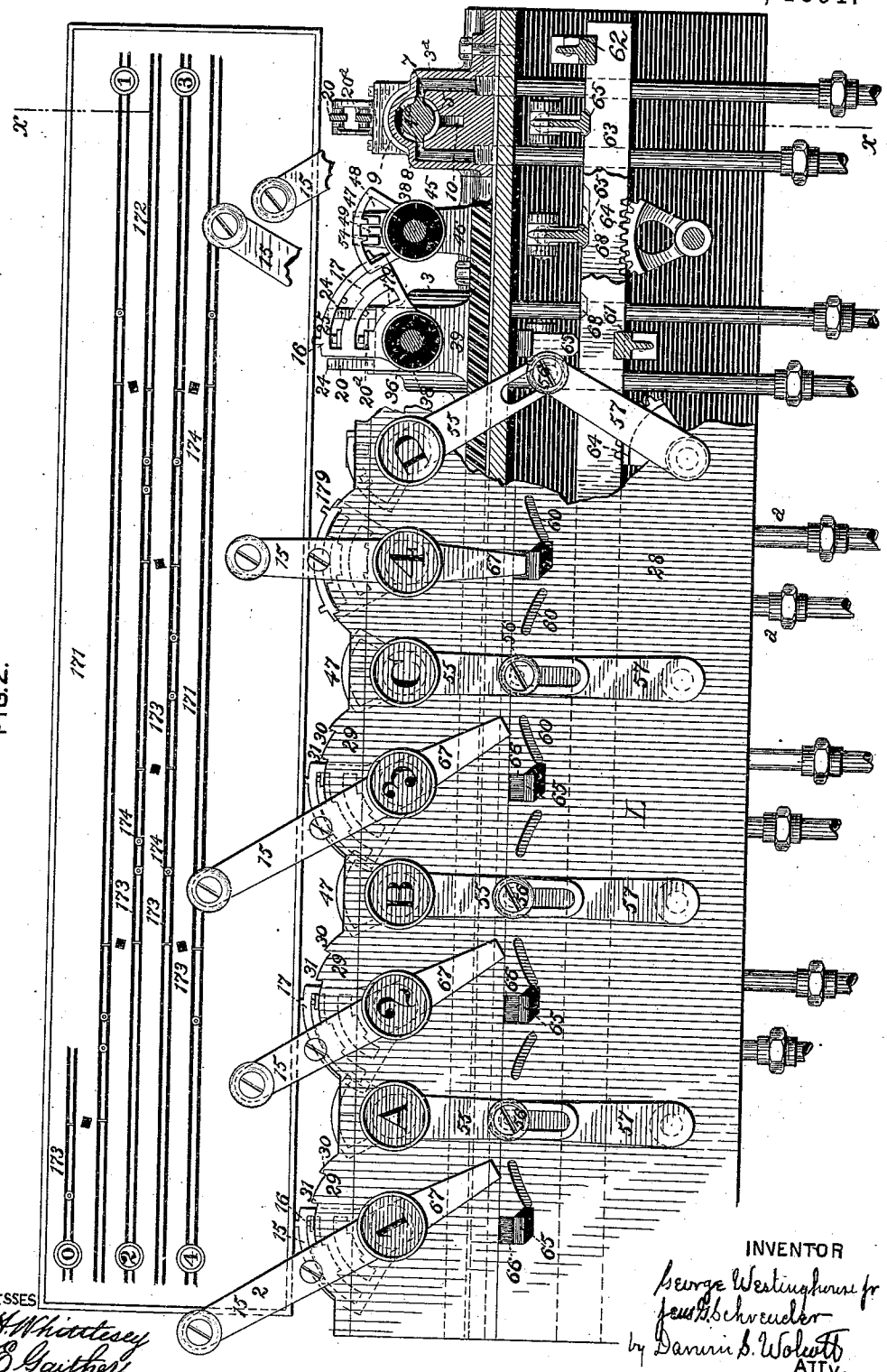

FIG. 2.

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(No Model.) 9 Sheets—Sheet 3.

G. WESTINGHOUSE, Jr., & J. G. SCHREUDER.

SWITCH AND SIGNAL APPARATUS.

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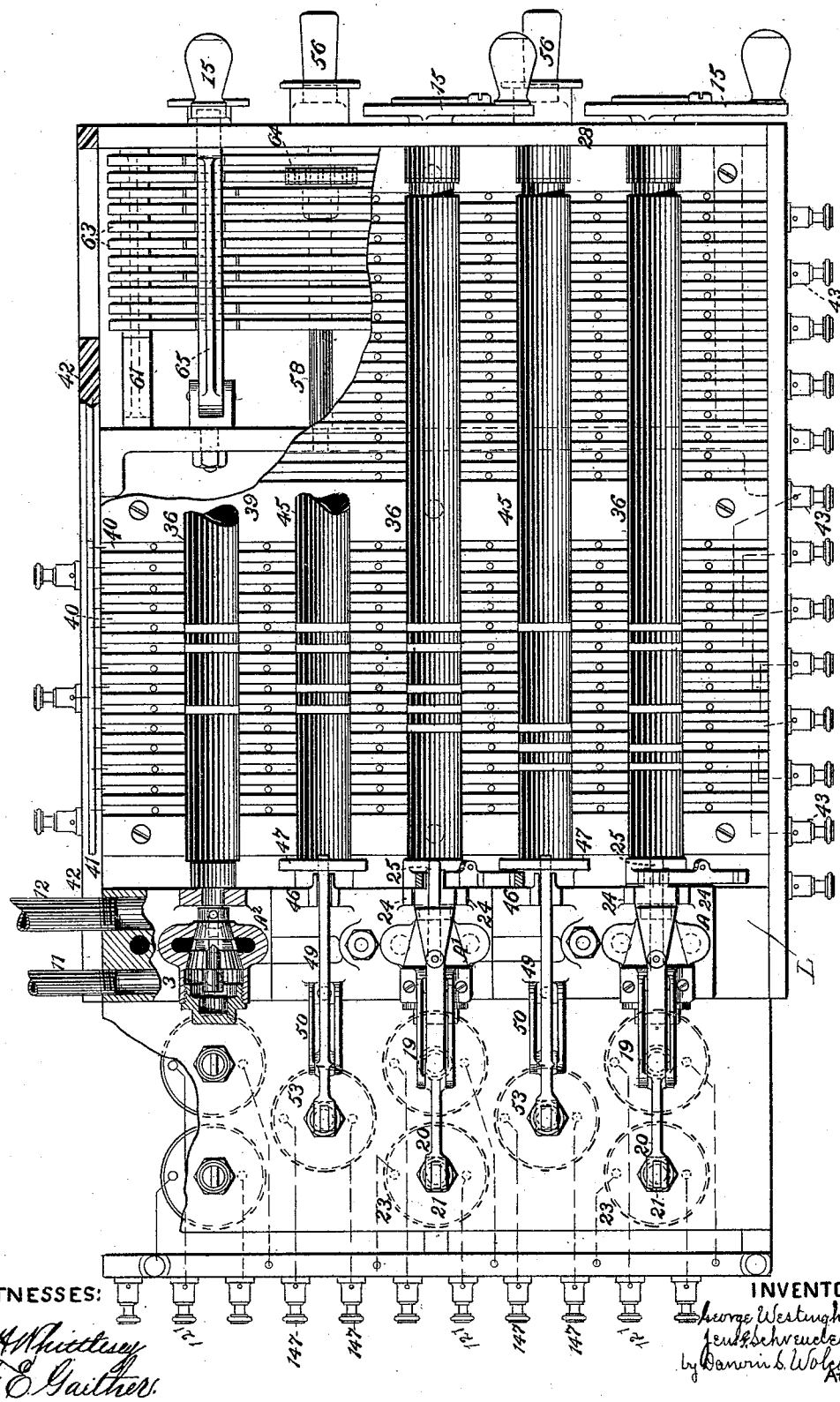
FIG. 3.



WITNESSES:

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(No Model.) 9 Sheets—Sheet 4.

G. WESTINGHOUSE, Jr., & J. G. SCHREUDER.

SWITCH AND SIGNAL APPARATUS.

No. 446,159. Patented Feb. 10, 1891.

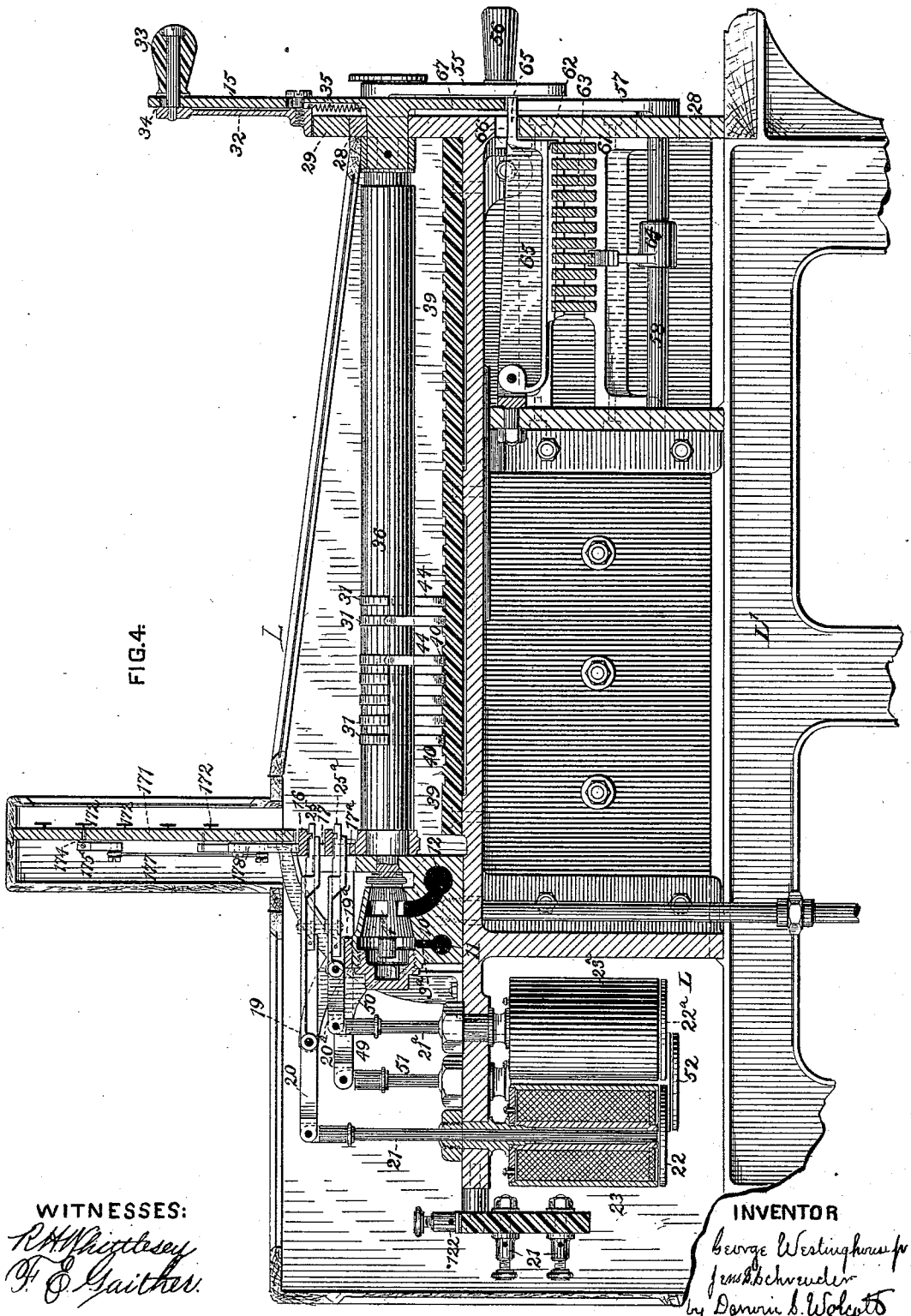

FIG. 4.

