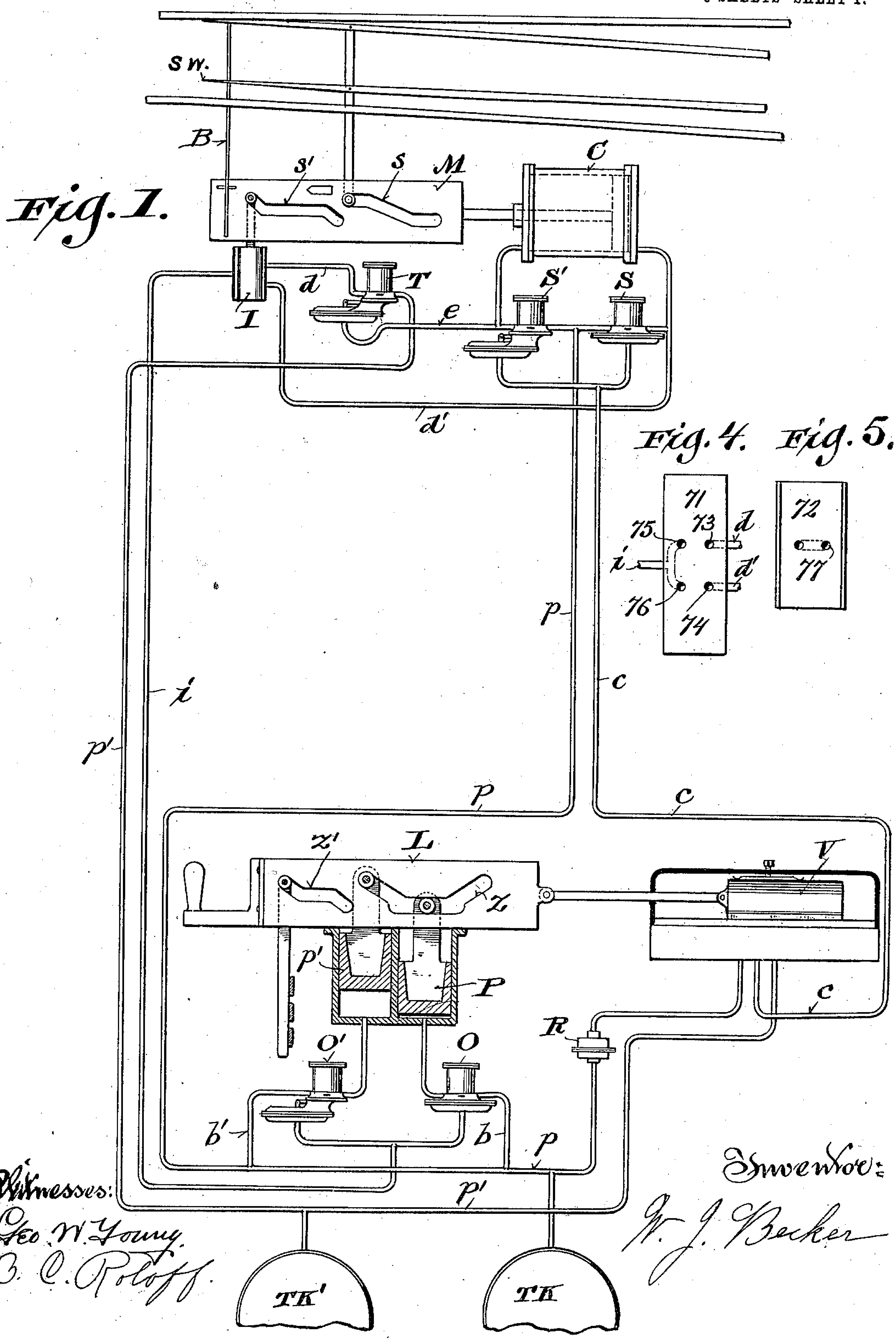
No. 756,929. PATENTED APR. 12, 1904.

W. J. BECKER.

PNEUMATIC SWITCH AND SIGNAL APPARATUS.

APPLICATION FILED NOV. 3, 1902.

NO MODEL. 5 SHEETS—SHEET 1.



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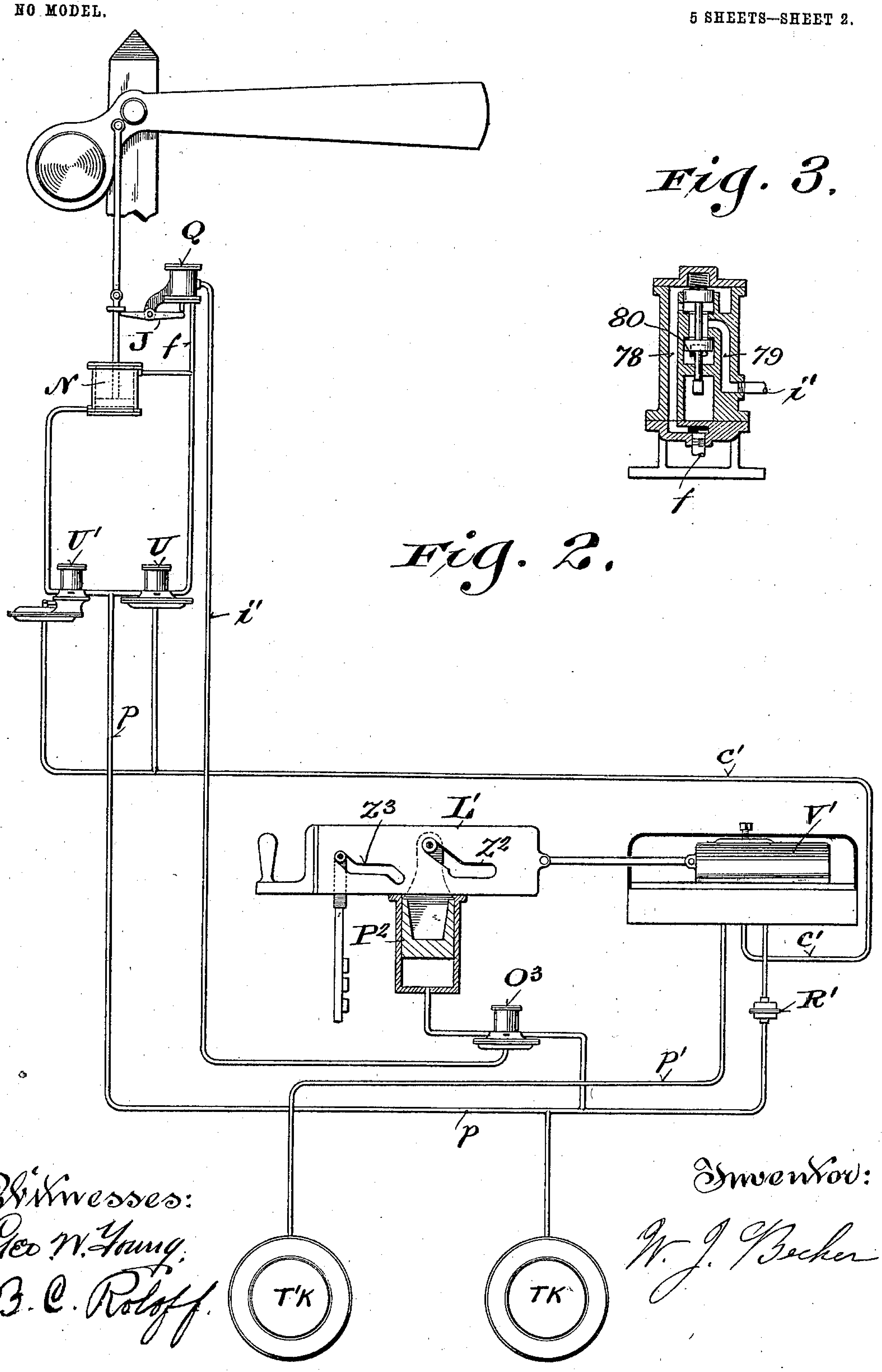
NO MODEL. 5 SHEETS—SHEET 2.

Fig. 3.

Fig. 2.



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NO MODEL.

5 SHEETS—SHEET 3.

Fig. 6.

