W. J. RICHARDS.

CONVERTIBLE SYSTEM OF PRESSURE OR VACUUM CONTROL.

APPLICATION FILED JAN. 25, 1905.

930,989.

Patented Aug. 10, 1909.

2 SHEETS—SHEET 1.

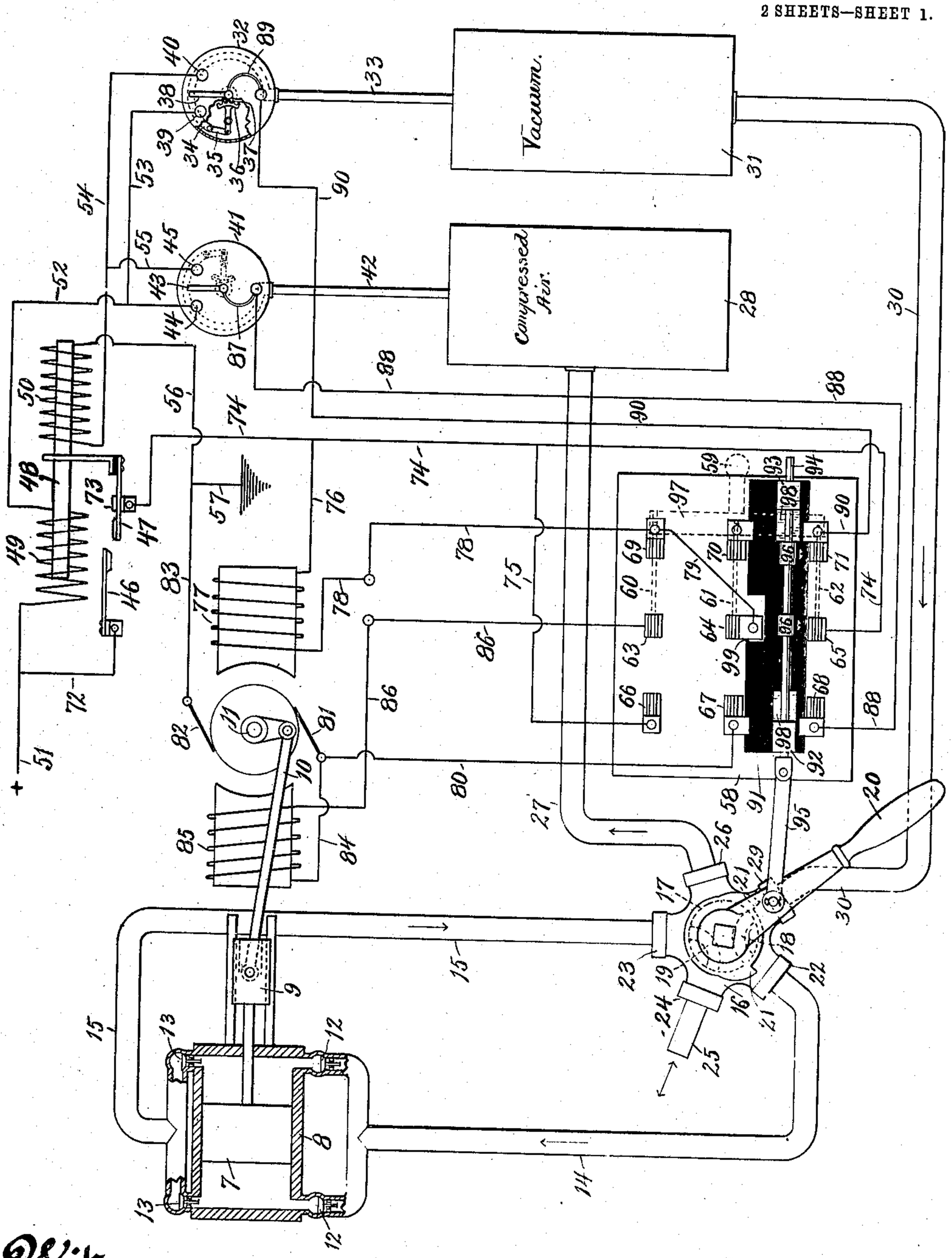

Fig. 1.

Witnesses
C. A. Kenney.
R. S. Caldwell.

Inventor.
Walter J. Richards.
By Benedict and Morsell.
Attorneys.

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2 SHEETS—SHEET 2.

Fig. 4.

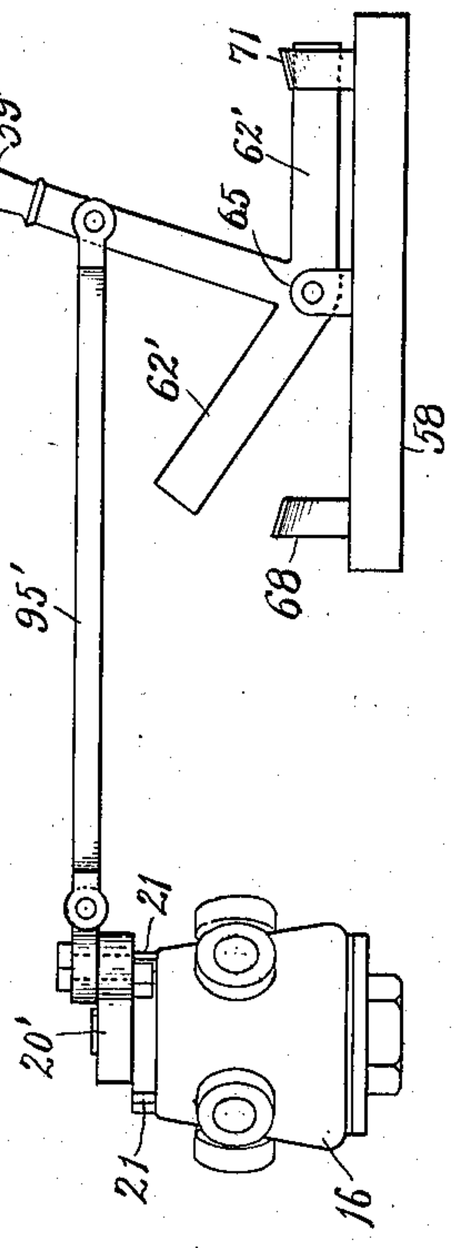


Fig. 3.

