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R. C. DUSTIN

2,389,348

PUMP CONTROL SYSTEM

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Fig. 1.

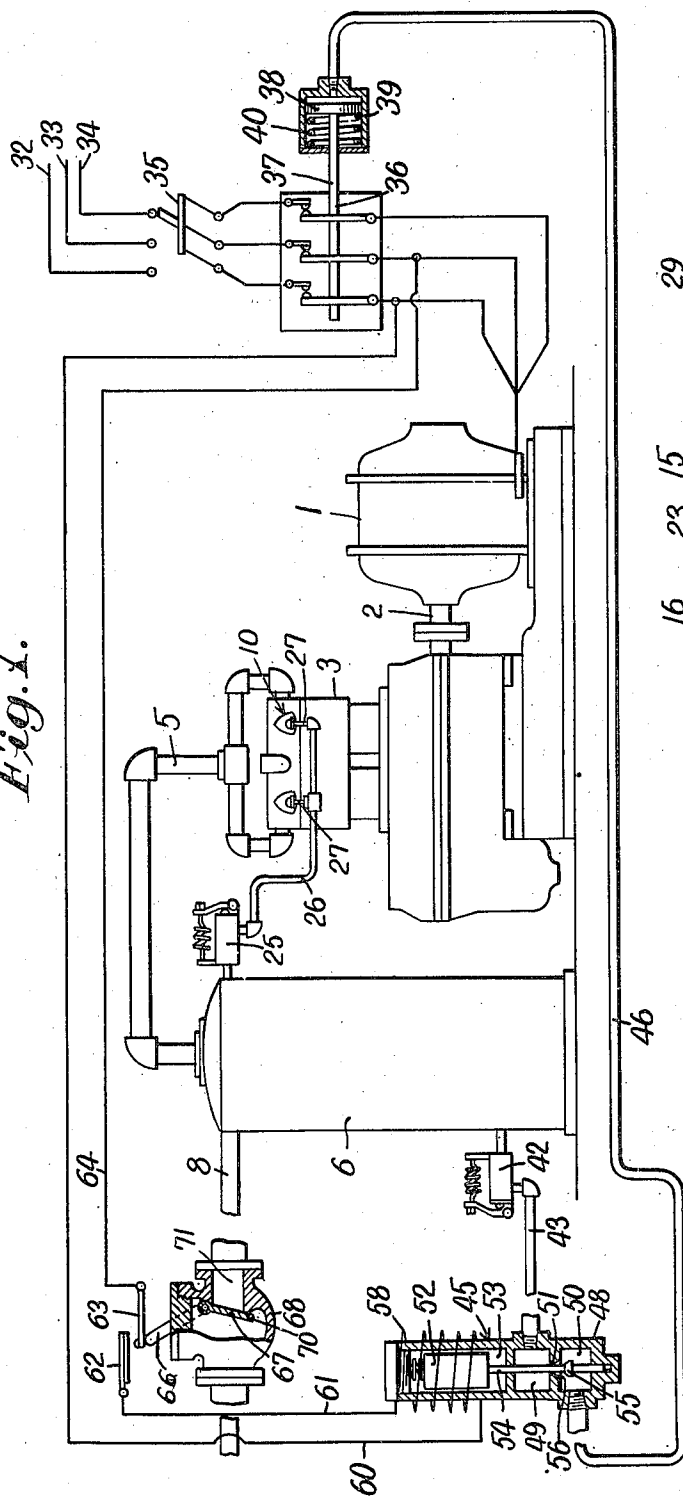


Fig. 2.