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(No Model.) 9 Sheets—Sheet 5.

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SWITCH AND SIGNAL APPARATUS.

No. 446,159. Patented Feb. 10, 1891.

FIG. 8.

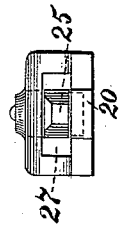


FIG. 7.

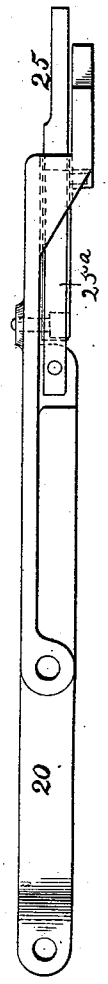


FIG. 6.

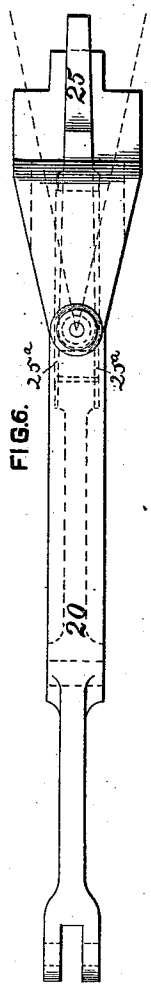
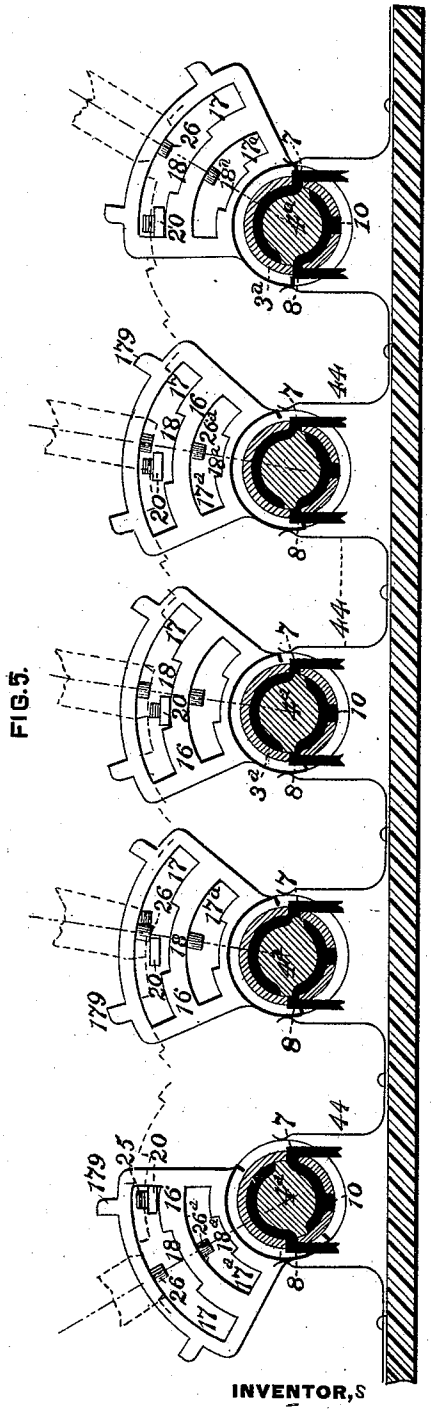


FIG. 5.



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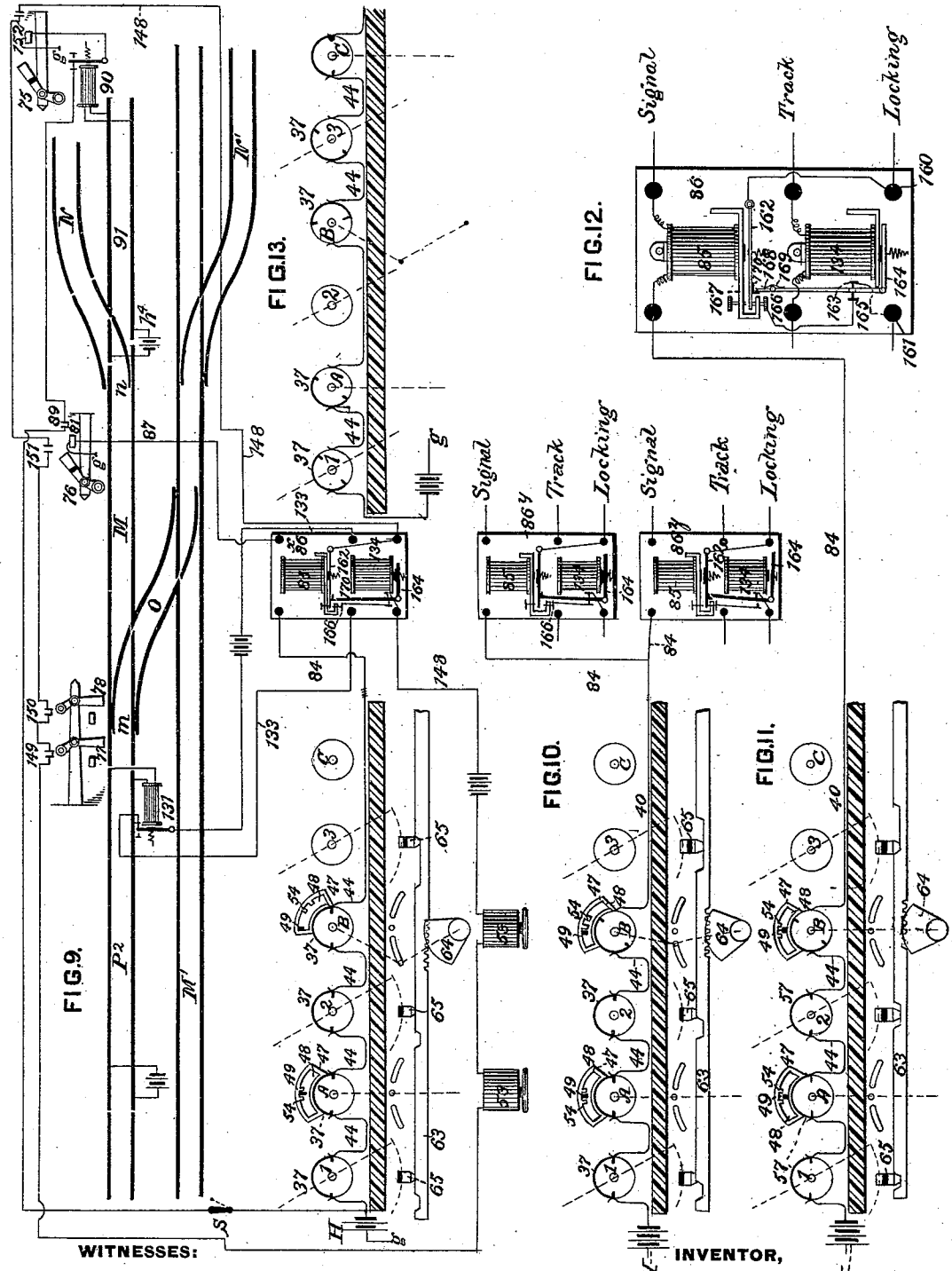
(No Model.) 9 Sheets—Sheet 6.

G. WESTINGHOUSE, Jr., & J. G. SCHREUDER.

SWITCH AND SIGNAL APPARATUS.

No. 446,159. Patented Feb. 10, 1891.



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G. WESTINGHOUSE, Jr., & J. G. SCHREUDER.

SWITCH AND SIGNAL APPARATUS.

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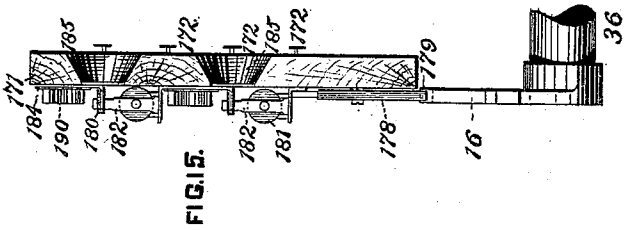
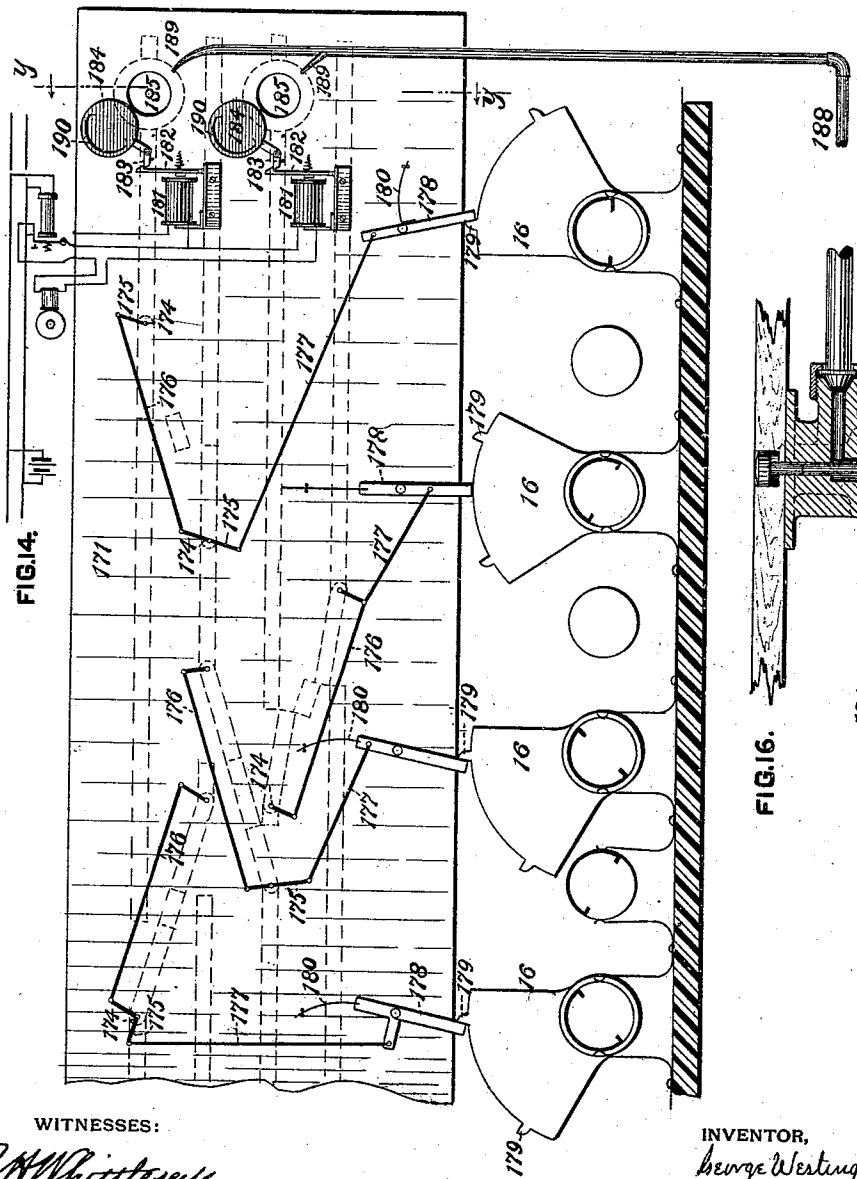
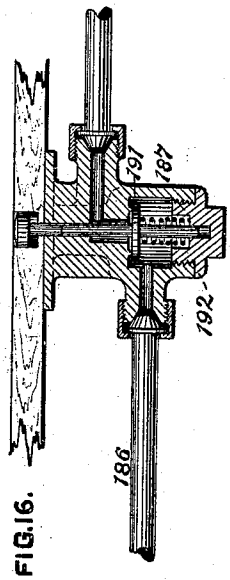


FIG. 15.





