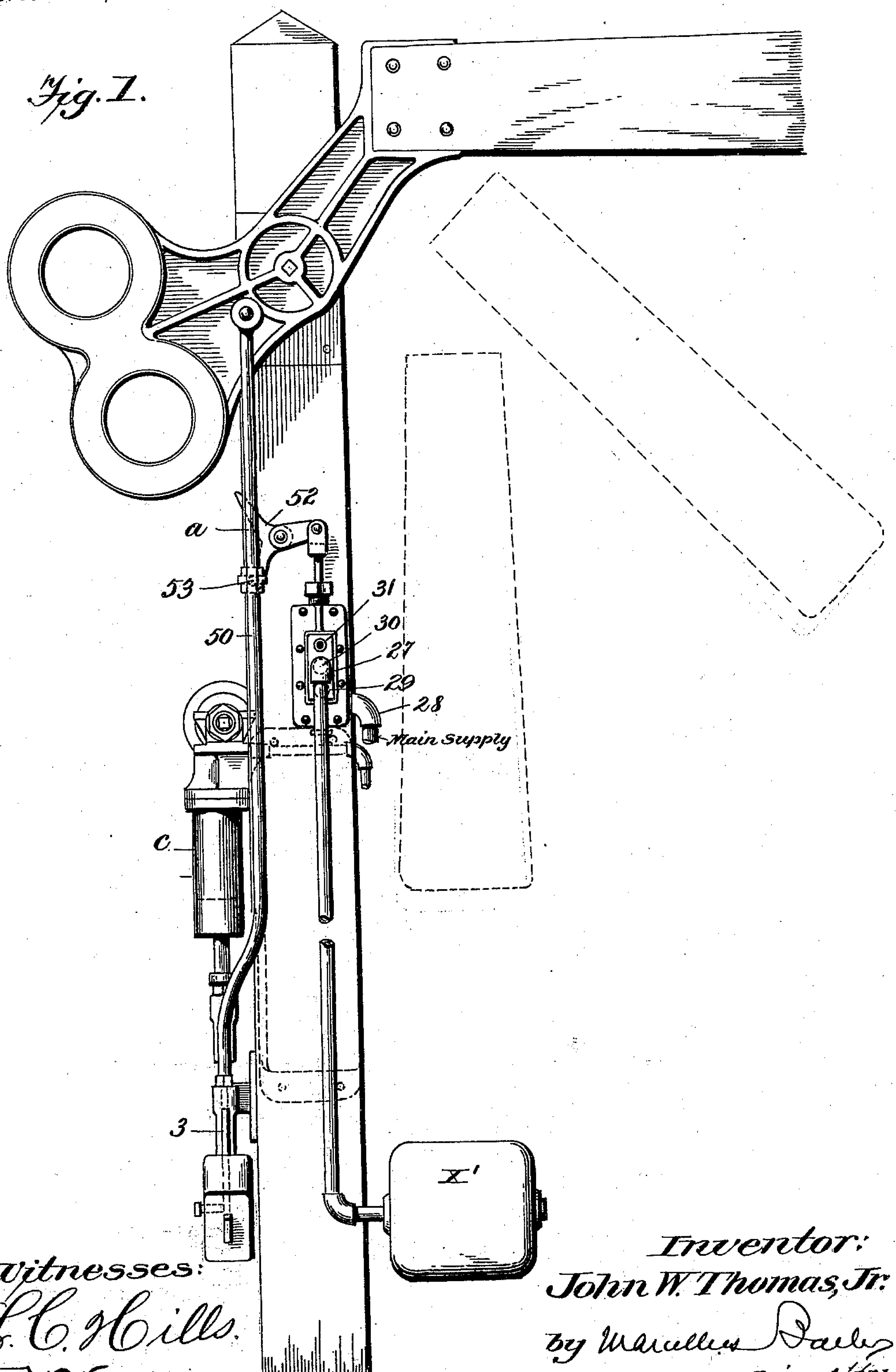
(No Model.) 5 Sheets—Sheet 1.

J. W. THOMAS, Jr.

PNEUMATIC APPARATUS FOR HANDLING RAILWAY SWITCHES.

No. 545,830. Patented Sept. 3, 1895.

Fig. 1.

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(No Model.) 5 Sheets—Sheet 2.

# J. W. THOMAS, Jr.

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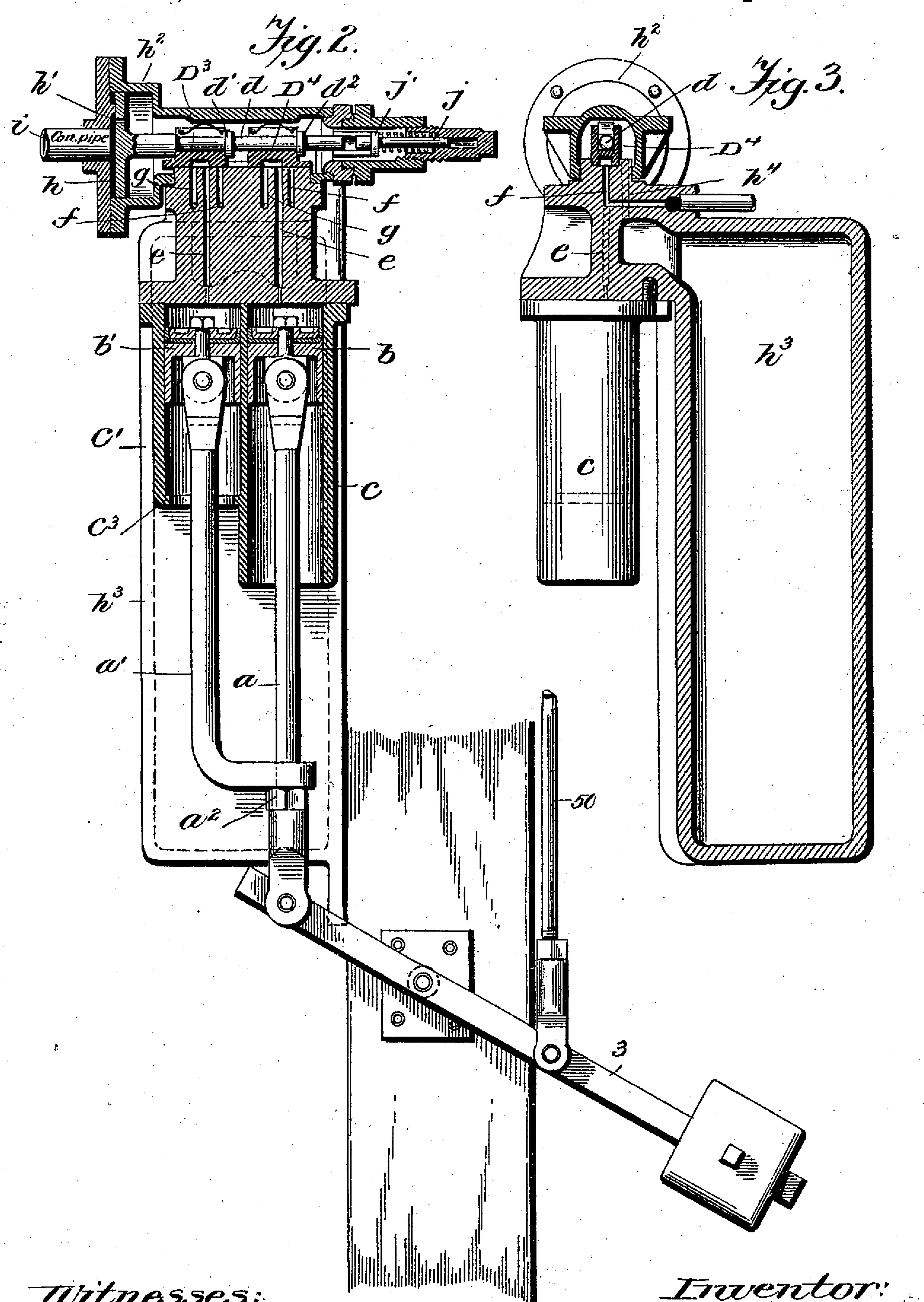