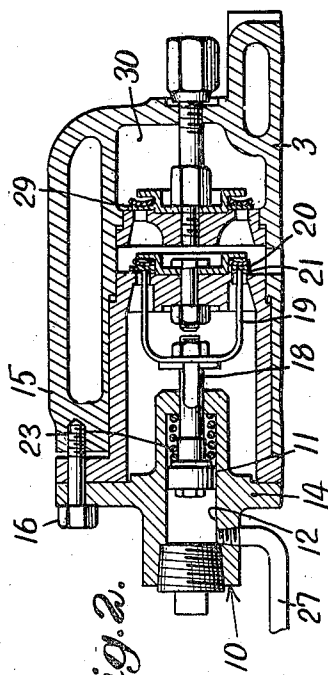
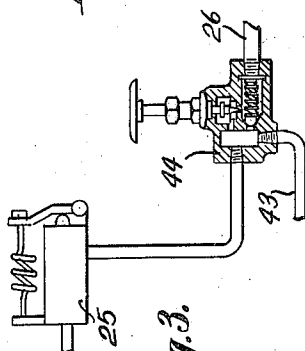


Fig. 3.



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PUMP CONTROL SYSTEM

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16 Claims. (Cl. 230—18)

My invention relates to control systems for pump mechanisms, and more particularly to systems for controlling automatically the operation of a motor driven compressor.

In the operation of a motor driven compressor, it is desirable to avoid the stopping and starting of the motor except at times when the discharge of fluid from the compressor will not be needed for a period of such length that a saving of power may be obtained by shutting down the motor. When the compressor discharges fluid to a receiver and the maximum desired receiver pressure is reached, the discharge of fluid may be discontinued by a compressor unloading device actuated by the receiver pressure. Such an unloading device ordinarily holds the compressor unloaded until the receiver pressure drops from a maximum to a predetermined lower value. If no fluid is being used from the receiver when the maximum pressure is reached, or, if fluid is being used at this time but its use is discontinued before the lower pressure value is reached, then it may be a considerable time before the receiver pressure drops to the lower pressure value. In such a case it is desirable that the compressor be unloaded and that its driving motor be stopped. If fluid is being used from the receiver at the time the maximum pressure is reached and will be used continuously until the pressure drops to the lower value, then the compressor should be unloaded but the motor should be kept running since the time required for the pressure drop to take place is comparatively short and the stopping and starting of the motor results in a greater inefficiency.

The above desired control of the compressor and the driving motor is made possible in this invention by providing a fluid actuated unloading mechanism for the compressor, and a normally closed fluid actuated switch in the motor circuit. When the maximum desired pressure limit is reached, pressure responsive means operate to supply pressure fluid to the unloading means and, if no fluid is being discharged from the receiver, to supply pressure fluid to open the switch. If fluid is being used from the receiver at the time the maximum pressure is reached, a valve is closed so that no pressure fluid can flow to the switch. As long as fluid continues to flow from the receiver, the valve is held closed and the motor circuit remains unbroken so that the motor continues to operate. If the flow of fluid from the receiver is discontinued before the lower pressure is reached, then the valve is opened and fluid flows to the switch, opening the latter and

stopping the motor. When the motor switch is once opened it will not close again until the pressure responsive means operate to vent the pressure fluid from the switch.

An object of this invention is to provide an improved control system for a pumping mechanism. Another object is to provide an improved control system for a motor driven compressor. Still another object is to provide a motor driven compressor having improved means for controlling the stopping and starting of the motor in accordance with the compressor discharge pressure and the flow of fluid to a point of use. Another object is to provide a motor driven compressor having improved means for effecting a driving of the compressor unloaded when a predetermined maximum discharge pressure is reached and fluid is being delivered to a point of use. Yet another object is to provide a motor driven compressor having improved means for effecting a stopping of the motor with an unloading of the compressor when a predetermined maximum discharge pressure is reached and no fluid is being delivered to a point of use. Another object is to provide a motor driven compressor having improved means for effecting a driving of the compressor unloaded when a maximum receiver pressure is reached and fluid is flowing from the receiver to a point of use, but operating to stop the motor when the flow of fluid is cut off and holding the motor stopped until a predetermined lower receiver pressure is reached. Other objects of the invention will appear more fully in the course of the following description.

In the accompanying drawing, in which one illustrative embodiment and a modification of my invention are shown,

Fig. 1 is a diagrammatic view showing a motor driven compressor having my improved control system associated therewith.

Fig. 2 is an enlarged sectional view of the compressor unloading mechanism.

