(No Model.) 6 Sheets—Sheet 1.

F. W. WEBB & A. M. THOMPSON.

STAFF APPARATUS FOR CONTROLLING TRAFFIC ON SINGLE LINE RAILWAYS.

No. 429,074. Patented May 27, 1890.

Fig. 1.

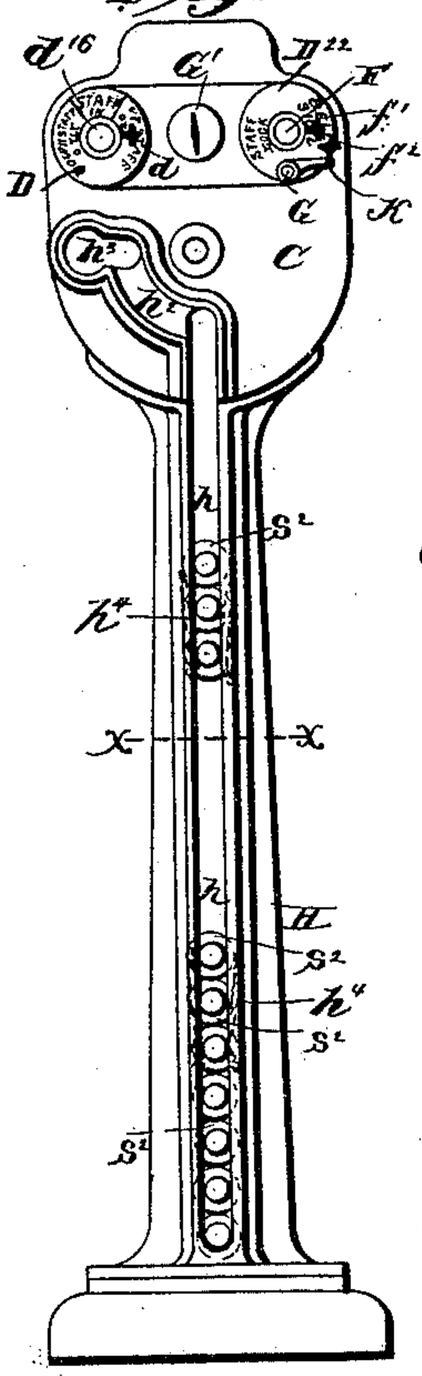


Fig. 2.

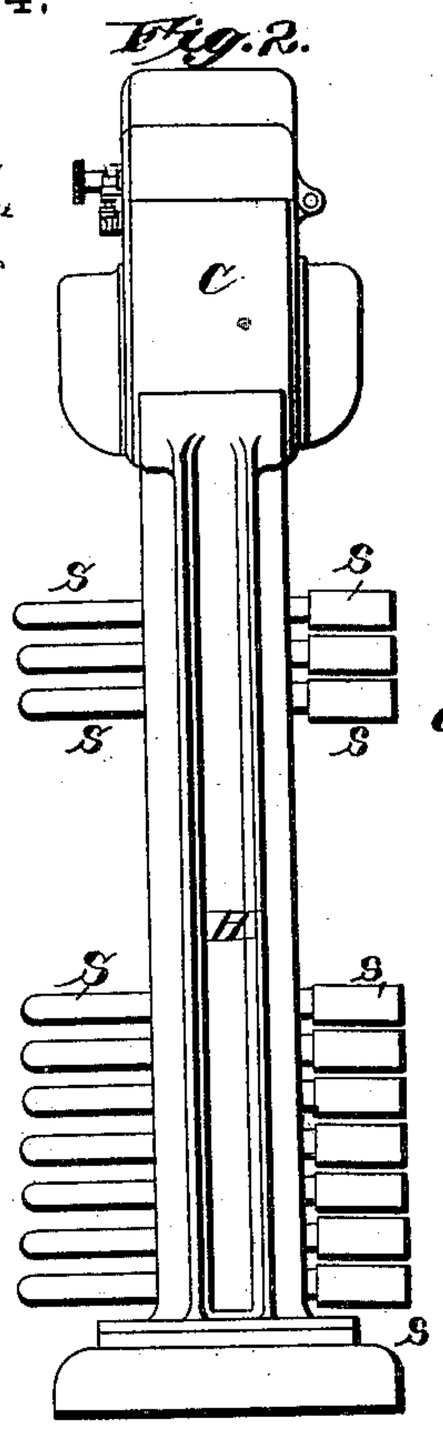


Fig. 5.

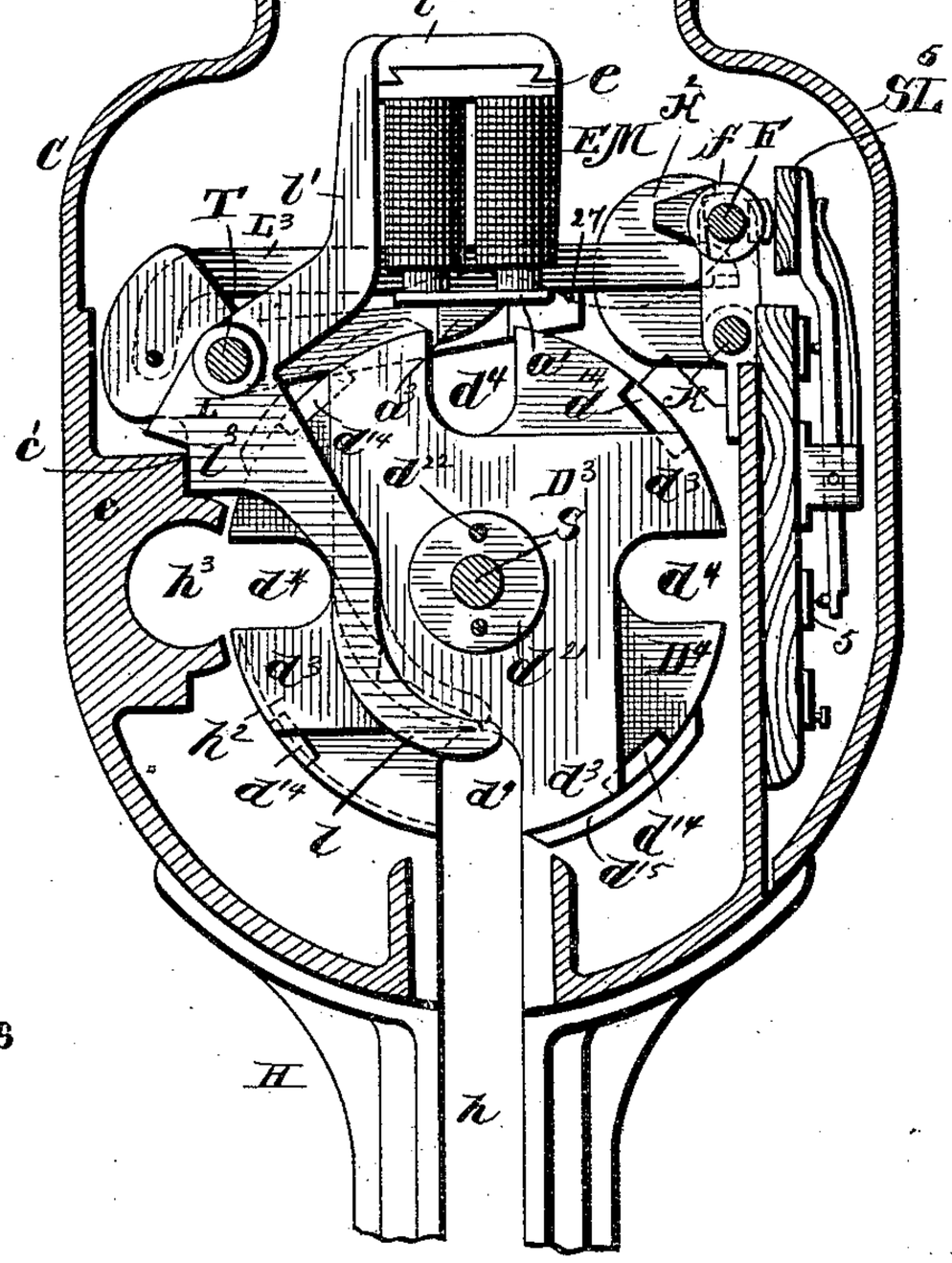


Fig. 3.

Fig. 4.

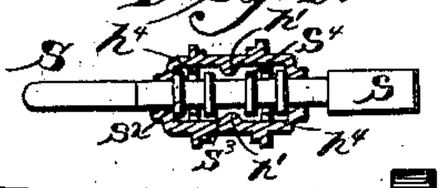


Fig. 10.

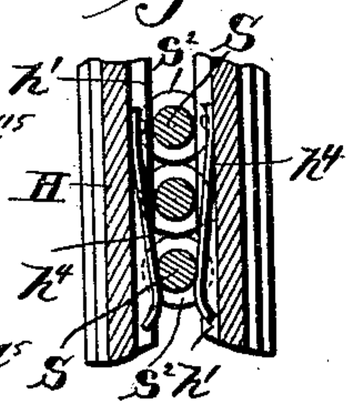


Fig. 6.

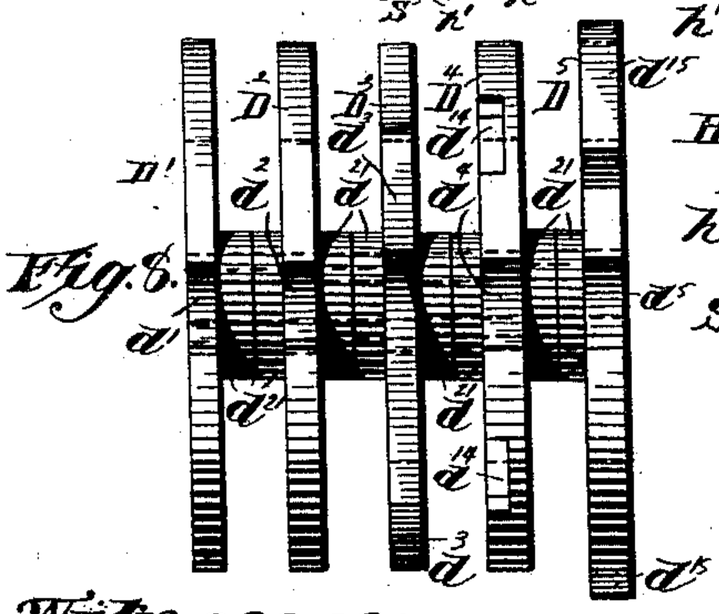
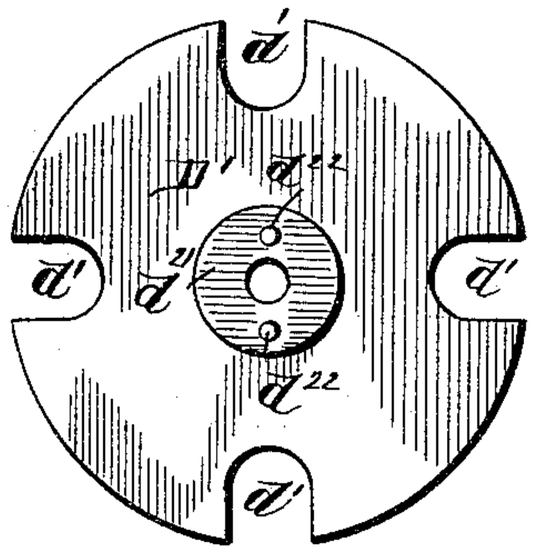


Fig. 9.