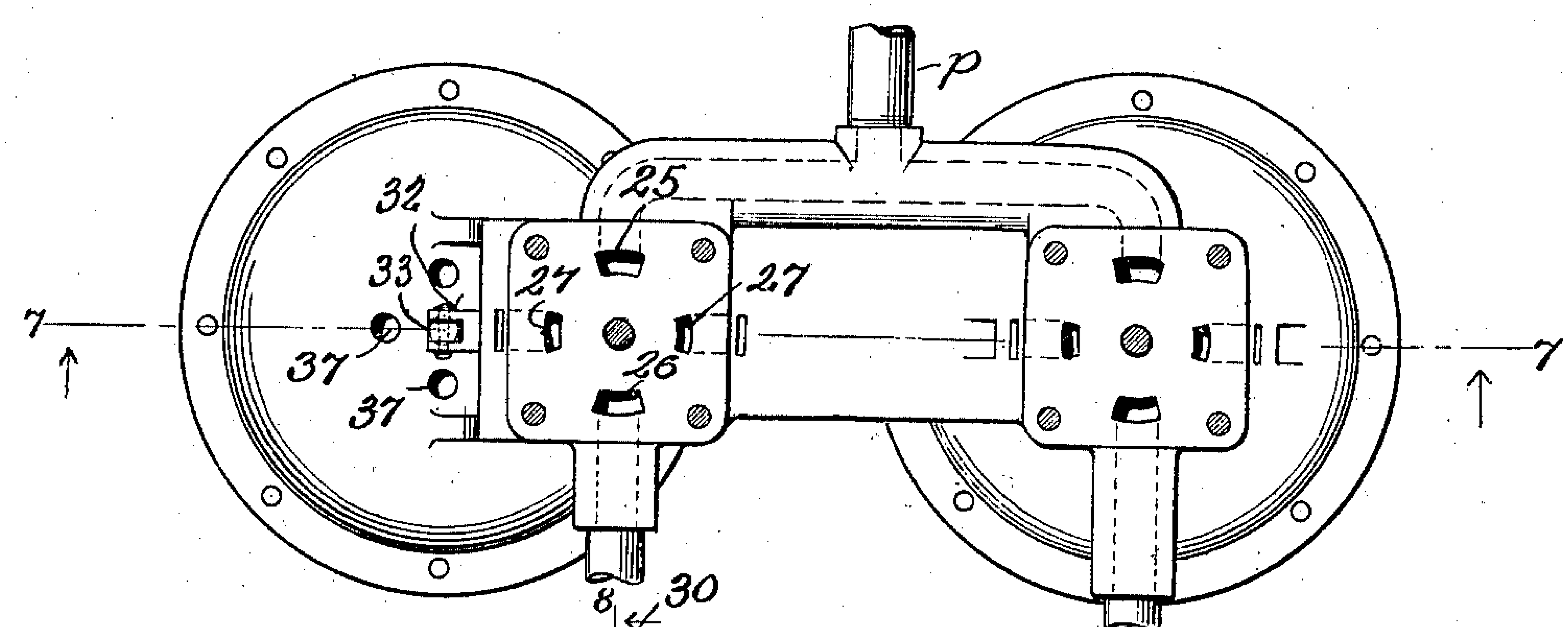


Fig. 7.

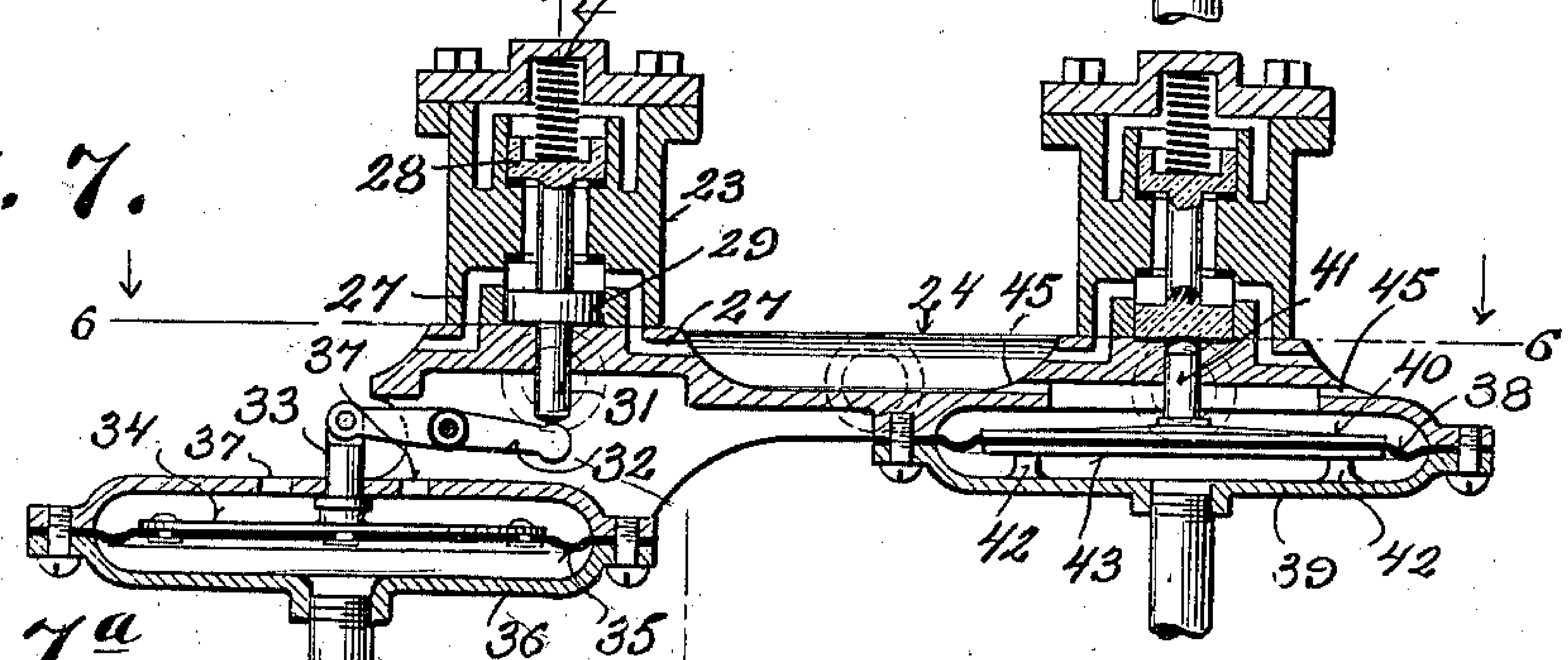


Fig. 7.a

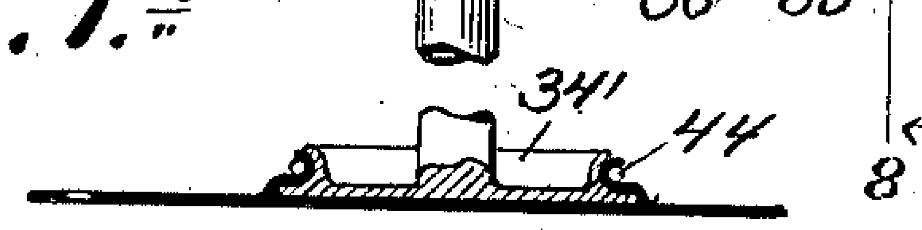
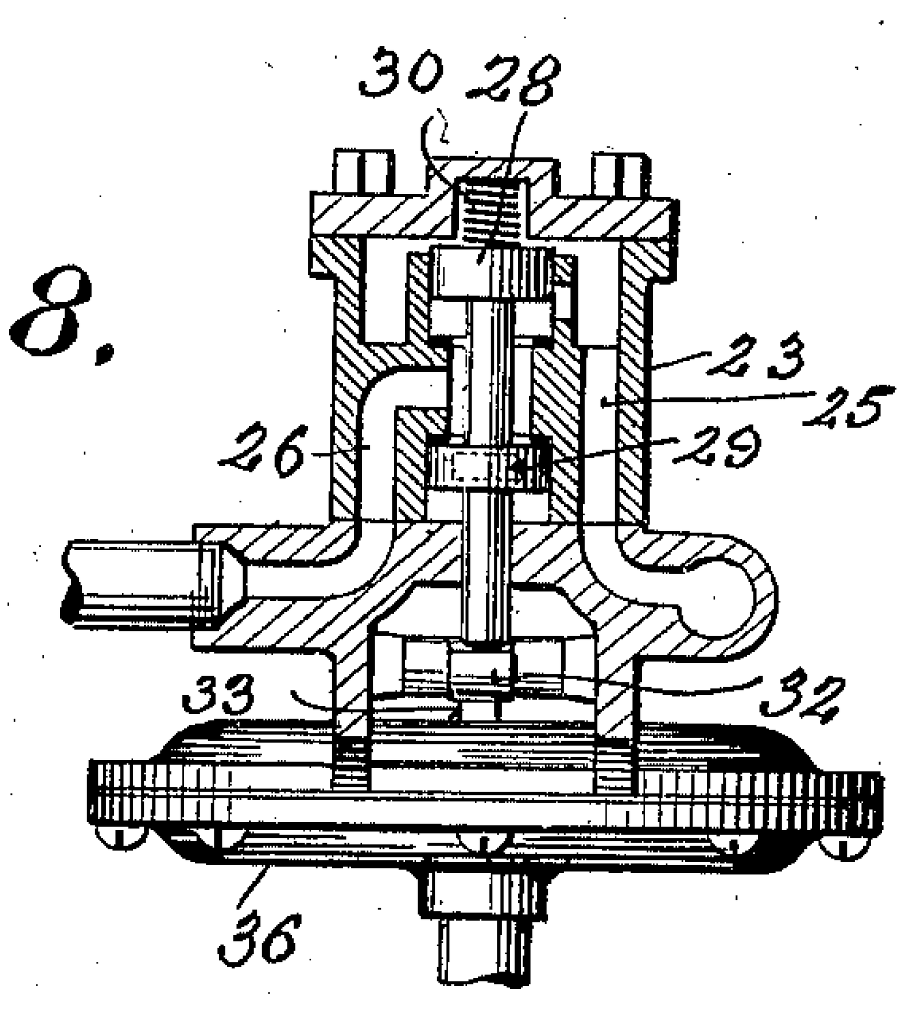


Fig. 8.



