No. 887,252. PATENTED MAY 12, 1908.

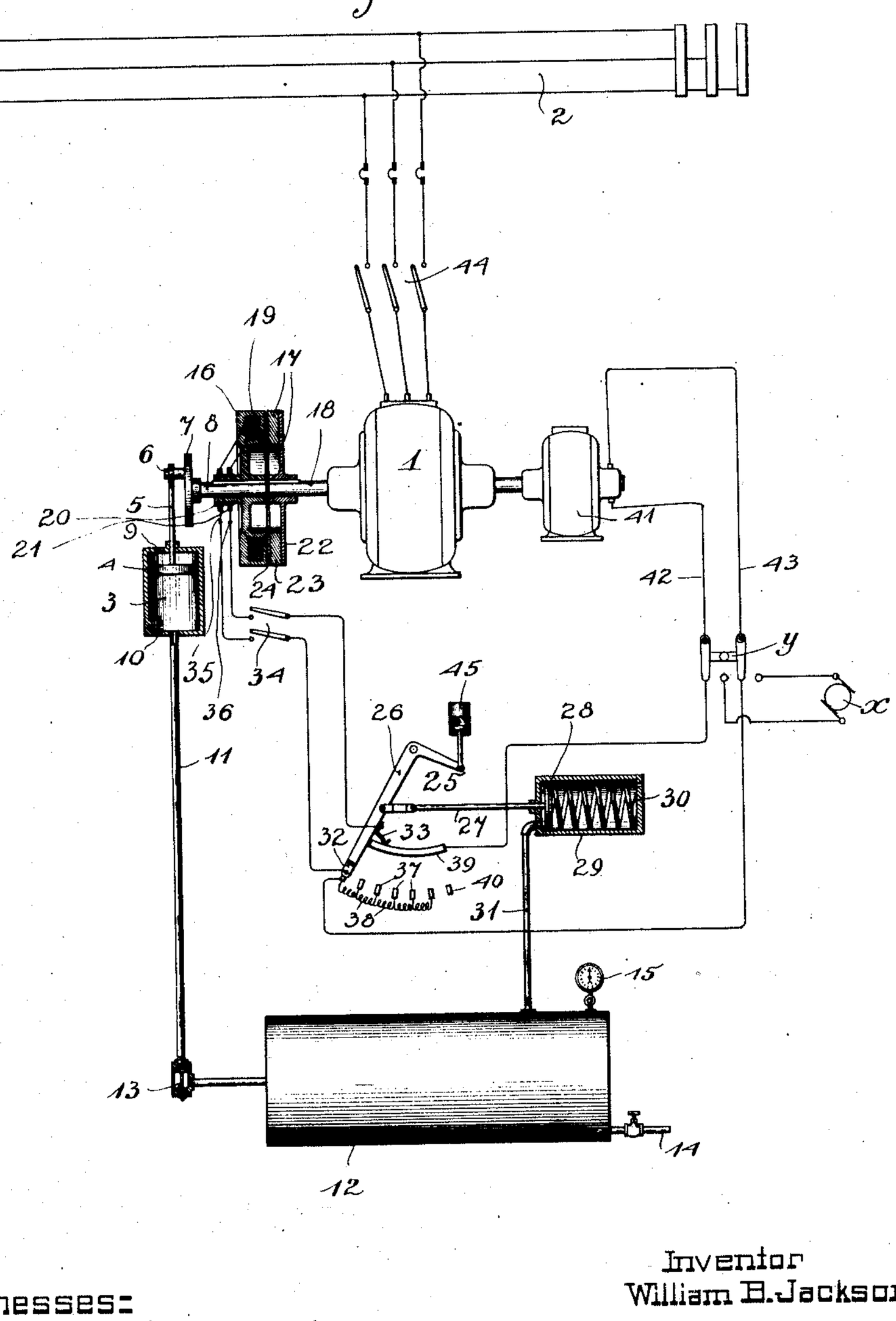
W. B. JACKSON.

CONTROLLING SYSTEM.

APPLICATION FILED SEPT. 16, 1905.

3 SHEETS—SHEET 1.

Fig. 1.