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(No Model.) 6 Sheets—Sheet 2.

F. W. WEBB & A. M. THOMPSON.

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No. 429,074. Patented May 27, 1890.

Fig. 6.

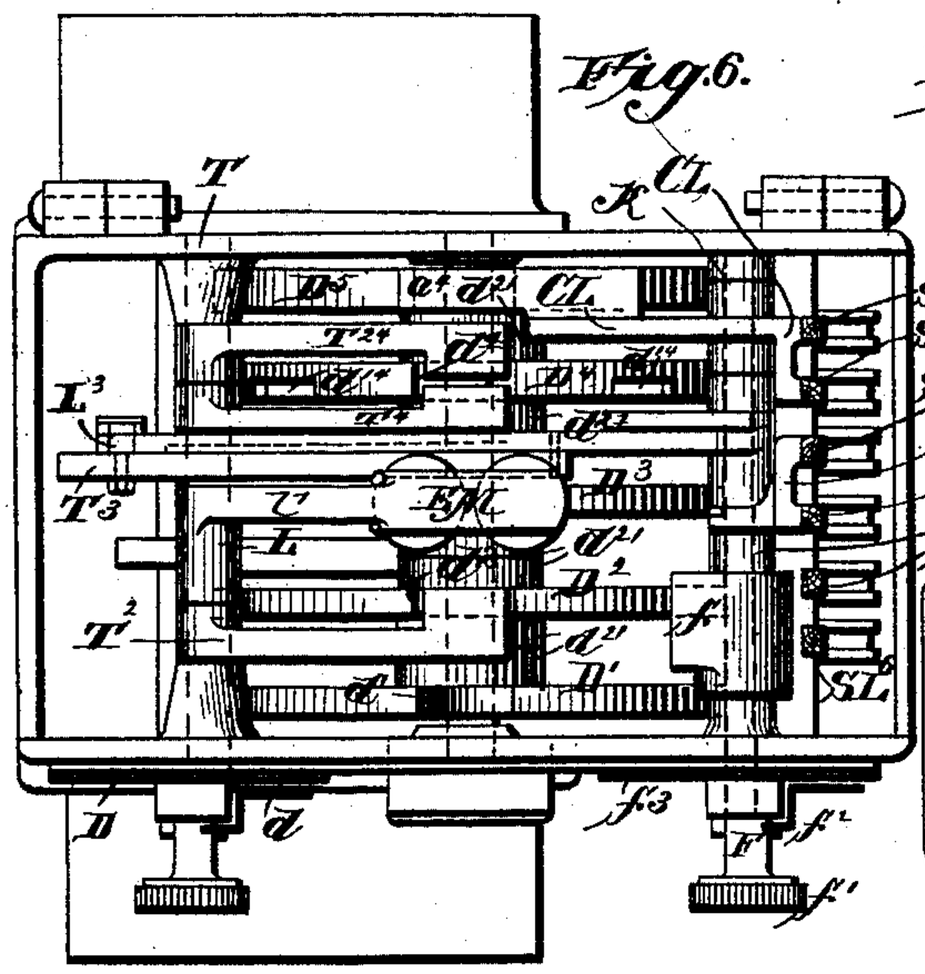


Fig. 7.

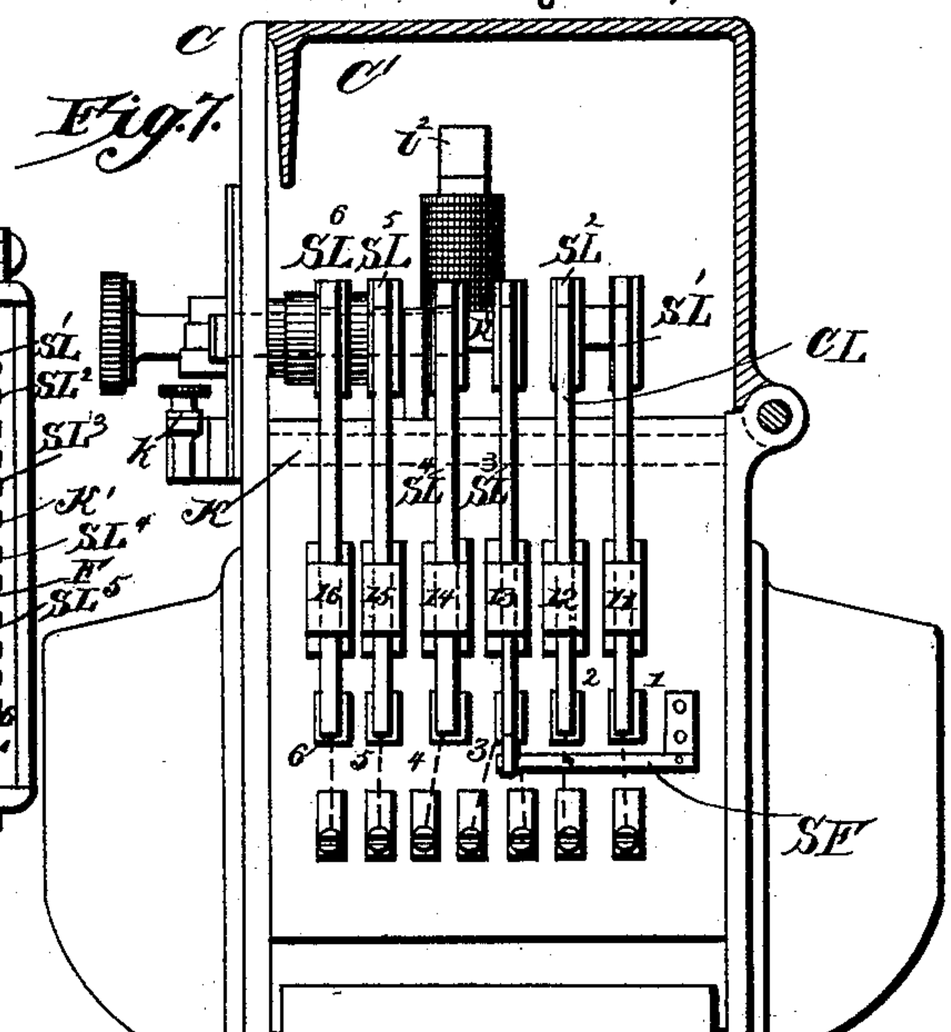


Fig. 10

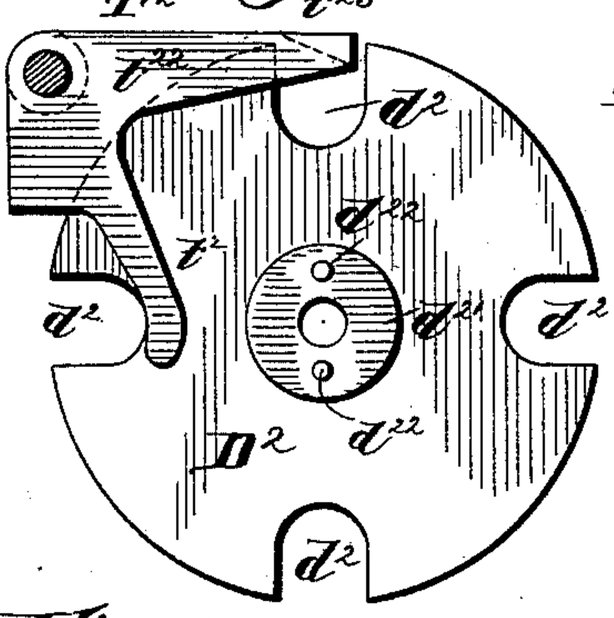


Fig. 10a.

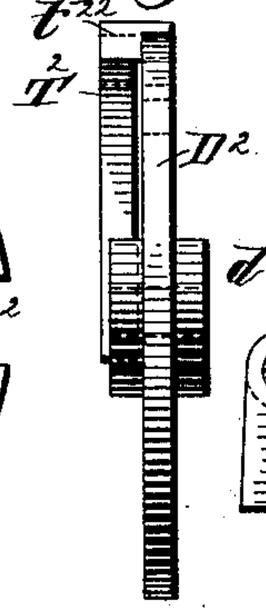


Fig. 12.

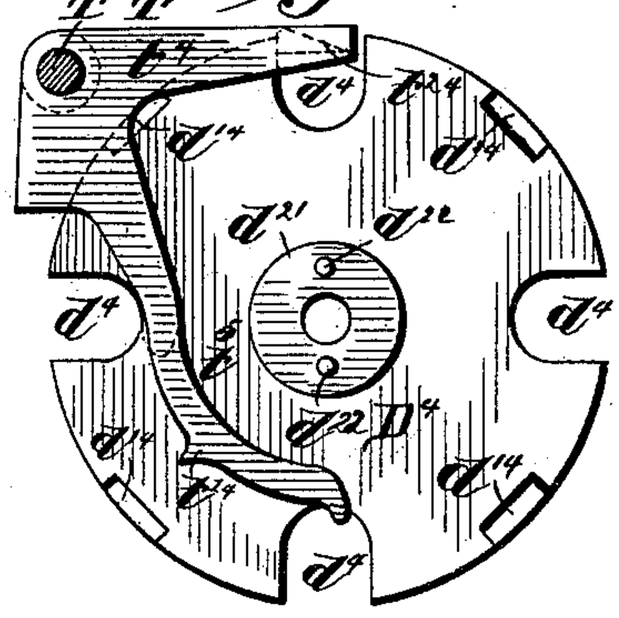


Fig. 12a.

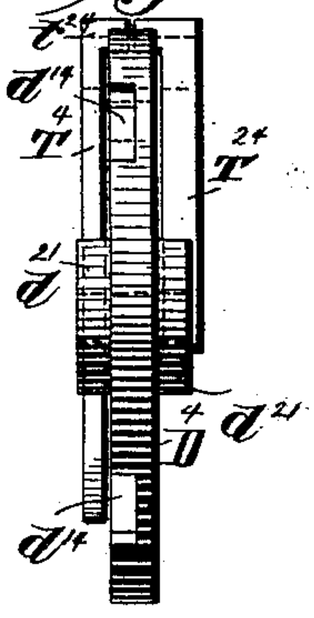


Fig. 13.