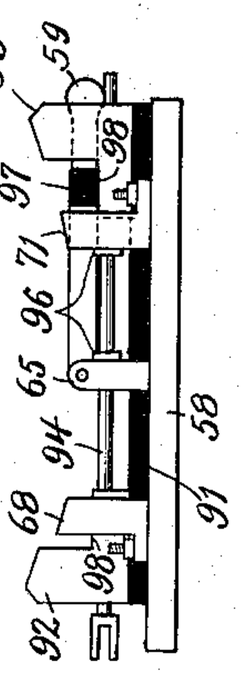
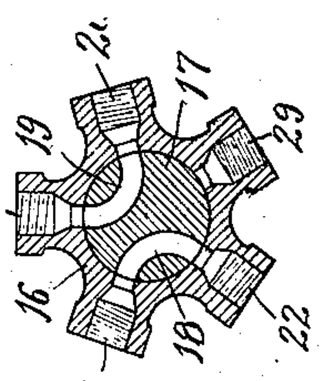


Fig. 2.



Witnesses.

C. N. Keeney.

R. S. Caldwell.

Inventor.

Walter J. Richards.

By Benedict and Morsell.

Attorneys.

UNITED STATES PATENT OFFICE.

WALTER J. RICHARDS, OF MILWAUKEE, WISCONSIN, ASSIGNOR TO NATIONAL BRAKE & ELECTRIC COMPANY, OF MILWAUKEE, WISCONSIN, A CORPORATION OF WISCONSIN.

CONVERTIBLE SYSTEM OF PRESSURE OR VACUUM CONTROL.

No. 930,989. Specification of Letters Patent. Patented Aug. 10, 1909.

Application filed January 25, 1905. Serial No. 242,616.

To all whom it may concern:

Be it known that I, WALTER J. RICHARDS, residing in Milwaukee, in the county of Milwaukee and State of Wisconsin, have invented new and useful Improvements in Convertible Systems of Pressure or Vacuum Control, of which the following is a description, reference being had to the accompanying drawings, which are a part of this specification.

This invention relates to convertible systems of pressure or vacuum control, and consists in a system and apparatus by which a pump may be operatively connected with either a compressed air system or a vacuum system, with automatic means for starting and stopping the operation of the pump in either case to maintain the compression or vacuum within predetermined limits.

This invention is designed for use wherever a single pumping mechanism is desired to supply air under compression at one time and to produce a vacuum at another time, particularly in the case of electric locomotives which are adapted to be connected at one time with a train equipped with a compressed air brake system and at another time with a train equipped with a vacuum brake system. In such cases it is necessary to provide a compressed air reservoir for use with the former brake system and a vacuum reservoir for use with the latter brake system, and it is a great convenience to be able to charge both of these reservoirs by means of the same pumping mechanism.

The control of the pumping mechanism for maintaining the pressure of air in the compressed air reservoir constant or practically so is accomplished by automatic means sensitive to the pressure in the reservoir, which will start the pumping mechanism in operation when the pressure reaches a predetermined minimum and will stop such operation of the pumping mechanism when the pressure reaches a predetermined maximum. As it is also desirable to similarly control the operation of the pumping mechanism when it is in connection with the vacuum reservoir, so that it will maintain a vacuum therein of a constant or practically constant degree, it is one of the objects of this invention to provide, in combination with a valve mechanism for making the necessary changes in the pneumatic connections to enable the pumping mechanism to be operatively connected with one reservoir or the other, a switch mechanism for changing the electrical connections of an electrical pump operating and controlling system, by means of which this desirable result may be accomplished.

Another object of this invention is to provide a switch mechanism for the above purpose which will connect in shunt with each other two or more field windings of a series wound pump operating motor, when said switch mechanism is in the position for effecting the compression regulation of the pumping mechanism, and which will connect said field windings of the series wound pump motor in series with each other when the switch mechanism is in the position for effecting the suction regulation of the pumping mechanism. By this means the pump operating motor is rendered capable of overcoming the greater resistance of back pressure during the compression operation thereof than it is subjected to during the suction operation, since the degree of compression necessary for the compressed air reservoir is considerably greater than the degree of suction necessary for charging the vacuum reservoir.

Another object of this invention is, in such a convertible system, to couple together the valve mechanism and the switch mechanism thereof, so that when the valve mechanism is in position to make the necessary connections between the pumping mechanism and the compressed air reservoir the switch mechanism can only be closed in the position for making the electrical connections for the operation and control of the pump motor for air compression, while the change to the other position of the valve mechanism will so affect the switch mechanism that it can only be closed to make the necessary connections for controlling and operating the motor for the vacuum operation of the pump.

Another object of the invention is to accomplish the last mentioned object by operatively connecting the valve mechanism with the switch mechanism, so that the change of position of one produces the proper change of position of the other.

With the above and other objects in view the invention consists in the system and

means for controlling pumps, the parts and combination of parts as herein set forth, and their equivalents.

Referring to the accompanying drawings in which like characters of reference indicate the same parts in the several views:—Figure 1 is a diagram showing the pneumatic and electrical connections of the several parts constituting the convertible system of pressure or vacuum control of this invention; Fig. 2 is a central sectional view of the five-way cock of the valve mechanism; Fig. 3 is a side elevation of the hand switch mechanism thereof; and, Fig. 4 is a side elevation of a modified form of hand switch mechanism and valve mechanism, showing an operative connection between them whereby the change of position of one produces the proper change of position of the other.