Fig. 3 is a fragmentary view showing a modification.

In the illustrative embodiment of the invention there is shown a motor 1 having its power shaft 2 connected in driving relation with a pump or compressor 3. The compressor shown herein is of the two cylinder single stage type, but it will be understood that my invention is equally applicable to any of the general types of compressors. The fluid is discharged from the compressor through a suitable pipe connection 5 into a receiver tank 6 from which it may be supplied through an outlet 8 to any point of use.

Associated with each of the compressor cylinders is a fluid actuated unloading mechanism, generally designated 10. This unloading mechanism comprises, as shown in Fig. 2, a piston 11 reciprocally mounted in a bore 12 formed in a plate member 14 attached to the side of the cylinder head 15, as by bolts 16. A piston rod 18 is fixed to the piston and carries at its inner end a forklike member 19 adapted to engage the inlet valve 20 and hold the latter from its seat 21. Surrounding the piston rod is a coiled spring 23 acting between the member 14 at the inner end of the bore 12 and the piston 11 for holding the forklike member 19 normally in a position out of engagement with the inlet valve. Pressure fluid for operating the unloading mechanisms is supplied from the receiver under the control of a pilot valve 25 to a conduit 26 which is connected by branch conduits 27 in communication with the outer ends of the bores 12. The pilot valve 25 operates at a predetermined maximum receiver pressure to connect the conduit 26 in communication with the receiver, and operates again at a predetermined minimum pressure to connect the conduit 26 in communication with atmosphere. When the bore 12 is vented through conduit 26 to atmosphere, the forklike member 19 is held by the spring 23 out of engagement with the inlet valve so that the latter operates normally to control the flow of fluid to the cylinder bore where it is compressed and then discharged past a discharge valve 29 to a passage 30 communicating with the conduit 5. When pressure fluid is supplied from the receiver to the bore 12, the piston 11 is forced to the right in Fig. 2 causing the inlet valve to be unseated by the member 19 and effect an unloading of the compressor.

The motor 1 is supplied with electric current from power lines 32, 33 and 34 under the control of a manually operated switch 35 and a fluid actuated switch 36. The switch 36 is provided with an actuating arm 37 carrying a piston 38 which is reciprocally mounted in a cylinder 39. A spring 40 is arranged within the cylinder 39 and acts against the piston to hold the switch 36 normally in its closed position. Pressure fluid for operating the switch 36 is supplied from the receiver past a pilot valve 42 to a conduit 43 which is connected through a valve mechanism, generally designated 45, to a conduit 46 communicating with the cylinder 39. The pilot valve 42 is like the pilot valve 25 and operates at the same maximum receiver pressure to supply pressure fluid to the conduit 43 but is adjusted to operate at a slightly higher minimum receiver pressure to vent the conduit 43 so that the switch 36 may close and start the motor before the compressor is reloaded. The same result may be obtained by providing a single pilot valve for controlling the flow of fluid relative to the unloading mechanism and the switch 36, and restricting the venting of fluid from the unloading mechanism. Such an arrangement is illustrated in Fig. 3 wherein 44 represents a well-known type of device for effecting a free supply of air to both of the lines 43 and 26 when the pilot valve 25 supplies pressure and a restricted venting of the pressure from the line 26 when the pilot valve 25 vents pressure. It will be seen that only the pilot valve 25 is needed with this arrangement.

The valve mechanism 45 is of the solenoid actuated type and comprises a valve casing 48 having chambers 49 and 50 communicating with each other through a port 51. A plunger 52 is arranged in an upper chamber 53 in the valve cas-