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(No Model.) 5 Sheets—Sheet 3.

# J. W. THOMAS, Jr.

## PNEUMATIC APPARATUS FOR HANDLING RAILWAY SWITCHES.

No. 545,830. Patented Sept. 3, 1895.

Fig. 4.

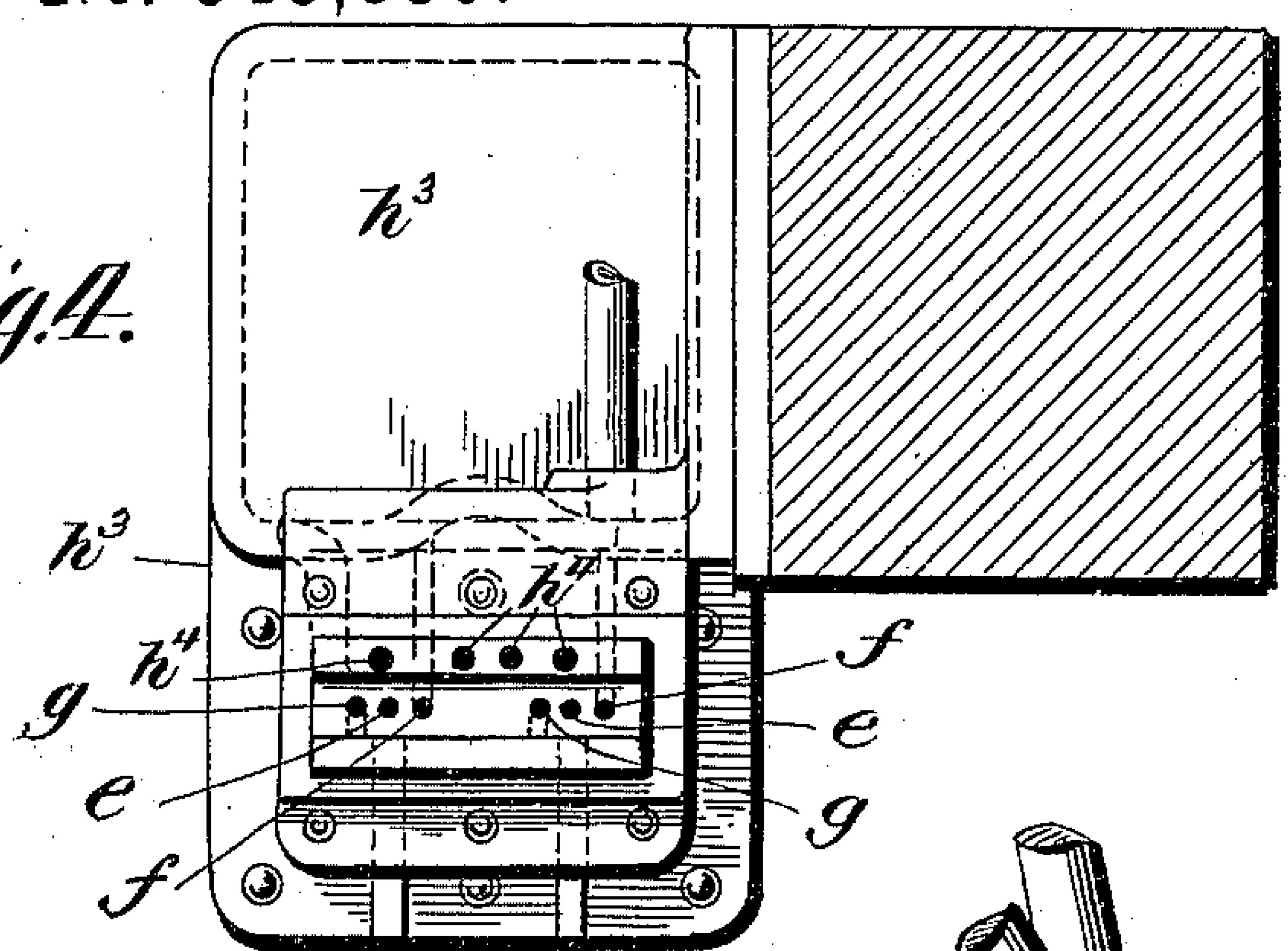



Fig. 5.