In these drawings 7 represents the piston of a pump which operates in a cylinder 8 and is connected to a cross head 9 having a pitman connection 10 with the crank 11 of a pump operating motor. The pump cylinder is provided with inlet valves 12 and outlet valves 13 at each end, the former being connected together by a forked suction pipe 14 and the latter being connected together by a forked discharge pipe 15.

A five-way cock 16 has five equi-distant pipe connections arranged radially thereabout, and its central valve plug 17 is provided with a pair of curved passageways 18 and 19 respectively, each adapted to connect the openings of two adjacent pipe connections together. A handle 20 is mounted on a squared end of the valve plug 17, by means of which said valve plug may be turned in its casing to change the position of the passageways 18 and 19 and cause them to connect the openings of different pairs of pipe connections. The movements of said handle 20 are limited by its engagement with a pair of stop shoulders 21 on the casing to determine the proper positions of the valve plug in which its passageways 18 and 19 exactly register with the openings of the pipe connections.

The suction pipe 14, above mentioned, connects with one of the pipe connections, 22, of the five-way cock and the discharge pipe 15 connects with another pipe connection, 23, thereof, there being a pipe connection 24 between pipe connections 22 and 23, which connects with the atmosphere, either direct or by way of a pipe 25. A pipe connection 26, next to the pipe connection 23, is connected by a pipe 27 with a compressed air reservoir 28, while the fifth pipe connection, 29, between pipe connections 26 and 22, connects by means of a pipe 30 with a vacuum reservoir 31.

The passageways 18 and 19 of the valve plug 17 are so located, that in one position of the handle 20, passageway 18 connects pipe conection 29 with pipe connection 22, establishing a through passage from the vacuum reservoir 31 to the inlet valves 12 of the pump, while passageway 19 connects pipe connection 23 with pipe connection 24, establishing a through passage from the outlet valves 13 of the pump to the atmosphere. These are the proper pneumatic connections for that condition of the system in which the pump is required to maintain a vacuum in the vacuum reservoir, by sucking air from the vacuum reservoir 31 through the pipes 30 and 14 and discharging it to the atmosphere through pipes 15 and 25. In the other position of the handle 20, passageway 18 connects pipe connection 24 with pipe connection 22, establishing a through passage from the atmosphere to the inlet valves 12 of the pump, while the passageway 19 connects pipe connection 23 with pipe connection 26, establishing a through passage from the outlet valves 13 of the pump to the compressed air reservoir 28. These are the proper pneumatic connections for that condition of the system in which the pump is required to charge the compressed air reservoir, by sucking in air from the atmosphere through pipes 25 and 14 and forcing it into the compressed air reservoir 28 through pipes 15 and 27. The position of the passageways 18 and 19 during the vacuum operation of the system is shown by dotted lines in Fig. 1, while the position thereof for the compression operation of the system is shown in Fig. 2.

The vacuum reservoir 31 is provided with a vacuum gage 32 connected thereto by means of a pipe 33. The gage 32 comprises a Bourdon spring tube 34, which communicates with the pipe 33 and has its closed free end connected by a link 35 with the outstanding arm of a pivoted segmental rack 36, meshing with a pinion 37 of a gage hand 38. The reduction in the degree of the vacuum in the vacuum reservoir 31, due to service use, causes the Bourdon tube 34 to straighten and swing the gage hand 38, by means of the segmental rack 36, to the left until it engages a minimum contact post 39 and makes an electrical contact therewith for starting the pump motor in operation by means to be later described. The increase in the degree of vacuum in the vacuum reservoir 31, as the air is drawn therefrom by the pump, causes the Bourdon tube 34 to contract and make the segmental rack 36 swing the gage hand 38 to the right, until it engages a maximum contact post 40 and makes an electrical contact therewith for stopping the operation of the pump motor by the said means to be later described.

The compressed air reservoir is provided with a pressure gage 41, connected thereto by means of a pipe 42, which gage is similar in all respects to the vacuum gage 32 of the

vacuum reservoir, except that its parts are reversed. By this arrangement the gage hand 43 is caused to swing to the left, as the air is drawn from the compressed air reservoir 28 by service use, until it engages with a minimum contact post 44 to make an electrical connection for starting the pump motor in operation, while the increase in pressure in the compressed air reservoir, due to the operation of the pump, causes the gage hand 43 to swing to the right and engage with a maximum contact post 45, for stopping the operation of the pump motor.

An automatic switch is provided for starting and stopping the pump motor, consisting of a stationary contact 46 and a movable contact 47, the latter being carried by a core 48 surrounded by a pair of oppositely disposed solenoids 49 and 50 respectively. The solenoid 49 is in a position to move the core 48 in the direction to bring the movable contact 47 into engagement with the stationary contact 46 for closing the motor circuit, and the solenoid 50 is in a position to move the core 48 in the opposite direction to cause it to withdraw the movable contact 47 from the stationary contact 46 for opening the motor circuit.

One terminal of a source of electrical supply, not shown, usually the trolley wire in the case of an electric locomotive, is indicated by the wire 51, the other terminal thereof being grounded. The motor switch closing solenoid 49 has one end connected to the trolley wire 51 and its other end connected by a wire 52 with the minimum contact post 44 of the pressure gage 41. A wire 53 connects said wire 52 with the minimum contact post 39 of the vacuum gage 32. The motor switch opening solenoid 50 has one end connected by means of a wire 54 with the maximum contact post 40 of the vacuum gage 32, and by means of a wire 55 leading from said wire 54, with the maximum contact post 45 of the pressure gage 41. The other end of solenoid 50 connects by means of a wire 56 to a ground connection 57.

A three-point, double-throw, knife switch is mounted on a switch board 58 and is adapted in one position, to make the necessary electrical connections for the system when operating as a vacuum controlling system, and is adapted in another position, to make the necessary electrical connections for the system when operating as an air pressure controlling system. The movable switch handle member 59 of the double-throw switch is shown in Fig. 1 in dotted lines, for convenience of illustration, in the proper position for operating the system as a vacuum controlling system. The three central contacts to which the movable member 59 has its three switch blades 60, 61 and 62, pivoted are marked 63, 64 and 65 respectively, while the three contacts for the switch at the compression end of the switch board, the left as shown in Fig. 1, are marked 66, 67 and 68 respectively, and those at the other end, the vacuum end of the switch board, are marked 69, 70 and 71 respectively.