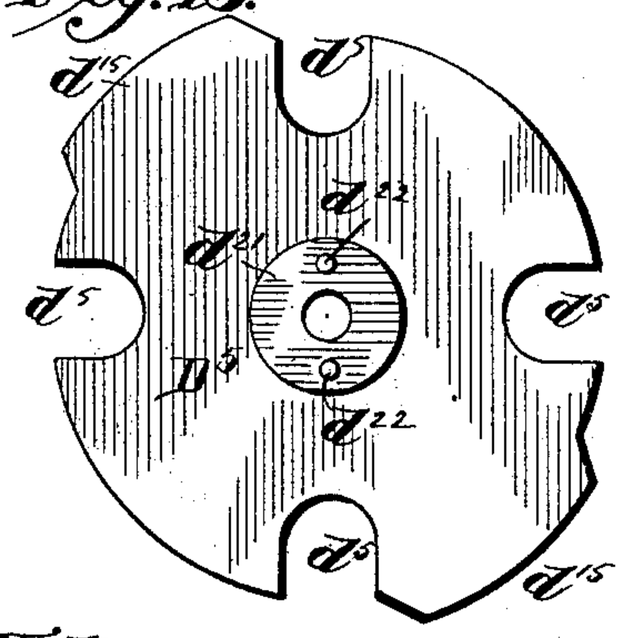
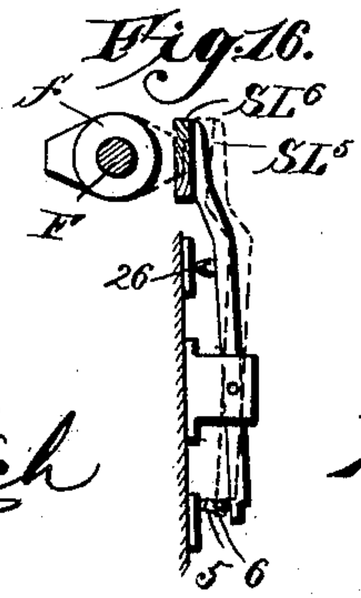


Fig. 16.



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STAFF APPARATUS FOR CONTROLLING TRAFFIC ON SINGLE LINE RAILWAYS.

No. 429,074. Patented May 27, 1890.

Fig. 12.

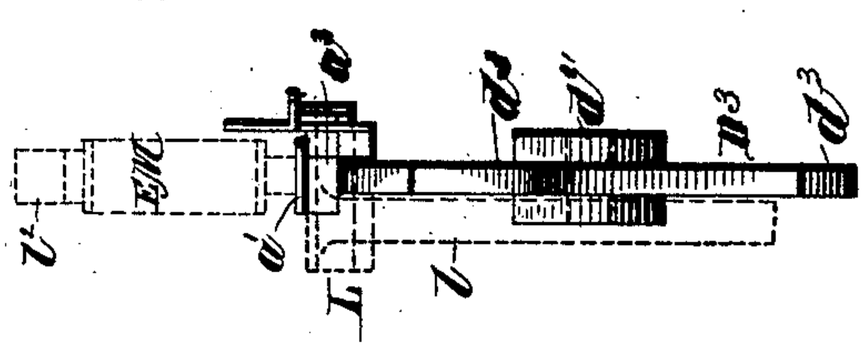


Fig. 13.

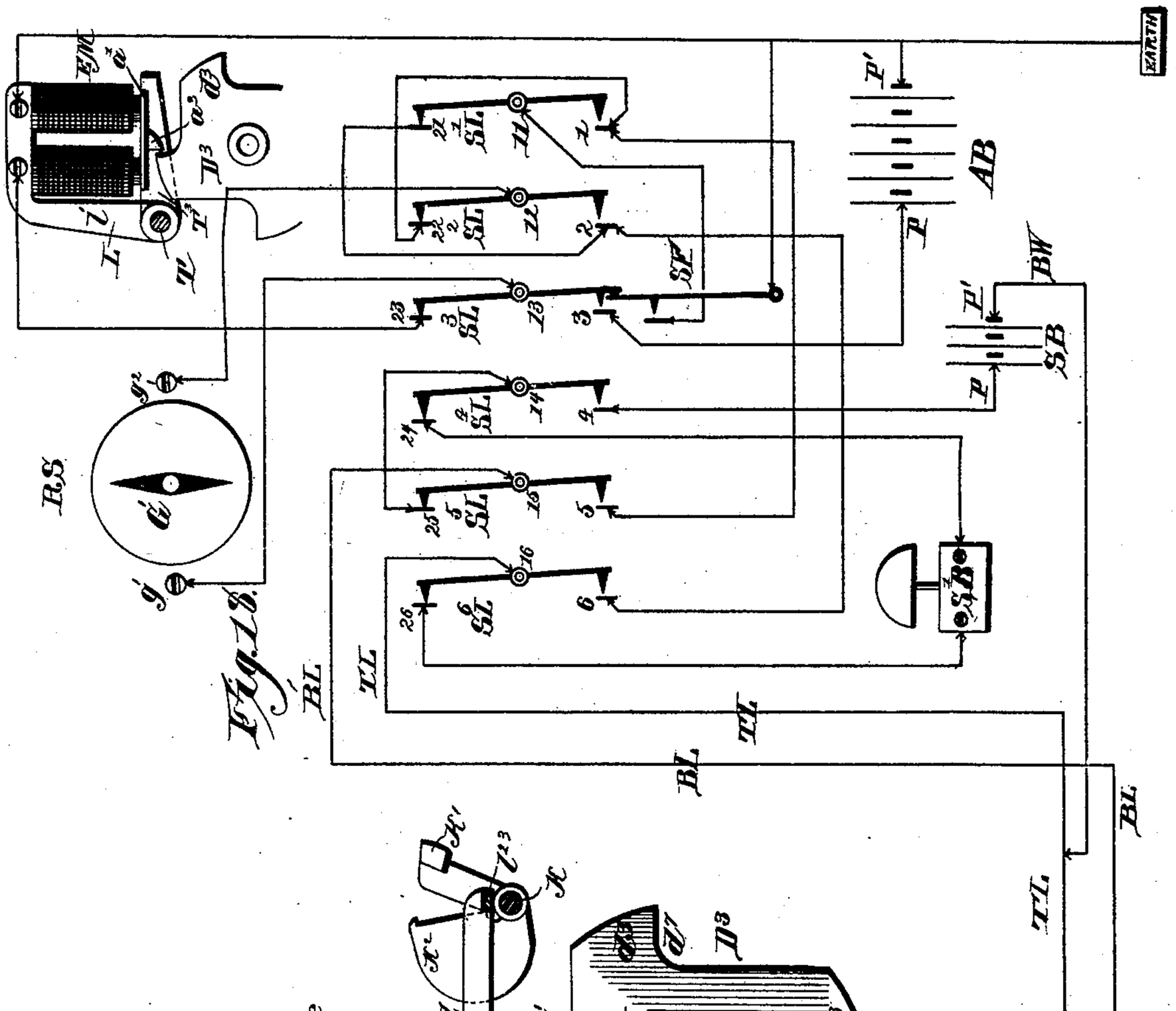
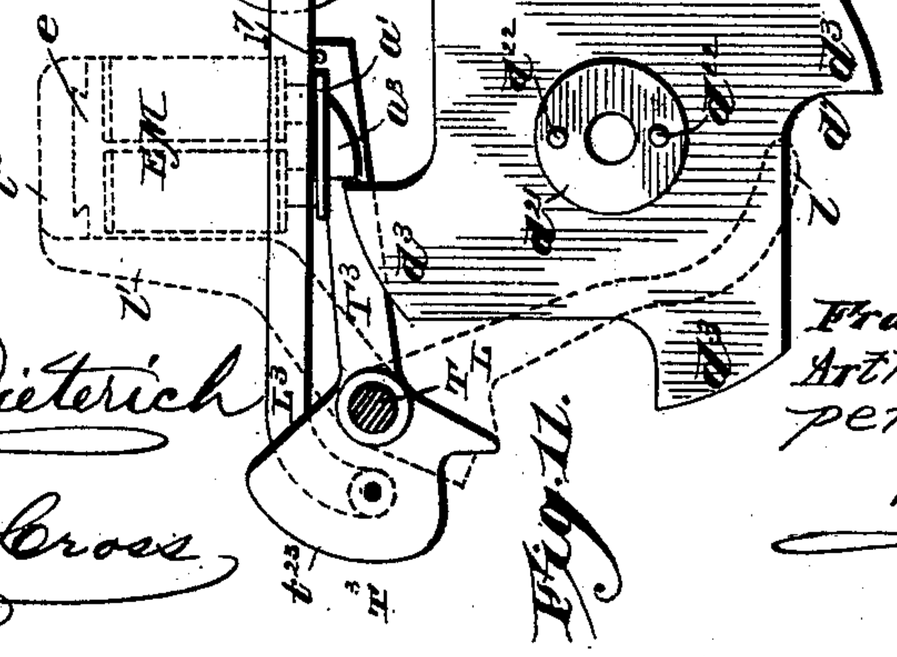


Fig. 14.



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(No Model.) 6 Sheets—Sheet 4.

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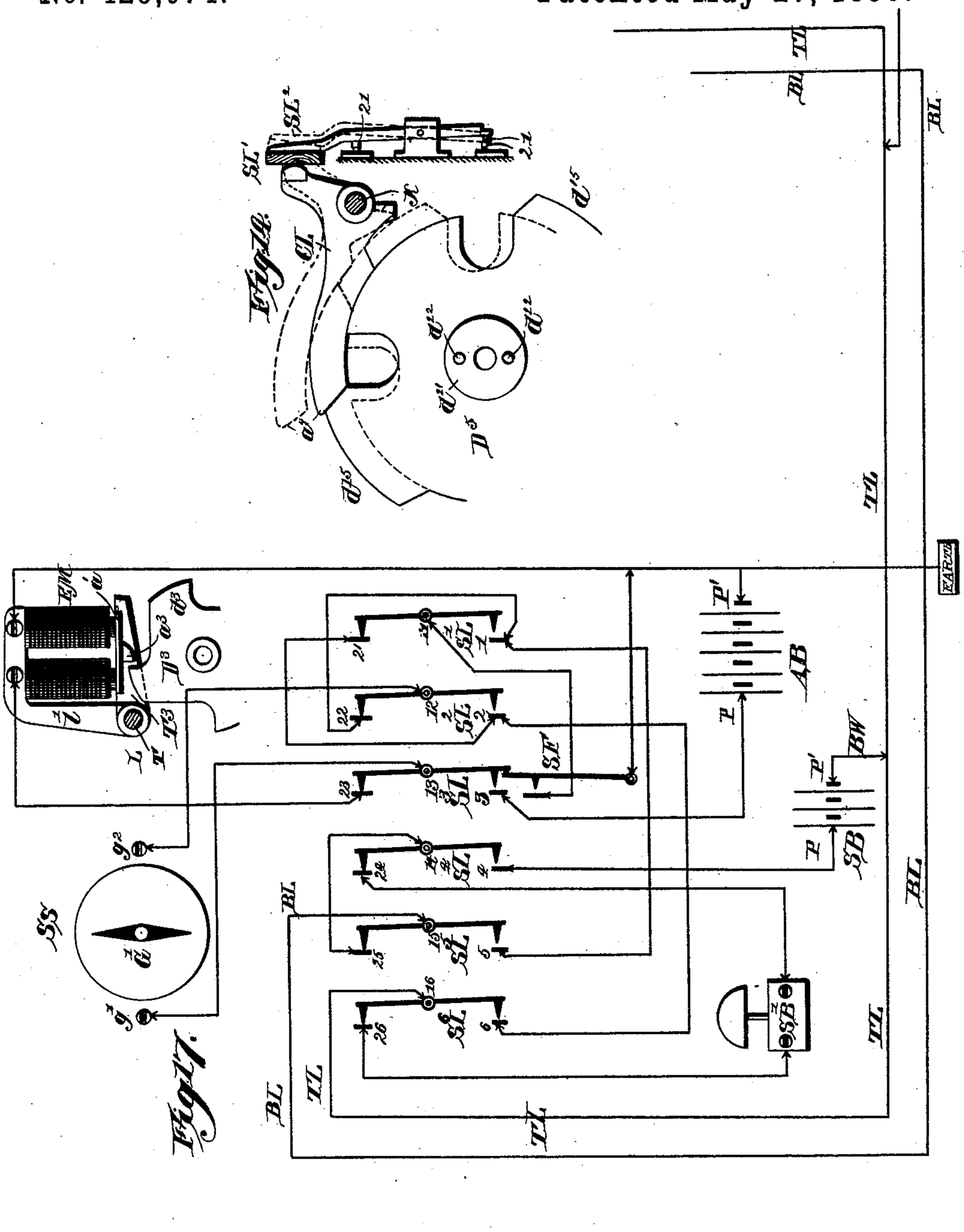
STAFF APPARATUS FOR CONTROLLING TRAFFIC ON SINGLE LINE RAILWAYS.