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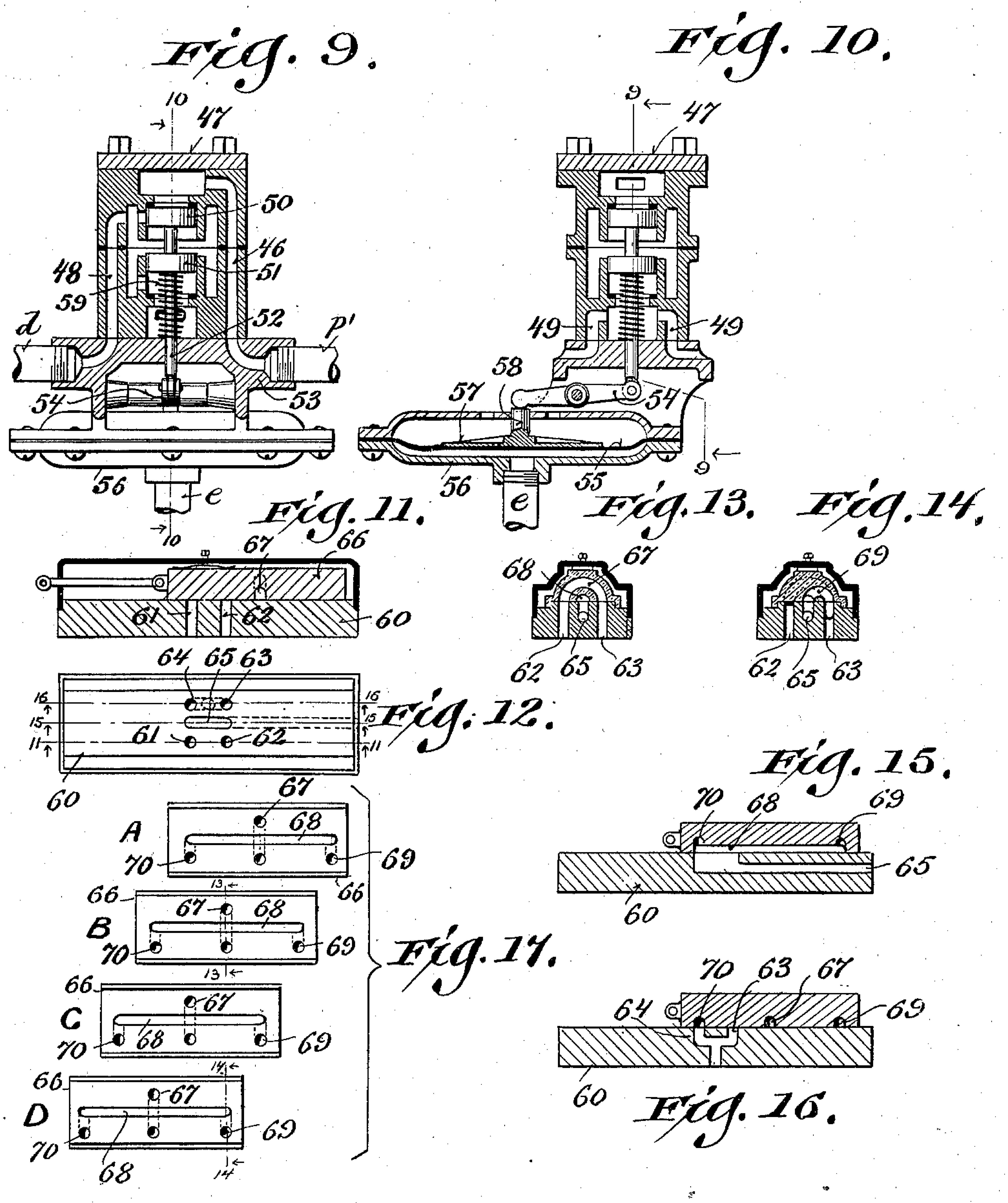
NO MODEL. 5 SHEETS—SHEET 4.



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NO MODEL. 5 SHEETS—SHEET 5.

Fig. 18.

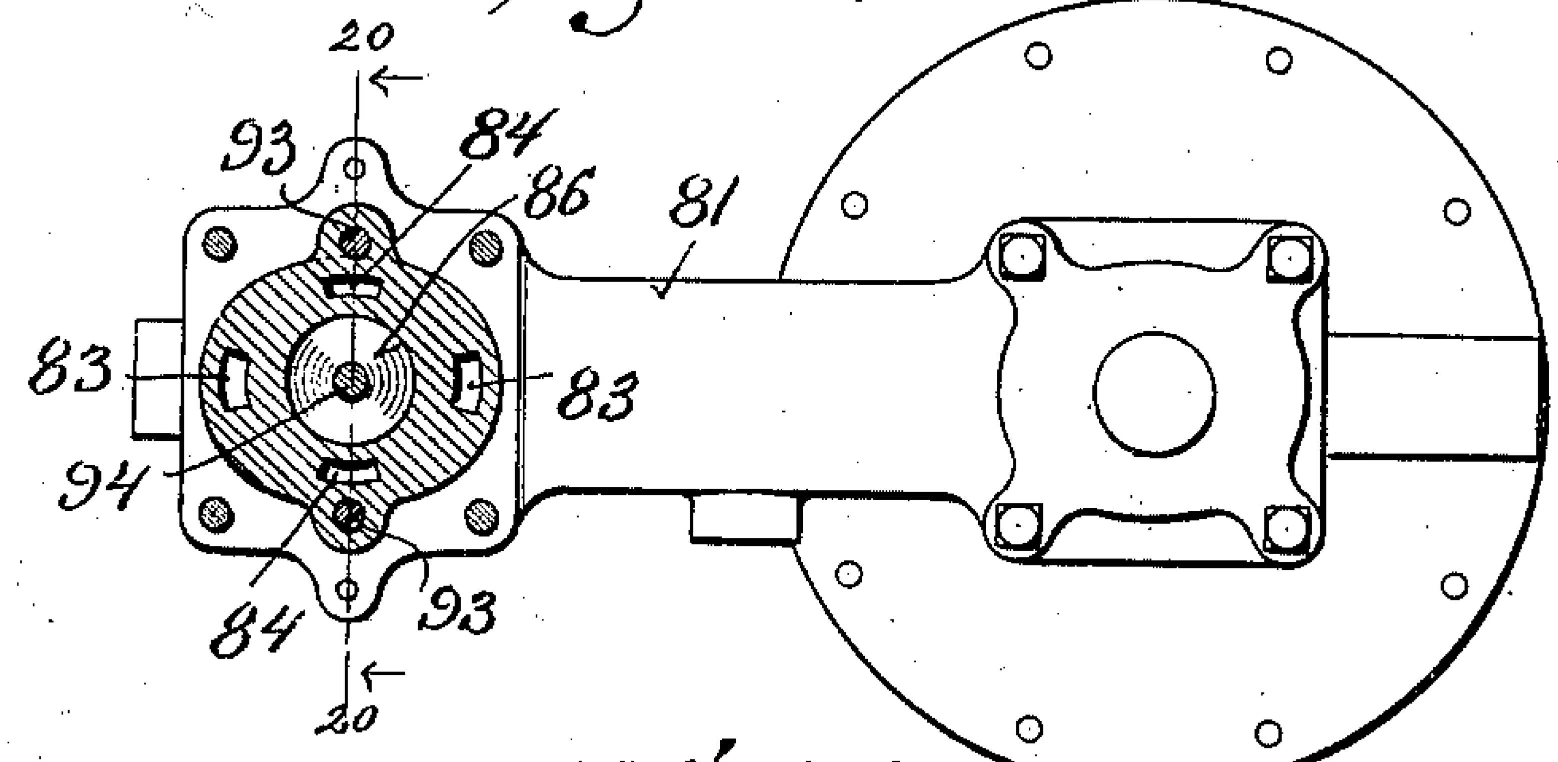


Fig. 19.