WITNESSES:

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(No Model.) 9 Sheets—Sheet 8.

G. WESTINGHOUSE, Jr., & J. G. SCHREUDER.

SWITCH AND SIGNAL APPARATUS.

No. 446,159. Patented Feb. 10, 1891.

FIG. 18.

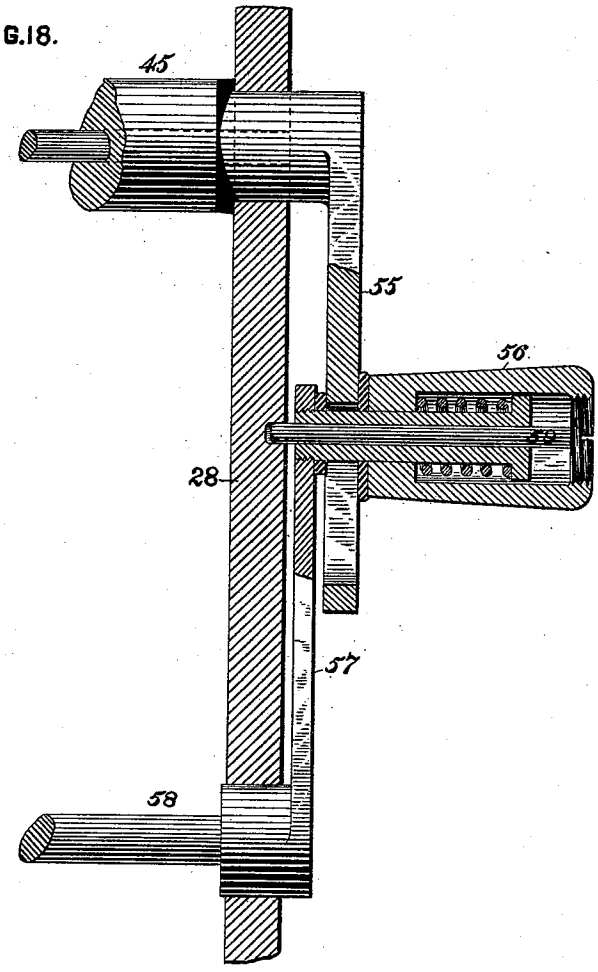
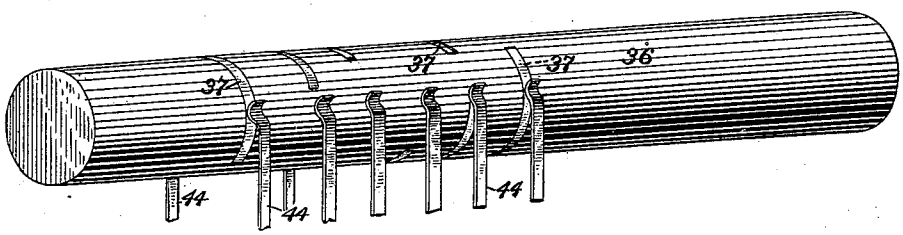


FIG. 17



WITNESSES:

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by Darwin S. Wolcott
Att'y.

(No Model.) 9 Sheets—Sheet 9.

G. WESTINGHOUSE, Jr., & J. G. SCHREUDER.

SWITCH AND SIGNAL APPARATUS.

No. 446,159. Patented Feb. 10, 1891.

Fig. 19.

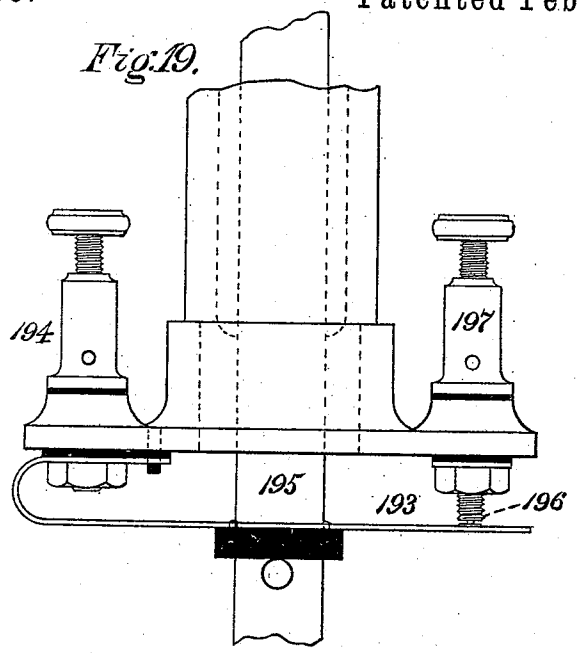
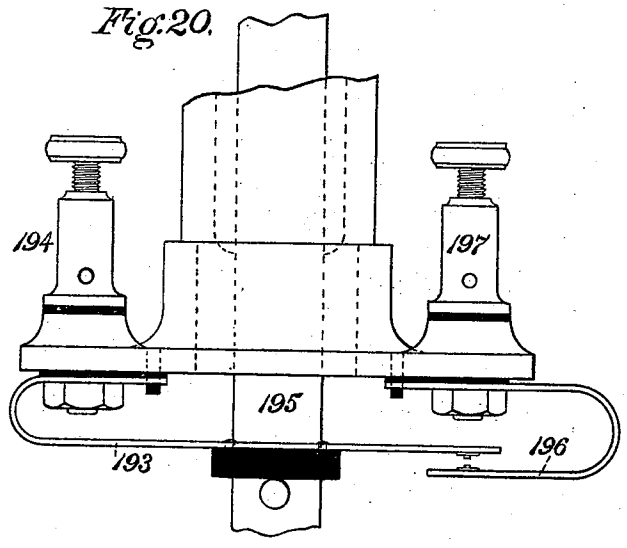


Fig. 20.



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ATTORNEY

UNITED STATES PATENT OFFICE.

GEORGE WESTINGHOUSE, JR., AND JENS G. SCHREUDÈR, OF PITTSBURG, PENNSYLVANIA.

SWITCH AND SIGNAL APPARATUS.

SPECIFICATION forming part of Letters Patent No. 446,159, dated February 10, 1891.

Application filed March 19, 1888. Renewed January 10, 1891. Serial No. 377,336. (No model.)

To all whom it may concern:

Be it known that we, GEORGE WESTINGHOUSE, Jr., a citizen of the United States, and JENS G. SCHREUDER, a subject of the King of Norway, both residing at Pittsburg, in the county of Allegheny and State of Pennsylvania, have invented or discovered a certain new and useful Improvement in Switch and Signal Apparatus, of which improvement the following is a specification.

The invention herein relates to interlocking mechanism for controlling by fluid-pressure and electrically-pneumatic or other pressure appliances for moving the switches and signals or other devices or appliances at a distance where a return indication of completion of such movement is desired, and the completion of such movement effects a locking of the controlling mechanism, the operation of said fluid control being also regulated electrically; and in general terms the invention consists in certain combinations of rotatable or revoluble rollers or barrels, some of which are connected to valve mechanisms controlling the operation of switches and themselves dependent for full movement upon the switch movements, said rollers being provided with insulated metallic strips so located around the barrels or rollers as to require certain predetermined positions of certain predetermined rollers for the completion of the controlling electric circuits.

It also consists of mechanism for locking switch-operating levers, said mechanism being operated by the signal-levers, which are in turn locked by electrically-controlled mechanism by the clearance of a signal and unlocked by the passage of the train from the section controlled by the cleared signal, all as more fully hereinafter described and claimed.

Figure 1 is a diagrammatic view showing a section of double tracks with a cross-over track and branch lines from each main line, together with the appropriate home and distant signals, mechanism for operating the switches and signals, the pipe-connections from the machine to such switch mechanism, and the electric circuits passing through the machine for controlling the signals. Fig. 2 is a front elevation of the machine, showing the switch and signal operating levers, a part of the front plate being broken away to show the mechanical locking and valve mechanisms, partly in section and partly in elevation. Fig. 3 is a plan view of the machine. Fig. 4 is a sectional elevation, the section being taken on the line x x, Fig. 2. Fig. 5 is a detail view, on an enlarged scale, of the electrically-actuated mechanism for locking the switch-levers, showing the progressive steps in the operation of shifting the switch. Figs. 6, 7, and 8 are plan, side, and end views of the electrically-actuated lever for locking the switch-lever. Figs. 9, 10, 11, and 13 are diagrammatic views illustrative of the electric circuits in different positions of the switches and signals and their operating mechanisms. Fig. 12 is a detail view, on an enlarged scale, of the interlocking relay. Fig. 14 is a rear view of an indicator-board containing miniature tracks, showing the different positions of the switches operated by the switch-controlling mechanisms, and also containing numbered disks indicating approaching trains. Fig. 15 is a sectional view on the line y y, Fig. 14. Fig. 16 is a sectional detail view of a valve for releasing fluid-pressure for returning the numbered disks to normal position. Fig. 17 is a perspective view of one of the make-and-break rollers controlling the signal-circuits. Fig. 18 is a sectional view of one of the signal-levers. Figs. 19 and 20 are views of the circuit-breaker operated by the signal-shifting mechanisms, the former being arranged for a normally-closed circuit and the latter for a normally-open circuit.

The machine consists of an iron frame L, supported by a table L′. In this frame, near its rear end, are arranged a series of three-way-valve mechanisms 1 2 3 4, &c. Each of these mechanisms consists of a case 3^a, having a conical opening therein for the reception of the correspondingly-shaped plug 4^a, having grooves 5 and 6 for connecting the ports 7 and 8 alternately with the inlet-port 9 and exhaust-port 10, said ports 7, 8, 9, and 10, being formed in the casing 3^a. The grooves 5 and 6 are made of such a length around the plugs 4^a that when the plugs are at center position the partitions between the grooves shall cover the ports 7 and 8, as shown in Fig. 2, and when the plug is shifted, as

hereinafter stated, to either side of its center position fluid-pressure will be admitted to either one or the other of the ports 7 and 8, depending upon the direction in which the plug is shifted. The several casings are formed with horizontal openings 11, registering with each other and forming a continuous passage under the casings through the machine for conducting fluid-pressure, said opening in each casing being connected with the inlet-port 9. The exhaust-port 10 in each casing is connected with a similar passage formed by openings 12 in the casings. The passage or opening 11, formed, as described, in the casings of the valve mechanisms of the series, is connected with a fluid-pressure reservoir 13 by a pipe 14. (See Figs. 1 and 3.) The ports 7 and 8 are connected with the valve mechanisms E, E′, E^2, and E^3, controlling the switch-operating mechanisms F, F′, F^2, and F^3, by pipes *a a′ b b′ c c′*.