No. 429,074. Patented May 27, 1890.



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(No Model.) 6 Sheets—Sheet 5.

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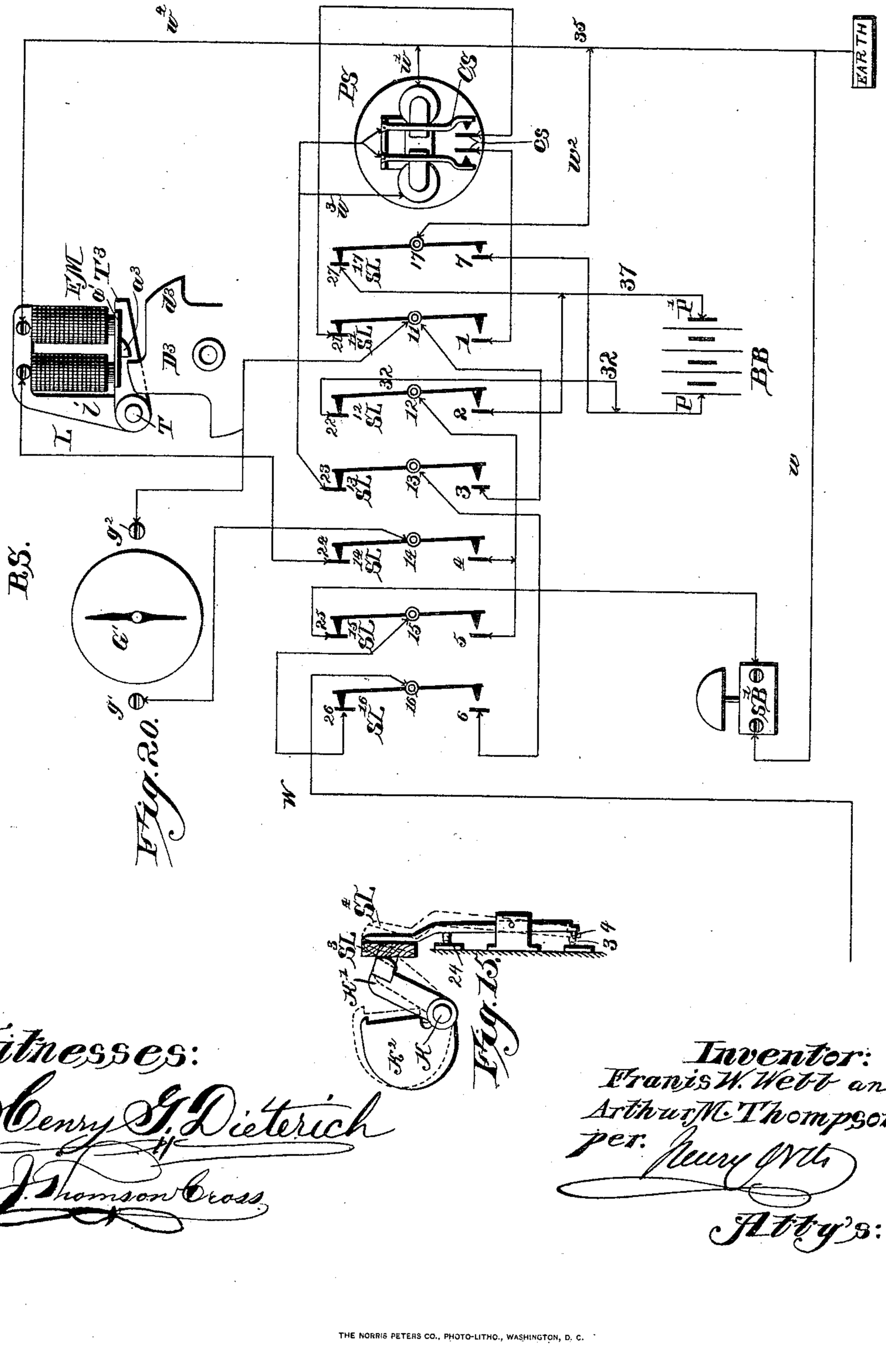
STAFF APPARATUS FOR CONTROLLING TRAFFIC ON SINGLE LINE RAILWAYS.

No. 429,074. Patented May 27, 1890.



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STAFF APPARATUS FOR CONTROLLING TRAFFIC ON SINGLE LINE RAILWAYS.

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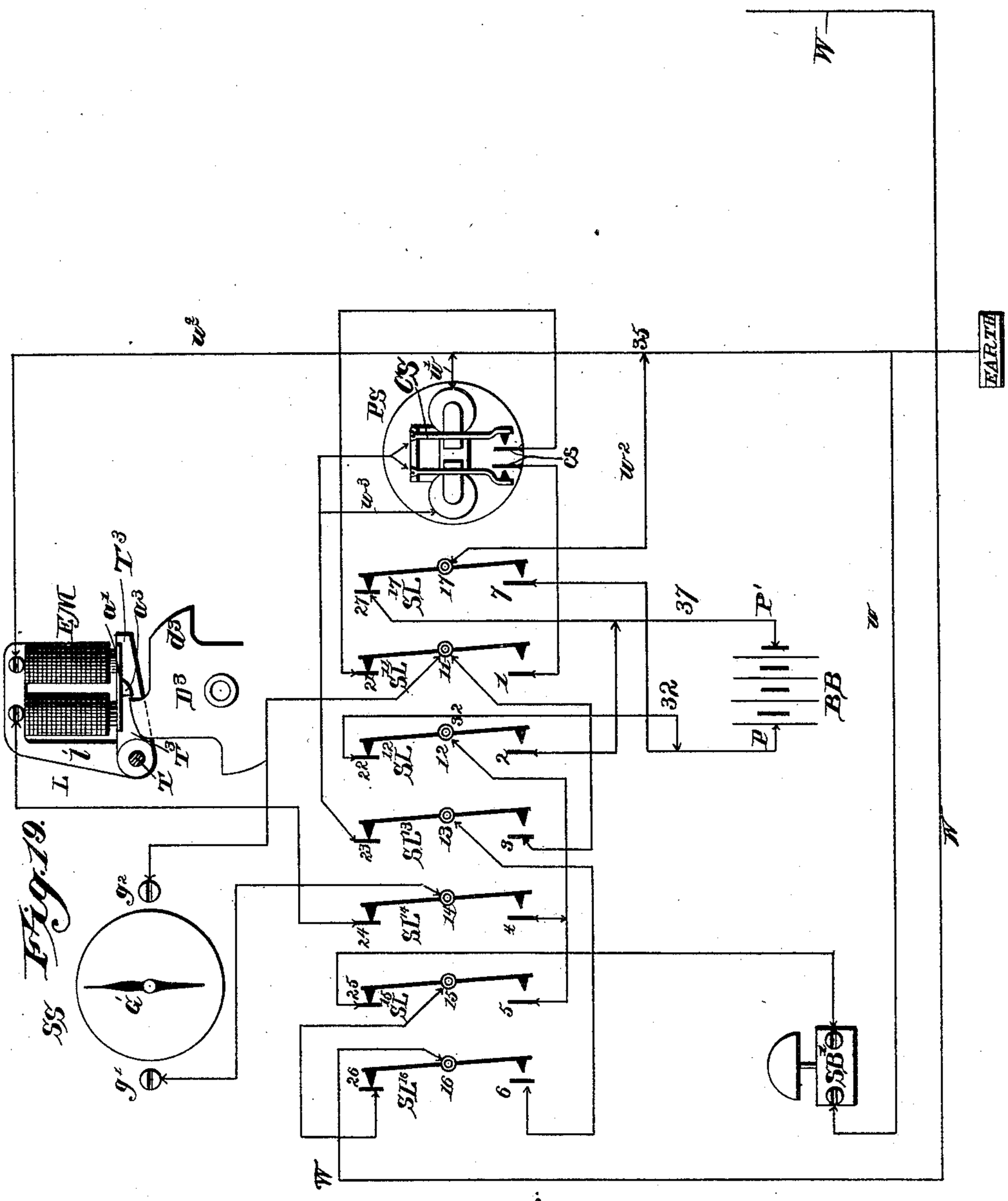

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UNITED STATES PATENT OFFICE.

FRANCIS W. WEBB AND ARTHUR MOORE THOMPSON, OF CREWE, COUNTY OF CHESTER, ENGLAND.

STAFF APPARATUS FOR CONTROLLING TRAFFIC ON SINGLE-LINE RAILWAYS.

SPECIFICATION forming part of Letters Patent No. 429,074, dated May 27, 1890.

Application filed January 24, 1890. Serial No. 337,977. (No model.) Patented in England January 23, 1889, No. 1,263; in France May 20, 1889, No. 198,572, and in Belgium May 20, 1889, No. 86,418.

To all whom it may concern:

Be it known that we, FRANCIS WILLIAM WEBB and ARTHUR MOORE THOMPSON, subjects of the Queen of the United Kingdom of Great Britain and Ireland, residing at Crewe, in the county of Chester, England, have invented certain new and useful Improvements in Staff Apparatus for Controlling the Traffic on Single-Line Railways, (for which we have obtained Letters Patent for the United Kingdom of Great Britain and Ireland, dated the 23d day of January, 1889, and numbered 1,263; for France, dated the 20th day of May, 1889, and numbered 198,572, and for Belgium, dated the 20th day of May, 1889, and numbered 86,418;) and we do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to the letters and figures of reference marked thereon, which form a part of this specification.