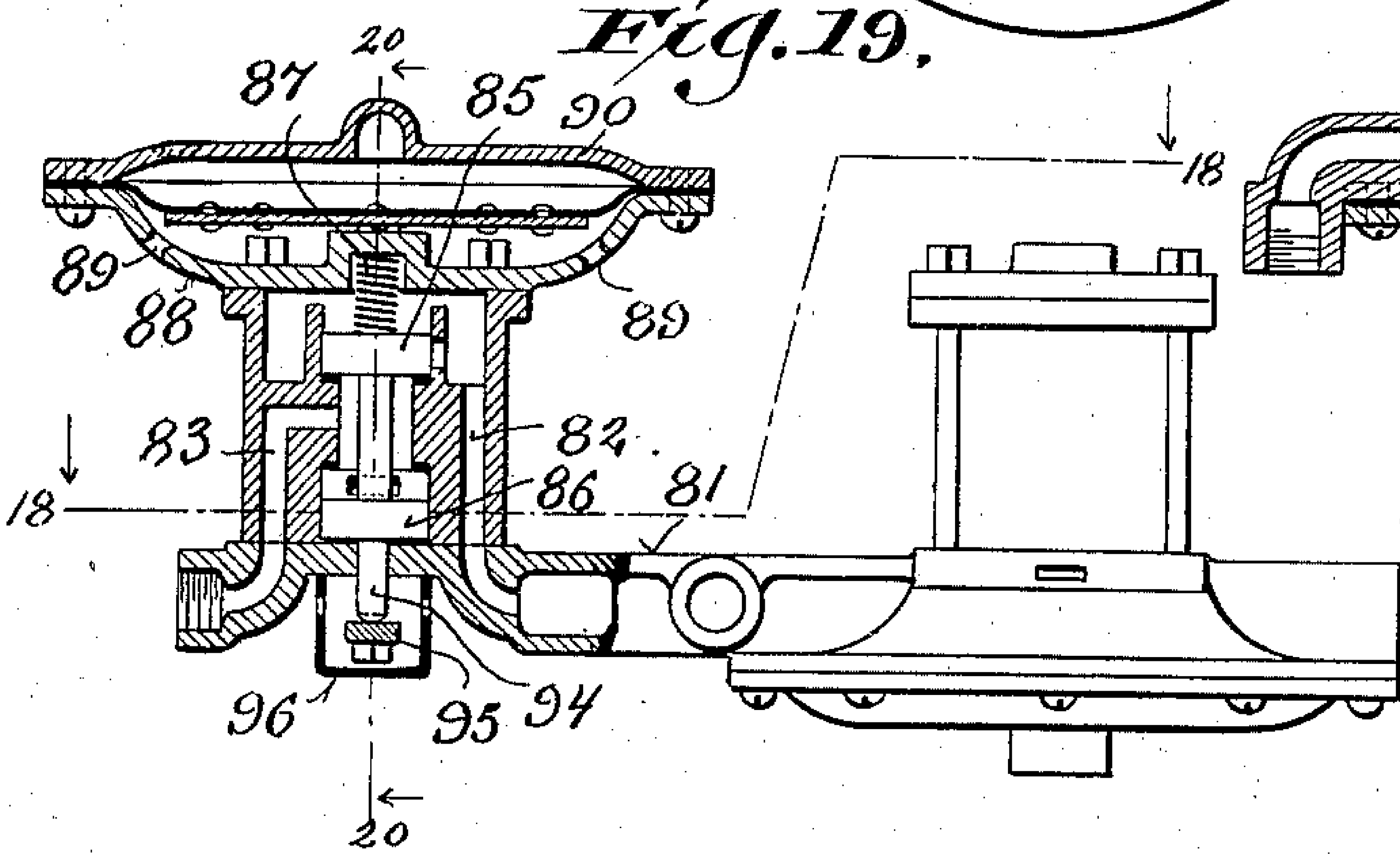


Fig. 20.

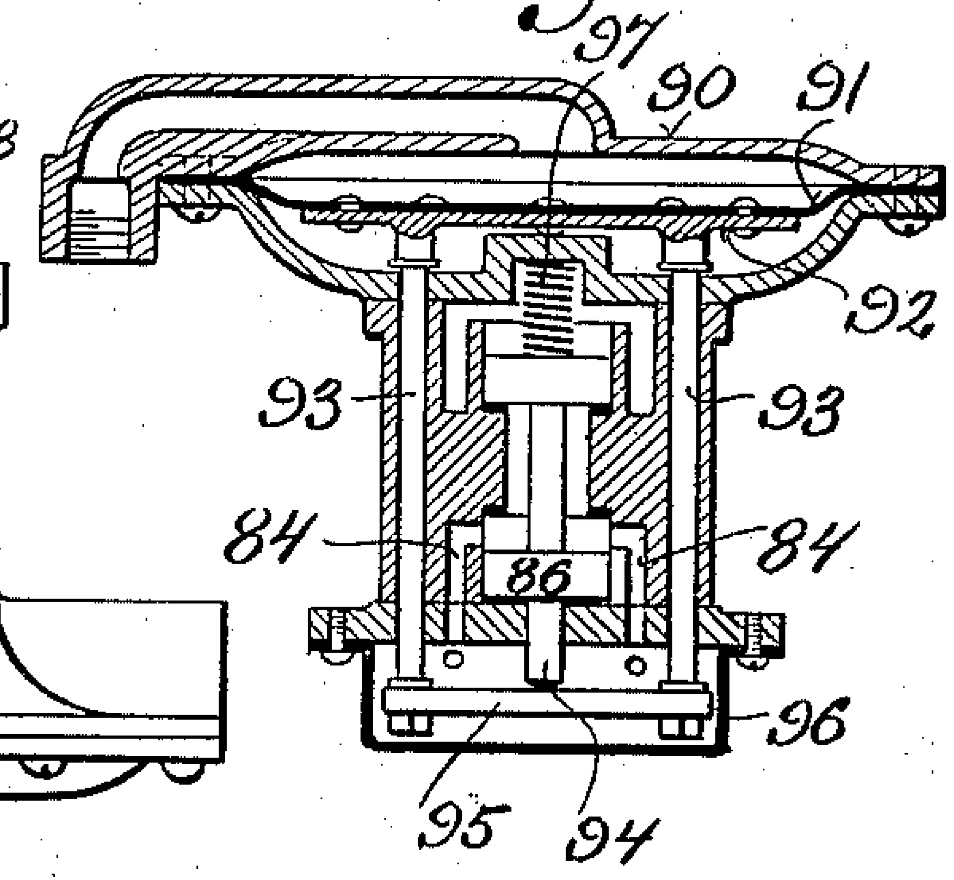


Fig. 21.

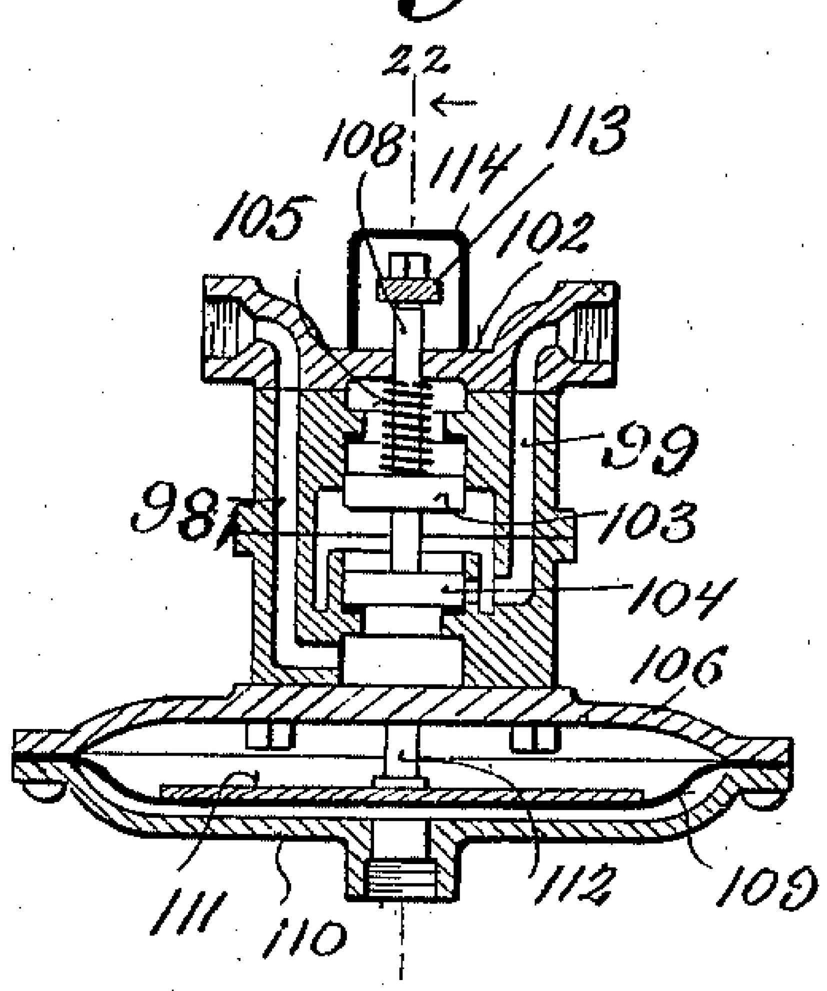
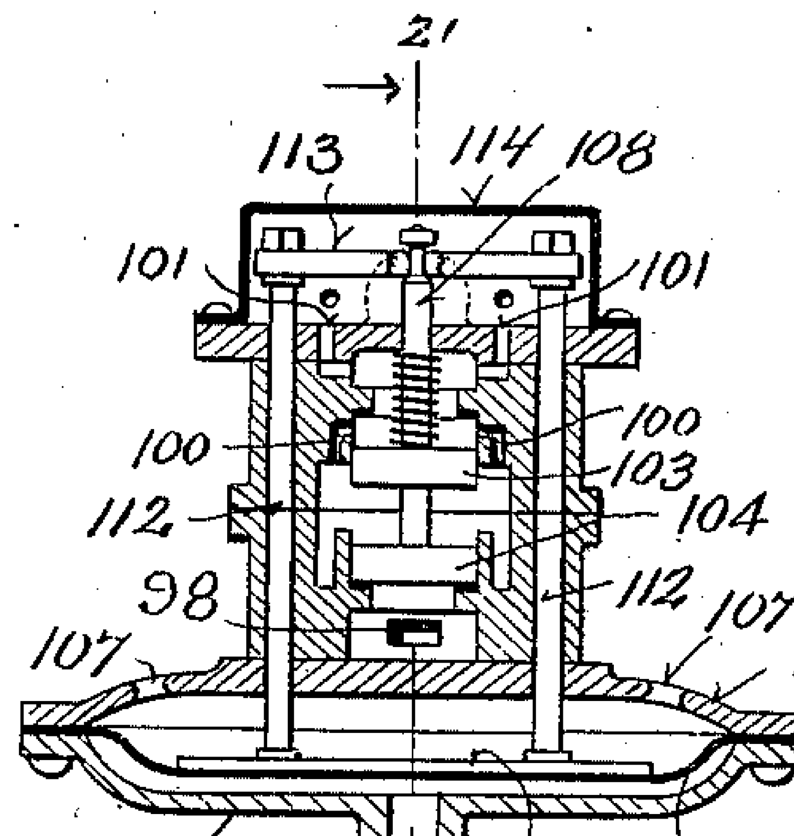


Fig. 22.



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Inventor:

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No. 756,929. Patented April 12, 1904.

UNITED STATES PATENT OFFICE.

WILLIAM J. BECKER, OF MILWAUKEE, WISCONSIN.

PNEUMATIC SWITCH AND SIGNAL APPARATUS.

SPECIFICATION forming part of Letters Patent No. 756,929, dated April 12, 1904.