The stationary contact 46 of the motor switch is connected by means of a wire 72 to the trolley wire 51, while the movable contact 47 thereof, being insulated from the core 48, slides in a contact guide 73 which is connected by means of a wire 74 with contact 65 of the switch board. A wire 75 connects said wire 74 with contact 66 of the switch board, while a wire 76 also connects wire 74 with one of the field windings 77 of the pump motor. The other end of said field winding 77 is connected by means of a wire 78 to the contact 69 of the switch board, which contact 69 is connected by means of a wire 79 with contact 64 of the switch board. A wire 80 connects one armature brush 81, of the pump motor with the contact 67 of the switch board, while the other armature brush 82 of said pump motor is connected by means of a wire 83 with the ground connection 57 before referred to. A wire 84 connects armature brush 81 with one end of another field winding, 85, of the pump motor, the other end of said field winding 85 being connected by means of a wire 86 to contact 63 of the switch board. The gage hand 43 of the pressure gage 41 connects by means of a flexible conductor 87 with a wire 88 leading to contact 68 of the switch board, while a similar flexible conductor 89 connects the gage hand 38 of the vacuum gage 32 with a wire 90 leading to contact 71 of the switch board. The contact 70 of the switch board is not used to make electrical connections.

The operation of the system, so far as the electrical circuits are concerned, is as follows: The switch handle 59 of the three-point double-throw switch being thrown to the right, as shown by dotted lines in Fig. 1, for the vacuum control operation of the system, and the vacuum gage 32 indicating a minimum degree of rarefaction of the air in the vacuum reservoir 31 by the gage hand 38 contacting with the minimum contact post 39, current will flow from the trolley wire 51, through the motor switch closing solenoid 49, the wires 52 and 53, the contact made between the contact post 39 and the gage hand 38, through the wires 89 and 90 to the contact 71 of the switch board, across the switch blade 62 to the contact 65, through wires 74 and 76 to the motor field winding 77, back to the switch board by way of wire 78 to contact 69, across the switch blade 60 to contact 63, through wire 86 to the other motor field winding 85, to brush 81 by wire 84, through the armature of the motor to

brush 82, and by way of wire 83 to the ground connection 57.

Current passing through the motor switch closing solenoid 49, included in the circuit thus established by the closing of the contact between gage hand 38 and contact post 39, causes the core 48 to move to the left and bring the movable contact 47 into engagement with the stationary contact 46, thereby closing the motor switch to establish a direct circuit through the motor. Current now passes from trolley wire 51, through wire 72, and the engaged switch contacts 46 and 47, through the contact guide 73 and wires 74 and 76, to the motor field winding 77, by wire 78 to the contact 69 of the switch board, across the switch blade 60 to contact 63, through wire 86 to the other motor field winding 85, by wire 84 to brush 81 of the motor armature, through the armature to the other brush 82 thereof, and by wire 83 to the ground connection 57.

The connection made by the motor switch contacts 46 and 47 establishes the motor operating circuit, just described, with the two field windings of the pump motor in series with each other and with the armature of said motor, and the motor is thereby caused to operate the pump to pump air from the vacuum reservoir 31 to the atmosphere, until the predetermined maximum degree of vacuum has been attained in the vacuum reservoir 31 and the gage hand 38 of the vacuum gage 32 contacts with the maximum contact post 40 as the result. This contact between the gage hand 38 and the maximum contact post 40 establishes a circuit through the motor-switch-opening solenoid 50 by current passing from the trolley wire 51, through wire 72, across the engaged motor switch contacts 46 and 47, through the contact guide 73 and wire 74 to contact 65 of the switch board, across the switch blade 62 to contact 71, by way of wires 90 and 89 to the gage hand 38, across the contact made thereby with the maximum contact post 40, through wire 54 to solenoid 50, and by wire 56 to the ground connection 57.

The motor-switch-opening solenoid 50 being energized, moves the core 48 to slide contact 47 away from the stationary contact 46, and thereby open the motor switch to deprive the motor of its current and stop its operation of the pump. This automatic starting and stopping of the pump motor at the predetermined minimum and maximum degrees of vacuum contained in the vacuum reservoir 31 will be repeated to maintain an approximately constant degree of vacuum for vacuum service purposes.

When the handle 59 of the three-point double-throw switch is thrown to the left, or to the compression position, opposite to that in which it is shown in dotted lines in Fig. 1, the vacuum gage hand is no longer in connection and the pressure gage 41 becomes operative for controlling the operation of the pump motor instead. Now, when the gage hand 43 indicates a predetermined minimum degree of compression in the compressed air reservoir 28 by contacting with the minimum contact post 44, the motor-switch-closing solenoid 49 is energized, by current passing from the trolley wire 51 through said motor-switch-closing solenoid 49 and the wire 52 to the minimum contact post 44, across the contact made by the gage hand 43 therewith, through the wires 87 and 88 to the contact 68 of the switch board, across the switch blade 62 to the contact 65, through wires 74 and 75 to contact 66, across switch blade 60 to contact 63, through wire 86 to motor field winding 85, by wire 84 to the armature brush 81, through the armature to the other brush 82 thereof, and by way of wire 83 to the ground connection 57. Incidentally there is a branch circuit from the one just traced which connects the field winding 77 of the motor in shunt with the field winding 85, this branch circuit leading from wire 74 through wire 76 and the field winding 77, by way of wire 78 to the contact 69, across wire 79 to contact 64, through the switch blade 61 to contact 67, and by way of wire 80 to the armature brush 81 where it returns to the circuit formerly described.