Referring to the drawings, Figure 1 is a front elevation of the staff-holder and its lock. Fig. 1ª is a vertical section of part of the holder. Fig. 2 is a side elevation thereof. Fig. 3 is a plan view of one of the staffs; Fig. 4, a section on line *x x* of Fig. 1; Fig. 5, a sectional elevation of the upper or lock case and of the staff-holder, some of the locking-disks being removed; Fig. 6, a top plan view of Fig. 5, the top of the lock-case being removed. Fig. 7 is a right-end elevation of Figs. 5 and 6, the lock-case being also removed. Fig. 8 is a detail elevation of the locking-disks, showing the manner of connecting the same. Figs. 9, 10, 11, 12, and 13 are face elevations of the said disks, as well as the locking devices therefor. Figs. 10ª, 11ª, and 12ª are edge views of the disks and tumblers shown in Figs. 10, 11, and 12, respectively. Fig. 14 shows a portion of one of the disks shown in Fig. 13, in connection with a commutator or switch-operating lever and the switch-levers operated thereby. Figs. 15 and 16 are side elevations of other switch-levers and the devices for operating the same. Figs. 17 and 18 are diagrammatic views of two stations, illustrating the electrical connections when two line-wires are used; and Figs. 19 and 20 are like views illustrating the electrical connections when a single line-wire is used.

The invention relates to a staff system for controlling the traffic on single-line railways. The most common system by which the traffic on a single-track railroad is controlled is known as the "train-staff" and "ticket system," and is that in which a staff is employed as the authority for a driver to proceed on his journey, and the safety of this system is based upon there being but one staff, and consequently but one train, in a section of road at a time; but where there is a heavy and variable traffic it is impossible to so time the trains that the staff will always be at the right end of the section, and consequently delays are frequent.

The object of our invention is to provide a simple form of apparatus for regulating or controlling the issue of staffs from a holder adapted to contain a plurality of such staffs. This we accomplish by so constructing the holder that a staff cannot be removed therefrom except in a particular manner—that is to say, by moving the staff in a predetermined direction—and by providing a lock mechanism not under the control of the attendant of a particular apparatus at a particular station or section of track or line, but under the control of the attendant at another station or section of track or line, thereby preventing the issue of a staff without the permission of the latter attendant. In this manner we obviate the delay now experienced by a staff being at the wrong end of a section, so that a single-track railroad may be worked to its fullest capacity with safety.

To these ends the invention consists in a staff-holder in which the staffs are movable in a given direction only, in combination with a lock mechanism and means for controlling the same from a distance; in the combination, with the lock-controlling devices, of a signal or alarm mechanism, suitable electrical connections between two apparatuses, and a switch for switching the current from the lock-controlling devices to the alarm mech-

anism, or vice versa; in the combination, with the electrically-controlled devices, of an automatic switch adapted to automatically cut out one or the other of said devices and of a hand-switch for restoring the same and of an indicator for indicating the condition of the electric circuits; in the construction of the staffs as to lock them in the holder against motion except in a given direction and to adapt said staffs to operate the lock mechanism whenever said lock mechanism is placed in proper condition for such operation through the medium of the electrically-controlled device; in the combination, with the electrically-controlled elements, the switches, and circuits, of a safety-switch for the purpose of preventing the electrically-controlled locking device being operated in case of the crossing of the line-wires when two such wires are used, and, finally, the invention consists in details of construction and combinations of parts or elements, as will now be fully described.

In the description to follow we will refer to two stations connected by two line-wires, which, for convenience of description, we will call the "top" and "bottom" line, respectively, and one of the stations we will denominate the "sending-station" and the other the "receiving-station," it being assumed that the trains run in one direction only, and from which the operation of the devices as to the control of trains running in opposite directions will be readily understood. By "sending-station" will be understood that station which, with the consent of the receiving-station, delivers a staff to an engineer or conductor of a train as his authority to proceed, and by "receiving-station" is meant that station at which the staff is again surrendered.

The staff.—Referring more particularly to Fig. 3, the staff S is substantially a cylindrical body, on which are formed four warts in the shape of annular flanges or ribs s^2 s^3 s^4 s^5, that serve to throw certain tumblers of a tumbler-lock, and each staff terminates in a key-head *s*, also provided with warts, by means of which the points or switches of sidings intermediate of two stations can be unlocked. The staff S is therefore not only the emblem of authority that allows a train to proceed on its way, but is also a key by means of which the bolts—or in this case the locking-disks—of the staff-holder lock are released from their tumblers after the electrically-controlled tumbler has been released from its locking device by the attendant at the receiving-station. A staff can therefore not be removed without the sanction of the attendant at the receiving-station.

The staff-holder.—The staff-holder H consists of a hollow column having a vertical transverse passage *h*, in which the staffs lie in a horizontal position, one on the other, and in which said staffs are free to move vertically. To prevent the staffs being withdrawn from the holder in horizontal direction, said holder is provided interiorly and on opposite sides with a vertical rib *h'*, that lies between two of the annular flanges or warts on the staff—namely, between the warts s^3 and s^4—said ribs also acting as guides to properly guide the staffs to the lock-case. To prevent damage to the staffs should they be allowed to drop when introduced through the lock-case and after reaching the vertical slot *h*, or should they be allowed to drop back accidentally while being removed, we provide spring-bearings h^4, arranged on opposite sides of the column, that catch the staffs. We have shown two sets of such spring-bearings h^4, arranged one above the other, so that a number of staffs may be held near the upper end of slot *h* to expedite their removal.

The lock mechanism.—Referring to Figs. 5 to 16, the lock mechanism is contained in a casing or housing C at the upper end of the staff-holder, and consists of bolts and tumblers adapted to lock said bolts against movement, one of said tumblers being controlled electrically from the receiving-station, the bolts in this case being constructed in the form of revoluble disks, as will be presently described. The lock-case has a through-slot h^2, of segmental form, that forms a continuation of the vertical slot *h* and that terminates in a key-hole h^3. The slot h^2 is a segment of a circle concentric with that described by the locking-disks, and is so positioned as to register with peripheral notches formed in the said disks, and is of a width equal to the depth of said notches or recesses. The axis of the key-hole h^3 lies in the horizontal axis of the locking-disks, and has an enlarged portion for the staff-head *s*, and a more contracted portion for the passage of the annular warts on said staff, so as to admit of the latter being readily introduced or removed. The lock-case C has a hinged cover C', that is normally locked, so that the attendant can not gain access to the lock mechanism. In the upper part of the lock-case is arranged a galvanometer G', its needle being exposed to view, so that the attendant can ascertain when an electric current is passing through the apparatus. To the left of the galvanometer is a dial D, on which revolves a hand *d*, secured to a spindle that carries a knob d^{16}. This dial bears indices that will remind the attendant whether a staff is in or out, and the hand is set by him accordingly.

On a spindle or arbor S', that is secured to the lock-case C, are mounted five disks D' D^2 D^3 D^4 D^5, Figs. 9 to 14, in the order named, and as shown in Fig. 6. All of said disks except D^3, which is a toothed disk, have four equidistant peripheral notches, (indicated by *d'*, d^2, d^4, and d^5, respectively,) and are so set on the arbor S' that two of said notches will lie in a vertical and two in a horizontal plane. Inasmuch as the key-hole lies in the horizontal axial plane of the arbor S', and as the segmental slot h^2 terminates in the upper end of the vertical slot *h* of the holder H, it

cannot be done except by the attendant at the receiving-station, as will hereinafter appear, it is obvious that he alone has control over the issue of such staffs.

The disk D^5 has two peripheral enlargements d^{15}, diametrically opposite each other, that serve to actuate a commutator-lever C L, loosely mounted on an arbor K, that has its bearings in the lock-case C, and carries in front of said case a key *k*, for purposes presently described. The commutator-lever C L operates two switch-levers S L′ S L^2, whereby, as the disks are turned a quarter-turn in either direction, the current is automatically and alternately switched from the top to the bottom line-wire, or, in case there is but one line-wire, from the negative to the positive pole of the battery. On the said arbor K of key *k* is also secured a cam K^2, which is engaged by the detector-lever L^3, heretofore referred to, should the tumbler T^3 remain lifted with its pallet a^3 out of engagement with a tooth of disk D^3, so that the key-arbor could not be turned by depressing the key until the tumbler is caused to engage the toothed disk D^3. The arbor K carries, furthermore, a lever K′, that actuates two switch-levers S L^3 and S L^4 in such manner as to reverse their position, as shown in full and in dotted lines in Fig. 15.

Above the key-arbor K is arranged an arbor F, that carries a cam *f*, adapted to control two switch-levers S L^5 and S L^6, the arbor F being provided at its outer end, outside of the lock-case front, with a handle or button *f′* for revolving the said arbor. According to the position of the cam *f*, a current may be sent either to the alarm or signal bell or to the electro-magnet E M of a distant station when the key *k* is depressed.

The electrical circuits.—We will now proceed to describe the electrical circuits and the connections with the operative devices, and, first, in conjunction with two line-wires, and, secondly, in conjunction with a single line-wire. Referring to Figs. 17 and 18, it will be assumed, for the purposes of describing the electrical circuits and connections, that S S, Fig. 17, is the sending-station, and R S, Fig. 18, the receiving-station, and that there is a train waiting at station S S for permission to proceed to station R S. The attendant at station S S depresses the key *k*, thereby moving the switch-levers S L^4 S L^3 into contact with contacts 4 and 3, respectively. A current will now flow from apparatus battery A B, or from bell or signal battery S B, according as the cam *f* and switch-levers S L^6 S L^5 stand for signal or apparatus, and in Fig. 17 the position of the cam *f* is assumed to be such as to cause said levers to stand for signal. The current flows, therefore, from pole P of battery S B to 4, to switch-lever S L^4 to 14, to 25, to switch-lever S L^5, to 15, thence through bottom line-wire B L to station R S. Entering said station the current passes to the axis 15 of switch-lever S L^5, through the said lever to contact 25, thence to axis 14 of switch-lever S L^4, through said lever to contact 24, thence to signal-bell S B′ of said receiving-station R S, giving an alarm or signal. From the signal-bell S B′ the current passes to 26, to switch-lever S L^6, from axis 16 of said lever to top line T L, back to sending-station S S, to branch wire B W, connected with said top line T L, to the opposite pole P′ of signal-battery S B. The attendant at the receiving-station R S acknowledges the signal. The attendants at both stations now turn the cam *f* on arbor F of their respective apparatuses, thereby operating the switch-levers S L^5 S L^6 to switch the electro-magnets E M into the circuit, thereby cutting out the signal-bell S B′. If the section is clear, the attendant at the receiving-station R S will give permission to the attendant at the sending-station S S to withdraw a staff. This he accomplishes by depressing his key *k*, thereby operating the switches S L^4 S L^3 to bring them in contact with 4 and 3, respectively. The cams *f* at both stations having been previously turned, as above set forth, to switch the electro-magnets E M into the circuit, the current now flows from pole P of apparatus battery A B at the receiving-station R S to 3, switch-lever S L^3, the lower end of said lever in contact with the safety-switch S F being provided with an insulating-block to prevent the current taking the shorter route through said lever. The current then flows to the axis 13, to galvanometer-connection *g′*, through the galvanometer G′, to connection g^2, the needle being deflected, thence to axis 12 of switch-lever S L^2, through said lever to contact 22, to lower contact 1 of switch-lever S L′, thence to lower contact 5 of switch-lever S L^5, the position of this lever, as well as that of the switch-lever S L^6, having been reversed by the turning of the cam *f*, as above set forth, the current passes to the axis 15 of lever S L^5, thence to bottom line B L. Entering the sending-station S S, the current flows to axis 15 of switch-lever S L^5 of apparatus of said station S S, the switches S L^5 S L^4 of which have also been reversed by the turning of the cam *f* of said apparatus, as above set forth, the current flowing through said lever S L^5 to its lower contact 5, thence to lower contact 1 of switch-lever S L′, thence to upper contact 22 of switch-lever S L^2, through said lever to the axis 12, thence to galvanometer-connection g^2, through galvanometer G′ to the connection *g′* thereof, deflecting the galvanometer-needle to show to the attendant that a current is passing through his apparatus and indicating to him that he has permission to withdraw a staff. From the contact *g′* the current flows to the axis 13 of switch-lever S L^3, through said lever to the upper contact 23 thereof, thence to the electro-magnet E M, whereby the armature *a′* is attracted, and thence to earth, thus completing the circuit. To prevent the cur-