Application filed November 3, 1902. Serial No. 129,373. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM J. BECKER, a citizen of the United States, residing at Milwaukee, in the county of Milwaukee and State of Wisconsin, have invented certain new and useful Improvements in Pneumatic Switch and Signal Apparatus, of which the following is a specification, reference being had to the accompanying drawings, forming a part thereof.

This invention relates to pneumatic switch and signal apparatus operated by low pressure.

The object of the invention is to so construct the apparatus that a minimum number of pipes for transmission may be used without impairing the efficiency and accuracy of the apparatus. In previous devices of this character it has been found necessary in order to avoid wrong movement of the switch or signal by accident to employ a separate pipe for each separate movement required in the cycle of operations. In my apparatus it is possible to use the same pipe for transmitting two separate movements. This is accomplished by using a positive pressure of air—that is to say, a pressure above the atmosphere—for one movement and a negative pressure of air or a partial vacuum for the other movement. These two sources of power being absolutely distinct and acting in opposite directions, there is no possibility of a false movement taking place even in case the apparatus became deranged in such a manner that the wrong kind of pressure would be introduced into the common pipe. The possibility of using a vacuum for the transmission is based upon the fact that in similar apparatus of this nature it has been found that a pressure of only five to seven pounds per square inch is necessary to produce a movement of the switch or signal by means of a relay. The normal pressure of the atmosphere is about fifteen pounds. Exhausting only one-half of the air from a vacuum-chamber will therefore produce a negative pressure of over seven pounds, and any well-constructed air-pump can maintain this negative pressure.

Further objects and advantages of the invention will appear from the following description, which describes the invention more in detail, by reference to the drawings accompanying and forming part of this specification.

In the accompanying drawings, Figure 1 is a general view of the parts of a switch-movement, showing the piping and mechanism attached thereto. Fig. 2 is a similar view of the parts of a signal-movement. Fig. 3 is a view of the indication-valve of the signal. Figs. 4 and 5 show views of the seat and slide of the indication-valve of the switch. Figs. 6, 7, and 8 show views of the relay-valves for both switch and signal, Fig. 6 being a section on the line 6 6, Fig. 7, Fig. 7 being a section on the line 7 7, Fig. 6, and Fig. 8 being a section on the line 8 8, Fig. 7. Fig. 7[a] shows a modified method of attaching the vacuum-diaphragm to its plate. Figs. 9 and 10 are views of the transfer-valve used at the indication end of the switch in a manner described in detail farther on, Fig. 9 being a section on the line 9 9, Fig. 10, and Fig. 10 a section on the line 10 10, Fig. 9. Figs. 11 to 17, inclusively, are views of the main controlling-valve and its seat. Figs. 18 to 20 are views of a different construction of the vacuum relay-valve from that shown in Figs. 6 to 8, Fig. 18 being a section on the line 18 18, Fig. 19, and Fig. 20 being a section on the line 20 20, Fig. 19. Figs. 21 and 22 show a different construction of the transfer-valve shown in Figs. 9 and 10, Fig. 21 being a section on the line 21 21, Fig. 22, and Fig. 22 being a section on the line 22 22, Fig. 21.

Referring to Fig. 1, the switch-points *Sw* are moved in both directions by a motion-plate M, having a suitable slot *s*, in which a roller attached to the switch-bar freely moves. This motion-plate M receives its movement from a piston working in a cylinder C. A second slot *s'* in the motion-plate moves an indication-valve I into one of two extreme positions, according to the position of the switch. Lugs on the motion-plate lock the switch by means of notches in a lock-bar B in both positions.

In the tower a main valve V, controlling the admission of air to the piping, is moved by a slide L, grasped by the operator. A slot Z of the form shown in said slide is connected by means of rollers to two pistons P P′, working in cylinders, as shown. A second slot Z′ in the slide carries the interlocking bar, the locking between the slides or levers controlling the various interlocked switches and signals being of the ordinary character commonly known in interlocking. A tank T*k* is supplied with compressed air from a suitable compressor. A tank T*k*′ is connected to a suitable air-pump, so that a partial vacuum is maintained in it. From the tank T*k* a main pipe *p* is carried to the switch. This pipe *p* has a branch leading to the valve-seat of V, as shown. A reducing-valve R is interposed in this branch to reduce the main pressure, which is generally from fifteen to twenty pounds per square inch, to the desired controlling pressure. Other branches *b b*′ lead to relay-valves O O′, which when open will allow the pressure to enter into the cylinders carrying the pistons P P′, respectively. At the switch branches from the pipe *p* lead to two relay-valves S S′, which when opened will allow the compressed air from the supply to enter into each end of the cylinder C, respectively. From the vacuum-tank T*k*′ a supply-pipe *p*′ leads to the valve-seat and to the switch, supplying a transfer-valve T, which when opened will allow the vacuum pressure to enter the pipe *d*, leading to the indication-valve I. From the valve-seat in the tower a single controlling-pipe *c* leads to the switch, where it has two branches, one leading to the diaphragm of the relay-valve S and the other to the diaphragm of the relay-valve S′. From the indication-valve I a single indicating-pipe *i* leads to the tower and has branches leading to the diaphragms of the relay-valves O O′, respectively. A pipe *e* leads from the outlet side of the relay-valve S′ under the diaphragm of the transfer-valve T. The operation of these various parts will appear farther on.

Fig. 2 shows the same related parts of a signal-movement. The semaphore-blade is attached, by means of a connecting-rod, to a piston working in a cylinder N. This piston is controlled by two relay-valves U U′, placed at the foot of the mast. An indication piston-valve Q (shown in detail in Fig. 3) is opened by a lever J, acted upon by a collar on the piston-rod striking its end when the signal has gone to "danger." In the tower a slide L′ operates the controlling-valve V′. This slide has a slot Z^2, similar to the one shown in the switch-movement, but carrying only one piston P^2. A slot Z^3 carries the interlocking bar. The relay O^3 controls the admission of air under the piston P^2. The main supply *p* from the pressure-tank T*k* is repeated in this figure and supplies the valve V′ through a reducing-valve and leads to the relays U U′. The vacuum-pipe *p*′ from the vacuum-tank T*k*′ leads to the valve only in this case. A single controlling-pipe *c*′ has two branches leading under the diaphragms of the relay-valves U U′. A single indication pipe *i*″ leads to the diaphragm of the indication-relay O^3 from the indication-valve Q. A branch *f* of the pipe leading to the top of the cylinder supplies the said indication-valve Q.

Figs. 6, 7, and 8 show details of the double relay-valves S S′ or U U′. Referring to these figures, the valve-casing 23 has an admission-chamber and an exhaust-chamber. From the main supply *p* passages in the base 24 feed both valves. The inlet-port 25, Fig. 8, leads into the admission-chamber of the valve-casing, and the outlet-port 26 leads to a pipe supplying the cylinder. Two exhaust-ports 27 lead from the exhaust-chamber to the atmosphere. Two connected valve-bodies 28 and 29, for which suitable seats are provided in the valve-casing, control the supply and exhaust. In the position shown in Fig. 8 the valve is open and a passage exists from the supply *p* through the inlet-port 25 to the outlet-port 26 and into the cylinder. The exhaust-port is closed by the valve-body 29. In the position shown in Fig. 7 the valve-body 28 closes the passage between the inlet and outlet ports, and said outlet-port, and consequently the cylinder, communicates with the atmosphere through the exhaust-ports 27. The closing of the valve is assisted by a spring 30 abutting against the cover of the valve-casing.

As thus far described both valves are identical in construction. On the left-hand side of Figs. 6 and 7 the mechanism is shown for operating the valve by means of a vacuum. From the exhaust-valve body 29 a stem 31 projects through the base. This stem is acted upon by the end of a lever 32, pivoted to this base, whose other end is connected by a hinged joint with the stem 33 of a plate 34, firmly connected to the diaphragm 35. This diaphragm is inclosed in a chamber formed by the base and a cover 36, which is provided with a screw-threaded boss into which a branch of the controlling-pipe is fixed. A shoulder on the stem 33 limits the upward movement of the diaphragm. Openings 37 37 in the top of the casing inclosing the diaphragm permit the entrance of the atmosphere to the top of the diaphragm. On the right-hand side of Figs. 6 and 7 is shown the mechanism for operating the valve by means of positive pressure. The diaphragm 38 is also inclosed in the space formed by the base and a cover 39, carrying a branch of the controlling-pipe, as previously described. On this diaphragm loosely rests a plate 40, having a stem 41, which projects through the base into contact with the exhaust-valve body, serving to operate the valve. To prevent downward movement of the diaphragm, lugs 42 are cast in the cover 39, and a loose plate 43 is interposed between the diaphragm and said lugs. Openings 45 45 above the diaphragm in the base-plate permit the escape of the air when said diaphragm is lifted. The diaphragms 35 and 38 may be constructed of rubber or other flexible material. As the diaphragm 35 must be attached to the plate 34 in such a manner as to cause said plate to move with it, it may be advantageous to construct said diaphragm of brass or other flexible metal to insure airtight riveting of the plate to the diaphragm. In case this diaphragm is made of rubber it may be attached to the operating parts in the manner shown in Fig. 7ª. In this case the plate is vulcanized around a groove in the plate 34′, and a stiffening-wire 44 is inserted in said groove. The operation of this double relay is as follows: If air under pressure be introduced into the controlling-pipe *c*, and consequently into the branches of said pipe leading under both diaphragms, the right-hand diaphragm will be raised, carrying with it the two valve-bodies and opening the valve. The left-hand diaphragm, it will be seen, will not be affected. The pressure exerted underneath it will simply be taken up by the shoulder on the stem, and no effect whatever is had on the valve, this valve remaining closed. If, on the contrary, this controlling-pipe is connected with the vacuum-supply, the vacuum created underneath the diaphragm 35 will cause the pressure of the atmosphere entering through the openings 37 37 on top of the plate and diaphragm to depress one end of the lever 32, raising the other end, and thereby opening the valve on this side. The other valve will not be affected thereby, the negative pressure on the diaphragm being taken up by the lugs 42 and plate 43. It will thus be seen that one valve only under any circumstances can be opened at a time, according to the pressure caused in the controlling-pipe, whether positive or negative. There is therefore no possibility of a false movement of the switch or signal.