The motor-switch-closing solenoid 49, being energized by current passing through this circuit, attracts the core 48 and causes it to move the contact 47 into engagement with the stationary contact 46, as before, to complete a direct motor circuit, which, however, differs somewhat from the motor circuit before established by the closing of this motor starting switch, because of the different position of the double-throw switch. Now the motor circuit passes from the trolley wire 51, through wire 72 and the engaged contacts 46 and 47, through the contact guide 73 and wire 74 to wire 76, through the motor field winding 77 and wire 78 to contact 69 of the switch board, over wire 79 to contact 64, across switch blade 61 to contact 67, by wire 80 to brush 81 of the motor armature, through said armature to the other brush 82 thereof, and by wire 83 to the ground connection 57. The circuit just traced includes the field winding 77 in series with the armature of the motor, but the field winding 85, instead of being in series with the field winding 77, as before, is now in shunt therewith, since the circuit divides at the point where wire 76 leads from wire 74, and besides that portion of the current which passes by way of wire 76 through the motor field winding 77, another portion thereof continues along wire 74 to wire 75 and contact 66 of the switch

board, then across switch blade 60 to contact 63, through wire 86 to the other motor field winding 85, and through wire 84 to armature brush 81, where it rejoins that portion of the current which has passed through the motor field winding 77, and of course continues therewith through the armature of the motor to the other brush 82 thereof, and by way of wire 83 to the ground connection 57.

The pump motor will continue to operate with the circuit above described causing the pump to compress air into the reservoir 28 until the maximum pressure of said reservoir is reached and causes the pressure gage hand 43 to contact with its maximum contact post 45 and establish a circuit through the motor-switch-opening solenoid 50 to open the motor switch and stop the operation of the pump. This contact of the pressure gage causes current to pass from the trolley wire 51, through wire 72 and the engaged switch contacts 46 and 47, through contact guide 73 and wire 74 to contact 65 on the switch board, across switch blade 62 to contact 68, through wires 88 and 87 to gage hand 43, across the contact made thereby with the maximum contact post 45, through wires 55 and 54 to solenoid 50, and by wire 56 to the ground connection 57.

From the foregoing it will be seen that while the pump motor operates as a series wound motor when connected for either the vacuum control operation of the system or the air pressure control operation of the system, in the former case its two field windings 77 and 85 are in series with each other and in the latter case the said field windings 77 and 85 are in shunt with each other, so that the power of the motor is increased in the latter case for overcoming the greater resistance of the back pressure during the compression operation than it is subjected to during the vacuum operation. This change of connection of the field windings has for its object the keeping of the speed of the motor within reasonable limits when operating under the light load during the vacuum connection.

Should the double-throw switch 59 be thrown to the vacuum position while the five-way cock was in the compression position, there would be no control over the operation of the motor, since the pressure gage 41 would not be in electrical connection, and therefore the compressed air in reservoir 28 would be allowed to become entirely exhausted by service use if the vacuum gage hand 38 were not in contact with its minimum contact post 39 to produce the operation of the pump motor, and on the other hand if the motor were caused to operate by such contact of the vacuum gage, it would continue to pump air into the compressed air reservoir, beyond the maximum compression which the pressure gage would have permitted, and possibly result in the destruction of some part of the apparatus. The foregoing is also true of the reverse connections, when the switch mechanism is closed to the compression position while the five-way cock is set for the vacuum position. Therefore, it is important that some means be adopted to prevent the switch mechanism being closed to make the electrical connections for one operation of the system when the five-way cock is set for another operation thereof.

With the above object in view the switch mechanism is preferably provided with a blocking means in connection with the five-way cock, adapted to be automatically moved to block the closing of the switch member 59 in one position or the other, as the five-way cock handle 20 is moved from one position to the other, and thereby prevent the switch being closed to the vacuum position when the five-way cock is in the compression position and vice versa. The blocking means comprises a slide 91 of insulating material, such as vulcanized fiber, which is slidable longitudinally upon the switch board 58 between the contacts 67, 64 and 70 and the contacts 68, 65 and 71, and is guided in its movements by overhanging projections on some of these contacts. At the ends of the sliding plate 91 are fixed blocking lugs 92 and 93 respectively through which slides a rod 94 connected by means of a link 95 with the handle 20 of the five-way cock, so that the movements of the handle 20, as the five-way cock is turned from one position to the other, cause the rod 94 to slide lengthwise through the blocking lugs. A pair of set stops 96 are mounted on the rod 94 in positions to engage the inner ends of the blocking lugs 92 and 93 respectively during the movements of the rod 94, and cause the slide plate 91 to move with the rod 94 a slight distance at the end of the movement of said rod in either direction, so as to change the positions of the blocking lugs 92 and 93. The positions of the said stops 96 on the rod 94 allow of a sufficient loose movement of said rod in either direction before the engagement of one of said stops with one of the blocking lugs 92 or 93, to nearly complete the change in position of the five-way cock before causing the movement of the slide plate 91. By this means the change in position of the slide serves as an indicator to inform the operator when the change in position of the five-way cock is complete and prevents the closing of the switch until such change of position of the five-way cock is effected. By this means, when the five-way cock lever 20 is thrown from one position to another, the slide 91 is automatically moved from one position to the other to bring one or the

other of the blocking lugs 92 and 93 thereof, to a position where it will stand in the path of the cross bar 97 of the switch handle 59 and prevent said handle moving the switch blades into engagement with the switch contacts on that end of the switch board. Thus, when the five-way cock is in position for making the pneumatic connections for the vacuum regulation, the switch handle 59 is prevented by the blocking lug 92 standing in the path of its cross bar 97, as shown in Fig. 1, from being closed to the position for making the electrical connections for the compression operation of the system, and when the five-way cock is in the opposite position, for making the pneumatic connections for the compression regulation, the blocking lug 93 stands in the path of said cross bar 97 of the switch handle 59, so that said switch can not be closed to make the electrical connections for the vacuum operation of the system.