The stems of the plugs 4^a of the several valve mechanisms 1 2 3 4, &c., are provided with operating handles or levers 15, and also with locking-quadrants 16, having curved slots 17, (see Figs. 2 and 5,) the lower walls of the slots having notches 18 formed midway of the length of the slots. On the valve-casings 3^a are formed brackets 19, to which are pivoted the safety-latches 20, having their rear ends connected by rods 21 to the armatures 22 of the electro-magnets 23, whereby the latches are operated, as hereinafter described. The front ends of the safety-latches engage the slots 17 in the quadrants 16, said latches being held as against lateral movement by studs 24, projecting upwardly from the valve-casings. When the circuit through the magnet 23 is broken, the weight of the armature 22 holds the front end of the safety-latch 20 on a plane above the notch 18, so that the quadrant can be fully reversed; but, as a full movement of the quadrant and its connections will, as hereinafter stated, complete an electric circuit, thereby rendering it possible to give a signal before the switches have been properly set, a tongue 25 is pivoted to the safety-latch 20 and is held in normal position by means of spring-leaves 25^a, riveted to a rib on the under side of the latch and bearing at their free ends on opposite sides of the tongue near its rear end, as shown in Fig. 7 and by dotted lines in Fig. 6, said tongue projecting through a slot 27 in the latch (see Fig. 8) and having its free end resting on top of the reduced end of the latch engaging the slot 17. This tongue is made of such a thickness that when the latch is in normal position—*i. e.*, the front end of the latch elevated by the armature, as above stated—a pin 26 on the upper wall of the slot 17 will engage said tongue while the quadrant is being reversed, thereby preventing any movement of the quadrant beyond its center position greater than the amount of play allowed the tongue by the slot 27 in the safety-latch. This amount of movement is, however, sufficient to so reverse the valve mechanisms 1 2 3 4, &c., as to admit fluid-pressure into that pipe which was in the previous position of the valve, the exhaust-pipe, and thereby shift the switch by means of fluid-pressure mechanism F. The unlocking of the switch—a step preliminary to its movement—will, by the mechanism indicated at 124 126, &c., Fig. 1, close the circuit passing through the magnet 23, and the movement of the armature consequent thereupon will depress the front end of the safety-latch 20 into the notch 18 and free the tongue from engagement with the pin 26, thereby preventing any further movement of the quadrant and valve mechanism until the switch has been fully changed and locked. The movement of the switch-locking mechanism breaks the circuit through the magnet 23, thereby permitting its armature to drop and raise the front end of the safety-latch from the notch 18 on the opposite side of the pin 26, when the quadrant and valve mechanism may be fully reversed.

In order to prevent any movement of the quadrant during the downward movement of the latch and tongue on the unlocking of the switch, as stated, the combined thickness of the tongue and latch is made greater than the distance between the lower end of the pin 26 and the bottom wall of the slot 17, so that the latch will engage the end of the notch 18 before the tongue is freed from the pin.

In order to relieve the locking mechanism just described from shocks or strains incident to a hurried operation of the machine and to regulate the preliminary movement of the switch-controlling mechanism, the upper edge of the front plate 28, immediately in the rear of the levers 15, is formed into a series of curved segments 29, provided with shoulders 30 and 31, the distance between the shoulders 30 being equal to the length of the slots 17 and the distance between the shoulders 31 corresponding to the length of the notches 18. On the rear side of the levers 15 are arranged the sliding latches 32, having their lower ends constructed to engage the shoulders 30 and 31, the upper ends of said latches being connected to the stems of operating-handles 33, said stems passing through slots 34 in the upper ends of the levers 15. These latches are held against the curved segments by springs 35. (See Fig. 4.) In shifting one of the levers the operator pushes on the handle 33 until the end of the latch drops into the notch forming the shoulders 31, which will prevent any further movement of the lever until the operator raises the handle sufficiently to lift the latch clear of the shoulders. At the time the latch 32 engages one of the shoulders 31 the quadrant 16, latch 20, and tongue 25 will be in the position shown by the middle quadrant in Fig. 5. The operator allows the lever to remain at rest until the latch 20 and tongue 25 have been shifted in the manner hereinbefore described to the position shown by the second

diagram from the right in Fig. 5. He then raises the handle 33 and shifts the lever 15 until the latch 32 comes in contact with the shoulder 30, at which time the quadrant, latch 20, and tongue 25 will be in the position shown by the diagram at the right of Fig. 5.

Around the stems of the plugs 4^a are arranged rollers 36, formed of rubber, hard wood, or other non-conducting material, and on the rollers are secured a series of metal bands 37, passing partially around said rollers, said bands being held in place by bending their ends inwardly and inserting such bent ends into longitudinal deep grooves or slots 38, formed in the surfaces of the rollers.

On the frame L, beneath the rollers, is arranged a bed-plate 39, formed of rubber, hard wood, or other suitable insulating material, and along this bed-plate, at right angles to the rollers 36, are secured a series of metal strips 40, connected on one side of the machine to a common metal strip 41, secured on an end plate 42, of rubber, hard wood, or other suitable insulating material, so as to insulate the strip 41 from the machine, the opposite ends of these strips 40 being connected to independent binding-posts 43. These strips 40 are not continuous along the bed-plate, but are formed of two, three, or more sections, each section being provided at its ends with metallic springs 44, arranged to bear upon the rollers 36, in line with the bands 37, so that in certain positions of the rollers the strips 40, springs 44, and bands 37 will form, except for breaks hereinafter described, a complete metallic circuit from the binding-posts to the common strip 41.

Parallel with the rollers 36, connected with the valve mechanism 1 2 3, &c., is arranged a series of rollers 45, similar in construction to the rollers 36 and provided with metallic bands 37, partially surrounding said rollers, and arranged in certain positions of the rollers to engage or have electrical contact with the springs 44 of some of the strips 40, as fully described in connection with the rollers 36. These rollers 45 are journaled at one end of the machine in bearings 46, located between the valve-casings 3^a and, if desired, formed integral therewith. The opposite ends of the rollers are journaled in bearings formed in the front plate 28 of the machine, as are also the rollers 36.

On the rear ends of the rollers 45 are secured quadrants 47, having slots 48 formed therein, (see Figs. 2, 9, 10, and 11,) and within these slots 48 are arranged the forward ends of locking-latches 49, which are pivoted on brackets 50 (see Figs. 3 and 4) and have their rear ends connected by rods 51 to the armatures 52 of the electro-magnets 53. These electro-magnets are included in electric circuits to be hereinafter more fully described, which are made or broken by the change of position of one or more signals included in one or more combinations of switches and signals and by interlocking relays which are controlled by the switch-operating mechanism and by track-circuits. When the electro-magnets 53 are charged, the front ends of the locking-latches 49 are held down against the lower walls of the slots 48 of the quadrants 47, which can then be shifted to one side or the other, as desired, (see Figs. 2, 9, 10, and 11;) but when the circuits through said magnets 53 are broken the weight of the armature will raise the front ends of the locking-latches 49 between the studs 54 on the upper walls of the slots 48, thereby preventing any movement of the quadrants, (see Figs. 9 and 10,) or between the ends of the slots and the studs 54 when only a limited movement of the quadrants is permitted.

The operating-levers 55 of the rollers 45 are slotted at their ends (see Fig. 2) for engagement with the stems of the handles 56 of the crank-arms 57 of the shafts 58, which are journaled in suitable bearings in the frame L, as shown in Figs. 2 and 4.

The handles 56 are provided with spring-actuated pins 59, adapted to engage a hole in the front plate 28 when the levers 55 and crank-arms 57 are in line with each other, at which time the locking-latches 49 will be in line with the notch between the studs 54 and also with curved slots 60 on both sides of the center position of the latch 49 and crank-arms, these slots 60 being made of a length so proportioned in relation to the distance between the studs 54 and the ends of the slots 48 of the quadrants 47 that when the ends of the levers engage either the ends of the slots or the studs 54 the pins 59 will bear against the corresponding ends of the slots 60. This construction and arrangement of devices preserves the quadrants and latches from being injured by accidental movements of the mechanism.

Beneath the rollers 36 and 45 and parallel therewith are arranged a series of brackets 61 and 62, having notches formed in their upper and lower edges, respectively, for the reception of a series of locking-bars 63, which are provided on the lower edges with a series of teeth adapted to engage with the toothed segments 64, secured to the shafts 58, each shaft being provided with a single segment 64 for engagement with one of the locking-bars. Above the locking-bars are arranged a series of locking-dogs 65, pivoted at their rear ends to the frame of the machines and having their front ends projecting through slots 66 in the front plate 28, said locking-dogs being arranged in the vertical plane passing through the axis of the rollers 36 and adapted when raised, as hereinafter stated, to engage the tails 67 of the levers 15. These locking-dogs are supported by the bars 63, which at suitable intervals are provided with notches or depressions 68 of sufficient depth to allow the dogs to drop down below the line of movement of the tails 67, the remaining portions of the bars being of sufficient height to raise the dogs into the path of movement of said

tails. It will be readily understood that as the switch-operating levers 15 are first shifted to the right or left of the center position and then the signal-levers are correspondingly moved, whereby the locking-bars 63 are so shifted as to raise the locking-dogs 65 from the depressions or notches 68 into the path of movement of the tails 67, the levers 15 cannot be reversed sufficiently far to change the switches until after the signal-levers 55 are returned to normal and the locking-dogs drop into the notches 68. As the locking-dogs extend across the entire series of locking-bars, and as each bar is designed to operate only such of the dogs as are included in one combination, the bars 63 are so constructed as regards their upper edges that only those dogs included in any one combination will be affected by the movement of the bars in such combination. In the present case this purpose is effected by notches in the bars, such depressions or notches being of a length equal to the full movement of the locking-bars. The "operative notches" 68, as they might be termed, are so constructed, being of a length only a little greater than the thickness of the dogs, that the first movement of the levers 55 from a center position will raise said dogs, thereby locking the levers 15 as against reversal until the levers 55 have been returned to normal or center position, as shown in Fig. 2.

The lay-out or diagram of tracks employed for illustrating the invention herein consists of the main lines M M′, having the branches N N′ and the cross-over O, and the switches for the branches and cross-over *m m′* and *n* and *n′*, respectively. These several switches are operated by the fluid-pressure mechanisms F, F′, F², and F³, as shown in Fig. 1. These mechanisms are connected to the valve mechanisms E, E′, E², and E³ by pipes 69, and the valve mechanisms are connected to the machine-valves 1 2 3 4, &c., by pipes *a a′*, *b b′*, and *c c′*, respectively, as hereinbefore stated.

In describing the signals and switches connected with the lay-out shown in Fig. 1 trains will be supposed to be moving in the direction of the arrow *x* on track M and in the direction of the arrow *y* on the track M′. The above-described system of tracks is provided with a distant signal 70, governing the approach of trains on the track M′ to the switches *m′* and *n′*, the home-signal 71, governing the main line past the switches *m′* and *n′*, the route-signal 72, governing the branching line N′, and the route-signals 78 and 74 governing the movement of trains from the branch N′ to the main lines M′ and M, respectively. The distant signal 75 governs the movements of trains on the track M as they approach the switches *m* and *n* in combination with the home-signal 76. The route-signals 77 and 78 govern the movement of trains from the line M to the lines M′ and N′, respectively. The movement of trains from lines M to N and return is governed by what is commonly termed "pot-signals" 79 and 80. The semaphore-signals from 70 to 78, inclusive, are operated by any suitable fluid-pressure mechanism 81, preferably that described and claimed in Letters Patent No. 357,109, granted February 1, 1887, to George Westinghouse, Jr., said mechanism being connected to the fluid-pressure reservoir 13 by main pipes 82 and branches 83. The flow of pressure to and from the signal-operating mechanism 81 is controlled by electro-magnets, as shown in said patent, said magnets being included in electric circuits controlled by the machine. The battery H is connected by a suitable wire with a binding-post electrically connected to the common strip 41, and the current passes from said strip 41 through the strips 40, springs 44, and bands 37 on the rollers 36 and 45 when said rollers have been properly adjusted, as will be hereinafter stated. The current controlling the magnet of signal mechanism 81 on the home-signal 76 passes from one of the binding-posts 43 by the wire 84 to the magnet 85 of the locking-relay 86, and thence by the wire 87 to the magnet on signal 76, and is there connected to branch pipe 83 of the system of fluid-pressure pipes which are connected to the opposite pole of battery H. The current controlling the magnet on distant signal 75 passes from one of the binding-posts 43 by the wire 88 through circuit-breaking mechanism 89, operated by the mechanism 81 on signal 76, thence to a circuit-breaking track-relay 90, controlled by track-section 91, and thence to one pole of magnet of signal mechanism on signal 75, the opposite pole being connected to branch pipe 83. The rails of insulated track-section 91 are connected at one end of said section to opposite poles of battery h^4 and at the opposite end thereof to the magnet of relay 90. The current controlling the magnet of the mechanism 81 of signal 77 passes from one of the binding-posts 43 by the wire 93 through the magnet 94 of the locking-relay 95, and thence by the wire 96 to the magnet on signal 77, from which point the current passes by the fluid-pressure pipes to the battery H. The current controlling the magnet of the operating mechanism 81 of the signal 78 passes from one of the binding-posts 43 by the wire 97 to the magnet 98 of the locking-relay 99, and thence by the wire 100 to the magnet on signal 78, whence it passes by the fluid-pressure pipes to the battery H. The currents controlling the magnets of the operating mechanisms 81 of the signals 71 and 72 pass from two of the binding-posts 43 by wires 101 and 102 to the magnets 103 and 104 of the locking-relays 105 and 106, and thence by the wires 107 and 108 to the magnets on said signals, whence they pass by the fluid-pressure pipes to the battery H. The currents controlling the magnets of the operating mechanisms 81 of the route-signals 73 and 74 pass from two of the binding-posts by the wires 109 and 110 to the magnets 111 and 113 of the locking-relays 112 and 114, thence by the wires 115 and 116 to the magnets of the route-sig-