The double relays O O′ are constructed precisely similar to the relays S S′ and produce the same functions. In order to produce a vacuum-pressure in indication-pipe *i* (see Fig. 1) when the switch is in the corresponding position, the transfer-valve T (illustrated in Figs. 9 and 10) is used. The main switch-cylinder is operated by positive pressure in both directions. The indication in one direction, however, is given by negative pressure. It is therefore necessary to convert this positive pressure on one side of the cylinder into negative pressure used for indication. For this purpose the vacuum-supply pipe *p*′ is carried to the switch, where it enters the transfer-valve T. This valve T has a casing which may be made in two parts, as shown in Figs. 9 and 10, in order to permit the guides for the valve-bodies to be constructed as shown. The pipe *p*′ communicates with the inlet-port 46, leading to the inlet-chamber at the top of the valve closed by the cover 47. The outlet-port 48 leads to a pipe *d*, communicating with the indication-valve I. Exhaust-ports 49 49 in the lower part of the valve connect the exhaust-chamber with the atmosphere. An inlet-valve body 50 and an exhaust-valve body 51, connected to move together, control communication between these ports by means of proper seats in the valve-casing. A stem 52, projecting from the exhaust-valve body through the base 53, is loosely hinged to a lever 54, pivoted to said base. A diaphragm 55 is confined in the chamber formed by an extension of the base and a cover 56, which has an opening to which is attached the pipe *e*, Fig. 1. On top of this diaphragm rests a plate 57, having a stem 58 loosely abutting against the end of the lever 54. A spring 59 serves to normally hold the valve closed. In the position shown in the figures the valve is closed, the outlet-port 48 communicates with the exhaust-port 49, and the exhaust is open. The inlet-valve will be held against its seat not only by the pressure of the spring, but also by the pressure of the atmosphere acting against the vacuum existing in the pipe *p*′ and the port 46. If air under positive pressure is introduced underneath the diaphragm through the pipe *e*, the supply will be placed in communication with the outlet and the exhaust will be closed by the seating of the valve-body 51. As soon as the pressure is released or the pipe *e* placed in communication with the atmosphere the valve will again close the vacuum-supply, and the pipe *d*, which, through the indication-valve I, communicates with the indication-pipe *i*, will be restored to normal pressure through the exhaust-ports 49. Suitable openings in the top of the diaphragm-casing permit the escape of the confined air.

Figs. 11 to 17 show the main controlling-valve in the tower V or V′ and its seat. Fig. 11 is a section through the valve and its seat on the line 11 11, Fig. 12, the valve being shown in its extreme right-hand position. Fig. 12 is a plan view of the valve-seat, showing the ports. Fig. 13 is a section on the line 13 13, Fig. 17ᴮ, through the valve and its seat. Fig. 14 is a similar section on the line 14 14, Fig. 17ᴰ. Fig. 15 and 16 are sections on the lines 15 15 and 16 16, respectively, of Fig. 12.

The valve-seat 60 has two supply-ports 61 and 62. In the switch-movement 61 is connected with the supply-pipe *p* from the positive-pressure tank T*k*, and 62 is connected with the supply-pipe *p*′ from the vacuum-tank T*k*′. Adapted to be placed in communication with either of these ports are the two ports 63 and 64, which are united into one at the bottom of the valve-seat, as best shown in Fig. 16, and communicate with the single controlling-pipe *c* or *c*′. A median exhaust-port 65, leading to the atmosphere, is located midway between the ports 63 64 and 61 62. The valve-slide 66 has an arched port 67, adapted to form communication between the ports 64 61 or the ports

63 62, according to the position of the valve. It has a long median exhaust-port 68, adapted at all times to communicate with the exhaust-port 65 in the valve-seat. With this exhaust-port 68 two exhaust-ports 69 and 70 are connected at the extreme ends and are adapted to place the ports 63 and 64, respectively, into communication with the atmosphere in the extreme positions of the valve. Fig. 17 shows the four positions of the valve with reference to its valve-seat. The valve in said Fig. 17 with reference to Fig. 12 is shown turned over from its position on the seat. In other words, when placed on the seat the upper lines of A B C D of Fig. 17 will correspond to the lower line of Fig. 12. Fig. 17[A] shows the extreme right-hand position of the valve corresponding to Fig. 11 and Figs. 15 and 16. In this position port 70 covers port 64, and consequently places said port and the controlling-pipe *c* or *c′* into communication with the atmosphere through 68 and 65. Both supply-ports 61 and 62 are shut off. In the position B, Fig. 17, the arched port 67 places the port 63, and consequently the pipe *c* or *c′*, into communication with the port 62, and therefore with the vacuum-tank T*k′* through the pipe *p′*, Fig. 1. The controlling-pipe will thereupon be under a vacuum-pressure. The supply 61 still remains shut off. In the position C this arched port 67 connects ports 61 and 64, and therefore connects the positive pressure-supply tank T*k* through the pipe *p* with the controlling-pipe *c* or *c′*, and the port 62 is shut off. In the extreme left-hand position D, Fig. 17, both supply-ports 61 and 62 are shut off, and the port 63, and consequently the controlling-pipe *c* or *c′*, is placed in communication with the atmosphere through 68, 69, and 65.

Figs. 4 and 5 show the indication-valve I, Fig. 1, Fig. 4 showing the seat 71 and Fig. 5 the slide 72. The seat has two ports 73 and 74, which communicate with the pipes *d* and *d′*, respectively, said pipe *d′* leading from the back of the cylinder C. It also has two ports 75 and 76, which unite into one and communicate with the indication-pipe *i*. The slide has one arched port 77, which in the position of the switch shown will form communication between the ports 73 and 75, and consequently between the pipes *d* and *i*, and in the other extreme position of the switch will form a communication between 74 and 76, and consequently between *d′* and the same pipe *i*.

The indication-valve Q for the signal is shown in detail in Fig. 3 and is constructed similarly to the relay-valves. The pipe *f* communicates with an inlet-port 78. The outlet-port 79 communicates with the indication-pipe *i′*. An exhaust-port 80 (shown in dotted lines) communicates with the atmosphere. When the signal is at "danger," the collar on the connecting-rod shown depresses the end of the lever J and opens communication between the ports 78 and 79, closing off the exhaust by means of the valve-bodies and their seats, as shown in the figure. This is the normal position of said valve, in which communication exists between *f* and *i′*. As soon as the signal leaves its danger position, however, the collar receding from the end of the lever J allows the spring to close said valve and open *i′* to exhaust through 79 and 80.

Figs. 18, 19, and 20 show a modified and preferred construction of the vacuum-relay valves S′ O′ U′. In these figures the inlet-port communicating with the main supply through the base 81 is shown at 82. The outlet-port communicating with the cylinder is shown at 83. The exhaust-ports communicating with the atmosphere through the base are shown at 84 84. The two connected valve-bodies 85 and 86 are held to their normal position, closing the passage between 82 and 83 by the spring 87. The lower part of the diaphragm-chamber is formed in one with the valve-casing cover 88. It is provided with openings 89 89 to allow access of the atmosphere. The upper part of the diaphragm-chamber is formed by the cover 90, provided with a boss having a passage, as shown, to which the controlling-pipe *c* or *c′* is connected. Attached to the diaphragm 91 is a plate 92, carrying two projecting rods 93 93, which pass through appropriate bosses in the valve-casing outside of the ports and through the base 81. The exhaust-valve body has a stem 94, and the two rods 93 93 are connected by a cross-bar 95, adapted to abut against said stem and to open the valve when the diaphragm is raised. A hood 96 is provided for the projecting parts to prevent any operation of the valve by hand or by accident. This hood has openings for the escape of air. A similar hood may be provided for the mechanism shown in Figs. 6 to 8 to avoid this contingency. The positive pressure-relay is not changed in its construction and is shown in outline, both valves being placed upon the common base 81 and having a common supply. The operation of this construction is as follows: When the controlling-pipe *c c′*, and consequently the diaphragm-chamber, is placed in communication with the vacuum, the pressure of the atmosphere acting through the openings 89 89 on the inside of the diaphragm will lift said diaphragm and with it the rods 93 93 and the cross-bar 95, opening the valve. When said controlling-pipe is again placed in communication with the atmosphere, the spring 97, assisted by the pressure of the supply through the port 82, will close the valve and the diaphragm will drop. If, on the contrary, positive pressure above the atmosphere be introduced into the pipe *c c′*, no movement will take place, as the shoulders shown on the rods 93 will abut against the cover 88 and prevent any movement of the diaphragm.