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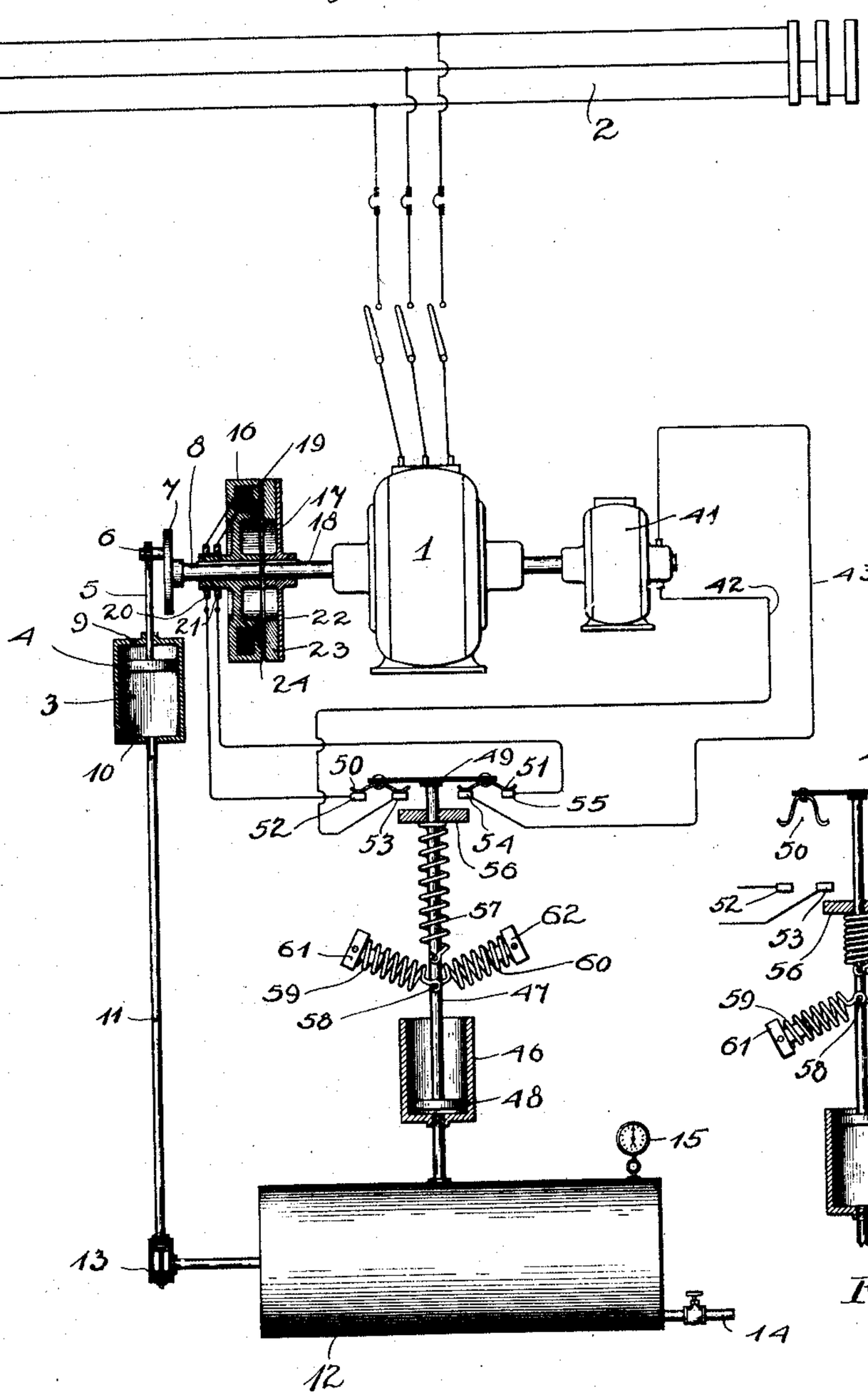
3 SHEETS—SHEET 2.

Fig. 2.