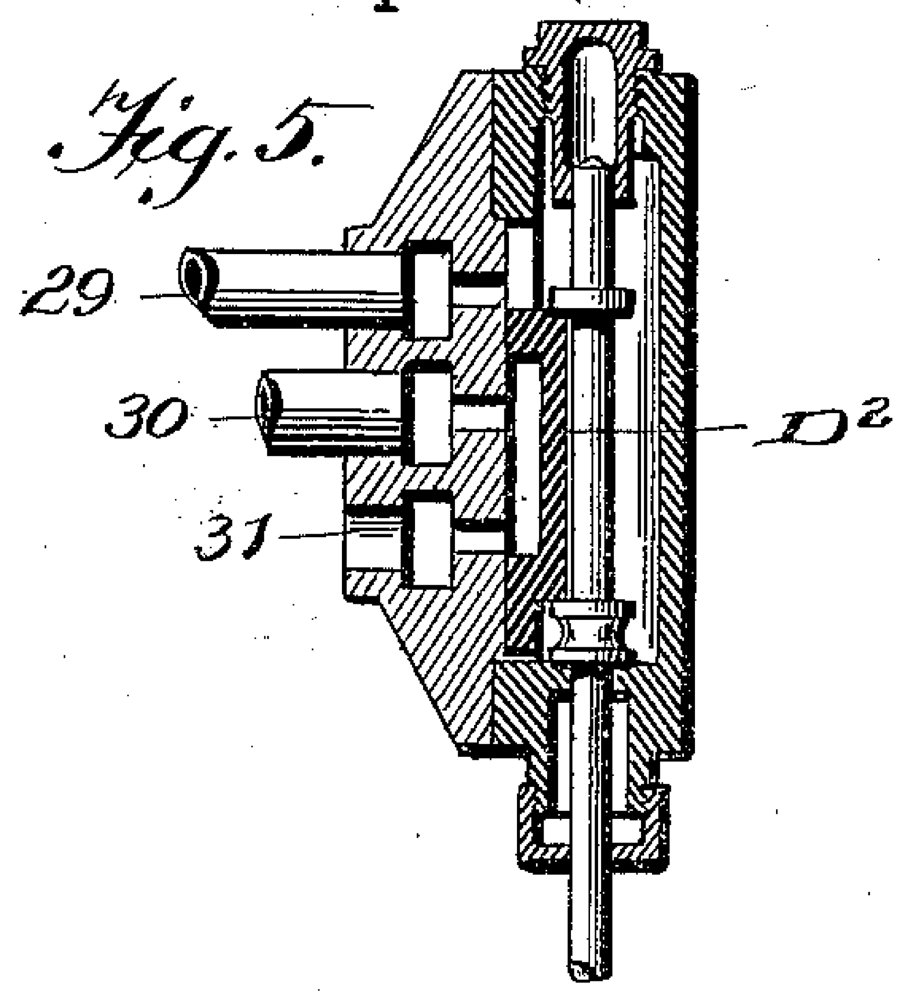
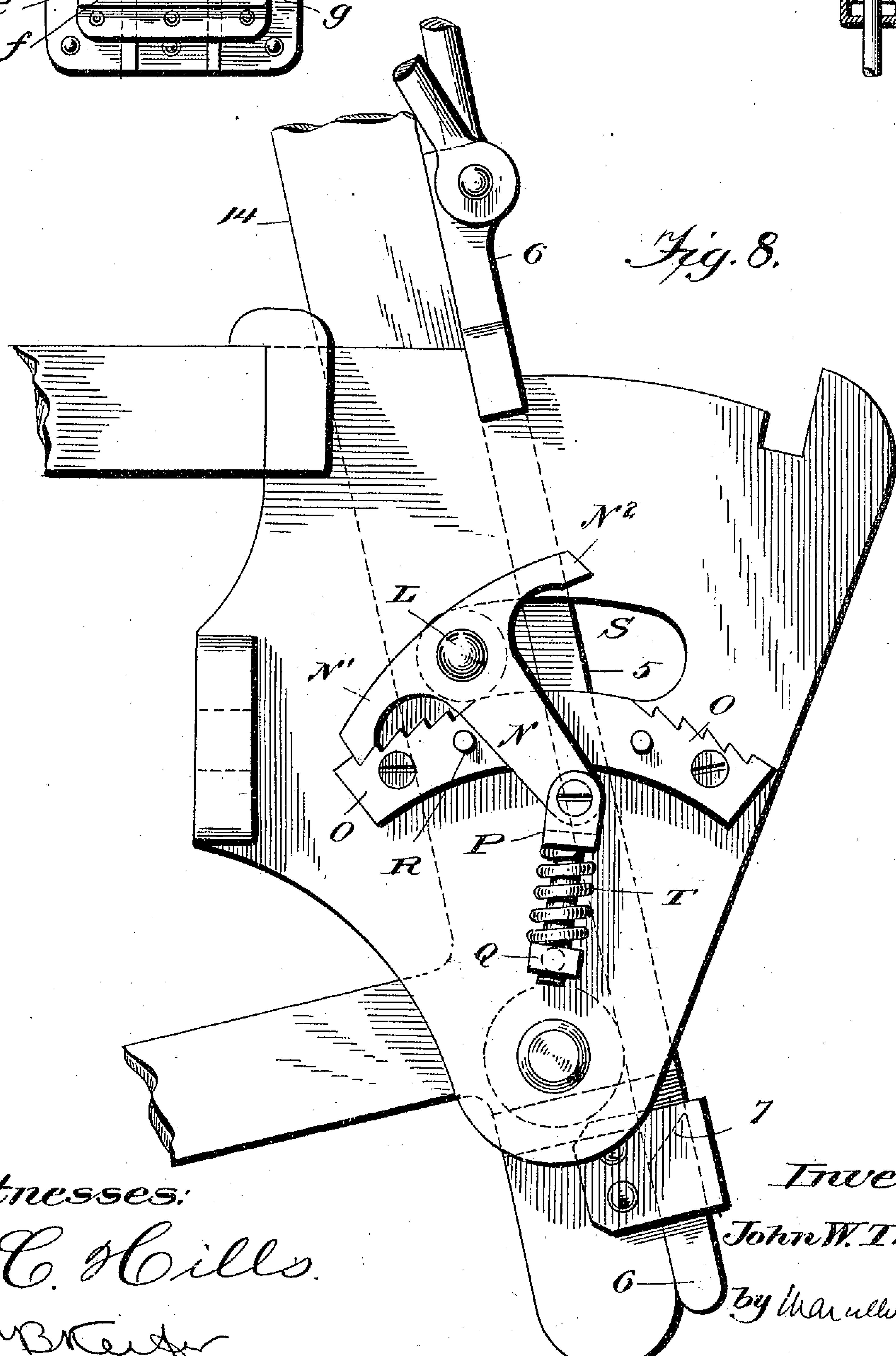



Fig. 8.