Figs. 21 and 22 likewise show a modified and preferred form of the transfer-valve T. The casing is made in two parts, as shown, to permit assembling. The casing is provided with the inlet-port 98, the outlet-port 99, and the exhaust-ports 100 100 and 101 101. The inlet-port communicates with the vacuum-supply pipe p' through a suitable boss and port in the cover 102. The pipe d, leading to the indication-valve, communicates with the outlet-port 99 through a similar boss and port in said cover. Two connected valve-bodies 103 and 104 control the admission and exhaust, suitable seats being provided for them in the valve-casing, as shown. A spring 105 normally keeps the valve closed. The base of the valve 106, to which the casing is connected, forms the upper part of the diaphragm-chamber and is provided with openings 107 107 to permit the escape of the confined air. A stem 108 projects from the exhaust-valve body 103 through the cover 102. The diaphragm 109 is held between the base 106 and a cover 110, which is provided with an opening and a boss to which the pipe e (see Fig. 1) is attached. On this diaphragm loosely rests a plate 111, carrying two projecting rods 112 112, united by a cross-bar 113 similar to the construction shown in Figs. 19 and 20. The stem 108 loosely passes through this cross-bar and carries a nut or abutment to permit it to be lifted by this bar. With the parts in the position shown communication between 98 and 99, and therefore between p' and d, is closed by the valve 104, which is firmly pressed against its seat by the spring 105 and likewise by the atmospheric pressure entering through the exhaust-ports and acting against the vacuum existing in port 98 and its connected supply-pipe. When positive pressure is introduced under the diaphragm through the pipe e, said diaphragm and the plate 111, carrying with it the rods and cross-bar, will be lifted, thus opening the valve 104 and closing the exhaust. The ports 100 100 are provided to insure communication between the outlet-port 99 and the atmosphere when the valve is closed. A hood 114 is attached to the cover 102 to cover the projecting parts and prevent interference.

The operation of the parts is as follows: Referring first to Fig. 1, we will assume that it is desired to reverse the switch. The operator grasps the handle on the slide L, pulling it toward him until the roller carried by the piston P abuts against the shoulder in the slot Z shown. This will place the valve V from the position shown, A, Fig. 17, into the position C, Fig. 17, passing the position B. Port 67 of said valve will therefore place controlling-pipe c into communication with the positive pressure-pipe p through ports 61 64. Pressure will therefore be exerted on the diaphragms of the relay-valves S S'. As explained before, the valve S' will not be affected thereby; but the valve S will be opened, allowing pressure from the main supply p to enter the cylinder C back of the piston through its ports. (See Fig. 8.) This piston will be moved forward, carrying with it the motion-plate, and through the configuration of the slot s will first unlock the switch, the lug on the motion-plate passing out of the notch in the locking-bar B, and will then reverse said switch through the inclined portion of the slot, finally completing the operation by locking the switch through the second lug. The slot s' of the motion-plate has through its inclined portion at the beginning of the movement moved the indication-valve I (see Fig. 4 and Fig. 5) into a middle position in which all its ports are shut off from communication with each other. At the end of the stroke, however, the second inclined portion of said slot will move said valve to its extreme lower position in said figure. In this position said valve will form a communication between the pipe d', leading from the back of the cylinder and communicating with the supply, to the indication-pipe i. This pipe leads back to the tower and branches out under the diaphragms of the indicator relay-valves O O'. As noted above, O' will not be affected by this pressure; but O will be opened, allowing the air from b under pressure to enter below the piston P, lifting the roller on the piston away from the shoulder into the slot and completing the stroke of the slide L and the valve V automatically through the inclined portion of the slot Z. The valve V will now be in the position D, Fig. 17—that is to say, the supply will be shut off and the controlling-pipe c will be placed in communication with the atmosphere through the ports 68 69 65. The pressure in said pipe will therefore be restored to the normal, allowing the relay-valve S to close, shutting off the supply p from the cylinder and opening said cylinder to exhaust. The pipe d', and consequently through I the indication-pipe i, will also be placed in communication with the atmosphere, thereby allowing the relay O to close and to open the indication-cylinder to the atmosphere, thus restoring normal pressure in all the parts and completing the cycle. The interlocking bar has been carried along by the slot Z' and has likewise completed its movement, freeing the corresponding levers through the well-known Tappet interlocking movement. (Not shown.) To restore the switch to the position shown in the figure, the slide carrying the valve is pushed back until the roller of the piston P' abuts against the other shoulder of the slot Z. This will place the valve from the position D to the position B, passing over the position C, Fig. 17. Communication is now established between the controlling-pipe c and the vacuum-pipe p' through 62, 63, and 67. A vacuum, therefore, will be produced in the pipe c and the branches leading to the diaphragms of the relay-valves S S'. The relay-valve S will not be affected, as previously explained; but the pressure of the atmosphere acting on the diaphragm 35 through the openings 37 against the vacuum created will depress said diaphragm, carrying with it the lever 32, and consequently opening the relay-valve S′. Pressure from the supply p can now enter the cylinder C at its forward end, pushing back the piston and replacing the switch in the manner above described. At the same time pressure will enter the pipe e, lifting the diaphragm 55 of the transfer-valve T, Figs. 9 and 10, and opening a passage between the pipe p' and d. A vacuum will therefore take place in the pipe d; but it cannot enter the indication-pipe i until the switch has reached the extreme limit of its movement, placing the indication-valve I in such a position that d and i communicate through 73 75 77, Figs. 4 and 5. When this has taken place, the vacuum will transmit itself through the pipe i to the tower and through the branches of said pipe to the diaphragms of the relays O and O′. Here again O will not be affected. O′ will be opened in the manner above described, allowing air from p through b' to enter the indication-cylinder, pushing up its piston and completing the stroke in the manner aforesaid. The valve will now be in the position A, Fig. 17, communicating with the atmosphere through 64 70 68 65. Both supply-ports are shut off. Normal atmospheric pressure will consequently be restored in the controlling-pipe c, allowing the relay S′ to close in the manner described and to place the cylinder in communication with the atmosphere. The pipe e will therefore also be placed in communication with the atmosphere, and the spring 59, assisted by the vacuum in P′, will close the transfer-valve T, opening d, and consequently i, through I to the atmosphere. This will cause O′ to close, shutting off the supply and opening the indication-cylinder to the atmosphere, and all the parts will again be normal. The operation of the signal is similar; but as indication is necessary only for the normal position of said signal the construction is somewhat simplified.

Referring to Fig. 2, the parts are shown in their normal position with the signal at "danger." In order to place the signal at "safety," the operator grasps the slide L′ and pulls it toward him, together with the valve V′, to the extent limited by the end of the slot Z^2. This will place the valve in the position C, Fig. 17. The controlling-pipe c' will now be in communication with the vacuum-pipe p', which in this case leads to the port 61 and through said port 61 to the ports 64 and 67. A vacuum will therefore exist in said pipe and in the branches leading to the diaphragms of the relay-valves U U′, which valves are precisely similar in construction to the valves S S′ of the switch. As explained before, this will cause the valve U′ to open without affecting the valve U and will allow pressure from the pipe p to enter under the piston of the cylinder N, raising said piston and depressing the signal-blade. The moment the piston begins its upward movement the collar on the piston-rod will lift away from the lever J and the indication-valve Q will close, shutting off communication between f and i' and opening i' to the atmosphere through 80. The signal remains in this position as long as it is desired to hold it there, and no further movement of the lever takes place unless it be desired to indicate the safety position of the signal also in a similar manner, as both positions of the switch are indicated, in which case the switch construction is merely duplicated. To again place the signal at "danger," the operator pushes in the slide L′ until the roller on the piston P^2 abuts against the shoulder of the slot Z^2 and the valve V′ is brought to the position B, Fig. 17. Communication is now opened through 62, 63, and 67 between the controlling-pipe c' and the pressure-pipe. A vacuum still exists in the pipe c'; but as this pipe is now placed into communication with the full volume of the positive-pressure supply this vacuum will be quickly replaced by the positive pressure. This pressure in said pipe c' will, as explained before, open the relay-valve U without affecting the valve U′ and allow pressure to enter the top of the cylinder, depressing the piston, assisted by the counterweight of the signal-blade. At or near the horizontal position of the said blade the collar of the piston-rod will again strike the extremity of the lever J, opening the valve Q and allowing air under pressure to enter i' through f. The pressure in i' returning to the tower will open the relay-valve O^3, which is exactly similar in construction to U, and allow air from p to enter under the piston P^2, lifting the roller away from the shoulder and completing the stroke through the diagonal part of the slot Z^2. The valve will now be in the position A, Fig. 17. Both supply-ports will be shut off, and the controlling-pipe c' will be placed in communication with the atmosphere through 64 70 65 68. This allows the relay-valve U to close and the cylinder N to exhaust, as well as the indication-pipe i'. When the pipe i' has been restored to normal pressure, the relay-valve O^3 will close and the indication-cylinder will likewise exhaust.

Should it be desired to indicate the normal position of the signal by the vacuum, the vacuum-line may be carried to the signal, a transfer-valve similar to the one used in the switch movement inserted, and a vacuum-relay substituted for the positive-pressure relay O^3.

It will be understood that the construction shown in Figs. 18 to 20 for the vacuum-relay and in Figs. 21 and 22 for the transfer-valve may be substituted for the other constructions without any change in the cycle of operations.

Should it be desired in the switch movement to open the relay on one side by positive pressure and to indicate the corresponding completed movement through the vacuum, and vice versa, it would only be necessary to transpose the relative positions of the relays O O' and to insert the transfer-valve T in the pipe d' in the same manner in which it is now interposed between d and e.

The power directly actuating the switch or signal may be of whatever character desired—hydraulic or electric, for instance, as well as pneumatic—as any source of actuating power may be released in the manner shown, necessary changes of construction in the valves or other releasing mechanism being fully within the scope of ordinary mechanical skill.

It is evident that any other gaseous fluid may be substituted for atmospheric air as controlling or actuating power medium, the word "air" in the claims being used in its generic sense.