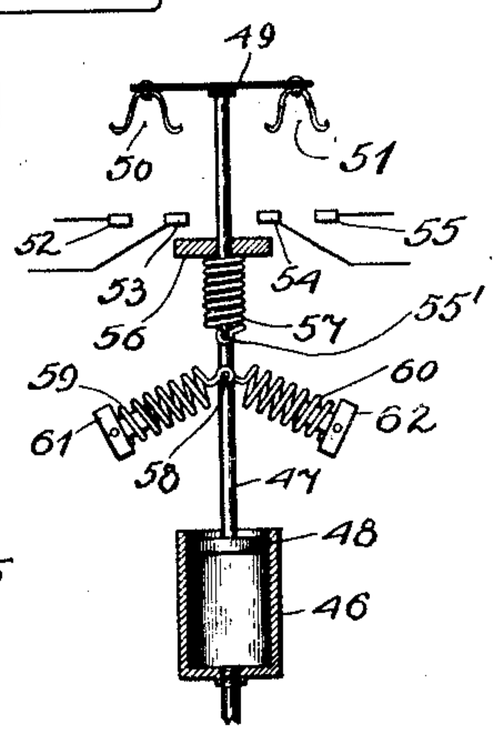


Fig. 3.

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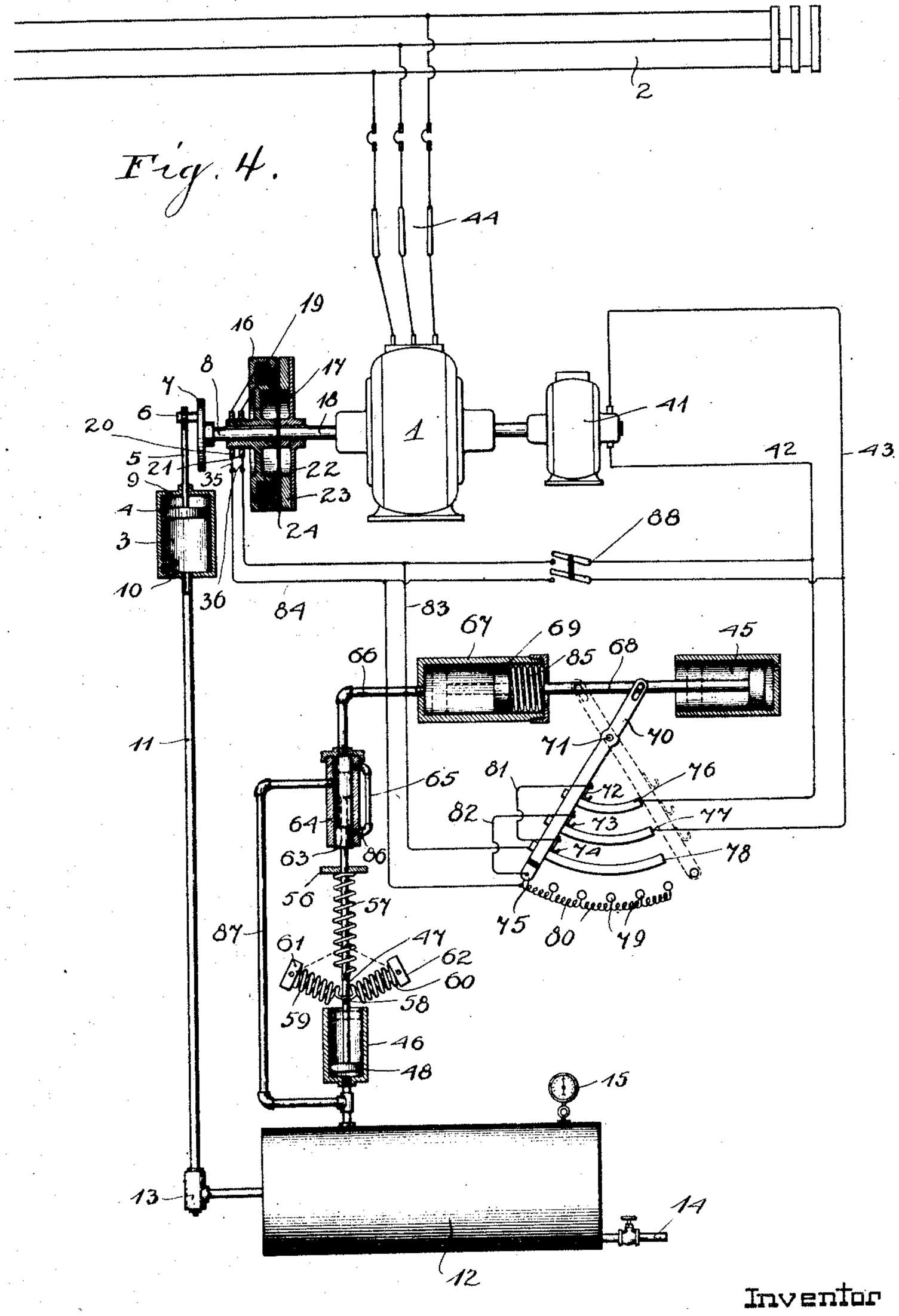
3 SHEETS—SHEET 3.