nals 73 and 74, and from said magnets to the battery H by the fluid-pressure pipes. The current controlling the magnet of the operating mechanism 81 of the distant signal 70 passes from one of the binding-posts 43 by the wire 117 to a circuit-breaking track-relay 118, controlled by track-section 119, and thence by wire 120 through the magnet in signal 70 to battery H by the fluid-pressure pipes.

It will be observed that all the above-described circuits start from one side of the machine and that the battery H is connected to the opposite side of the machine. Hence it is necessary that such of the rollers 36 and 45 as are included in any combination should be in certain predetermined positions before any current can pass through said circuits to the magnets on the signal-operating mechanisms 81 of the signals. The movements of the rollers 36, so far as a completion of circuits above described through their bands 37 is concerned, is electrically controlled by the magnets 23, as hereinbefore described. One pole of each of these magnets is connected to the independent binding-posts 121 and the opposite pole thereof to a common metallic strip 122, insulated from the machine, said strip 122 being electrically connected to one pole of the battery H, whose opposite pole is connected to the fluid-pressure pipes, as shown in Fig. 1. The circuit, including the magnet 23, controlling that one of the rollers 36 which is connected to the valve mechanism 1, as hereinbefore stated, is formed by the wire 123, leading from one of the binding-posts 121 to one part of the circuit-breaking mechanism 124, the other part of said mechanism being connected to one of the fluid-pressure pipes. This circuit-breaking mechanism 124 is controlled by the locking-pin of the switch m and is so constructed that the circuit is completed while the switch is unlocked and broken when the switch is locked in either of its positions. These circuit-breaking mechanisms controlling the movements of the valve mechanisms on the machine may be operated by any other moving part of the switch or its shifting mechanism—as, for example, the deflector-rails, the switch-points of the piston of the fluid-pressure mechanism F—provided that the circuit-breaking mechanism be so operated as to close the circuit at the beginning of the switch-shifting operation and break the circuit when the switch-points have been fully shifted. It is preferred, however, that the circuit-breaking mechanism be operated by the locking-bolt, as stated, for the reason that the valve mechanism 1 cannot be released, having once been locked by a completion of its controlling-circuit, until after the switch-points have been fully shifted and locked.

The circuit-breaking mechanisms 124, 126, 128, and 130 are constructed substantially as described in Patent No. 357,109, hereinbefore referred to, and in the diagrammatic view, Fig. 1, they are represented as moving in a direction parallel with the track-rails, and, although shown for convenience outside of the rails, they are in practice arranged between them.

The making and breaking of the switch-circuits, which are effected automatically by the movements of the switch-locking bolts, cause the latches to rise and fall, and thereby guide the operator and indicate to him the position of the switches and the proper time for setting the signals.

As the switches m and m', being opposite ends of the cross-over O, should be operated together, the valves E and E′ of the switch-operating mechanisms F and F′ are connected, as shown, to the same valve mechanism 1 of the machine, as shown in Fig. 1, and hence it is necessary that a double electric lock controlled by the movements of both switches should be applied to said valve mechanism 1. For this purpose a second slot 17^a, similar in construction to the slot 17, is formed in the quadrant 16, as shown in Figs. 2, 4, and 5, and a second latch 20^a, similar to the latch 20 in construction and function, is pivoted to a bracket or support 19^a, said latch being controlled by an electro-magnet 23^a. This electro-magnet is included in a circuit formed by a wire 125, passing from one of the binding-posts 121 to one part of the circuit-breaking mechanism 126, the other part of said mechanism being connected, as shown, to one of the fluid-pressure pipes. This circuit-breaking mechanism 126 is controlled by the locking-pin of the switch m' in the manner above described in connection with the mechanism 124 of the switch m.

The magnet 23 of the machine-valve mechanism 3, which controls the operating mechanism F^3 of the switch n' through the medium of the valve mechanism E^3, is included in the electric circuit formed by the wire 127, passing from one of the binding-posts 121 to one part of the circuit-breaker 128, the other part of which is connected electrically to the fluid-pressure pipes. The magnet 23 of the valve mechanism 2, controlling the movements of the switch n, is included in the electric circuit 129, passing the circuit-breaker 130 in a manner similar to that above described in the connection with the other switch-circuits.

The track-circuit controlled by the circuit-breaker 131, which is controlled by track-section P^2 of track M, is formed by the wire 133, leading from one part of the circuit-breaker 131 to the magnet 134 of locking-relay 86, thence to the magnet 135 of locking-relay 114, thence to the battery h, and then to the other part of the circuit-breaker.

The track-circuit controlled by the circuit-breaker 136, which is controlled by the track-section P of track M′, is formed by the wire 138, leading from one part of the circuit-breaker to the magnet 139 of the locking-relay 106, thence to the magnet 140 of locking-relay 105, thence to battery h', thence to magnets 141 and 142 of locking-relays 95 and 99,

thence to one part of circuit-breaker 143, and thence back to the circuit-breaker 136. It will be observed that the above-described circuit is also controlled by the track-section P′ through the medium of the circuit-breaker 143.

The track-circuit controlled by circuit-breaker 144, which is controlled by the track-section P^4 of track M′, is formed by wire 145, leading from one part of the circuit-breaker 144 to magnet 146 of the locking-relay 112, and thence back to the other part of said circuit-breaker.

The movements of rollers 45 necessary for making or breaking the signal-circuits through the machine are controlled through the medium of the latches 49 by the magnets 53, which are electrically connected to independent binding posts 147.

The circuit in which the magnet or magnets 53, controlling the movements of the roller or rollers 45 for making or breaking the circuits through the machine for signals governing train movements along and from the track M, is formed by wire 148, leading from one of the binding-posts 147 to circuit-breaking mechanism controlled by magnets 94 and 141 of locking-relay 95, thence to circuit-breaking mechanism controlled by magnets 98 and 142 of locking-relay 99, thence to circuit-breaking mechanism controlled by magnets 85 and 134 on locking-relay 86, thence to circuit-breaking mechanisms 149, 150, 151, and 152, controlled by signals 78, 77, 76, and 75, and thence to the fluid-pressure pipes, which are electrically connected to the battery h^2, included in the above circuit.

The number of signal-rollers 45 included in a locking-circuit depends upon the number of train movements in any one lock-combination.

The circuit in which the magnet 53, controlling the movement of the roller 45 for making or breaking the circuits through the machine for signals governing train movements along, to, and from track M′, is formed by wire 153, leading from one of the binding-posts 147 to circuit-breaker controlled by magnets 140 and 103 in locking-relay 105, thence to circuit-breaking mechanism controlled by magnets 104 and 139 on locking-relay 106, thence to circuit-breakers 154, 155, 156, 157, and 158, controlled by signals 70 71 72 73 74, thence to fluid-pressure pipe and battery h^3, thence to circuit-breaking mechanism controlled by magnets 111 and 146 on locking-relay 112, thence to circuit-breaking mechanism controlled by magnets 113 and 135 on locking-relay 114, and thence to locking-magnet 53.

The binding-post 43, forming the machine-terminus of wire 88 to the distant signal 75, is connected to the common strip 41 by a continuous strip 40, in lieu of passing through strips 37 around the rollers; but it will be observed that this circuit 88 passes through circuit-breaker 89, controlled by the home-signal 76, and through the circuit-breaker operated by relay 90, controlled by insulated track-section 91, which forms part of the circuit of the battery h^4. Hence it is necessary to clear the home-signal 76, thereby closing the circuit 88 through breaker 89, and also that the circuit through the track-relay 90 should be complete before the distant signal 75 can be cleared.

As one of the circuit-breakers in circuit 88 is controlled by track-section 91, the entrance of a car upon said section will by cutting out the relay 90 break the circuit 88, thereby causing the signal 75 to return to "danger," and thus protect the rear of a train passing along the track M. It is sometimes necessary to allow a train to pass the distant signal and move up to the home-signal; but, as in the above-described arrangement, the distant signal is always cleared by setting the home-signal at "safety." A switch is placed in the circuit 88 at the machine, so that said circuit may be broken by the operator, thereby returning the distant signal 75 to "danger," while the home-signal is at "safety." This machine-switch in circuit 88 may be an ordinary key or one of the signal-rollers 45 not otherwise employed. This machine-switch may be employed in lieu of the track-section 91 for throwing the distant signal to "danger" after the passage of the train.

In lieu of interposing a circuit-breaker controlled by the home-signal 71 in the circuit 117 of the distant signal 70, a circuit-breaker 159, controlled by the signal 71, is interposed in the insulated track-section 119, forming a part of the circuit of battery h^5, said circuit also including the relay 118, controlling circuit-breaking mechanism in the circuit 117. The circuit 117, being a normally-open circuit, for the reason that the track-circuit 119 is also a normally-open circuit, being closed only when the signal 71 is cleared, the distant signal 70 will remain at "danger" until the circuit through the track-section 119 is closed by the home-signal 71 going to "safety," and the signal 70 will remain at "safety" until either the signal 71 is set to "danger" or until a car enters the track-section 119 while the signal 71 is at "safety," or until an operator opens a key on the machine, as described, in connection with circuit 88.

The construction and operation of the locking-relays 86, &c., are clearly shown on an enlarged scale in Fig. 12, and by reference to said figure it will be observed that the signal and track circuits pass through the magnets 85 and 134 thereof, but that the locking-circuits are connected to insulated binding-posts 160 and 161, the former being electrically connected to the armature 162 of the upper magnet 85, the other post 161 to the contact-point 163, attached to but insulated from one arm of the bell-crank 164, the other arm of said bell-crank forming the armature of the lower magnet 134 of the locking-relay. Within the scope of movement of the contact-point 163 is arranged a stationary contact-point 165, which is electrically connected to a contact-point

166 on the spectacles 167 of the magnet 85. On the end of the vertical arm of the bell-crank 164 is hinged a pawl 168, held by a spring 169 in line with the arm of the bell-crank, but permitting of backward bending of the pawl when the vertical arm of the bell-crank is thrown to the left by closing the circuit through the magnet 134. The operation of this locking-relay is as follows: It being premised that signal-circuits are normally open and the track-circuits normally closed, and while said circuits are in their normal condition, the above-described devices will assume the position shown, thereby closing the locking-circuit. If now the signal-circuit should be closed, the armature 162 will be raised, thereby breaking the locking-circuit at the contact-point 166, and if the track-circuit be broken the locking-circuit will be broken at the contact-point 165. When the armature 162 is raised by closing the signal-circuit while the track-circuit is closed, the pawl 168 will be thrown to the left, the end of the pawl being moved into line with the insulated bracket 170 on the armature 162, so that when the signal-circuit is again broken the bracket will engage the step in the end of the pawl, thereby preventing the armature 162 from dropping down upon the contact-point 166 and completing the locking-circuit as long as the track-circuit remains closed. Hence, in order to close the locking-circuit after it has been broken by closing the signal-circuit, it is necessary to break the track-circuit, thereby permitting its armature to drop and move the vertical arm of the bell-crank to the right, thus disengaging the notch in the pawl 168 and permitting the armature 162 to drop upon the contact-point 166; but, as by the movement of the vertical arm of the bell-crank to the right the locking-circuit is broken at the contact-point 165, the track-circuit must be again completed, thereby throwing the contact-points 163 and 165 together before the locking-circuit is closed.