Each of the blocking lugs 92 and 93 has its inner end cut away to form a shoulder 98 for engaging and limiting the movement of the cross bar 97 of the switch handle 59 when said switch is being closed. The slide plate 91 has a cut away portion 99 to form shoulders for engaging the opposite sides of contact 64 and limiting the movement of the plate in its slidable mounting. The construction of this blocking means is such, that for converting the system from a pressure controlling system to a vacuum controlling system, or vice versa, the switch 59 must first be opened to allow the motor to come to a stop, if it is then in operation. An attempt to change the five-way valve without first opening the switch would be checked as soon as the loose movement of rod 94 were taken up, since a stop 96 would engage with the blocking lug opposite the switch, and as the slide plate can not move with it, being held by the other blocking lug engaging with the switch, the valve is prevented from moving farther and has not yet opened the connections for the change of operation of the system. Therefore the operator is first required to open the switch to release the valve and allow the motor to slow down, then change the valve to move the blocking means from the path of the switch, and finally close the switch to its new position, the old position being blocked.

The modification shown in Fig. 4 illustrates another method by which the switch mechanism and the valve mechanism are prevented from being set for different operations of the system, and in addition provides for the simultaneous operation of the two mechanisms. In this construction the movable member 59′ of the switch has its switch blades projecting on each side of the handle proper to form an anchor shaped switch member, each of the switch blades 60, 61 and 62 being duplicated as shown by the blades 62′, so that the handle 59′ is only required to move through a small arc in order to disengage the switch blades from one set of contacts and engage them with the other set of contacts. The five-way cock is only altered from the five-way cock of the construction before described by having a crank arm 20′ instead of the handle 20, which crank arm 20′ is connected to the switch handle by means of the jointed link 95′. With this construction, the change of position of the switch mechanism, by throwing the switch handle 59′ from one position to another, besides changing the electrical connections from those for one operation of the system to those of the other, also, through the medium of the link 95′, changes the position of the five-way cock to change the pneumatic connections from those of one operation of the system to those of the other. Aside from this simultaneous operation of the switch mechanism and the valve mechanism, this modification is identical with the construction previously described.

The vacuum reservoir having for its purpose to contain a vacuum, so that when connected with a vacuum brake system or other vacuum service it will constitute a source of vacuum supply therefor, by drawing air therefrom, is herein referred to as being charged when the degree of vacuum contained in it is increased by the pump operating to pump air therefrom. Correspondingly, the terms maximum and minimum, as applied to the vacuum gage, refer to maximum and minimum degrees of vacuum and not to maximum and minimum pressures.

The term gage as employed herein with reference to the pressure gage or the vacuum gage is intended to include all devices sensitive to variations in fluid pressure by which the necessary contacts may be made, and the claims are to be read with this understanding. For convenience the swinging parts of the three-point double-throw knife switch, including the switch blades, are referred to as the switch member, and as this member must be in one of its two closed positions in order that the system may be operative, these positions are intended when it is said that the operation of the switch depends upon the operation of the five-way cock or vice versa, and when the switch is said to be changed from one position to another the change from one operative position to the other operative position is meant.

What I claim as my invention is:—

1. A convertible system of fluid pressure or vacuum supply, comprising a pump, a suction pipe leading to the inlet valves of the pump, a discharge pipe leading from the outlet valves of the pump, a compressed air reservoir, having a compressed air pipe connected therewith, a vacuum reservoir having

a vacuum pipe connected therewith, and means for connecting the several pipes with each other and with the atmosphere to make the necessary connections between the pump and the compressed air reservoir for causing the pump to charge the compressed air reservoir or for making the necessary connections between the vacuum reservoir and the pump for causing the pump to charge the vacuum reservoir.

2. A convertible system of fluid pressure or vacuum supply, comprising a motor operated pump, a suction pipe connected to the inlet valves of the pump, a discharge pipe connected to the outlet valves of the pump, a compressed air reservoir, a compressed air pipe connected therewith, a vacuum reservoir, a vacuum pipe connected therewith, and a five-way cock having connection with all of the said pipes and with the atmosphere, adapted in one position to connect the vacuum pipe with the suction pipe and the discharge pipe with the atmosphere for causing the pump to charge the vacuum reservoir, and adapted in another position to connect the atmosphere with the suction pipe and the discharge pipe with the compressed air pipe for causing the pump to charge the compressed air reservoir.

3. A convertible system of pressure or vacuum control, comprising a motor operated pump, a compressed air reservoir and a vacuum reservoir, a valve for operatively connecting one reservoir or the other with the pump, an automatic switch for closing and opening the motor operating circuit of the pump motor, a pressure gage sensitive to pressure in the compressed air reservoir adapted to make electrical connections to cause the automatic switch to close and open the motor circuit at the minimum and maximum pressures respectively within the compressed air reservoir, a vacuum gage sensitive to the degree of vacuum in the vacuum reservoir and adapted to make electrical connections to cause the automatic switch to close and open the motor circuit at the minimum and maximum degrees of vacuum respectively in the vacuum reservoir, and a switch for rendering either the pressure gage or the vacuum gage inoperative for the control of the automatic switch.

4. A convertible system of pressure or vacuum control, comprising a motor operated pump, a compressed air reservoir and a vacuum reservoir having connection with the pump, a valve mechanism for rendering ineffective either the connection of the compressed air reservoir with the pump or the connection of the vacuum reservoir with the pump, an automatic switch for closing and opening the motor operating circuit of the pump motor, a pressure gage connected to the compressed air reservoir and adapted to make electrical connections to cause the automatic switch to close the motor circuit when the pressure of the air in the compressed air reservoir reaches the minimum and to open the motor circuit when the pressure in the compressed air reservoir reaches the maximum, a vacuum gage connected to the vacuum reservoir and adapted to make electrical connections to cause the automatic switch to close the motor circuit when the degree of vacuum in the vacuum reservoir reaches the minimum and to open the motor circuit when the degree of vacuum in the vacuum reservoir reaches the maximum, and a switch for rendering ineffective the electrical connections made by either the pressure gage or the vacuum gage, said switch being so related to the valve mechanism that the valve mechanism when in position for connecting the vacuum reservoir with the pump prevents the switch being operated to cause the connections made by the pressure gage to become effective and when in position for connecting the compressed air reservoir with the pump prevents the switch being operated to cause the connections made by the vacuum gage to become effective.