Fig. 4.



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UNITED STATES PATENT OFFICE.

WILLIAM B. JACKSON, OF MADISON, WISCONSIN, ASSIGNOR TO HIMSELF AND DUGALD C. JACKSON, OF MADISON, WISCONSIN, A COPARTNERSHIP.

CONTROLLING SYSTEM.

No. 887,252. Specification of Letters Patent. Patented May 12, 1908.

Application filed September 16, 1905. Serial No. 278,707.

To all whom it may concern:

Be it known that I, WILLIAM B. JACKSON, citizen of the United States, residing at Madison, in the county of Dane and State of Wisconsin, have invented a certain new and useful Improvement in Controlling Systems, of which the following is a full, clear, concise, and exact description, reference being had to the accompanying drawings, forming a part of this specification.

My invention relates to compressor systems, and its object is to provide improved operation and control therefor.

Where large compressors, of which varying amounts of work are expected, are driven directly from electric motors or other motive sources, serious difficulties have always been encountered. In some instances, the motor and the compressor parts driven thereby are stopped when the pressure rises to a maximum predetermined point in the reservoir and must be started when the pressure drops to a predetermined minimum value, but this continual stopping and starting of the motor is often found impracticable, especially when the motor is operated by alternating currents. In other instances the motor is driven continuously, and, therefore, the compressor members connected to the motor are in continuous operation. By the use of by-passes or mechanism actuating the valves of the compressor, the load is removed from the actuating parts of the compressor and the motor, at the time of starting the motor and after the desired pressure is reached in the reservoir, but even such arrangements are inefficient as there is still some load on the motor and the moving compressor parts are continually subjected to wear. Furthermore the compressor continuously runs at full speed when the useful work demanded of it might at times only require reduced speed or short intervals of operation, and driving the compressor to suit the work would reduce repairs and the depreciation of the machinery and the power consumed by the motor.

The object of my invention is to provide a more elastic connection between the motor and compressor instead of the direct connection heretofore used, and I provide this by the use of a magnetic clutch or accelerator by means of which whenever no useful work is demanded the motor is free and the pump or compressor is at rest. The electric motor for driving the compressor may be one in which the depreciation when running is little more than when standing still. The degree of driving connection between the compressor and the motor which is maintained by the magnetic clutch will be determined by the pressure in the reservoir. If the pressure is only slightly to be raised the clutch mechanism will act to cause only a sufficient operation of the pump to restore the pressure, and if the range of pressure to be restored is very great the clutch mechanism will rigidly connect the pump with the motor and the full force of the motor will actuate the pump to restore the pressure. When the pressure in the reservoir is normal the motor runs without appreciable load and the pump mechanism is at rest.

My invention will be best understood by reference to the accompanying drawings, in which

Figure 1 diagrammatically illustrates a pressure system embodying the features of my invention, Fig. 2 shows a slightly modified arrangement, Fig. 3 shows an alternative position of circuit controlling apparatus in Fig. 2, and Fig. 4 shows another modified arrangement.