In describing the operation of this plant reference will be had principally to Figs. 1, 2, 5, 9, 10, and 11, and for the purpose of said description it will be supposed that a train on track M, moving in the direction of arrow x from a point to the right of the section of track shown in Fig. 1, is to be shifted to track N′.

Figs. 9, 10, and 11 illustrate the operation of the signals, the circuits controlling and controlled by the signals, and the switch-interlocking mechanism controlled by the signal-operating mechanism only during the movement of the train from the right-hand end of M to and past the interlocking track-section P^2. For this purpose it is necessary that switches n and m should remain normal, as shown, and that signals 76 and 75 should be cleared in the order named, until the train has passed track-sections 91 and P^2, the entrance of the train onto track-section 91 automatically shifting the distant signal 75 to "danger," so as to protect the rear end of the train, said signal remaining at "danger" until the train has passed off of track-section 91, when the signal will return to and remain at "safety" until its controlling-circuit is broken by returning the home-signal 76 to "danger," unless, as should always be the rule, said controlling-circuit is broken by the operator by means of a key S, (see Fig. 9,) interposed in said circuit at the machine while the train is passing along track-section 91, in which case the signal 75 will remain at "danger" after the train has passed off of track-section 91. The train having passed beyond the track-section P^2, it is necessary, in order that the train may pass over to N′, that the switches m, m', and n' be shifted, the signal 77 be cleared, and all opposing signals, including in this case all other signals shown, must be locked at normal or "danger."

As the switches m and n are normal or set for clear main line, it is only necessary for the passage of trains to a point beyond the track-circuit P^2 that the signals 76 and 75 should be cleared. This is effected by throwing the second signal-lever 55 of the signal-controlling mechanism B, Figs. 2 and 9, to the left, thereby so turning its roller 45 that one of the bands 37 thereon will come into contact with the springs 44 on each side thereof, and so completing the controlling-circuit for the signal 76 through the machine, said circuit being formed by wires 84 and 87 and passing through magnet 85 in the locking-relay 86. The completion of this signal-circuit operates the mechanism 81 of signal 76, so as to shift said signal to "safety," and at the same time closes the circuit for distant signal 75 at the circuit-breaker 89, thereby operating the mechanism 81 at signal 75, so as to clear said signal. The completion of the circuit for signal 76 through magnet 85 of locking-relay 86 raises the armature 162, (see locking-relay $86^{\times}$,) thereby breaking the normally-closed locking-circuit formed by wire 148, which is also broken at circuit-breakers 151 and 152 by the movement of signals 76 and 75 to "safety." This breaking of the locking-circuit 148 permits the locking-latches 49 to rise in their slots 48 of quadrants 47, attached, as hereinbefore stated, to rollers 45, which are operated by the first and second signal-levers 55 of signal-controlling mechanism A, as shown in Figs. 2 and 9. The latch of the first signal mechanism A enters the notch between the lugs 54, thereby locking said mechanism in its center position as against any movement for the reason that said lever controls, through circuits hereinafter mentioned, the signals 77, 78, and 74, which govern train movements in opposition to those controlled by signals 76 and 75, already cleared, as stated. The latch 49 of the second signal mechanism B, Figs. 2 and 9, enters the space between the left-hand end of the slot 48 in its quadrant 47 and one of the lugs 54, thereby locking said mechan-

ism as against its return to center position; but the distance between the lug 54 and the end of the slot is sufficient to permit of such a movement of the roller 45 of said signal mechanism B as to move the band 37 from contact with one of the springs 44, thereby breaking the signal-operating circuit and returning the signals 76 and 75 to "danger" at the will of the operator; but the breaking of the signal-circuit and the consequent return of the signals 76 and 75 to "danger" will not complete the locking-circuit 148, as the pawl 168 (see Figs. 9 and 12) was moved under the bracket 170 by the action of the spring 169 when the armature 162 was raised, as hereinbefore stated, and said pawl will prevent the armature 162 from dropping onto the contact-point 166 until the circuit formed by wire 133 through magnet 134 has been broken and then closed, either by the passage of the train onto and off from the track-section P^2 or by the operator through the medium of a key placed in the circuit 133 at the machine for use in emergencies.

In Fig. 10 is shown the position of the parts of the machine included in Fig. 9 after the signal mechanism B has been shifted toward the right from the extreme left-hand position shown in Fig. 9 until one of the lugs 54 encounters the latch 49. This movement of the signal-controlling mechanism B will, as shown in Fig. 10, break the signal-circuit 84 by turning the band 37 of said mechanism out of contact with one of the springs 44. As soon as this break occurs the signals 76 and 75 return to "danger" and the armature 162 of magnet 85 drops down, but cannot come into contact with the pin 166 on account of the pawl 168 engaging the bracket 170 on said armature. (See locking-relay 86^x, Fig. 10.) As soon, however, as the train enters the unlocking-section P^2 the track-circuit 133 is broken and the armature forming part of bell-crank 164 drops, thereby disengaging the pawl 168 from the bracket of armature 162, thereby permitting said armature to drop into contact-point 166, completing the locking-circuit at that point; but said circuit is simultaneously broken as the contact-pin 163 was drawn away from pin 165 by the above-described movement of the bell-crank, as shown in relay 86^2, Fig. 10. As soon, however, as the train passes off of the unlocking track-section P^2 the track-circuit 133 is again completed and the bell-crank 164 is so moved as to bring the pins 163 and 165 into contact, thereby completing the locking-circuit 148. (See Fig. 12.) The magnets 53 being excited by the completion of the circuit 148, the latches 49 are moved down below the path of movement of the lugs 54, thereby unlocking the signal mechanisms A and B, whereupon the latter may be returned to center or normal position, as shown in Fig. 11. This return of the mechanism B to normal so moves the locking-bars 63 as to bring the notches therein in line with the dogs, which thereupon drop down out of the line of movement of the levers of the switch-controlling mechanisms 1 2 3, &c.

In Fig. 13 are shown the positions of the bands 37 on rollers 36 or 45, controlling switches and signals for routes conflicting with the route given when said rollers are in the positions shown in Fig. 9. By reference to said Fig. 13 it will be clearly seen by the positions of the bands 37 that the signal-circuit of which the bands 37 form a part cannot be completed until the rollers are turned; but, as hereinbefore stated, the shifting of the signal-lever to clear the signal for any given route locks up the levers and rollers controlling any conflicting route—as, for example, it is necessary, in order to give a route in conflict with that given in Fig. 9, to shift the switch-controlling mechanisms 1, 2, and 3 and the signal-controlling mechanisms A and B to the right in Fig. 9 in order to complete the signal-circuit of which the bands 37 therein shown form a part; but by reference to Fig. 9 it will be seen that said mechanisms are and will remain locked until the signal mechanism B has been returned to normal, (see Fig. 11,) thereby sending the signal controlled thereby to "danger." The purpose of this locking of the signal-controlling mechanisms from returning to center position, although the signals have been returned to "danger," is to prevent any movement of the switch-controlling mechanisms which have been mechanically locked by the movement of the signal-lever 55 of signal mechanism B through the medium of locking-bars 63 and dogs 65, as hereinbefore described, until it is certain that the train has passed beyond the last fouling-point in the combination, and this is indicated by the breaking and closing of the track-circuit 133, due to the passage of the train over the unlocking-section P^2. When the unlocking has been thus completed by the return of signals 76 and 75 to normal and the passage of the train over the unlocking-section P^2, as above stated, the signal-controlling mechanism may be returned to center position, thereby unlocking the machine and all connections.

The train having passed the unlocking-section P^2, as above stated, it is necessary, in order that it may be shifted onto track N', to change switches m, m', and n' and to clear the signal governing such route. As the switches m and m' are controlled, as hereinbefore described, by the same valve mechanism on the machine—*i. e.*, the one operated by that one of the levers 15 designated by 1 in Fig. 2—said lever is shifted from the position shown in Fig. 2, to the right until the latches 20 and 20^a, or rather the tongues 25 and 25^a, thereon encounter the pins 26 and 26^a in the slots 17 and 17^a of the quadrant 16, as shown in the second quadrant from the left in Fig. 5. This movement of the lever shifts the valve 4 so as to open the port 7 to the exhaust and the port 8 to the fluid-pressure supply.

Such change in the fluid-pressure so shifts the valve mechanisms E and E′ as to set the switch mechanisms F and F′ into operation. The first movements of the switch mechanisms withdraw the locking-bolts thereof and thereby so operate the circuit-breaking mechanisms 124 and 126 as to complete the switch-locking circuits formed by wires 123 and 125, passing through magnets 23 and 23ª. The excitation of these magnets produced by closing the circuits causes, through the described connections with the armatures 22 and 22ª, the forward ends of the latches 20 and 20ª, with their tongues, to drop into notches 18 and 18ª of the quadrant 17, thereby permitting to clear the tongues 25 and 25ª from the pins 26 and 26ª and pass to the opposite sides thereof, as shown in Fig. 5. The quadrant and its connections remain locked, however, by the latches 20 and 20ª engaging the notches until after the entire switch movements have been completed and locked. The movements of the locking-bolts in locking the switch-rails break the switch-circuits 123 and 125, thereby permitting the armatures 22 and 22ª to drop and raise the latches 20 and 20ª from the notches 18 and 18ª, whereupon the lever designated 1 can be shifted to the limit of its movement to the right, the spring-latch 32 on said lever having first been raised so as to clear the shoulder 31. The complete movement of the lever and the roller 36 attached thereto brings that strip 37, forming a part of the circuit of the signal required in the combination, into contact with the springs 44 on each side of the roller. Simultaneously with the shifting of that lever designated 1 in Fig. 2 the lever designated 3 is also shifted to the right, the immediate locking and unlocking of its quadrant 16 and of the switch N′, as described in connection with lever 1, being effected in the same manner and order stated, as is also the closing of another break in the signal-circuit by a strip 37 on the roller 36 connected to the lever 3.