ing and is provided with a valve stem 54 extending through the chambers 49 and 50. Fixed to the valve stem is a valve member 55 adapted to engage a valve seat 56 surrounding the port 51 when the plunger 52 is raised. The conduits 43 and 46 open, respectively, into the chambers 49 and 50, and these chambers normally communicate with each other through the port 51 since the valve member 55 is normally held in its open position by the weight of the plunger 52. Surrounding the plunger is a solenoid winding 58 which acts, when energized, to raise the plunger and seat the valve member 55, thereby cutting off communication between chambers 49 and 50. One end of the solenoid winding is connected by a conductor 60 to one of the power lines on the motor side of the fluid actuated switch 36. The other end of the solenoid is connected by a conductor 61 to a switch element 62, and another element 63 of the same switch is connected by a conductor 64 to another one of the power lines on the motor side of the fluid actuated switch. The switch elements 62 and 63 are normally held apart but are adapted to be moved into engagement with each other by an arm 66 fixed to a flapper 67 which is pivotally mounted on a chamber providing member 68. The member 68 is connected in the receiver outlet 8, and the flapper 67 is supported within the member 68 in such a position that fluid discharged from the receiver causes the flapper and the arm 66 to swing and move the switch element 63 into engagement with the element 62. When the flow of fluid through the outlet is stopped, the flapper drops into engagement with a seat 70 surrounding a port 71 at the admission side of the member 68, and the arm 66 swings with the flapper to release the switch element 63 from the element 62.

The operation of the mechanism described is as follows: Assuming that the receiver pressure is low and that the pilot valves 25 and 42 are in positions venting the conduits 26 and 43, then the compressor with be loaded and the switch 36 will be in its closed position. If the manually operated switch is then closed, the motor will operate and drive the compressor for supplying fluid to the receiver. If the need for pressure fluid is low, the receiver pressure will build up to the maximum desired value and the pilot valves 25 and 42 will open supplying fluid to conduits 26 and 43. Fluid supplied to conduit 26 will be conducted to the unloading devices to effect an immediate unloading of the compressor. Fluid supplied to the conduit 43 will flow to the chamber 49 in the valve casing 48 and, if there is not enough fluid flowing from the receiver through the outlet 8 to lift the flapper 67 and close the switch elements 62 and 63, the valve member 55 will be unseated so that fluid will flow through the port 51, the chamber 50 and the conduit 46 to the cylinder 39 where it will act on the piston 38 to open the switch 36. When the switch 36 is once opened, the electromagnet winding 58 cannot be energized by a closing of the switch elements 62 and 63 since the conductors 60 and 64 are connected to the power lines at the motor side of the switch. When the receiver pressure drops to the lower pressure limit of the pilot valve 42, pressure fluid is vented from the cylinder 39 through the conduit 46, the chamber 50, port 51, chamber 49 and conduit 43, and the switch 36 is closed to start the motor. When the pressure drops to the lower limit of the pilot valve 25, the conduit 26 is vented to reload the compressor. If fluid is flowing through the outlet 8 in sufficient quantity to lift the flapper and close the switch elements 62 and

63 at the time the pilot valve 42 opens, then the valve member 55 will be seated and will prevent the flow of fluid to the conduit 46. The switch 36 will remain closed, and the compressor will be driven unloaded.

As a result of this invention there is provided improved means for controlling the operation of a compressor. The control system is comparatively simple and is adapted for use in various types of pumps or compressors to improve their efficiency of operation. Other advantages of the invention will be clearly apparent to those skilled in the art.

While there are in this application specifically described one form and a modification which the invention may assume in practice, it will be understood that these forms of the same are shown for purposes of illustration and that the invention may be further modified and embodied in various other forms without departing from its spirit or the scope of the appended claims.

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

1. In a control system, in combination, a compressor, a motor for driving said compressor, a normally closed switch for controlling the supply of electric current to said motor, means operative on the supply of pressure fluid thereto for effecting an opening of said switch, passage means for conducting pressure fluid to said fluid operated means, means including valve means operative at a predetermined maximum compressor discharge pressure for supplying pressure fluid to said passage means, and means responsive to the flow of pressure fluid from said compressor to a point of use for controlling the flow of fluid through said passage means.

2. In a control system, in combination, a compressor, a motor for driving said compressor, a normally closed switch for controlling the supply of electric current to said motor, means operative on the supply of pressure fluid thereto for effecting an opening of said switch, passage means for conducting pressure fluid to said fluid operated means, means including valve means operative at a predetermined maximum compressor discharge pressure for supplying pressure fluid to said passage means, and means operating on the flow of pressure fluid from said compressor to a point of use for cutting off communication through said passage means.