follows that the introduction or withdrawal of a staff S will necessitate a quarter of a revolution of the disks, so that they will always be properly set for operation. The disks are loosely mounted on the arbor S′, but revolve together. To this end they are provided with hubs d^{21}, through which pass two connecting bolts or rods d^{22}. The disks D′ and D⁵ at opposite ends of the arbor have no locking levers or tumblers, the former disk being a guide-disk and the latter actuating switch mechanism, as hereinafter described. The locking levers or tumblers are all loosely mounted on a spindle or arbor T, secured to the lock-case C. The disk D² has a bell-crank tumbler T², whose arm t^{22} is provided with a locking lip or pallet t^{23}, the under face of which inclines from right to left, as shown in dotted lines in Fig. 10, said pallet t^{23} projecting into the top notch d^2 of disk D². The other arm t^2 of tumbler T² extends to the center notch of said disk and lies along the inner end thereof within reach of the annular wart s^2 on staff S. It will be seen that the moving of a staff into the lower notch of the disk D² will not throw the tumbler, since the arm t^2 thereof is out of reach of the staff as it enters said lower notch, but inasmuch as the locking-pallet inclines from right to left the disk itself will lift or throw the tumbler, as said disk is rotated from left to right on the withdrawal of a staff, but is locked against rotation in a reverse direction—*i. e.*, from right to left—so that a staff cannot be introduced until the tumbler is lifted. As the arm t^2 of the tumbler T² extends over the end of the left center notch that registers with the key-hole h^2, the tumbler is lifted by the wart s^2 on staff S when introduced into the key-hole and notch, so that the disk D² can be rotated in the last-named direction to enable the attendant to move a staff along the slot h^2 into passage h of holder H. The disk D³, as before mentioned, is a toothed disk, and the tumbler therefor is electrically controlled from the receiving-station. The tumbler T³ carries an armature a', from the under side of which projects a locking lip or pallet a^3, that is adapted to engage the teeth d^3 of the disk. The under face of this pallet is inclined from left to right, so that the tumbler will be lifted by the teeth of the disk when the latter is revolved from right to left in introducing a staff S, but locks the disk against reverse rotation, so that a staff cannot be removed.

Upon arbor T is loosely mounted a two-armed lever L, whose arm l extends to the lower notch or space between two teeth, and so as to be within reach of the annular wart s^3 on staff S when introduced into the lower notches of the disks D′ D² D⁴ D⁵, the four teeth on disk D³ being so arranged that the left face d^7 will coincide with the right-hand edge of the disk-notches.

The arm l' of lever L has detachably connected therewith an electro-magnet E M, whose cores or poles rest upon the armature a' on tumbler T³. This constitutes the electrically-controlled lock, as it is obvious that so long as no current passes through the electro-magnet E M the armature a' will not be attracted so as to adhere to the poles of said electro-magnet; hence if an attempt were made to withdraw a staff the wart s^3 thereon would engage the lever-arm l and lift the electro-magnet E M clear of the tumbler-armature a', since the tumbler T³ is loosely mounted on arbor T, independently of lever L. When, however, an electric current passes through the electro-magnet, the armature a' will be attracted thereby, and will adhere thereto, and when a staff is removed the lever L will not only lift the electro-magnet, but also its armature and armature lever or tumbler T³, thereby lifting the pallet a^3 clear of the tooth d^3 of the disk D³.

The armature lever or tumbler T³ has an enlargement t^{23}, to which is fulcrumed a locking-lever L³, which we call the "detector-lever," and the function of which will be described presently, the said lever resting on a stud l^7 on said tumbler T³. The lever L has a V-shaped notch l^3, Fig. 5, forming two shoulders adapted to abut against corresponding abutments c' on the key-hole boss c of the lock-case C, to limit the motion of said lever and prevent the electro-magnet E M from being tilted over and out of reach of the armature a'. The disk D⁴ has two tumblers—one T²⁴, exactly like the tumbler T² of disk D², and operating in precisely a similar manner, the disk itself lifting the tumbler-pallet when said disk is turned from left to right by the removal of a staff; but on the introduction of a staff the tumbler-lever is actuated by the wart s^{24} on said staff. The tumbler T⁴ has a rectangular pallet t^{24} on its arm t^4, while the arm t^5 of said tumbler is of such form as to extend to the rear end of the left-hand horizontal, as well as the lower notch d^4 of disk D⁴, in reach of the wart s^4 on the staff, so that whether a staff is introduced or removed the said wart s^4 will throw the tumbler. Between those portions of the lever-arm t^5 that lie in proximity to the center and lower disk-notches d^4 of disk D⁴ is formed a projection t^{14}, formed between the notches d^4 in the periphery of said disk D⁴, to prevent the pallet t^{24} of tumbler T⁴ from engaging the said notches when a staff is being introduced or removed, the wart s^4 thereon engaging the projection and lifting the tumbler-pallet clear of said notches as the disk is revolved in either direction. We form these notches d^{14} as an additional security in case the disks were carried around so far as not to be locked by the tumblers.

From the described arrangement of lock mechanism, it will be seen that any number of staffs within the capacity of the holder can be successively introduced into the holder, but that no staff can be removed therefrom without first sending an electric current through the electro-magnet E M, and as this

rent from passing from switch-lever S L^3 to the safety switch-lever S F, the lower end of said lever S L^3 in contact with said safety switch-lever is provided with an insulated contact-face. As soon as the attendant at the sending-station S S perceives the deflection of the galvanometer-needle he knows that he can withdraw a staff, since the tumbler T^3 is now attracted and held by the electro-magnet, so that it may be lifted with it out of engagement with the disk D^3, through the medium of the arm *l* of lever L, as hereinbefore described. The withdrawal of a staff imparts a quarter-revolution to all of the disks D′ D^2 D^3 D^4 D^5, one of the peripheral enlargements d^{15} on disk D^5 operating on the commutator-lever C L, Figs. 5 and 14, and the latter on the switches S L′ S L^2, thereby cutting off the current by switching the apparatus at station S S from the bottom to the top line, the galvanometer-needles at both stations assuming their normal positions of rest. This will indicate to the attendant at station R S, who has kept his key *k* depressed all the time, that a staff was removed from holder H at station S S. The apparatus at the latter station is now switched onto the top line, while that at station R S is still on bottom line, so that a current through the electro-magnets cannot be sent from either apparatus. If the staff were returned to the apparatus at the sending-station S S, the commutator-switches would be operated to switch the apparatus back to the bottom line, again connecting both apparatuses, as before. If, on the other hand, the staff is taken to station R S, as it should be, and there placed into the holder, the apparatus at the latter station will be switched onto the top line, both apparatuses being again in connection, and a current can be sent through the magnet-coils of either apparatus. Thus the attendant at station R S can give permission to the one at S S to take out a staff, or vice versa. In case of an accidental blow-down of the line-wires and their becoming crossed or entangled, the attendant at one station sending a current, say, through bottom line, and this passing over top line would enable the attendant at the other station to take out a staff when one might be out already. To obviate this, we provide a safety-switch S F, so that a current sent, say, from station S S over bottom line B L and passing onto top line would return to the opposite pole of the sending-battery, a small portion of the current, not sufficient to hold the armature *a′* of apparatus at station R S, would pass over said top line to the latter station, the coils of the electro-magnets E M being so wound as to give a resistance five or six times greater than that of the line-wire. Consequently the small amount of current that would pass through the electro-magnet would not produce energy enough to lift the tumbler T^3. The signal-coils are similarly wound, so that no signal will be given under the above-described circumstances. When there is but a single line-wire W, as in Figs. 19 and 20, for connecting the stations, the signal-battery S B is dispensed with, a single battery B B being employed at each station, and in addition thereto a polarized switch P S and an additional switch S L^{17}, the various switches having their functions changed to suit the altered circuits. Assuming a train to be waiting at station S S to proceed to station R S, and that S L^{16} is the switch controlled by the cam *f*, and S L^{15}, S L^{14}, and S L^{13} the switches controlled by the key *k*, and S L^{12}, S L^{11}, and S L^{17} the commutator-switches actuated by the commutator-lever C L and cam-faces d^{15} of disk D^5, the attendant at station S S presses down his key *k*, thereby moving the switch-levers S L^{15}, S L^{14}, and S L^{13}, so as to contact with the lower contacts 5, 4, and 3. A current will now flow from pole P of battery B B, through wire 32, to upper contact 22 of switch-lever S L^{12}, through said lever to the axis 12, thence to lower contact 5 of lever S L^{15}, through said lever to the axis 15 thereof, and thence to upper contact 26 of switch-lever S L^{16}, through said lever to the axis 16 thereof. From the axis 16 of switch-lever S L^{16} the current passes to the main line-wire W, entering station R S at the axis 16 of switch-lever S L^{16}, and thence to upper contact 26 of said lever to axis 15 of switch-lever S L^{15}, through said lever to the upper contact 25 thereof to the signal-bell S B′, and thence by wire *w* to earth, returning to station S S from earth to 35, to axis 17 of switch-lever S L^{17}, through said lever and upper contact 27, and by wire 37 to opposite pole of battery B B at said station S S. The attendant at station R S acknowledges the signal, and both attendants turn the cam *f* to switch the line-wire W from their signals to their electro-magnets, the galvanometer G′, and the polarized switch P S. The attendant at station R S, if the section is clear, depresses his key *k* so as to bring the switch-levers S L^{15}, S L^{14}, and S L^{13} in contact with their lower contacts 5, 4, and 3. A current will now flow from pole P of battery B B, station R S, through wire 32, to upper contact 22 of switch-lever S L^{12}, through said lever to the axis 12 thereof, and thence to lower contact 4, to switch-lever S L^{14}, to the axis 14 of said lever, thence to galvanometer-connection *g′*, through the galvanometer-coils to connection g^2, the needle of the said galvanometer being deflected. From connection g^2 the current passes to the axis 11 of switch-lever S L^{11}, thence to lower contact 3 of switch-lever S L^{13}, through said lever to the axis 13 thereof, and from said axis to the lower contact 6 of switch-lever S L^{16}. As the latter switch-lever is now reversed, the current passes to the axis 16 of said lever, and thence to main line-wire W, entering the apparatus at station S S, also at the axis 16 of switch-lever S L^{16}. Said lever being also reversed, the current passes to the lower contact 6 thereof, and thence to axis 13 of switch-lever S L^{13}, to the upper contact 23 of said le-