The switches m, m', and n' having been set, as described, for the passage of the train to the track N′, it remains to clear the signal 77 and lock all opposing signals and such of the switch-levers as are included in the combination or any other combination conflicting therewith. In order to clear signal 77, the signal-lever A, Fig. 2, is shifted to the left, thereby bringing a strip 37 on the roller 45, operated by the lever A, into contact with springs 44 on each side of the roller, thereby completing the circuit of signal 77 through the machine, the roller 45, operated by lever B, which is included in the same combination as lever A, having a strip 37 so located thereon as to form electrical connection between springs 44 on each side thereof and included in the circuit of signal 77 when the lever B is at normal or center position. The circuit of signal 77 from the machine to the signal passes by the wires 93 and 96 through the magnet 94 of locking-relay 95 to the signal-operating mechanism 81, and the completion of the circuit, as described, operates said signal mechanism to shift the signal to "safety," and also, by raising the armature 162 of the magnet 94, breaks the locking-circuit 148, which is also broken by the movement of the signal 77 to "safety" through the circuit-breaker 150. This break in the locking-circuit causes the latches 49 to rise, the latch of quadrant 47, connected to lever B, entering the notch between the lugs or pins 54, thereby locking said quadrant and its lever in center position, and the latch for quadrant connected to lever A entering the space in slot 48 to the left of the lugs or pins 54, thereby locking said lever A as against a return to center position until unlocked by the passage of the train onto and over the track-section P′, thereby opening and closing the circuit through magnet 141 of locking-relay 95, and thereby completing the locking-circuit 148, provided signal 77 has been returned to "danger" in the manner hereinbefore fully set forth in connection with the movement of the train along track M; but the space in the slot 48 between the left-hand end of said slot and the lugs or pins 54 is long enough to permit of such a movement of the roller 45, connected to lever A, as will break the signal-circuit and return the signal 77 to "danger." The signal 77 having been cleared, as above described, the train is free to move from track M along the cross-over O to the track M′, and thence onto the track N′. As the train enters the section P′ the relay-operating circuit-breaker 143 is cut out, thereby breaking the track-circuit 138 and releasing the armature forming a part of bell-crank 164 of locking-relay 95 and permitting the armature 162 to drop down onto contact-point 166, thus effecting the first step necessary, as hereinbefore described, for completing the locking-circuit 148 through said locking-relay 95. As soon as the train passes off of track-section P′ the circuit 138 is again closed, thereby causing the armature of the bell-crank 164 to be raised and the contact-points 163 and 165 to be brought together, thus completing the locking-circuit 148 through locking-relay 95 and unlocking the signal-levers A and B, the signal 77 having been thrown to "danger" as soon as the train had moved past said signal by shifting the lever A the amount permitted by the distance between the lugs 54 and the end of slot 48, as hereinbefore stated.

It will be observed that lever C, controlling signal 73, forming a part of a combination different from that above described and in opposition to the above-described train movements, is not included in locking-circuit 148; but said signal cannot be cleared while the switches m and m' are reversed or set for the cross-over O, for the reason that a part of the circuit-controlling signal 73 is formed by strips 37 on the roller 36 connected to the lever 1, controlling switches m m', said strip be-

ing so located as to be incapable of completing connection with the springs 44 of said signal-circuit until the lever 1 has been shifted to normal position, thereby causing the switches m and m' to move to normal.

As an additional safeguard against the clearing of signal 73 while signal 77 is cleared, the circuit-controlling signal 77 is formed in part by a strip 37, so located on the roller 45, connected to signal-lever C, as to require said signal-lever to be in center or normal position before the circuit for signal 77 can be completed.

If now it should be desired to run the train from track N′ onto track M′, and thence along said track in the direction indicated by arrow y, the machine having been unlocked by the passage of the train over track-section P′, the signal-lever A is returned to normal or center position, thereby unlocking the switch-levers 1 and 3, which had been mechanically locked by the movement of the signal-lever A to the left in clearing signal 77 through the medium of locking-bars 63 and dogs 65 in the manner hereinbefore fully described. The switch-lever 1 is now turned to the left or normal position, thereby shifting the switches m and m' to clear main line; but the switch-lever 3 is not disturbed, the position into which it had been shifted for the train movement just described being the same as required for the train movement desired—*i. e.*, for branch line N′. The movement of the switch-lever 1 and switches m m' will be accompanied by the locking and unlocking movements controlled by circuit-breakers 124 and 126, described in connection with the movements of said lever and switches required for the train movements last referred to. The switch N′ being in proper position for the passage of the train from track N′ to M′, it now remains to clear the signal 73, and this is effected by turning signal-lever C to the right, thereby completing signal-circuit 109 through the machine through the medium of a properly-located strip 37 on the roller 45, operated by said signal-lever, a portion of said circuit having been previously completed when the switch-lever 3 was shifted to the right, as hereinbefore stated. The closing of circuit 109, which passes through magnet 111 of locking-relay 112, breaks locking-circuit 153 through the raising of armature 162 of said magnet, said locking-circuit being also broken by the movement of signal 73 to "safety" through the medium of circuit-breaker 158. The breaking of circuit 153 permits the armature 52 of the magnet 53 pertaining to the signal-lever C to drop, thereby raising the latch 49 for locking said lever to rise in the slot 48 of the quadrant 47 into the space between the right-hand end of said slot and the lugs 54, thus locking said lever as against any return to center position, but permitting such movement to the lever C and its roller 45 as will effect a break in the signal-circuit 109 for the purpose of returning signal 73 to "danger." The above-described movement of lever C mechanically locks the switch-lever 3 through the medium of locking-bars 63 and dogs 65, and hence said switch-lever and its switch n' cannot be changed until the signal-lever C has been returned to normal or center position. This return of the signal-lever to normal or center position cannot be effected until the latch 49 is dropped to the bottom of slot 48 of quadrant 47, and such movement of the latch 49 can only be effected by closing the breaks in the locking-circuit 153 by returning the signal 73 to "danger" and the passage of a train over the track-section P^4, thereby breaking and closing the track-circuit 145, and so operating the bell-crank 164 of locking-relay 112 in the manner hereinbefore described as to complete the circuit 153 through said locking-relay. As the circuits of signals 70, 71, and 72 are formed in part by strips 37, so located on the roller 45 of lever C as to come into contact with springs 44 only when the lever C is turned to the left, it is evident that such signals cannot be cleared until after the lever is unlocked from its right-hand position by the passage of trains over the unlocking track-section P^4, as hereinbefore described, the signal 73 having been returned to "danger."

The machine having been unlocked by the passage of the train over track-section P^4, as stated, it is necessary for the movement of the train along the line M′ in the direction of the arrow y, after having passed out of branch line N′, that the switch n' should be returned to normal and the signals 71 and 70 be cleared. The latter can only be cleared in case the train has passed off of the track-circuit 119, for the reason hereinbefore stated, that the short-circuiting of this track-section through the wheels of a car standing thereon will break signal-circuit 117, thereby preventing the clearing thereof.

In order to return the switch n' to normal, it is necessary to unlock its controlling-lever 3 by shifting the signal-lever C to center position, thereby so shifting the locking-bar 63 that the dog 65 will drop into a notch 68 therein, thus freeing the switch-lever 3, so that it may be shifted to the left or normal position and through the fluid-pressure of mechanisms controlled thereby set the switch for main line. The operator now shifts the signal-lever 3 to the left, thereby completing the circuit formed by wires 101 and 107 through the machine and clearing the home-signal 71. The movement of the signal 71 to "safety" closes the circuit through track-section 119, by closing circuit-breaker 159, and, in case no cars are standing on said section, thereby closes the circuit 117, controlling the distant signal 70, and shifts said signal to "safety," the circuit 117 having been completed through the machine by the movement of the signal-lever C to the left, as hereinbefore described. As the circuit 107 passes through magnet 103 of locking-relay 105 the closing of said circuit raises the armature 162 of said

magnet from the contact-point 166, thereby breaking the locking-circuit 153, which is also broken by the movement of signal 71 to "safety" through circuit-breaker 155 and locking the signal-lever C as against return to center position in the manner fully described in connection with the clearing of signal 73. As the roller 45, connected to lever C, is provided with a strip 37, forming part of the circuit-controlling signal 73, and said strip 37 is so located that said signal-circuit is completed only when said lever is turned to the right, it is evident that said opposing signal 73 cannot be given while signal-lever is locked to the left, as described; and as it is necessary that the signal 71 should be returned to "danger," thereby closing the break 155, and that the track-circuit 138 should be broken and then closed by the passage of the train over track-section P, in order that lever C may be unlocked and turned to the right, it is evident that the opposing signal 73 cannot be given until after the train has passed all fouling-points in the arrangement of tracks shown in Fig. 1. Although the strip 37 on roller 45 of lever C is so located as to complete, so far as said roller is concerned, the circuit-controlling signal 72 when lever C is turned to the left, it will be impossible to clear the signal 72, for the reason that a portion of the circuit-controlling signal 72 is formed by a strip 37 so located on the roller 36 of lever 3 as to complete said signal-circuit only when the lever 3 has been shifted to the right for reversing switch n'.

The arrangement of tracks and switches, together with their controlling-signals, the several electric circuits for controlling the position of signals, and the operating-machine, as shown in the drawings and hereinbefore described, is employed for the purpose of illustrating the several features of the invention herein as they may be applied in use; but the invention is not limited to the arrangement, number, or combinations of switches, signals, and controlling-circuits shown, as the skilled operator will be enabled from the foregoing to apply the invention as the various and continually-changing conditions of use may require.

Above the machine is arranged a board (see Figs. 2 and 4) having miniature rails 172 arranged thereon in correspondence with the tracks and switches controlled by the machine, the switches being represented by short sections 173, each having one end free to move, and the opposite secured to a pin 174, passing through the board 171, and on the end of the pin 174, projecting through the rear side of the board, is secured a crank-arm 175. (See Figs. 4 and 14.) As each switch is represented by two of the sections 173, one in each rail, the crank-arms 175 are connected in pairs, as shown in Fig. 14, by bars 176, so that each of the sections will be simultaneously swung out of line with the rail 172 and into line with each other, as shown in Figs. 2 and 14. One of the crank-arms 175 is connected by a rod 177 to a lever 178, so pivoted on the board 171 that one of its ends extends down into the line of movement of the lugs 179, formed on the quadrant 16, connected to the switch-controlling mechanisms of the machine. These levers 178 are held normally in a center position by springs 180, as shown in Fig. 14, and the sections 173, forming a pair, are so connected by the rods 177 to the levers 178 and to each other that when the levers are held in center position, as above stated, the sections are held out of line with the main rails and with each other, as shown in Fig. 14. These levers 178 are shifted to one side or the other by the lugs 179 in accordance with the movement of the quadrants, the lugs being so located on the quadrants as not to engage the levers until the quadrants approach closely the limits of their movements, and as the quadrants cannot, on account of the locking mechanism hereinbefore described, approach closely the limits of their movements until the switch-rails have been shifted and locked the sections will, after the first movement of the quadrants in shifting a switch, remain in their normal or broken position, as stated, until after the switch-rails have been fully shifted and locked, thereby permitting of the completion of the movement of the quadrants.

Any known devices operated by train movements along the track to make and break electric circuits may be employed in lieu of the insulated track-sections herein described, and such devices are hereby included as the full equivalents of the track-sections and fully within the spirit and scope of the invention herein.

Each line of track, whether main or branch line, forming the system under control of any machine is duly numbered, and in order to notify the operator on which line of track a train is approaching short sections of the tracks at a distance of a mile and a half or two miles are insulated from the rest of the tracks and form parts of normally-closed electric circuits, which are opened by the passage of a car over the insulated track-sections, thereby closing a normally-open circuit operating an electric bell near the machine and causing the magnet 181 to attract the armature 182, thereby withdrawing said armature from engagement with a finger 183, connected to the disk 184, thereby permitting said disk to drop down into line with the opening 185 through the board 171, said disk being pivotally mounted on the rear side of said board, as shown.

Each of the rails or lines 172 on the indicator-board is provided with an opening 185 and a properly-numbered disk 184, so that the operator when the bell is rung needs only to glance at the board to ascertain which of the tracks and signals he must prepare for the approaching train.