5. A convertible system of pressure or vacuum control, comprising a motor operated pump, a five-way cock to which the suction and discharge valves of the pump are connected, a compressed air reservoir and a vacuum reservoir connected to the five-way cock, one of the ports of the five-way cock being connected to the atmosphere, said five-way cock being adapted in one position to connect the vacuum reservoir with the suction valves of the pump and the discharge valves of the pump to the atmosphere and in its other position to connect the compressed air reservoir with the discharge valves of the pump and the suction valves of the pump with the atmosphere, an automatic switch for closing and opening the motor circuit of the pump motor, a pressure gage connected to the compressed air reservoir and adapted to make electrical connections for causing the automatic switch to close and open the motor circuit at the minimum and maximum pressures respectively of the compressed air reservoir, a vacuum gage connected to the vacuum reservoir and adapted to make electrical connections to cause the automatic switch to close and open the motor circuit at the minimum and maximum degrees of vacuum respectively contained in the vacuum reservoir, and a switch for rendering ineffective the connections made by either gage.

6. In a convertible system of pressure or vacuum control, comprising a motor operated pump, a compressed air reservoir and a vacuum reservoir having operative connections with the pump, a valve mechanism adapted to render ineffective the pump connections of the compressed air reservoir in

one position and the pump connections of the vacuum reservoir in another position, an automatic switch for closing and opening the motor circuit of the pump motor, a pressure gage connected to the compressed air reservoir and adapted to make electrical connections to cause the automatic switch to close and open the motor circuit at the minimum and maximum pressures respectively of the compressed air reservoir, a vacuum gage connected to the vacuum reservoir and adapted to make electrical connections to cause the automatic switch to close and open the motor circuit at the minimum and maximum degrees of vacuum respectively in the vacuum reservoir, and a switch mechanism adapted to render ineffective the electrical connections made by either the pressure gage or the vacuum gage and also included in the motor circuit.

7. A convertible system of pressure or vacuum control, comprising a motor driven pump, a compressed air reservoir and a vacuum reservoir having operative connections with the pump, a valve mechanism to render ineffective the pump connections of the compressed air reservoir in one position and to render ineffective the pump connections of the vacuum reservoir in another position, an automatic switch for closing and opening the motor circuit of the pump motor, a pressure gage connected to the compressed air reservoir and adapted to make electrical connections to cause the automatic switch to close and open the motor circuit at the minimum and maximum pressures respectively in the compressed air reservoir, a vacuum gage connected to the vacuum reservoir and adapted to make electrical connections to cause the automatic switch to close and open the motor circuit at the minimum and maximum degrees of vacuum respectively in the vacuum reservoir, and a switch mechanism for closing the electrical connection to one gage in one position and for closing the electrical connection to the other gage in another position, said pump motor having its windings connected with the switch mechanism so that they will be connected in one manner in one position of the switch mechanism and will be connected in a different manner in the other position of the switch mechanism.

8. A convertible system of pressure or vacuum control, comprising a motor driven pump, a compressed air reservoir and a vacuum reservoir having operative connections with the pump, a valve mechanism for rendering ineffective the pump connections of the compressed air reservoir in one position and for rendering ineffective the connections of the vacuum reservoir in another position, an automatic switch for closing and opening the motor circuit of the pump motor, a pressure gage connected to the compressed air reservoir and adapted to make electrical connections for causing the automatic switch to close and open the motor circuit at the minimum and maximum pressures respectively of the compressed air reservoir, a vacuum gage connected to the vacuum reservoir and adapted to make electrical connections to cause the automatic switch to close and open the motor circuit at the minimum and maximum degrees of vacuum respectively of the vacuum reservoir, and a switch mechanism adapted to make electrical connection for the pressure gage in one position and to make electrical connection for the vacuum gage in the other position, said pump motor having its field windings connected to the switch mechanism so that they will be connected in series with each other in one position of the switch mechanism and will be connected in shunt with each other in the other position of the switch mechanism.

9. A convertible system of pressure or vacuum control, comprising a motor driven pump, a five-way cock with which the pump connects, a compressed air reservoir and a vacuum reservoir connected to the five-way cock, said five-way cock adapted in one position to operatively connect the compressed air reservoir with the pump, and in the other position to operatively connect the vacuum reservoir with the pump, an automatic switch adapted to connect and disconnect the motor circuit of the pump motor and having a switch closing solenoid and a switch opening solenoid, a pressure gage connected to the compressed air reservoir adapted to establish a circuit through the switch closing solenoid and through the switch opening solenoid at the minimum and maximum pressures respectively of the compressed air reservoir, a vacuum gage connected to the vacuum reservoir and adapted to establish a circuit through the switch closing solenoid and the switch opening solenoid at the minimum and maximum degrees of vacuum respectively of the vacuum reservoir, a switch mechanism for completing the circuit of the pressure gage in one position and for completing the circuit of the vacuum gage in another position, the field windings of the pump motor being connected to the switch mechanism so that they will be connected in series with each other in one position of the switch mechanism and in shunt with each other in the other position of the switch mechanism, and means for determining the operative position of the switch mechanism by the operative position of the five-way cock.