ver, and thence to the polarized switch P S. A small portion of the current will pass over branch wire w^3 and the coils of said polarized switch P S to earth by branch wire w'. The contact-spring C S of the polarized switch will be drawn in contact with the contact $c\,s$, the current passing from said contact to the upper contact 21 of switch-lever S L^{11}, to the axis 11 of said lever, to the galvanometer-connection g^2, through said galvanometer, deflecting the needle thereof, to the connection g'. From g' the current flows to the axis 14 of switch-lever S L^{14}, thence through said lever to the upper contact 24 thereof, to the electro-magnet E M, and thence by wire w^4 to earth and back to station R S, entering apparatus at 35, and by wire w^2 to axis 17 of switch-lever S L^{17}. From 17 the current flows through lever S L^{17} to the upper contact 27 thereof, and thence to pole P′ of battery B B at said station R S. As soon as the attendant at station S S sees the galvanometer-needle deflect he withdraws a staff from the holder H. The withdrawal of the staff imparts to the disks one-quarter revolution, and the commutator-disk D^5, operating on lever C L, cuts off the current, as before described, the galvanometer-needles again assuming their normal positions of rest, thereby indicating to the attendant of station R S, who has kept his key depressed, that a staff has been removed from its holder at station S S. The apparatus at the latter station is now switched onto the pole P′ of the battery B B, and as the apparatus at station R S is still switched onto the pole P of the battery no current can pass from one apparatus to the other through the electro-magnet and galvanometer unless the staff taken out at station S S is returned, or the staff withdrawn at said station and carried to station R S is there introduced into the holder. In the former case the apparatus at station S S would be switched back to pole P of the battery B B at said station, thus re-establishing the connection, and in the latter case the apparatus would be switched from pole P of the battery at that station to the pole P′ of said battery, also re-establishing the connection. Where there are a number of stations, each intermediate station will be provided with two apparatuses, one for each section of track. In this case the flanges or warts on the staffs for one section will differ in their arrangement or form from that of the flanges or warts on the staffs for the other section, corresponding changes being made in the tumblers, and we are thereby enabled to effectually prevent the use of the staffs indiscriminately, thus further insuring the safety of the trains on the different sections.

From the description of the lock mechanism it will readily be seen that all of the locking devices except the electrically-controlled devices may be dispensed with without thereby impairing the efficiency of the lock or affecting the nature of our invention; but this would limit the scope of the operative devices. By using a plurality of locking disks and tumblers, their arrangement, as well as the arrangement of the warts on the staff, may be varied almost infinitely, as will be readily understood by all those conversant with tumbler-locks, so that each section of road will have its staffs, and so that those staffs alone will operate the lock of that section, thereby insuring against the indiscriminate and unwarranted use of the staffs.

Having described our invention, what we claim, and desire to secure by Letters Patent, is—

1. In a staff system for controlling the traffic on single-line railroads, a holder provided with a passage for the introduction and removal of a staff, and a lock adapted to obstruct the passage of a staff to and from the holder, in combination with a staff constructed and adapted to operate the lock to clear the passage to or from the holder, substantially as and for the purposes specified.

2. In a staff system for controlling the traffic on single-line railroads, a holder provided with a passage for the reception of the staffs, and with locking-ribs on opposite sides of said passage, a lock-case connected with the holder and provided with an aperture for the introduction and removal of a staff, and with a passage connecting the aperture with the holder-passage, and a lock mechanism adapted to obstruct the passage to and from the holder, in combination with a staff provided with flanges or warts adapted to engage and operate the lock mechanism to clear the passage and to be engaged by the vertical ribs in the holder, substantially as and for the purposes specified.

3. In a staff system for controlling the traffic on single-line railroads, a holder provided with a passage for the introduction and removal of a staff, a lock mechanism comprising revoluble disks adapted to intercept the travel of a staff into and out of said passage, and tumblers adapted to lock the disks against revolution, in combination with a staff adapted to engage and throw the tumblers to unlock the disks and to engage and revolve the disks to clear the passage, substantially as and for the purposes specified.

4. In a staff system for controlling the traffic on single-line railroads, a holder provided with a passage for the introduction and removal of a staff, a lock mechanism comprising revoluble disks adapted to intercept the travel of a staff into and out of said passage, and tumblers adapted to lock the disks against revolution, in combination with a staff adapted to engage and revolve the disks, said staff being provided with flanges or warts adapted to engage and throw the tumblers, substantially as and for the purposes specified.

5. In a staff system for controlling the traffic on single-line railroads, a holder provided with a passage for the reception of the staffs, a lock-case connected with the holder and provided with an aperture for the introduc-

tion and removal of a staff, and with a passage connecting the aperture with the holder-passage, a lock mechanism comprising revoluble disks adapted to obstruct the passage to and from the holder, and tumblers adapted to lock the disks against revolution, in combination with a staff adapted to engage and revolve the disks to clear the said passage, said staff being provided with flanges or warts adapted to engage and throw the tumblers to unlock the disks, substantially as and for the purposes specified.

6. In a staff system for controlling the traffic on single-line railroads, a holder provided with a passage for the reception of the staffs, and with locking-ribs on opposite sides of said passage, a lock-case connected with the holder and provided with a transverse aperture for the introduction and removal of a staff, and with a transverse passage connecting the aperture with the holder-passage, a lock mechanism comprising revoluble disks adapted to obstruct the passage to and from the holder, and tumblers adapted to lock the disks against revolution, in combination with a staff adapted to engage and revolve the disks to clear the passage, said staff being provided with flanges or warts adapted to engage and throw the tumblers to unlock the disks and to be engaged by the ribs in the holder, substantially as and for the purposes specified.

7. In a staff system for controlling the traffic on single-line railroads, a holder provided with a passage for the reception of the staffs, and locking-ribs on opposite sides of said passage, a lock-case connected with the holder and provided with an aperture for the introduction and removal of a staff, and with a segmental passage connecting the aperture with the holder-passage, a lock mechanism comprising revoluble disks provided with peripheral recesses registering with one another and adapted to register with the lock-case aperture and its passage and with the holder-passage, and tumblers adapted to lock the disks against revolution, said tumblers being provided with arms extending along the inner edge of some of said recesses, in combination with a staff adapted to engage one of the recesses in said disks and revolve the same, said staff being provided with flanges or warts adapted to engage the tumbler-arms to throw said tumblers and unlock the disks and to be engaged by the locking-ribs in the holder, substantially as and for the purposes specified.

8. In a staff system for controlling the traffic on single-line railroads, a holder provided with a vertical transverse slot for the reception of the staffs and with resilient bearings on opposite sides of said passage, and a lock adapted to intercept the introduction or removal of a staff to or from the holder-passage, in combination with a staff constructed and adapted to operate the lock to clear its passage to and from the holder, substantially as and for the purposes specified.

9. The vertically-slotted holder H, provided with the internal locking-ribs h', in combination with a staff S, provided with flanges or warts adapted to engage said locking-ribs, substantially as and for the purposes specified.

10. In a staff system for controlling the traffic on single-line railroads, the combination, with the staffs, of the vertically-slotted holder H, and the spring-bearings h^4, arranged on opposite sides of the holder-slot and at different elevations, substantially as and for the purposes specified.

11. In a staff system for controlling the traffic on single-line railroads, the combination, with the staffs provided with flanges or warts, of the vertically-slotted holder H, provided with locking-ribs h', and the spring-bearings h^4, arranged on opposite sides of the slot at different elevations, substantially as and for the purposes specified.

12. In a staff system for controlling the traffic on single-line railroads, a holder provided with a passage for the introduction and removal of a staff, a bolt adapted to obstruct the passage of a staff from the holder, and an electrically-controlled lock adapted to lock the bolt against operation, in combination with a staff constructed and adapted to throw the bolt when released by the electrically-controlled lock, substantially as and for the purposes specified.

13. In a staff system for controlling the traffic on single-line railroads, a holder provided with a passage for the introduction and removal of a staff, a bolt consisting of a revoluble disk adapted to obstruct the passage of a staff from the holder, a tumbler adapted to lock the disk against revolution, and an electrically-controlled lock to lock the tumbler against operation, in combination with a staff constructed and adapted to engage and revolve the disk to clear its passage from the holder and to engage and throw the tumbler when released from its electrically-controlled lock, substantially as and for the purposes specified.

14. In a staff system for controlling the traffic on single-line railroads, a holder provided with a passage for the introduction and removal of a staff, a bolt consisting of a revoluble disk adapted to obstruct the passage of a staff from the holder, a tumbler adapted to lock the disk against revolution, an electrically-controlled lock consisting of a lever carrying an electro-magnet the poles or cores of which are in contact with the tumbler and hold the same in engagement with the disk, and a normally-interrupted electric circuit including said electro-magnet, in combination with a staff adapted to engage and revolve the disk to clear its passage from the holder and to engage and tilt the lever that carries the electro-magnet, substantially as and for the purposes specified.

15. In a staff system for controlling the traffic on single-line railroads, a holder provided

with a passage for the introduction and removal of a staff, a bolt consisting of a revoluble disk adapted to obstruct the passage of a staff from the holder, a tumbler provided with an armature and adapted to lock the disk against revolution, a lever carrying an electro-magnet the poles or cores of which are in contact with the tumbler-armature to hold said tumbler in engagement with the disk, and a normally-closed electric circuit connecting the electro-magnet with a distant station, in combination with a staff adapted to engage and revolve the disk to clear its passage from the holder and to engage and tilt the lever that carries the electro-magnet, substantially as and for the purposes specified.

16. In a staff system for controlling the traffic on single-line railroads, a holder provided with a passage for the introduction and removal of a staff, a bolt adapted to obstruct the passage of a staff from the holder, an electrically-controlled lock adapted to lock the bolt against operation, a suitable electric circuit including the electrically-controlled lock, and a switch for cutting said lock out of the circuit, in combination with a staff adapted to engage and operate the bolt when released from its electrically-controlled lock, and to simultaneously engage and operate the switch to cut said electrically-controlled lock out of said circuit. substantially as and for the purposes specified.