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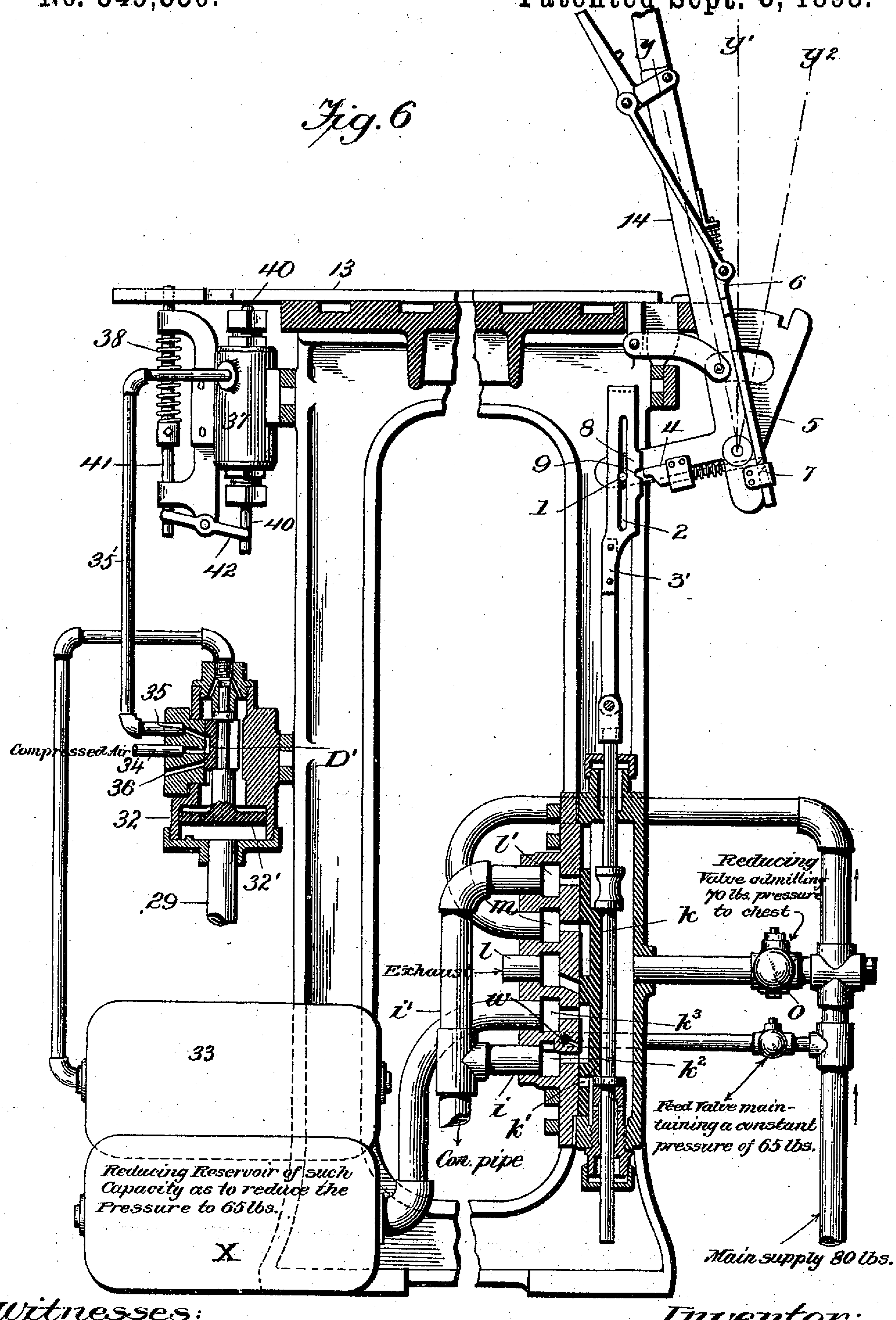
(No Model.) 5 Sheets—Sheet 4.

# J. W. THOMAS, Jr.

## PNEUMATIC APPARATUS FOR HANDLING RAILWAY SWITCHES.

No. 545,830. Patented Sept. 3, 1895.

Fig. 6

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(No Model.) 5 Sheets—Sheet 5.

# J. W. THOMAS, Jr.

## PNEUMATIC APPARATUS FOR HANDLING RAILWAY SWITCHES.

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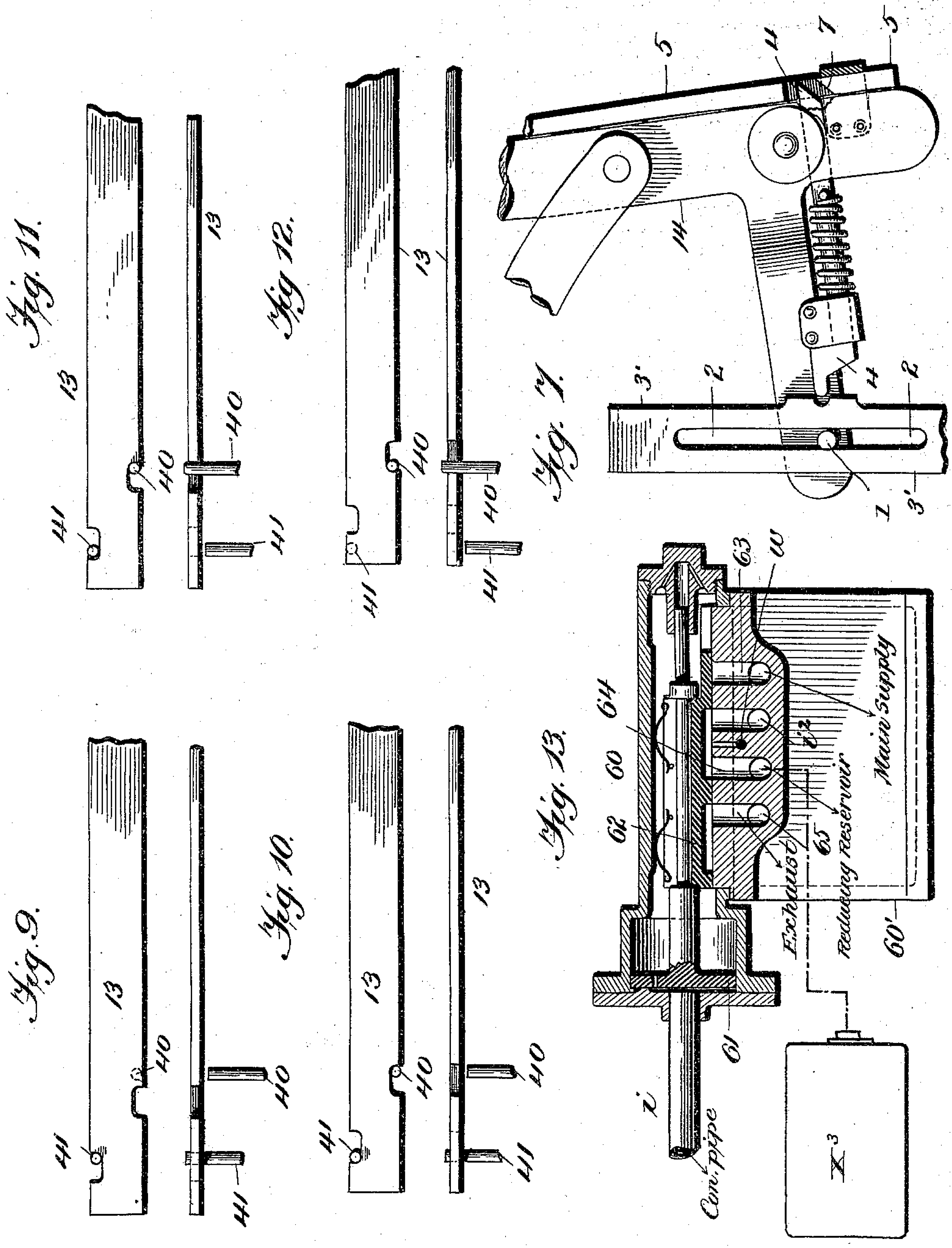


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# UNITED STATES PATENT OFFICE.