I have shown a motive source as a three-phase motor 1 fed from the supply wires 2. The pump or compressor mechanism to be driven by the motor is shown as consisting of the compression cylinder 3 and the piston head 4, the piston rod 5 being shown as connected with the crank pin 6 extending from the crank wheel 7 mounted on a shaft 8. The compressor is provided with the inlet opening 9 and the check valve 10, the outlet pipe 11 leading from the compressor to the reservoir 12, a check valve 13 being interposed in said pipe. The compressed air may be drawn from the reservoir for use through the pipe 14 and the pressure in the reservoir may be indicated by the gage 15. The magnetic clutch is of a gradually accelerating multipolar type and may consist of the field cylinder 16 mounted on the shaft 8 and the armature 17 mounted on the shaft 18 of the motor 1. The field winding 19 connects with collector rings 20 and 21 having connection with the conductors of the energizing circuit. The armature consists of the cylinder or disk 22 near the outer edge of which is secured the ring 23 of magnetic material to be disposed

opposite the multipolar face 24 of the field frame. With this arrangement the relative speeds between the field frame and the armature will be determined by the degree of energization of the field, and the current flow which determines the degree of energization is controlled by the pressure in the reservoir, through the medium of the rheostat mechanism 25, as illustrated in Fig. 1. The contact arm 26 of the rheostat is connected through the rod 27 with the piston head 28 adapted to reciprocate within the cylinder 29. Between the rear wall of this cylinder and the piston is the compression spring 30, and the cylinder compartment at the other side of the piston connects through piping 31 with the reservoir 12. The rheostat arm 26 is provided with the contact shoes 32 and 33 insulated from each other and adapted for connection through the switch 34 with the brushes 35 and 36 engaging the collector rings 20 and 21 of the clutch mechanism. The contact shoe 32 upon actuation of the rheostat arm successively engages the rheostat contact buttons 37 bridged by the resistance coils 38 while the contact shoe 33 is in continuous engagement with the contact segment or arc 39. At one end of the stroke of the rheostat arm the contact shoe 32 is disconnected from the resistance circuit and may engage the dead button 40. Any suitable source of current may be provided for supplying current through the rheostat mechanism to the clutch winding, but, as here shown, the current is derived from the direct current dynamo 41. This exciting generator is shown directly connected with the motor shaft but may be connected therewith through belting, or otherwise, as is convenient. Where the alternating current motor is not self-starting this exciting machine could also primarily be connected with a source x by means of switch mechanism y to be operated as a motor to start the alternating current motor and when the alternating current motor has reached its proper speed the starting motor would again act as a generator to supply the exciting current for the motor and also the current for the clutch mechanism, the exciting dynamo being connected through the conductors 42 and 43 respectively with the contact arc 39 and one end of the series of resistance coils 38.

The operation of this system is as follows: The motor 1 if self-starting is connected directly with the supply mains through the main switch 44, and if not self-starting, it is started by the exciter as before described, or by any other available means. When the system is first started the pressure is usually zero and the piston 28 is moved by the spring 30 to hold the rheostat arm 26 in the position shown in Fig. 1, the contact shoe 32 in this position engaging the end button of the resistance series to cut all resistance out of the clutch circuit, and if the switch 34 be closed to connect the clutch winding directly with the exciter, although the full current is thus thrown upon the clutch winding, if the clutch is of the gradually accelerating type it will take hold gradually and it will take some time for the field frame and armature to rotate in synchronism, and therefore the compressor piston 4 will be started slowly and accelerated to full speed, thus relieving the entire mechanism from sudden strains when started under no load. The rheostat arm 26 may be pushed to the right by hand and held there until the compressor has been started, if the clutch tends to take hold with undesirable rapidity. The air or other fluid is now compressed into the reservoir 12, the check valves 10 and 13 acting in a manner well known in the art. The strength of the spring 30 may be such that when the pressure in the reservoir, and consequently at the left hand side of the piston 28, reaches a certain value the rheostat arm 26 will be gradually drawn to carry the contact shoe 32 successively into engagement with the buttons 37 to gradually include the resistance coils 38 in the clutch circuit and to eventually open this circuit when the pressure reaches its maximum value. The clutch then becomes deënergized and disconnects the motor from the compressor, so that the compressor stops and the motor runs without appreciable load. When the compressed air in the reservoir is drawn upon the pressure will diminish and the spring 30 will move the piston 28 to gradually return the rheostat arm to its position with the rheostat excluded from the clutch exciting circuit. The adjustment of the spring and piston mechanism may be such that the rheostat will not be actuated until a predetermined minimum pressure has been reached, or the adjustment may be such that the rheostat will operate immediately upon any decrease in pressure to allow sufficient current flow to restore the pressure if the decrease is small, and to remove all the resistance from the clutch circuit when a predetermined minimum pressure is reached. When the pressure is normal the motor runs without load and the clutch field and compressor mechanism are at rest, and even when the adjustment of the rheostat controlling mechanism compels the compressor mechanism to operate at full speed upon a decrease in pressure, the full current is not suddenly thrown upon the clutch winding but is fed gradually thereto and in proportion to the decrease in pressure. To further assure an easy and gradual acceleration of the clutch mechanism the motion of the rheostat arm in the direction to magnetize the clutch may be retarded by a dash pot mechanism 45.