17. In a staff system for controlling the traffic on single-line railroads, a holder provided with a passage for the introduction and removal of a staff, a bolt adapted to obstruct the passage of said staff to or from the holder, an electrically-controlled lock adapted to lock the bolt against operation, a signal or alarm mechanism, an electric circuit including the lock and alarm mechanism, and a switch in said circuit adapted to switch the current from the lock to the alarm mechanism, or vice versa, in combination with a staff adapted to engage and operate the bolt and to simultaneously engage and operate the switch, substantially as and for the purposes specified.

18. In a staff system for controlling the traffic on single-line railroads, a holder provided with a passage for the introduction and removal of a staff, a bolt adapted to obstruct the passage of said staff to or from the holder, an electrically-controlled lock adapted to lock the bolt against operation, a signal or alarm mechanism, an electric circuit including the lock and alarm mechanism, and a switch in said circuit adapted to switch the current from the lock to the alarm mechanism, or vice versa, in combination with a staff adapted to engage and operate the bolt and to simultaneously engage and operate the switch, and a hand-switch in said electric circuit adapted to switch the current back from the alarm mechanism to the lock, or vice versa, substantially as and for the purposes specified.

19. In a staff system for controlling the traffic on single-line railroads, a holder provided with a passage for the introduction and removal of a staff, a bolt adapted to obstruct the passage of said staff to or from the holder, an electrically-controlled lock adapted to lock the bolt against operation, a signal or alarm mechanism, a galvanometer, an electric circuit including the lock, alarm mechanism and galvanometer, and a switch in said circuit adapted to switch the current from the lock and galvanometer to the alarm mechanism, or vice versa, in combination with a staff adapted to engage and operate the bolt, and to simultaneously engage and operate the switch, substantially as and for the purposes specified.

20. In a staff system for controlling the traffic on single-line railroads, a holder provided with a passage for the introduction and removal of a staff, a bolt adapted to obstruct the passage of said staff to or from the holder, an electrically-controlled lock adapted to lock the bolt against operation, a signal or alarm mechanism, a galvanometer, an electric circuit including the lock, alarm mechanism, and galvanometer, and a switch in said circuit adapted to switch the current from the lock and galvanometer to the alarm mechanism, or vice versa, in combination with a staff adapted to engage and operate the bolt and to simultaneously engage and operate the switch, and a hand-switch in said circuit adapted to switch the current back from the alarm mechanism to the lock and galvanometer, or vice versa, substantially as and for the purposes specified.

21. In a staff system for controlling the traffic on single-line railroads, a holder provided with a passage for the introduction and removal of a staff, a bolt adapted to obstruct the passage of said staff to or from the holder, an electrically-controlled lock adapted to lock the bolt against operation, a signal or alarm mechanism, a galvanometer, an electric circuit including the lock and alarm mechanism and the galvanometer, a switch in said circuit adapted to alternately switch the current from the lock and galvanometer to the alarm mechanism, or vice versa, in combination with a staff adapted to engage and operate the bolt and to simultaneously engage and operate the switch, a hand-switch in said circuit adapted to switch the current back from the alarm mechanism to the lock and galvanometer, or vice versa, and a key-switch interposed in the electrical connections between the lock and galvanometer and the alarm mechanism and operating to permit the passage of a current to the one or the other, according to the position of the hand-switch, substantially as and for the purposes specified.

22. In a staff system for controlling the traffic on single-line railroads, a holder slotted vertically and provided with locking-ribs on opposite sides of the slot, a lock-case provided with a transverse aperture and a passage connecting said aperture with the holder-

slot, a bolt mechanism consisting of revoluble disks adapted to obstruct the passage of a staff to or from the holder, tumblers adapted to lock the disks against revolution, one of said tumblers being provided with an armature, a lever carrying an electro-magnet arranged with its poles in contact with the tumbler-armature, a normally-interrupted electric circuit including the electro-magnet, and a switch adapted to cut the electro-magnet out of the circuit, in combination with a staff adapted to engage and revolve the disks, said staff being provided with flanges or warts adapted to be engaged by locking-ribs of the holder and to engage and throw the tumblers and the lever that carries the electro-magnet and to simultaneously engage the switch to cut the said electro-magnet out of the circuit, substantially as and for the purposes specified.

23. In a staff system for controlling the traffic on single-line railroads, a holder slotted vertically and provided with locking-ribs on opposite sides of the slot, a lock-case provided with a transverse aperture and a passage connecting said aperture with the holder-slot, a bolt mechanism consisting of revoluble disks adapted to obstruct the passage of a staff to or from the holder, tumblers adapted to lock the disks against revolution, one of said tumblers being provided with an armature, a lever carrying an electro-magnet arranged with its poles in contact with the tumbler-armature, a galvanometer, an alarm mechanism, an electric circuit including the electro-magnet, galvanometer, and alarm mechanism, and a switch adapted to switch the current from the electro-magnet and galvanometer to the alarm mechanism, or vice versa, in combination with a staff adapted to engage and revolve the disks, said staff being provided with flanges or warts adapted to be engaged by the locking-ribs of the holder and to engage and throw the tumblers and the lever that carries the electro-magnet, and to simultaneously engage and operate the switch to switch the current from the electro-magnet and galvanometer to the alarm mechanism, or vice versa, substantially as and for the purposes specified.

24. In a staff system for controlling the traffic on single-line railroads, a holder slotted vertically and provided with locking-ribs on opposite sides of the slot, a lock-case provided with a transverse aperture and a passage connecting said aperture with the holder-slot, a bolt mechanism consisting of revoluble disks adapted to obstruct the passage of a staff to or from the holder, tumblers adapted to lock the disks against revolution, one of said tumblers being provided with an armature, a lever carrying an electro-magnet arranged with its poles in contact with the tumbler-armature, a galvanometer, an alarm mechanism, an electric circuit including the electro-magnet, galvanometer, and alarm mechanism, and a switch adapted to switch the current from the electro-magnet and galvanometer to the alarm mechanism, or vice versa, in combination with a staff adapted to engage and revolve the disks, said staff being provided with flanges or warts adapted to be engaged by the locking-ribs of the holder and to engage and throw the tumblers and the lever that carries the electro-magnet and to simultaneously engage and operate the switch to switch the current from the electro-magnet and galvanometer to the alarm mechanism, or vice versa, and a hand-switch in said electric circuit adapted to switch the current back from the alarm mechanism to the electro-magnet and galvanometer, or vice versa, substantially as and for the purposes specified.

25. In a staff system for controlling the traffic on single-line railroads, a holder slotted vertically and provided with locking-ribs on opposite sides of the slot, a lock-case provided with a transverse aperture and a passage connecting said aperture with the holder-slot, a bolt mechanism consisting of revoluble disks adapted to obstruct the passage of a staff to or from the holder, tumblers adapted to lock the disks against revolution, one of said tumblers being provided with an amature, a lever carrying an electro-magnet arranged with its poles in contact with the tumbler-armature, a galvanometer, an alarm mechanism, an electric circuit including the electro-magnet, galvanometer, and alarm mechanism, and a switch adapted to switch the current from the electro-magnet and galvanometer to the alarm mechanism, or vice versa, in combination with a staff adapted to engage and revolve the disks, said staff being provided with flanges or warts adapted to be engaged by the locking-ribs of the holder and to engage and throw the tumblers and the lever that carries the electro-magnet and to simultaneously engage and operate the switch to switch the current from the electro-magnet and galvanometer to the alarm mechanism, or vice versa, a hand-switch in said electric circuit adapted to switch the current back from the alarm mechanism to the electro-magnet and galvanometer, or vice versa, and a key-switch interposed in the electrical connections between the electro-magnet and galvanometer and the alarm mechanism, and operating to permit the passage of a current from one to the other, according to the position of the hand-switch, substantially as and for the purposes specified.

26. In a staff system for controlling the traffic on single-line railroads, a holder provided with a passage for the introduction and removal of the staffs, a lock mechanism, and a staff adapted to operate the lock mechanism on being introduced into or removed from the holder-passage, in combination with an auxiliary lock adapted to be controlled from a distance and operating on the lock mechanism to lock the staff against removal only, substantially as described.

27. In a staff system for controlling the traf-

fic on single-line railroads, a holder provided with a passage for the introduction and removal of the staffs, a tumbler-lock, and a staff adapted to operate the lock on being introduced into or removed from the holder-passage, in combination with an electrically-controlled lock adapted to operate one of the tumblers of the lock to lock the staff against removal only, substantially as described.

28. In a staff system for controlling the traffic on single-line railroads, a holder provided with a passage for the introduction and removal of a staff, a lock mechanism comprising bolts and tumblers, an electrically-controlled tumbler, and a bolt locked thereby, in combination with a staff adapted to engage and throw all the tumblers and move the bolts when being introduced into the holder, but prevented from engaging and throwing the tumblers and moving the bolts when being removed from the holder, and means, substantially such as described, to disengage the electrically-controlled tumbler from its bolt to enable the staff to throw all the tumblers and bolts to permit the removal of such staff from the holder, substantially as and for the purposes specified.

29. In a staff system for controlling the traffic on single-line railroads, a holder, a tumbler-lock adapted to lock the staffs against removal from the holder, an electro-magnet adapted to control one of the lock-tumblers, a galvanometer, an electric circuit including said electro-magnet and galvanometer, and a suitable battery for said circuit, an alarm mechanism, an electric circuit including the same, and a suitable battery for said circuit, switches and suitable electrical connections adapted to switch either battery-current from one to the other circuit, in combination with a safety-switch interposed in said circuits and adapted to close the same through the sending-battery should the line-wires become crossed, substantially as and for the purposes specified.

30. The combination, with the lever L, its electro-magnet E M, and the detector-lever L^3, fulcrumed to lever L, of the key-arbor K, its switch-operating lever K′, and the cam K^2 on said arbor, said parts being constructed and operating substantially as and for the purposes specified.

31. The combination, with the vertically-slotted staff-holder, the lock-case C, the notched disks D′ D^2, the toothed disk D^3, and the tumblers T^2 T^3 for said disks D^2 D^3, of the disk D^4, provided with peripheral notches d^4 d^{14}, and the tumbler T^{24}, provided with a locking-pallet the under face of which is inclined from right to left, and with an arm t^{24}, extending to the left center notch d^4, and the tumbler T^{24}, provided with a rectangular locking-pallet and with an arm t^5, extending in proximity to both the center and lower notches d^4 of said disk D^4, said arm t^5 having a projection t^{14}, in a radial plane intersecting the notches d^{14} of disks D^4, the pallets of the tumblers engaging the upper notch of the said disk, substantially as and for the purposes specified.

In testimony whereof we affix our signatures in the presence of two subscribing witnesses.

F. W. WEBB.
A. MOORE THOMPSON.

Witnesses:
PETER J. LIVSEY,
WILLIAM FAULKNER.