JOHN W. THOMAS, JR., OF NASHVILLE, TENNESSEE.

## PNEUMATIC APPARATUS FOR HANDLING RAILWAY-SWITCHES.

SPECIFICATION forming part of Letters Patent No. 545,830, dated September 3, 1895.

Application filed July 11, 1895. Serial No. 555,646. (No model.)

*To all whom it may concern:*

Be it known that I, JOHN W. THOMAS, Jr., of Nashville, in the county of Davidson and State of Tennessee, have invented certain new and useful Improvements in Pneumatic Apparatus for Handling Railway-Signals, of which the following is a specification.

My present invention resides in certain improvements on the pneumatic system of and apparatus for handling railway-signals set forth in my Patent No. 520,813, of June 5, 1894. While these improvements are designed particularly with reference to the needs of a railway signal system, yet in some respects they are applicable to the handling of railway-switches as well.

The improvements forming the subject of my application will first be described by reference to the accompanying drawings, and will then be pointed out more specifically in the claims.

In the drawings, Figure 1 is a front elevation of the upper part of a signal-mast provided with apparatus for working a three-position signal. Fig. 2 is a side elevation of the same, omitting the signal-indicator chest and signal and showing in section the three-position valve and cylinders for working the signal. Fig. 3 is a cross-section of the same with the cylinders in elevation. Fig. 4 is a sectional plan of the parts shown in Figs. 2 and 3 with the valve-chest removed to disclose the valve-seat and ports therein. Fig. 5 is a section of the signal-indicator chest shown in Fig. 1. Fig. 6 is a sectional side elevation of the signal-operating lever (supposed to be located in the tower) and its appurtenances. Fig. 7 is a detail view, on an enlarged scale, of the devices by which the operating-lever can at will be engaged with or disengaged from the controlling-valve which it operates. Fig. 8 is a side elevation, on an enlarged scale, of a portion of the signal-operating lever, together with its quadrant, having combined with it devices whereby the lever after having been started from one or the other of its extreme positions cannot be returned to that position until it has made a full stroke in the direction in which it was started. These devices are omitted from Fig. 6 in order to avoid obscuring the other parts. Figs. 9, 10, 11, and 12 are diagrammatic views in plan and side elevation illustrating the different positions assumed by the indicator or locking pins relatively to the tappet of the signal-operating lever. Fig. 13 is a sectional view of an intermediate valve mechanism to be interposed in the controlling-pipe line at a point about half-way of the length of the line when the distance between the tower and signal is considerable.

In this apparatus, as in my patented apparatus, I make use of controlling-pipe lines, which contain at all times air at more than atmospheric pressure, and equalizing-pistons, which are actuated by the reduction and restoration of air-pressure in said controlling-pipes and control by their movement the valves by which the admission of air to and its exhaust from the working cylinders for the signal and indicator or locking pins is regulated.

In the system described in my said patent, No. 520,813, I provided a pressure of eighty pounds to the square inch, but worked at a reduced pressure in the controlling-pipe lines—viz., between a maximum pressure of sixty pounds and a minimum pressure of fifty pounds—the reduction being effected by means of reducing-valves or relief-valves. I find it, however, preferable to work at a higher pressure—viz., with a maximum pressure in the controlling-pipe lines of eighty pounds, or, in other words, the same as that of the main supply, and a minimum pressure of seventy pounds for a two-position signal and sixty-five pounds for a three-position signal. I also do away entirely with puppet or relief valves for the controlling-pipes, using in lieu thereof reducing-reservoirs, with which the controlling-pipes are caused to communicate whenever a reduction of pressure is required. In this way, and for reasons more fully set forth in my application filed of even date herewith, Serial No. 555,647, for improvements in pneumatic apparatus for handling railway-switches, I am enabled to secure much better results and more efficient action and quicker response of the signal and the indicator-pins.

The apparatus shown in Figs. 1 to 4, inclusive, is similar to that shown in Figs. 8 and 9 of my Patent No. 520,813, save that the valve-seat and the reservoir for increasing the capacity of that valve-chest are in a single casting. The two working cylinders are preferably made separate therefrom and are bolted to the under side of the offset portion of the casting on which the valve-seat is located.

The counterbalanced semaphore-blade on the mast is jointed by a connecting-rod *a* to one end of the pivoted counterweighted lever 3, as usual. The other end of lever 3 is joined by a connecting-rod to the piston *b* of the "safety-cylinder." The piston *b'* of the shorter adjoining "caution-cylinder" *c'* has pinned to it a rod *a'*, formed at the other end to encircle and slide on rod *a* and normally abutting against a shoulder $a^2$ on rod *a*. Stop $c^3$ is provided to limit the down movement of rod *a'* and is so placed as to arrest the movement of rod *a'* when the signal reaches "caution" position. Further movement of the signal from "caution" to "safety" is effected by the movement of rod *a* alone.

The admission of air to and its exhaustion from the two cylinders *c c'* is effected through two sets of ports *e f g*, one for each cylinder. In each, *e* is the inlet-port to cylinders, *f* is the port communicating with the source of compressed-air supply, and *g* is the exhaust-port. On the seat containing these ports are two slide-valves $D^3$ $D^4$, one for each set, these valves being engaged with their stem *d* by collars *d'* $d^2$, so located as to permit the stem *d* (when in the position shown in Fig. 2) a movement to the right sufficient to shift caution-valve $D^3$ before safety-valve $D^4$ is moved. Stem *d* is provided with an equalizing-piston *h*, having equalizing-port *h'*, this piston and the valve being contained in a valve-chest $h^2$, having for the purpose of increasing its capacity a storage-reservoir $h^3$, with which it communicates through constantly-open ports $h^4$, Figs. 3 and 4. Into the head of the chest opens the controlling-pipe *i*, by which the movement of the equalizing-piston is controlled. This pipe at all times contains air at more than atmospheric pressure, this pressure being varied by mechanism controlled by the signal-operating lever in the tower. Beyond and in axial alignment with the valve-stem *d* a rod *j* is mounted to slide within the valve-chest, this rod being spring-pressed toward the valve-stem and having a collar *j'* to limit its movement toward the stem. Normally (as is Fig. 2) the stem and rod are separated by an interval sufficient to permit the stem to move far enough to the right to shift valve $D^3$ before it brings up against rod *j*. If the air-pressure delivered through controlling-pipe *i* is not sufficient to overcome resistance of the spring-pressed rod *j*, the stem *d* will stop after shifting caution-valve $D^3$ and air will be admitted to the caution-cylinder *c* only. By increasing the pressure in the controlling-pipe enough to overcome the resistance of rod *j* the stem *d* will move farther to the right, and the safety-valve $D^4$ will also be shifted, with the result of admitting air to the safety-cylinder *c*. Provision for thus varying the pressure in the controlling-pipe is made by the apparatus in Fig. 6. The valve mechanism in this figure is similar in a general way to that shown in Fig. 9 of my Patent No. 520,183, with such differences as are made necessary by the addition of a reducing-reservoir, which latter is shown at X. The parts in this figure, so far as they correspond with those of my patent, are designated by the same reference-letters, and the same, it may here be said, is true of the figures already described.