The clutch circuit might also be connected

directly with the supply source without the intervention of a rheostat, and such an arrangement is shown in Figs. 2 and 3. A cylinder 46 is connected with the reservoir, and the piston rod 47 connected with the piston head 48 in said cylinder is connected at its upper end with a mounting bar 49 supporting at its ends the switch blades 50 and 51 associated respectively with the switch shoes 52, 53, 54 and 55'. Disposed between the pin 55 extending from the stem 47 and the abutment 56 is a compression spring 57, and engaging the pin 58 extending through the stem are the compression and extension springs 59 and 60 which at their other ends engage the pivoted abutments 61 and 62. The force of these springs 59 and 60 is directed to hold the stem 47 downwardly and the piston head 48 at the bottom of the cylinder 46 when the fluid pressure in the reservoir 12 is low, and in this position the blades 50 and 51 join the shoe 52 with 53 and the shoe 54 with 55, thus completing the circuit from the clutch to the exciter through conductors 42 and 43. When the motor is now started the clutch field winding will be in direct connection with the exciter 41 and the reservoir will be supplied with compressed air from the compressor mechanism connected with the clutch. The increasing pressure causes the piston head 48 to be moved upwardly, and the pivot position of the spring abutments 61 and 62 is such that when a predetermined pressure is reached in the reservoir the force of these springs will be suddenly directed to thrust the stem 47 upwardly. The blades 50 and 51 are U-shaped when inert as shown in Fig. 3, and being elastic will maintain engagement in the respective contacts to keep the clutch circuit closed until this predetermined maximum point is reached and the whole arrangement has a tendency to act as a snap switch. Upon the upward thrust of the piston rod 47 the spring 57 will be compressed as shown in Fig. 3, but the fluid pressure against the piston 48 when it is at a maximum range added to the force of the springs 59 and 60 is sufficient to resist the force of the spring 57, and the clutch circuit will remain open during this maximum pressure. Should the pressure be sufficiently decreased by some draft upon the supply of fluid in the reservoir, the force of the spring 57 will become sufficient to overbalance the combined forces acting against it, and the rod 47 will be moved downwardly, and when the pin 58 passes beyond the line of the pivot centers of the abutments 61 and 62 the direction of the force of the springs 59 and 60 will be such as to assist the spring 57, and the tendency will be to snap the switch blades into sudden engagement with their respective contact shoes to again close the clutch circuit. The maximum and minimum pressure values at which the switch will open and close can be determined by the adjustment and relative positions of the several springs, and even though the clutch circuit is suddenly closed the compressor mechanism will be gradually started and accelerated to full speed when the clutch is of the gradually accelerating type.