In order to return the indicator-disks to

normal after the passage of a train, a branch 186 of the fluid-pressure pipe is connected to the valve mechanism 187, located on the machine within convenient proximity to the operator, and to said valve mechanism is also connected the pipe 188, provided with nozzles 189, located in such relation to the disks 184 that a stream of air or other fluid escaping from said nozzles 189 will impinge upon plates 190, secured in the rear side of the disks 184, and force said disks upward, so as to be held out of line with the openings 185 by engagement of the fingers 183 with the armatures 182. The admission of fluid-pressure to the pipes 188 is controlled by the valve 191, normally held in a closed position by the spring 192, as shown in Fig. 16.

In Fig. 19 is shown the preferred form of circuit-breaker employed in the circuits of home and distant signal controlling the locks on the machine. The contact-spring 193 is attached at one end to one of the binding-posts 194, while its opposite end is free to be shifted by the piston-rod 195 of the signal-shifting mechanism, which is preferably of the construction shown and described in Letters Patent No. 357,109, hereinbefore referred to. The free end of the spring 193 is, on shifting the signal to "safety," moved away from the contact-point 196 on the binding-post 197, and is returned into electrical connection with such point on the return of the signal to normal or danger position.

In Fig. 20 is shown the preferred arrangement of circuit-breaker employed in the circuits by which the home-signal controls the distant signal. As these circuits are normally-open circuits, the circuit-breaker is so constructed that the spring 193 is brought into electrical engagement with the contact-point 196 when the home-signal is shifted by its mechanism to a safety position.

It will be observed that the locking mechanism controlled by the switch-locking bolt operates only as a temporary check or lock to prevent a full throw of the switch-controlling mechanisms 1 2 3, &c., until after the switches controlled by such mechanisms have been fully shifted and locked, the movement of the levers 15 of the switch-controlling mechanisms 1, 2, and 3 slightly beyond a central position being sufficient to open the ports 7 and 8 to the exhaust and inlet ports 1 and 10, thereby setting the switch-motors into operation. As the metallic bands 37 on the rollers 36 of the switch-controlling mechanisms 1 2 3, &c., are so placed as to come in contact with their appropriate springs 44, thereby partially completing the signal-controlling circuits, only when said switch-controlling mechanisms have moved to either limit of their movements, and as the signal-controlling mechanisms, when in the same combination with the switch-controlling mechanisms, are not locked or in any way limited by the switch-controlling mechanisms, and hence can be shifted at any time to clear a signal, it is necessary that the switch-controlling mechanisms should be temporarily checked in their movements to insure the shifting and locking of the switch before the signal-controlling circuits are completed by the bands 37 on the rollers 36 of the switch-controlling mechanisms.

It has heretofore been stated that the circuit controlling each signal is formed in part by a band 37 on the roller 36 of the mechanism controlling the switch guarded by said signal, and that said band is so located on the roller 36 that it is brought into contact with its spring 44 only when the switch-controlling mechanism has been so moved as to cause such adjustment and locking of the switch that a clear signal may properly be given. Hence a proper adjustment of the switch is always and absolutely necessary prior to the clearance of a signal, although the signal-controlling mechanism is not interlocked with the switch-controlling mechanism.

By reference to Figs. 9 and 10 it will be observed that although the levers 15 of the switch-controlling mechanisms are locked by the dogs 65 when raised as against such a movement as will effect a shifting of the switches a considerable movement can be imparted to them. Such movement, however, will only result in moving the band 37 on roller 36 out of contact with its springs 44, thereby breaking the signal-circuit and shifting the signal to "danger." It will also be seen by reference to the same views that the signal-controlling mechanism, when locked by the pawl 49 out of center position, has a sufficient range of movement to permit of the signal-circuit being broken, but cannot move far enough to so shift the locking-bars 63 as to lower the dogs 65, thereby unlocking the switch-shifting mechanism. This partial movement of the signal-controlling mechanism permits the operator to take a signal away from a train at will; but as the movement of the signal-controlling mechanism to clear the signal in the first instance not only mechanically locked the switch-controlling mechanism, but also locked itself as against a return to center position by breaking the locking-circuit through the medium of the locking-relay, as hereinbefore described, the machine cannot be unlocked until the train has passed over, unlocking track-section P. The movement of train onto the unlocking track-section first breaks the circuit through the lower magnet of the locking-relay, and the passage of the train off of said section again completes or restores said circuit, such making and breaking of the circuit through the lower magnet completing the locking-circuit, as hereinbefore stated, provided the signal has been previously returned to "danger."

One of the characteristic features of the invention herein is the controlling of the signal-circuits by the switch-controlling mechanisms of the machine. It will be observed that each signal-circuit is formed in part by

a band 37 on one or more of the rollers 36 of the switch-controlling mechanisms, said bands being so located on the rollers that all switches must be set and locked for the route indicated by the signal before such signal-controlling circuit can be closed by shifting the signal-controlling mechanism. Each signal-controlling circuit is formed in part not only by a band 37 on the controlling mechanism of the switch guarded by such signal, but also in part by bands 37 on the rollers of the mechanisms controlling such switches as will permit of an opposing train movement, and the bands are so located that the opposing switches must be in proper position for the route desired before the signal-circuit can be closed by the switch-controlling mechanism.

We claim herein as our invention—

1. The combination of a fluid-pressure motor for reversing the switch or other part or appliance connected with a track and provided with a fluid-pressure-controlled valve mechanism, a supply-and-exhaust valve mechanism controlling the motor-valve and constructed to retain fluid-pressure on one side or the other of the motor-valve in accordance with the position of the switch, an electrically-controlled mechanism for locking the supply-and-exhaust valve mechanism during the operation of the fluid-pressure motors, and a normally-open electric circuit for controlling the locking mechanism, such circuit being closed to lock the supply-and-exhaust valve mechanism during the movements of the switch mechanisms, substantially as set forth.

2. The combination of a series of two or more fluid-pressure motors for reversing a series of two or more switches or other parts or appliances connected with a track and provided with fluid-pressure-controlled valve mechanisms, a supply-and-exhaust valve mechanism for controlling the motor-valves, a series of two or more electrically-controlled mechanisms for locking the supply-and-exhaust valve mechanism during the operation of the fluid-pressure motors, and a series of two or more electric circuits for controlling the locking mechanisms, each electric circuit being controlled through the moving parts of one of the switch mechanisms.

3. The combination of a fluid-pressure motor for reversing the switch and provided with a fluid-pressure-controlled valve mechanism, a supply-and-exhaust valve mechanism controlling the motor-valve and constructed to retain fluid-pressure on one side or the other of the motor-valve in accordance with the position of the switch, an electrically-controlled mechanism for locking the supply-and-exhaust valve mechanism during the operation of the fluid-pressure motor, and an electric circuit for controlling the locking mechanism, such electric circuit being controlled by the switch-locking mechanism, substantially as set forth.

4. The combination of fluid-pressure motors for shifting the signals, electric circuits controlling the signal mechanisms, such circuits being dependent upon make-and-break mechanisms, one for each signal mechanism, operated by the switch-controlling mechanisms, and locking mechanisms operated by the signal-controlling mechanisms to lock the switch-controlling mechanisms, substantially as set forth.

5. The combination of a slotted quadrant provided with locking-pins and an electrically-controlled latch engaging with the pin, substantially as set forth.

6. The combination of a rotating-valve mechanism, a roller provided with insulated metallic bands extending partially around said roller, and an insulating bed having metallic strips divided into sections attached thereto, said sections being provided at their ends with contact points or springs constructed to engage the bands on both sides of the rollers when the latter have been properly adjusted, substantially as set forth.

7. The combination of an insulating-bed having metallic strips divided into sections attached thereto, said sections being provided at their ends with contact points or springs, a series of two or more rotating rollers formed of insulating material arranged between the contact points or springs, and metallic bands passing partially around said rollers and so located thereon as to engage with the contact points or springs in certain predetermined positions of two or more of the rollers, thereby forming a metallic circuit across the bed, substantially as set forth.

8. The combination of rotating rollers formed of insulating material, in any desired number, having metallic bands thereon for making and breaking circuits by rotation of the rollers, and metallic strips in line with said bands and provided with contact springs or points, some or all such strips having electric connection through the bands of a part only of the rollers, substantially as set forth.

9. The combination of a switch, a switch-shifting mechanism, a hand-operated mechanism controlling the switch-shifting mechanism, an electrically-controlled signal-shifting mechanism, an electric circuit controlling the signal-shifting mechanism, a metallic strip divided into sections provided at their ends with contact points or springs, the end sections being connected with the signal-circuit, and rotating rollers provided with bands for engagement with the contact-points in certain predetermined positions of the rollers, one of said rollers being operated by the switch-controlling mechanism and the other by a hand-lever, substantially as set forth.

10. The combination of a series of miniature tracks arranged in correspondence with the system of tracks controlled by the machine, a series of movable sections arranged in correspondence with the switches of such track system, and connections from such movable sections to the switch-controlling mechanism, whereby said movable sections are

shifted simultaneously and in correspondence with the switch-controlling mechanism, substantially as set forth.

11. The combination of a series of miniature tracks arranged in correspondence with the system of tracks controlled by the machine and a series of movable sections arranged in correspondence with the switches of said track system, said sections being arranged in pairs, each pair being connected to a spring-lever which at normal tension holds the sections in position indicating unlocked switch, and movable points connected to the switch-controlling mechanism for shifting said lever, substantially as set forth.

12. The combination of a series of electrically-controlled disks having numbers or other marks indicating certain lines of track, provided with a projecting plate, an electric-track circuit controlling the movements of said disks in one direction, said circuit being controlled by the passage of trains over an insulated track-section forming part of said circuit, fluid-pressure pipes provided with nozzles so arranged that fluid-pressure escaping from said nozzles will impinge upon the projecting plates of the disks and return the same to normal, and a valve controlling the escape of fluid-pressure from said nozzles, substantially as set forth.

13. The combination of electrically-controlled mechanisms for shifting the home and distant signals, electric circuits controlling the signal mechanisms, make-and-break mechanisms, each controlling one of the signal-circuits, and a circuit-breaker included in the electric circuit controlling the distant signal and controlled by the home-signal, substantially as set forth.

14. The combination of electrically-controlled mechanisms for operating the distant signal, an electric circuit controlling such mechanism, a make-and-break mechanism controlling such circuit, a circuit-breaker included in the signal-circuit, and a track-circuit controlling the circuit-breaker, whereby the passage of the train onto the track-circuit will shift the distant signal to "danger," substantially as set forth.

15. The combination of electrically-controlled mechanisms for shifting the home and distant signals, electric circuits controlling the signal mechanisms, make-and-break mechanisms, each controlling one of the signal-circuits, an electrically-controlled circuit-breaker included in the circuit controlling the distant signal, a track-circuit controlling the circuit-breaker, and a circuit-breaker operated by the home-signal and controlling the track-circuit, substantially as set forth.

16. The combination of a lever 15, for operating the valve mechanism controlling the switch, a lever controlling the signal-circuits, a longitudinally-movable bar operated by the signal-lever and provided with notches on its upper edge, and a pivoted dog normally resting in the notch in the movable bar and having its free end adapted to engage the lever 15 when the dog is raised from the notch by the movement of the bars, substantially as set forth.

17. The combination, with a rotating valve mechanism, of a slotted quadrant moving with said valve mechanism and provided with a locking-pin and notch, an electrically-controlled latch adapted to engage the notch, and a spring-tongue connected to the latch and adapted to engage the pin in the slot of the quadrant, substantially as set forth.

18. The combination, with a slotted quadrant having locking-stops located within the slot, of an electrically-controlled latch adapted to engage said stops, a lever for operating the quadrant, provided with spring-actuated pin or pawl, and shoulders or stops formed on the front plate of the machine, substantially as set forth.

In testimony whereof we have hereunto set our hands.

GEO. WESTINGHOUSE, JR.
J. G. SCHREUDER.

Witnesses:
W. D. UPTEGRAFF,
DARWIN S. WOLCOTT.