The slide-valve *k* (shown in normal or "danger" position in Fig. 6) has two cavities, the one to operate in connection with the ports *l' m*, through which the maximum pressure needed to operate safety-valve $D^4$ is supplied to the controlling-pipe *i*, and the other to operate in connection with the lower or caution port $k^2$, the exhaust-port *l*, and the reducing-reservoir port $k^3$. Port *m* communicates with the main supply, containing air at eighty pounds pressure, port *l'* communicates with controlling-pipe *i* through branch pipe *i'*, and port $k^2$, which communicates with controlling-pipe *i*, takes its supply of compressed air from the valve-chest, which contains air at, say, seventy-five pounds pressure, delivered to it from the main supply through a reducing-valve *o*. The reducing-reservoir X is of a capacity calculated to reduce the pressure in the controlling-pipe *i* to sixty-five pounds.

In the position of parts shown in Fig. 6 the reducing-reservoir and the controlling-pipe are in communication through ports $k^2$ $k^3$, pressure in the controlling-pipe *i* is reduced to sixty-five pounds, and the signal is at "danger."

To put signal to "caution," signal-operating lever 14 is moved to its *y'* or middle position. This lifts the valve *k* far enough to bring the port *k'*, with which it is provided, over port $k^2$, thus establishing communication between the pipe *i* and the interior of chest *k*, while the lap of the valve is sufficient to still hold closed port *l'*, and at the same time port $k^3$ of the reducing-reservoir X is put in communication with the exhaust, and consequently is relieved of the charge of compressed air which it contained, while, as the controlling-pipe is now in communication with the body of the chest *k*, pressure in it is increased to seventy-five pounds, and the caution-valve $D^3$ at the signal-mast consequently is shifted, with the effect of putting signal to "caution." To put signal to "safety," operating-lever 14 is moved its full stroke or to its $y^2$ position, thus raising valve *k* to its extreme upward position. When it reaches this position, port $k^2$ will be blanked and air at eighty pounds pressure will pass to the controlling-pipe *i* by way of ports *m l'* and branch pipe *i'*. By this increase of pressure the resistance of the spring-pressed rod *j* will be overcome and the valve-stem *d* at the mast will be moved far enough to the right to shift safety-valve $D^4$, and thus put the signal to "safety."

To put signal again to "danger," all that is needed is to return valve $k$ to the position shown in Fig. 6. In this position the controlling-pipe $i$ will be thrown into communication with reservoir X and the requisite reduction of pressure in the pipe to seventy pounds will follow, the reducing-reservoir having been relieved of its charge of compressed air during the time the controlling-pipe was in communication with source of air-supply. Under this arrangement it will be noted, as concerns the exhaust-controlling pipe and reducing-reservoir, that the arrangement of ports is such that the controlling-pipe alternately communicates with the reducing-reservoir and the source of supply, the reducing-reservoir alternately communicates with the controlling-pipe and the exhaust, and the communication between the exhaust and reducing-reservoir is established at the time the controlling-pipe communicates with the source of supply.

In the case of a "two-position" signal, or a signal which occupies only "safety" and "danger" position, the caution-cylinder and its valve mechanism would be omitted, the safety-cylinder would be provided with a simple D-valve controlling a single set of ports $e\, f\, g$ and itself actuated by the equalizing-piston $h$, and the valve $k$ at the tower would be an ordinary D slide-valve controlling a single set of ports $l\, k^2$ and $k^3$, having the same functions and connections with the atmosphere, the controlling-pipe, and the reducing-reservoir, respectively, as above described, the controlling-pipe when in communication with the chest of valve $k$ receiving air at full pressure of eighty pounds, supplied to said chest from the main supply. The reducing-reservoir X in this case need be of a capacity to reduce the pressure to seventy pounds only.

In the arrangement shown in the drawings, Fig. 6, the signal-operating lever 14 is normally disconnected from the slide-valve $k$, and appliances are provided by which it can at will be connected thereto. The lever 14 is of the elbow or bell-crank type, operates in connection with a notched quadrant, and is provided with the slotted sliding tappet 13, all as usual. The shorter arm of the lever 14 has a pin 1, which enters a longitudinal slot 2 in the bar 3′, pinned to the stem of valve $k$. This arm of the lever 14 carries a spring-retracted sliding latch or dog 4, mounted in suitable guides on the arm. The dog can be pressed forward against the stress of its spring by a sliding extension 5 of the latch-lever 6, which extension is provided with a cam or incline 7, that acts, when the latch-lever is closed against the operating-lever, against the heel of the dog 4. When the dog is thus pressed forward, its nose will engage the latch projection 8 on the bar 3′. There are two points of engagement—viz., the top shoulder of the projection and a notch 9 below that shoulder. In the normal or "danger" position of the parts (which is that represented in the drawings) the nose of the latching-dog 4 is opposite to but out of engagement with the notch 9. The pin-and-slot connection between the lever 14 and the bar 3′ is for the purpose of holding the bar at all times in proper position to permit the latching mechanism to operate.

To put the signal from "danger" to "caution," latch-lever 6 is closed upon the operating-lever 14, thus causing the latch or dog 4 to be pressed forward into engagement with notch 9, and the operating-lever is brought to its $y'$ or middle position. This will bring valve $k$ to its middle position, and then, if the signal responds properly, the latch-lever is released, thus unlatching the operating-lever from the valve $k$, and then the operating-lever can be put in its reverse or $y^2$ position in order to accomplish the proper interlocking. In this position the nose of dog 4 will be just above the level of the top of projection 8. To return the signal from "caution" to "danger," latch-lever 6 is pressed, thus projecting the nose of dog 4 over the top of projection 8, and operating-lever 14 is brought from $y^2$ to $y'$ position, thus returning valve $k$ to normal position. The latch-lever is released, with the result of disengaging the dog 4 from projection 8, and thus, if the signal has responded properly, the operating-lever can be returned to its normal or $y$ position.