The arrangement described in Figs. 2 and 3 is one which may be used where there is no particular necessity of gradual current control. In Fig. 4, however, is shown an arrangement which may be considered as a combination of the arrangements shown in Figs. 1 and 2 and in which rheostat mechanism is provided for gradually supplying current to the clutch winding. The piston rod 47 in this arrangement terminates in a piston 63 adapted to reciprocate within the cylinder 64, whose ends are connected through the by-pass 65 and whose upper end is connected through pipe 66 with the cylinder 67. The piston rod 68 connected with the piston 69 within the cylinder 67 connects with one end of the rheostat lever 70 pivoted at 71. Contact shoes 72, 73, 74 and 75 are carried by the rheostat arm, the shoes 72, 73 and 74 being adapted for engagement with the contact segments as arcs 76, 77 and 78, while the contact shoe 75 is adapted for engagement with the contact button 79 bridged by resistance coils 80. The contact shoes 72 and 74 are connected with each other through the conductor 81 and the contact shoes 73 and 75 are connected with each other through the conductor 82. The contact segments 76 and 77 are connected respectively with the conductors 42 and 43 leading to the direct current supply source. The contact segment 78 is connected through conductor 83 with the brush 36 engaging the collector ring 21, while the end of the series of resistance coils of the rheostat 80 connects through the conductor 84 with the brush 35 engaging the collector ring 20 of the clutch mechanism. The forward movement of the piston 69 to close the current supply to the clutch mechanism is opposed by the spring 85 within the cylinder 67, and the motion of the piston is further retarded by the dash pot mechanism 45.

The adjustment of the spring mechanism comprising the springs 57, 59 and 60 is such that the piston rod 47 will not be thrust upwardly until maximum pressure in the reservoir is reached. The piston 63 is disposed to close the lower part 86 of the by-pass 65 when the pressure in the cylinder is decreased, and the pipe 87 connected with the reservoir is in communication with the cylinder 64 and through the pipe 66 with the cylinder 67. The position of the apparatus as shown in full lines is that which will be assumed when the pressure in the reservoir is below maximum, the piston 69 and rod 68 having been moved by the fluid pressure so as to carry the rheostat arm 70 into the posi-

tion which affords direct connection of the direct current supply source 41 with the clutch mechanism which operates to actuate the compressor mechanism to restore the pressure in the reservoir. As maximum pressure is approached the piston 48 begins to move, and when maximum pressure is reached the springs 59 and 60 will direct their force to thrust the rod 47 upwardly and to carry the piston 63 quickly to shut off communication of the pipe 87 with the cylinder 64. At the same time the opening 86 of the by-pass is clear and the exhaust air from the cylinder 67 may escape by way of the pipe 66, cylinder 64, by-pass 65, opening 86 and thence to the open air. The spring 85 now moves the piston 69 and rod 68 so as to move the rheostat arm out of engagement with the rheostat contact buttons and to open the clutch circuit. The clutch is de-energized and the compressor stops. As the reservoir contents are drawn upon, the pressure again falls, and when it reaches a predetermined minimum value the pressure of the spring 57 will overcome the opposing forces of the springs 59 and 60 and the air behind the piston 48, and the rod 47 will be thrust downwardly to again open communication between the reservoir 12 and the cylinder 64 and to close the exhaust port 86, whereupon the fluid under pressure will again enter the cylinder 67 and will move the rheostat mechanism to gradually connect the clutch mechanism directly with the supply source. The motion of the rod 47 it will be noticed is comparatively slow at first until the changing point in the direction of force of the springs 59 and 60 is reached when the piston 63 will be rapidly moved and the port 86 and that from the pipe 87 to the cylinder 64 will be suddenly entirely opened or closed.

It will be noticed that when there is not sufficient pressure in the reservoir to overcome the spring 85 the rheostat arm will be out of engagement with the rheostat contact buttons and the clutch circuit is consequently open. In order that the apparatus may be readily started upon closure of the main switch when the reservoir pressure is exhausted, there must be provided means for directing current to the clutch mechanism. This can be easily obtained by manually holding the rheostat arm in engagement with the contact buttons until the compressor has been actuated sufficiently to produce enough pressure so that the piston 69 will hold the rheostat arm in the engaged position; or a starting switch 88 may be provided, bridged about the rheostat mechanism, and this switch is closed upon closure of the main switch and opened after the pressure is sufficiently high to automatically control the rheostat.

Many other modifications of the arrangements herein shown may also be made without departing from the spirit of my invention, the main feature of which is to provide separable and more elastic connection between the compressor mechanism and the driving motor, such as a magnetic clutch or accelerator, and to provide controlling mechanism for the magnetic clutch circuit which is automatically governed by the pressure in the reservoir or piping system associated with the compressor, the clutch mechanism being disconnected from or connected with compressor mechanism in accordance with a predetermined increase or decrease of the pressure of the fluid in the system.