3. In a control system, in combination, a compressor, a motor for driving said compressor, a normally closed fluid actuated switch for controlling the supply of electric current to said motor, means for conducting actuating fluid to said switch, means including valve means operative at a predetermined maximum compressor discharge pressure for supplying actuating fluid to said conducting means, and valve means responsive to the flow of pressure fluid from said compressor to a point of use for controlling the flow of fluid through said fluid conducting means.

4. In a control system, in combination, a compressor, a motor for driving said compressor, a normally closed fluid actuated switch for controlling the supply of electric current to said motor, means for conducting actuating fluid to said switch, means including valve means operative at a predetermined maximum compressor discharge pressure for supplying actuating fluid to said conducting means, and valve means operating at a predetermined flow of pressure fluid from said compressor to a point of use for preventing

a flow of fluid through said fluid conducting means.

5. In a control system, in combination, a compressor, fluid actuated unloading means therefor, a motor for driving said compressor, a normally closed switch for controlling the supply of electric current to said motor, means operative on the supply of pressure fluid thereto for effecting an opening of said switch, means for conducting pressure fluid to said unloading means and to said fluid operated means, means including valve means operative at a predetermined maximum compressor discharge pressure for supplying pressure fluid to said fluid conducting means, and means responsive to the flow of pressure fluid from said compressor to a point of use for controlling the flow of fluid to said fluid operated means.

6. In a control system, in combination, a compressor, fluid actuated unloading means therefor, a motor for driving said compressor, a normally closed switch for controlling the supply of electric current to said motor, means operative on the supply of pressure fluid thereto for effecting an opening of said switch, means for conducting pressure fluid to said unloading means and to said fluid operated means, means including valve means operative at a predetermined maximum compressor discharge pressure for supplying pressure fluid to said fluid conducting means, and means operating on the flow of pressure fluid from said compressor to a point of use before said maximum discharge pressure is reached for cutting off communication through said fluid conducting means to said fluid operated means.

7. In a control system, in combination, a compressor, a motor for driving said compressor, a normally closed switch for controlling the supply of electric current to said motor, means operative on the supply of pressure fluid thereto for effecting an opening of said switch, means for conducting pressure fluid to said fluid operated means, means including valve means operative at a predetermined maximum compressor discharge pressure for supplying pressure fluid to said fluid conducting means, valve means for controlling the flow of pressure fluid through said fluid conducting means, a solenoid for controlling the operation of said last mentioned valve means, and means including a switch responsive to the flow of fluid from said compressor to a point of use for controlling the energizing of said solenoid.

8. In a control system, in combination, a compressor, a motor for driving said compressor, a normally closed switch for controlling the supply of electric current to said motor, means operative on the supply of pressure fluid thereto for effecting an opening of said switch, means for conducting pressure fluid to said fluid operated means, means including valve means operative at a predetermined maximum compressor discharge pressure for supplying pressure fluid to said fluid conducting means, valve means for controlling the flow of pressure fluid through said fluid conducting means, a solenoid for controlling the operation of said last mentioned valve means, and means including a switch closing on the flow of fluid from said compressor to a point of use for energizing said solenoid.

9. In a control system, in combination, a compressor, a motor for driving said compressor, a normally closed switch for controlling the supply of electric current to said motor, means opera-

tive on the supply of pressure fluid thereto for effecting an opening of said switch, means for conducting pressure fluid to said fluid operated means, means including valve means operative at a predetermined maximum compressor discharge pressure for supplying pressure fluid to said fluid conducting means, valve means for controlling the flow of pressure fluid through said fluid conducting means, a solenoid for controlling the operation of said last mentioned valve means, and means including a circuit connected to the motor circuit at the motor side of said normally closed switch and a switch responsive to the flow of fluid from said compressor to a point of use for controlling the energizing of said solenoid.