10. A convertible system of pressure or vacuum control comprising a motor driven pump, a five-way cock with which the pump is connected, a compressed air reservoir and a vacuum reservoir connected to the five-

way cock, said five-way cock being adapted to operatively connect the compressed air reservoir with the pump in one position and to operatively connect the vacuum reservoir with the pump in another position, an automatic switch for closing and opening the motor circuit of the pump motor, a pressure gage connected to the compressed air reservoir adapted to make electrical connections for closing and opening the automatic switch at the minimum and maximum pressures respectively in the compressed air reservoir, a vacuum gage connected to the vacuum reservoir and adapted to make electrical connections for causing the automatic switch to close and open the motor circuit at the minimum and maximum degrees of vacuum respectively in the vacuum reservoir, a switch mechanism adapted to complete the circuit to the pressure gage in one position and to complete the circuit to the vacuum gage in another position, the field windings of the pump motor being connected to the switch mechanism so that in one position of the switch mechanism they are connected in series with each other and in the other position of the switch mechanism they are connected in shunt with each other, a slide mounted on the switch mechanism having a pair of blocking lugs thereon, a rod slidable through the blocking lugs, set stops on the rod for permitting loose movement of the rod and for engaging the blocking lugs to cause the slide to move, and a link connecting the rod with the five-way cock so that in one position of the five-way cock one of the blocking lugs prevents the switch mechanism being closed in one position and in the other position of the five-way cock the other blocking lug prevents the switch mechanism being closed in the other position.

11. A convertible system of fluid pressure or vacuum control, comprising a motor operated pump, a suction pipe connected to the inlet valves of the pump, a discharge pipe connected to the outlet valves of the pump, a compressed air reservoir, a vacuum reservoir, a five-way cock having connection with the atmosphere with the suction and discharge pipes and with the compressed air and vacuum reservoirs adapted in one position to connect the vacuum reservoir with the suction pipe and the discharge pipe with the atmosphere for causing the pump to charge the vacuum reservoir and adapted in another position to connect the atmosphere with the suction pipe and the discharge pipe with the compressed air reservoir for causing the pump to discharge said compressed air reservoir, a double throw switch, means for controlling the operation of the pump by variations of conditions in the compressed air reservoir and the vacuum reservoir respectively and having connection with the double throw switch, said double throw switch being adapted to establish the vacuum control connections when closed on one side and to establish the compressed air control connections when closed on the other side, a slide plate, blocking lugs thereon adapted to stand in the path of the double throw switch to prevent its closing on one side in one position of the slide plate and adapted to prevent its closing on the other side in another position of the slide plate, and means for connecting the slide plate with the five-way cock.

12. A convertible system of fluid pressure and vacuum control, comprising a motor operated pump, a suction pipe connected to the inlet valves of the pump, a discharge pipe connected to the outlet valves of the pump, a compressed air reservoir, a vacuum reservoir, a five-way cock having connection with the atmosphere with the suction and discharge pipes and with the compressed air and vacuum reservoirs adapted in one position to connect the vacuum reservoir with the suction pipe and the discharge pipe with the atmosphere for causing the pump to charge the vacuum reservoir and adapted in another position to connect the atmosphere with the suction pipe and the discharge pipe with the compressed air reservoir for causing the pump to charge said compressed air reservoir, a double throw switch, means for controlling the operation of the pump by variations of conditions in the compressed air reservoir and the vacuum reservoir respectively and having connection with the double throw switch, said double throw switch adapted to establish the vacuum control connections when closed on one side and to establish the compressed air control connections when closed on the other side, a slide plate, blocking lugs thereon adapted to stand in the path of the double throw switch to prevent its closing on one side in one position of the slide plate and to prevent its closing on the other side in another position of the slide plate, a rod slidable through the blocking lugs, stops thereon to engage the blocking lugs and cause the slide to move, and a connection between the rod and the five-way cock whereby the change in position of the five-way cock changes the position of the blocking lugs, thus requiring a change in position of the double throw switch before the change in position of the five-way cock may be effected.

13. A double throw switch, comprising a member adapted to swing from one position to another, contacts adapted to be engaged by the member in its different positions, a blocking device to prevent the closing of the switch member in one position or the other thereof, and means for moving the blocking device for removing the bar to the closing of the switch in one position and sub-

stitute a bar to the closing of the switch in another position.

14. A double throw switch, comprising a switch base, a switch member mounted to swing thereon, contacts on the switch base adapted to be engaged by the switch member in different positions thereof, a blocking mechanism comprising a slide plate slidably mounted on the switch base, blocking lugs carried thereby and adapted to stand in the path of the switch member to prevent the closing thereof on one side in one position of the slide plate and to prevent the closing thereof on the other side in another position of the slide plate, and means for moving the slide plate.

15. A double throw switch, comprising a switch base, a switch member mounted to swing thereon, contacts on the switch base adapted to be engaged by the switch member when closed on either side, a slide plate slidably mounted on the switch base and guided by the contacts, blocking posts on the slide plate to prevent the switch member being closed on one side in one position of the slide plate and to prevent the switch member being closed on the other side in another position of the slide plate, and means for moving the slide plate.

16. A double throw switch, comprising a switch base, a switch member mounted to swing thereon, contacts adapted to be engaged by the switch member when closed on one side or the other, a slide plate slidably mounted on the switch base, blocking lugs on the slide plate to prevent the switch member being closed on one side in one position of the slide plate and adapted to prevent the switch member being closed on the other side in another position of the slide plate, a rod slidably mounted on the slide plate, stops thereon to engage the blocking lugs and cause the movement on the slide plate, and means for moving the rod.

17. A double throw switch, comprising a switch base, a switch member mounted to swing thereon, contacts adapted to be engaged by the switch member when closed on either side, a slide plate slidably mounted on the switch base, blocking lugs on the slide plate to prevent the closing of the switch member on one side in one position of the slide plate and to prevent the closing of the switch member on the other side in another position of the slide plate, stop shoulders on the blocking lugs adapted to limit the movement of the switch member when said switch member is closing, a rod slidably mounted through the blocking lugs, adjustable stops on the rod to engage the blocking lugs and cause the slide plate to move, and means for moving the rod.

In testimony whereof, I affix my signature, in presence of two witnesses.

WALTER J. RICHARDS.

Witnesses:

R. S. C. CALDWELL,

ANNA F. SCHMIDTBAUER.