What I claim as new and desire to secure by Letters Patent is:

1. In a fluid pressure system, the combination with a compressor, of a driving engine, a magnetic clutch device intervening between the said compressor and driving engine, rheostat mechanism associated with the energizing circuit of the clutch device, means controlled by the fluid pressure to quickly actuate the rheostat mechanism and open the circuit when the maximum fluid pressure is reached, means for gradually actuating the rheostat mechanism when the fluid pressure falls substantially below the maximum, and means for quickly actuating the rheostat mechanism when the fluid pressure reaches a determined minimum.

2. In a fluid pressure system, the combination with a compressor of a driving engine, a magnetic clutch device intervening between said compressor and driving engine, rheostat mechanism associated with the energizing circuit of the clutch device, means controlled by the fluid pressure to quickly actuate the rheostat mechanism and open the circuit when the maximum fluid pressure is reached, and means for gradually actuating the rheostat mechanism when the fluid pressure falls substantially below the maximum.

3. In combination, a fluid compressor, a motor, a magnetic clutch for connecting the motor with the compressor, a pressure system supplied by the compressor, valve mechanism controlled by the pressure in the system, a cylinder whose connection with the pressure system is controlled by said valve, a piston within said cylinder, and rheostat mechanism operated upon movements of the piston to control the circuit for the magnetic clutch.

4. In combination, a fluid compressor, a pressure system supplied by the compressor, a motor, a magnetic clutch for connecting the motor with the compressor, a cylinder, a piston in the cylinder, rheostat mechanism controlled by the movements of the piston, a circuit for the magnetic clutch controlled by said rheostat, means for causing said cylinder to be suddenly connected with the pressure system when minimum pressure in the system is reached, and means for sud-

denly disconnecting said cylinder from the pressure system when the maximum pressure is reached.

5. In combination, a fluid compressor, a pressure system supplied by the compressor, a motor, a magnetic clutch for connecting the motor with the compressor, a cylinder, a piston in the cylinder, rheostat mechanism controlled by the movements of the piston, a circuit for the magnetic clutch controlled by said rheostat, means for causing said cylinder to be suddenly connected with the pressure system when minimum pressure in the system is reached, means for suddenly disconnecting said cylinder from the pressure system when the maximum pressure is reached, and means for causing slow and gradual actuation of the rheostat mechanism after the cylinder is connected with the pressure system whereby current is slowly supplied to the magnetic clutch.

6. In combination, a compressor for supplying a fluid pressure system, a motor, a magnetic clutch for connecting the motor to the compressor, a cylinder, a piston within the cylinder, rheostat mechanism controlled by movements of the piston, a supply circuit for the magnetic clutch controlled by the rheostat, valve mechanism controlled by the pressure in the system for controlling the connection of the cylinder with the pressure circuit, means for causing movements of the valve mechanism when maximum pressure is reached to disconnect the cylinder from the pressure system, and to allow said cylinder to exhaust, and means for moving said valve mechanism when minimum pressure is reached in the system to connect the cylinder with the pressure system whereby the rheostat is actuated to connect the magnetic clutch in the circuit.

7. In combination, a compressor for supplying a pressure system, a motor, a magnetic clutch for connecting the motor with the compressor, a cylinder, a piston in the cylinder, rheostat mechanism controlled by the movements of the piston, a supply circuit for the clutch controlled by the rheostat mechanism, a valve controlled by the pressure in the system for controlling the connection of the cylinder with the pressure system and with atmosphere, means for causing sudden movement of the valve mechanism when the pressure reaches maximum in the system to disconnect the cylinder from the pressure system and to connect the cylinder with atmosphere, and means for causing quick movements of the valve mechanism when minimum pressure of the system is reached to connect the cylinder with the pressure system.

8. In combination, a fluid compressor, a motor, a magnetic clutch for connecting the motor with the compressor, a pressure system supplied by the compressor, valve mechanism controlled by the pressure in the system, fluid power mechanism whose connection with the pressure system is controlled by said valve mechanism, and rheostat mechanism operated by the fluid power mechanism to control the circuit for the magnetic clutch.

In witness whereof, I hereunto subscribe my name this twelfth day of September A. D. 1905.

WM. B. JACKSON.

Witnesses:
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