From this description of the apparatus it will be seen that if the vacuum-pressure is not used for indicating except in the switch movement the vacuum-line need not extend farther away from the tower than the farthest switch. Only one pipe is necessary for controlling both movements, and a single pipe likewise indicates both positions, and there is no danger of getting the levers "crossed"—that is to say, of having the lever at the tower in one position indicating a certain position of the switch, whereas the switch itself is in the other position. If, as in some similar apparatus, reliance is placed upon differential pressure or reduction of pressure to perform two movements through the same pipe, such reduction may take place accidentally without being controlled by the lever, and the movement of the switch may take place without a corresponding movement of the lever.

The details of the apparatus shown may be varied. The signal may be worked by a diaphragm instead of a cylinder. The relay-valves may be operated by a piston instead of a diaphragm. The indication-valve details may be different likewise, and the construction of the slide with its slots may be altered, all of these features being well known in the art and forming no part of my invention, the essential features of which are set forth in the following claims.

What I claim is—

1. In a power switch or signal apparatus, a switch or signal, a power-supply for said switch or signal and means actuated by atmospheric pressure against a vacuum to release said power-supply to operate the switch or signal.

2. In a power switch or signal apparatus, a switch or signal, a power-supply for said switch or signal and means actuated by atmospheric pressure against a vacuum to release said power-supply to operate the switch or signal in one direction only.

3. In a switch or signal apparatus, a switch or signal and means to indicate the position of said switch or signal by atmospheric pressure against a vacuum.

4. In a switch or signal apparatus, a switch or signal and means to indicate the position of said switch or signal by atmospheric pressure against a vacuum in one direction only.

5. In a power switch or signal apparatus, a switch or signal, means for controlling the movement of said switch or signal, and means to indicate the position of said switch or signal by atmospheric pressure against a vacuum, said indicating means acting upon the controlling means.

6. In a power switch or signal apparatus, a switch or signal, means for controlling the movement of said switch or signal and means to indicate the position of said switch or signal by atmospheric pressure against a vacuum in one direction only, said indicating means acting upon the controlling means.

7. In a switch or signal apparatus, a switch or signal, means for operating the same, a power-supply for indicating the position of said switch or signal after completed operation and means actuated by atmospheric pressure against a vacuum to release said power-supply to give said indication.

8. In a switch or signal apparatus, a switch or signal, means for operating the same, a power-supply for indicating the position of said switch or signal after completed operation and means actuated by atmospheric pressure against a vacuum to release said power-supply to give said indication in one direction only.

9. In a pneumatic switch or signal apparatus, a switch or signal, a motor for the switch or signal, a supply of air under pressure for operating said motor in both directions and means actuated by atmospheric pressure against a vacuum for releasing said supply to operate the motor in one direction only.

10. In a power switch or signal apparatus, a switch or signal, a supply of air above atmospheric pressure, a vacuum-supply and means for operating the switch or signal in one direction only by air above atmospheric pressure and in the other direction only by atmospheric pressure against the vacuum.

11. In a switch apparatus, a supply of air above atmospheric pressure, a vacuum-supply, means for indicating one position of the switch only by air above atmospheric pressure and means for indicating the other position of the switch only by atmospheric pressure against the vacuum.

12. In a pneumatic switch or signal apparatus, a switch or signal, a supply of air above atmospheric pressure, a vacuum-supply, a motor, connections between the motor and the switch or signal, and means to cause the motor to move in one direction only by the air above atmospheric pressure, and in the other direction only by atmospheric pressure against the vacuum.

13. In a power switch or signal apparatus, a switch or signal, a supply of air above atmospheric pressure, a vacuum-supply, a motor at the switch or signal, a controlling-station, a single air-carrying connection between the controlling-station and the motor, means at the motor for causing it to move in one direction only when air above atmospheric pressure is introduced into said single connection, means at the motor for causing it to move in the other direction only when said single connection is connected with the vacuum-supply and means at the controlling-station for alternately connecting said supply above atmospheric pressure or said vacuum-supply with the single connection.

14. In a power-switch apparatus, a switch, a supply of air above atmospheric pressure, a vacuum-supply, a motor for the switch, means for controlling the movement of the motor, mechanism actuated alternately by air above atmospheric pressure and by atmospheric pressure against the vacuum and operating upon said controlling means to indicate the position of said switch, a single air-carrying connection between said indicating mechanism and the switch, and means for alternately forming a connection between the supply of air above atmospheric pressure or the vacuum-supply with said single connection, according to the position of said switch.

15. In a pneumatic switch or signal apparatus, a switch or signal, a supply of air above atmospheric pressure, a vacuum-supply, a cylinder, a piston, connections from the piston to the switch or signal to operate the latter in either direction, valve mechanism to admit air above atmospheric pressure from the supply to either side of the piston alternately, a single pipe controlling said valve mechanism, means for connecting the supply of air above atmospheric pressure or the vacuum-supply alternately with said single pipe and means to operate the valve mechanism to admit air to one side of the piston only when the single pipe is connected with the supply of air above atmospheric pressure and to the other side of the piston only when said single pipe is connected to the vacuum-supply.

16. In a pneumatic switch or signal apparatus, a switch or signal, a supply of air above atmospheric pressure, a vacuum-supply, a cylinder, a piston, connections from the piston to the switch or signal to move the latter in either direction, two valves to admit air above atmospheric pressure from the supply to either side of the piston alternately, a single pipe controlling both valves, means for connecting the supply of air above atmospheric pressure or the vacuum-supply alternately with said single pipe, means to operate one of the valves through said single pipe by the air above atmospheric pressure without affecting the second valve, and means to operate said second valve through said single pipe by atmospheric pressure against the vacuum without affecting the first valve.

17. In a pneumatic switch or signal apparatus, a switch or signal, a cylinder, a piston for operating the switch or signal, a supply of air above atmospheric pressure, a vacuum-supply, two valves for admitting air above atmospheric pressure into said cylinder to opposite sides of said piston, two diaphragms for operating said valves, a single air-carrying connection leading to both diaphragms, means connecting one diaphragm and its valve to cause said valve to open to admit air to the cylinder only when air above atmospheric pressure is introduced into said connection, means connecting the other diaphragm and its valve to cause this latter valve to open to admit air to the cylinder only when the vacuum-supply is connected to said single connection and means to connect the single connection with the supply of air above atmospheric pressure or the vacuum-supply alternately.

18. In a pneumatic switch apparatus, a supply of air above atmospheric pressure, a vacuum-supply, a switch, a cylinder and piston for operating said switch, a controlling mechanism at the tower, indicating mechanism at the tower acting upon said controlling mechanism to indicate the position of the switch, a single pipe from the indicating mechanism to the switch, a slide-valve at the switch for alternately connecting two independent pipes with said single connection according to the position of the switch, a valve and diaphragm located between said pipes and cylinder, one of said pipes communicating with one end of the cylinder and the other of said pipes communicating with the outlet-port of said valve, the inlet-port communicating with the vacuum-supply, an air-passage leading from the other end of the cylinder into the air-chamber under the diaphragm and means connecting the diaphragm with the valve to open the latter and establish communication between the inlet and outlet ports when air above atmospheric pressure is introduced into said air-passage and to close said communication and open the outlet to the atmosphere through exhaust-ports in said valve when no pressure exists in said air-passage.

19. The combination in a pneumatic relay-valve of a valve for controlling the admission of air at a pressure different from that of the atmosphere, a diaphragm operated by air at a pressure also different from that of the atmosphere but on the other side of the atmospheric pressure-line from the pressure controlled by the valve, with means connecting the diaphragm with the valve for operating the latter.

20. The combination in a pneumatic relay-valve for controlling the admission of air at a pressure different from that of the atmosphere, of a valve-casing provided with suitable inlet, outlet, and exhaust ports, and with

valve-seats, an admission-valve body and an exhaust-valve body connected to move together and to suitably control communication between said ports, a diaphragm operated by air at a pressure also different from that of the atmosphere but on the other side of the atmospheric pressure-line from the pressure controlled by the valve, a stem projecting from the exhaust-valve body through the casing, a plate on the diaphragm, rods projecting from said plate outside of the ports, and a cross-bar attached to the rods and in line with the exhaust-valve stem for operating the valve-bodies from the diaphragm through the stem.

21. The combination in a pneumatic relay-valve for controlling the admission of air at a pressure different from that of the atmosphere, of a valve-casing provided with suitable inlet, outlet, and exhaust ports, and with valve-seats, an admission-valve body and an exhaust-valve body connected to move together and to suitably control communication between said ports, a diaphragm operated by air at a pressure also different from that of the atmosphere but on the other side of the atmospheric pressure-line from the pressure controlled by the valve, a stem projecting from the exhaust-valve body through the casing, a plate on the diaphragm, rods projecting from said plate outside of the ports, and a cross-bar attached to the rods and in line with the exhaust-valve stem for operating the valve-bodies from the diaphragm through the stem, and a hood attached to the casing to protect the projecting parts.

22. In railway signaling apparatus, means whereby one movement of the switch-points, signal, or other movable part and the indication of such movement is effected or controlled by a pressure above atmospheric pressure and the other or reverse movement is effected or controlled by suction or vacuum.

23. In pneumatic railway signaling, means whereby air-pressure in a pipe effects or controls one movement of the apparatus which movement effects or controls its own indication also by air-pressure in a pipe, and a vacuum or suction in the same pipe or pipes effects or controls the other or reverse movement of the apparatus and the indication of such movement, substantially as described.

In witness whereof I hereto affix my signature in presence of two witnesses.

WILLIAM J. BECKER.

Witnesses:
CARRIE McC. FITZGERALD,
CHARLES C. McCORD.