To put the signal from "danger" to "safety," the latch-lever 6 is not released when the operating-lever reaches its middle or $y'$ position, but is held until the latter lever is fully reversed or reaches its $y^2$ position.

To return the signal from "safety" to "danger," the latch-lever is pressed, thus causing the dog 4 to engage notch 9, and the operating-lever makes a half-stroke from $y^2$ to $y'$, bringing valve $k$ to middle position. Then the latch-lever is released, the operating-lever is returned to $y^2$ position, and the latch-lever is again pressed, this time with the effect of causing the nose of dog 4 to engage the top of projection 8. The operating-lever then is put from $y^2$ to $y'$ position again, with the result of returning valve $k$ to normal position, the latch-lever is released, and then, if the signal has responded, which will be ascertained by the movement of the indicator or tappet locking pins, the operating-lever can be brought back to its normal or $y$ position.

For a two-position signal the projection 8 need not have a notch 9 and would be of a length equal to that portion of the projection between the notch 9 and the top shoulder. Such an arrangement as the one last referred to is illustrated in my companion application, filed of even date herewith, Serial No. 555,647, for pneumatic apparatus for handling railway-switches, &c.

The sequence of movements above described of the operating-lever in returning the signal from "safety" to "danger" is made necessary by the fact that I now employ two indicator or locking-pins for the tappet 13 instead of one locking-pin, as in my Patent 520,813. I have found it necessary in practice to employ two locking-pins instead of one. These pins form part of the indicator mechanism, which will now be described.

The chest of the signal-indicator valve $D^2$ on the mast is shown at 27. The body of the chest, Fig. 5, is supplied with compressed air from main supply through pipe 28. It has three ports 29 30 31. 29 is the supply-port and has a like-designated pipe, which leads to the equalizing-piston-valve indicator mechanism at the tower. 30 communicates with reducing-reservoir X′, and 31 is exhaust. Valve $D^2$ is operated by having its stem connected to the rod 50, which extends between and connects the signal and the counterweighted lever 3, as illustrated in Fig. 1. The valve-stem is pinned to one end of a crocodile-jaw lever 52, pivoted to the mast and having its jaws in the path of a pin 53 on rod 50, the arrangement being such that one or the other of the jaws will be struck by the pin 53 when the rod moves up or down, as the case may be, thus rocking the lever 52 and consequently shifting the valve. The ports are so arranged that the lever is rocked during the first part of the movement of the rod 50—that part of the movement which serves to bring the signal from one or the other of its extreme positions to the intermediate or "caution" position—while during the rest of the movement the working lever will be unaffected. This arrangement is adapted more particularly to the needs of a three-position signal, where the shift of valve D′ must be fully accomplished by the time the operating-lever reaches its $y'$ position. In the normal position of parts (as in Figs. 1 and 5) port 29 is in communication with the body of chest 27 and is supplied with air at eighty pounds pressure and the reducing-reservoir is in communication with the exhaust. Pipe 29 leads to the head of a chest 32, Fig. 6, in the tower, provided with a capacity-increasing reservoir 33 and containing an equalizing-piston 32′, which controls a slide-valve D′, operating in connection with ports 34 35 36, of which 34 communicates with the source of compressed-air supply. 36 is the exhaust, and 35 communicates by suitable piping 35′ with the upper end of the small indicator-cylinder 37. The piston of this cylinder carries a rod 40, which forms one of the indicator or locking pins. The other pin is formed by a vertical rod 41, supported and capable of sliding in suitable guides and connected to the piston-rod 40 by an intermediate pivoted lever 42, the connection being such that when one pin is up the other must be down. When cylinder 37 is charged with air, pin 40 will be down and pin 41 up, as in Fig. 6. A spring 38 operates, when the cylinder 37 is exhausted of its air, to reverse the position of the pins.

It is more important to know that a signal resumes its "danger" position than it is to know that it goes to "safety," and I therefore so arrange things that with the signal in normal or "danger" position there must be maximum pressure in the indication-pipe 28. Such is the condition of things represented in the drawings, and Fig. 9 shows the relative position of the tappet and locking-pins at the time.

In putting the signal from "danger" to "safety" should the signal fail to respond when the operating-lever reaches its $y'$ position then the locking-pins would remain unmoved and the tappet would stand in the position shown in Fig. 10 and the lever could not be carried to $y^2$ position, or far enough in that direction to unlock the conflicting levers. Should the signal, however, respond properly, then the pressure in indication-pipe 28 would be reduced, with the result of shifting the position of the indicator-pins to that shown in Fig. 11, thus releasing the tappet and allowing the lever to be completely reversed. When reversed, the pins and tappet stand in the relation indicated in Fig. 11, and it will be noted by reference to this figure that in returning the lever to "normal" pin 40 stands ready to arrest its movement when it reaches $y'$ position unless the signal has properly responded and gone to "danger," because until the signal thus responds the increased pressure in the indicator-pipe 28 needed to depress pin 40 would not be had.

It is essential for various prudential reasons that after the operating-lever has been started from one or the other of its extreme positions it cannot be returned until after it has made a full stroke forward or backward, as the case may be. Various mechanical devices can be used to effect this result. The means which I now prefer for the purpose are illustrated in Fig. 8. Upon the operating-lever 14 is the pin L, (the same pin which holds the link that connects the lever with the tappet.) The quadrant is slotted at S to permit free travel of the pin as it moves with the lever. On the pin is mounted a reversible double-pawl lever of **T** shape, having two pawls N′ $N^2$, one or the other of which will be thrown into engagement with a ratchet O, according to the position of the lever, and a shank N, which is pinned to the head of a pin P, the lower end of which fits and can slide lengthwise in the eye Q of a bolt. The eye forms a guide and bearing for the pin, and the eyebolt itself is swiveled in the quadrant, so that it may be capable of axial rotation. A spiral spring T is confined between the eye Q and the head of pin P. Normally the pin P and shank N stand at a slight angle to one another, so as to hold one of the pawls in engagement with the ratchet, the pawl-lever being retained in this position by the stress of spring T. When the operating-lever therefore is started from one or the other of its extreme positions, as, for example, from the position shown in Fig. 8, it cannot be returned, but must move in the direction in which it started. When the lever reaches about three-fourths stroke, the shank N of the pawl-lever brings up against one or the other of two pins R, with the result of reversing the pawl-lever by the time the operating-lever completes its stroke and putting the pawl which before was lifted into engagement with the ratchet. Consequently on the return stroke this pawl which has thus been called into action will serve to prevent any back movement of the operating-lever and will compel it to complete its return stroke, when the pawl-lever will be again reversed. I remark that the device is applicable not only to signal-operating levers, but to switch-operating levers as well, and I desire to be understood as including any such application in my claim.