10. In a control system, in combination, a compressor, a motor for driving said compressor, a normally closed switch for controlling the supply of electric current to said motor, means operative on the supply of pressure fluid thereto for effecting an opening of said switch, means for conducting pressure fluid to said fluid operated means, means including valve means operative at a predetermined compressor discharge pressure for supplying pressure fluid to said fluid conducting means, valve means for controlling the flow of fluid through said fluid conducting means, and means responsive to the flow of pressure fluid from said compressor to a point of use before said predetermined discharge pressure is reached for actuating said last mentioned valve means to cut off the flow of fluid through said fluid conducting means to said fluid operated means.

11. In a control system, in combination, a compressor, fluid actuated unloading means therefor, a motor for driving said compressor, a normally closed switch for controlling the supply of electric current to said motor, means operative on the supply of pressure fluid thereto for effecting an opening of said switch, means for conducting pressure fluid to said fluid operated means and to said unloading means, means including valve means operative at a predetermined maximum compressor discharge pressure for supplying pressure fluid to said fluid conducting means, valve means for controlling the flow of fluid through said fluid conducting means to said fluid operated means, a solenoid operative when energized to close said last mentioned valve means, and means including a circuit connected to the motor circuit at the motor side of said normally closed switch and a switch closing on the flow of fluid from said compressor to a point of use for energizing said solenoid.

12. In a compressor system, in combination, a compressor, a power unit for driving said compressor, means for controlling the supply of operating medium to said power unit, fluid actuated means for positioning said controlling means and operative on the supply of pressure fluid thereto for effecting a cutting off of the supply of operating medium to said power unit, means including valve means operative at a predetermined maximum compressor discharge pressure for supplying pressure fluid to said fluid actuated means, and means responsive to the flow of pressure fluid from said compressor to a point of use for controlling the flow of fluid from said valve means to said fluid operated means.

13. In a compressor system, in combination, a compressor, fluid actuated unloading means therefor, a power unit for driving said compressor, means for controlling the supply of operating medium to said power unit, fluid actuated means for positioning said controlling means and operative on the supply of pressure fluid thereto for effecting a cutting off of the supply of operating medium to said power unit, means including valve means operative at a predetermined maximum compressor discharge pressure for supplying pressure fluid to said unloading means and to said fluid actuated means, and means responsive to the flow of pressure fluid from said compressor to a point of use for cutting off the flow of fluid between said valve means and said fluid operated means.

14. In a compressor system, in combination, a compressor, a receiver for receiving fluid discharged from said compressor, a motor for driving said compressor, a normally closed switch for controlling the supply of electric current to said motor, means operative on the supply of pressure fluid thereto for effecting an opening of said switch, valve means operative at a predetermined maximum pressure in said receiver for supplying pressure fluid to said fluid actuated means, and means responsive to the flow of pressure fluid from said receiver for controlling the flow of fluid from said valve means to said fluid actuated means.

15. In a compressor system, in combination, a compressor, fluid actuated unloading means therefor, a receiver for receiving fluid discharged from said compressor, a motor for driving said compressor, a normally closed switch for controlling the supply of electric current to said motor, means operative on the supply of pressure fluid thereto for effecting an opening of said switch, valve means operative at a predetermined maximum pressure in said receiver for supplying pressure fluid to said fluid actuated means and to said unloading means, and means responsive to the flow of pressure fluid from said receiver and operative on such flow of fluid for cutting off communication between said valve means and said fluid actuated means.

16. In a control system, in combination, a compressor, a motor for driving said compressor, a normally closed switch for controlling the supply of electric current to said motor, means operative on the supply of pressure fluid thereto for effecting an opening of said switch, pressure fluid conducting means communicating with said fluid actuated means, valve means for controlling the connection of said fluid conducting means with the atmosphere and with the compressor discharge, said valve means operative at a maximum compressor discharge pressure for cutting off communication with the atmosphere and connecting said fluid conducting means in communication with the compressor discharge, valve means for controlling the flow of fluid through said fluid conducting means, and means operating on the flow of pressure fluid from said compressor to a point of use for actuating said second mentioned valve means to cut off the flow of fluid through said fluid conducting means.

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