The intermediate or relay valve shown in Fig. 13 is designed to hasten the action of signals and signal-indications. It is to be introduced in the controlling-pipe line, whether for the signal or the indicator mechanism, preferably about half-way between the tower and the signal, and it is to be used where signals are at a considerable distance from the tower. It comprises a valve-chest 60, having a capacity-increasing reservoir 60′, and contains an equalizing-piston 61, a slide-valve 62, controlled by the equalizing-piston, and a series of ports 63 $i^2$ 64 65, controlled by valve 62, of which 63 is in communication with the source of compressed-air supply, 64 is in communication with reducing-reservoir $X^3$, 65 is the exhaust, and $i^2$ leads to the head of the signal-valve chest on the mast, Fig. 2, containing the valves $D^3$ $D^4$ and their controlling equalizing-piston. The head of chest 60 is entered by the controlling-pipe $i$, leading from the tower. In other words, the controlling-pipe is in two sections $i$ $i^2$, of which the first section controls the pressure in the second through the agency of the intermediate valve, which is interposed between the valve mechanism for admitting air to and exhausting it from the working cylinder and equalizing-piston for controlling the same, on the one hand, and the primary valve or valve which controls the one by whose action, mediately or immediately, the equalizing-piston at the working point is controlled, the intermediate or relay valve governing the pressure in a controlling-pipe leading to the equalizing-piston at the working point and being itself governed in its action by an equalizing-piston controlled by a controlling-pipe the air-pressure in which is regulated by the primary valve. As the parts stand in the drawings, pressure in $i$ is at seventy pounds. Consequently equalizing-piston 61 is to the left. $i^2$ is in communication with reducing reservoir $X^3$, and pressure in it is thereby reduced also. Increase of pressure in controlling-pipe $i$ will bring about increase of pressure in pipe $i^2$, and this will result in the shifting of the signal. This intermediate valve can be introduced also in the controlling-pipe line of the indicator mechanism.

Ports $w$ in Figs. 6 and 13 are feed-ports by which the controlling-pipes, when at minimum pressure, are supplied with air at minimum pressure to compensate for any leakage that may occur in the system. This feature is the subject in part of my companion application of even date herewith, Serial No. 555,647, hereinbefore referred to, and therefore is not here claimed by me.

Having described my improvements and the manner in which the same are or may be carried into effect, I state in conclusion that I do not restrict myself narrowly to the structural details hereinbefore described and illustrated, since, manifestly, the same can be varied considerably without departure from the real invention; but

What I claim herein as new, and desire to secure by Letters Patent, is—

1. The combination with a pneumatically operated signal, a valve mechanism at the signal mast for controlling the admission and exhaust of the air by which said signal is worked, and an equalizing piston controlling said valve mechanism, of a controlling pipe connected at one end to the chest or cylinder in which said equalizing piston works, a signal valve at the tower or operator's cabin controlling air supply exhaust and reducing ports, the air supply port being connected to the controlling pipes, a reducing reservoir connected to the reducing port, and an operating lever for the signal valve under the arrangement and for joint operation, substantially as hereinbefore set forth.

2. In combination with the operating lever and its tappet; the two connected indicator pins; the indicator cylinder and piston for one of said pins; a spring or its equivalent for moving the pins in a direction opposed to that in which they are moved by the piston; valve mechanism for admitting air to and exhausting it from the indicator cylinder; an equalizing piston and cylinder and chest for controlling said valve mechanism; indicator valve mechanism at the signal mast comprising a slide valve operated by the signal or some part moving therewith, and air supply exhaust and reducing ports controlled by said valve; a controlling pipe leading from said air supply port to the head of the cylinder or chest of the equalizing piston, and a reducing reservoir connected to said reducing port, substantially as and for the purposes hereinbefore set forth.

3. In combination with the signal and its pneumatically actuated appliances for operating the same, and the indicator valve at the signal mast normally disconnected from said appliances, of means whereby the valve is connected to and caused to move by the said signal operating appliances during the first portion of their movement in either direction, and is free from further connection with said appliances during the remainder of their movement, substantially as hereinbefore set forth.

4. The indicator valve and its stem, in combination with the signal operating rod 50, the pin 53, and the crocodile jaw lever 52, substantially as and for the purposes hereinbefore set forth.

5. In a three position signal operating mech-

anism, the combination with the signal operating lever, its tappet, and indicator mechanism, and the pressure regulating valve controlled thereby of a projection or shoulder on the stem of the valve or some part moving in unison therewith, a notch or recess 9 below said shoulder, a spring retracted dog carried by the lever, and means also carried by said lever whereby the dog can at will be projected into engagement either with the said shoulder above or the notch 9 below, according to the position of the valve stem and the lever, substantially as and for the purposes hereinbefore set forth.

6. The combination with the operating lever, its tappet and the pressure regulating valve controlled thereby, of means substantially as described whereby said lever after having once been started from either one of its extreme positions and before it reaches its middle position is restrained from returning to its original or first position until after it has completed its full stroke in the direction in which it was started, substantially as hereinbefore set forth.

7. The combination with the valve mechanism for admitting air to and exhausting it from the working cylinders, the equalizing piston for controlling the same, and the primary valve mechanism, of an intermediate or relay valve mechanism, a controlling pipe leading therefrom to the equalizing piston at the working point, an equalizing piston for the relay valve, and a controlling pipe for said last named piston leading from the primary valve mechanism, under the arrangement and for operation, substantially as hereinbefore set forth.

8. The combination with the operating lever of the spring pressed reversible double pawl carried by and pivoted to the lever, the double ratchet on the supporting frame or table, and means substantially as described for reversing the pawl at the completion of the stroke of the lever in either direction.

9. The combination with the operating lever of the double ratchet fixed to the supporting table or frame, the double reversible pawl pivoted to and carried by the lever, a pin pivoted at one end to the shank of the double pawl and at the other end entering a bearing block swiveled to the lever, a spring confined between the bearing block and the head of the pin, and a stop pin at each end of the double ratchet to engage and reverse the pawl at the end of the stroke of the lever in either direction, substantially as hereinbefore set forth.

In testimony whereof I have hereunto set my hand this 8th day of June, 1895.

JOHN W. THOMAS, JR.

Witnesses:
R. T. SAUNDERS,
C. W. HARDIN.