

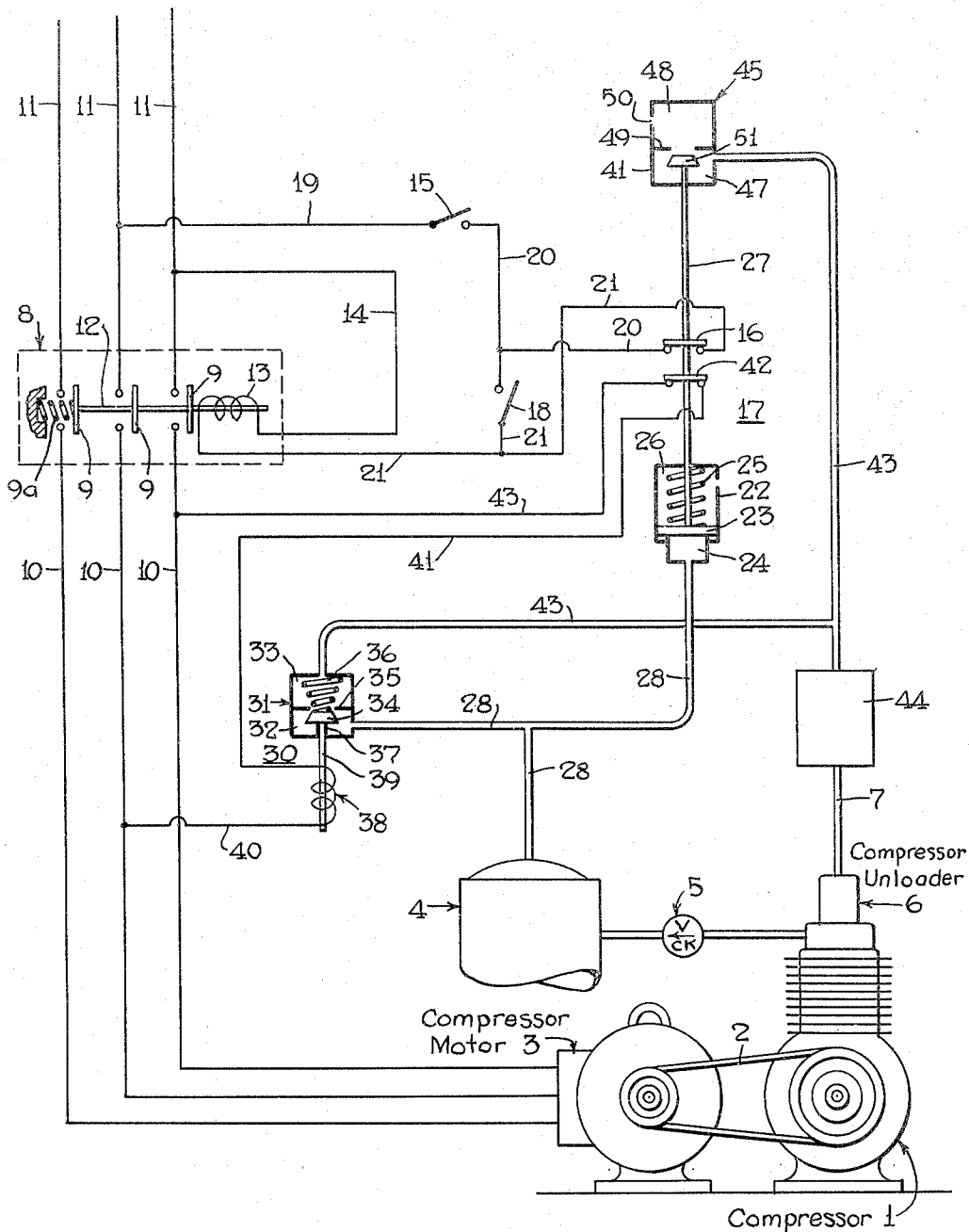
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UNLOADING CONTROL APPARATUS FOR AIR COMPRESSORS

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UNLOADING CONTROL APPARATUS FOR AIR COMPRESSORS

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This invention relates to apparatus for controlling operation of motor driven air compressors and more particularly to unloading operation thereof.

A principal object of the invention is the provision of improved apparatus of the above type.

Other objects and advantages of the invention will become obvious from the following detailed description of the invention taken in connection with the accompanying drawing in which the single figure is a schematic representation of the control apparatus embodying the invention and associated with a motor driven air compressor.

Description

Referring to the drawing, the reference numeral 1 designates an air compressor driven through such as a flexible belt 2 by an electric motor 3 to deliver compressed air to a fluid pressure storage reservoir 4 via the usual check valve 5. The compressor 1 is provided with the usual unloader device 6 which will respond to receipt of fluid under pressure in an unloader control conduit 7 to unload the compressor in the well-known manner by such as holding its exhaust valve open, for example, and said device 6 will respond to venting of conduit 7 to atmosphere to load the compressor for delivering compressed air to the reservoir 4. The usual line starter 8 provides for connecting and disconnecting the motor 3 to and from the line.

The line starter 8, for sake of illustration, schematically may comprise a plurality of switches 9, biased to open positions by a spring 9a, for making and breaking electrical connection between respective motor wires 10, connected to motor 3, and respective line wires 11 which are adapted to be connected to a suitable source of electrical energy (not shown) for operating the motor 3. In the drawing, three line wires and three motor wires indicate three phase operation of motor 3, but the control apparatus embodying the invention will just as readily adapt itself to use with such as two wire feed to the compressor motor in which case only two switches 9 need be included in the line starter 8. Each of the switches 9 is operably connected by means of such as linkage 12 to a solenoid 13 common to all for operation in unison to respective closed positions upon energization of the solenoid and to respective open positions upon deenergization of said solenoid.

According to the invention, for controlling operation of the motor 3, the control apparatus is provided with a wire 14 which constantly connects one terminal of the solenoid 13 to one of the line wires 11 while electrical connection of the opposite end of said solenoid to another of said line wires to complete electrical circuit through the solenoid for energizing same is effected by closure of a manual switch 15 and either a switch 16 associated with a pressure responsive device 17 or another manual switch 18; the latter two switches 16 and 18 being connected electrically in parallel with each other and in series with the switch 15 and solenoid 13.

One terminal of the switch 15 is connected via a wire

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19 to a respective line wire 11 other than the line wire 11 to which wire 14 is connected, and the opposite terminal of the switch 15 is connected to one terminal of both the switch 16 and the switch 18 by means of a wire 20 and branches thereof. Opposite terminals of both switches 16 and 18 are connected electrically one with the other and with the respective terminal of solenoid 13 by a wire 21 and branches thereof.

The pressure responsive device 17 comprises a fluid pressure actuator which may be in the form of a cylinder 22 having reciprocally disposed therein a snap-acting piston 23 subject opposingly to pressure of fluid in a pressure chamber 24 at one side and to force of a compression spring 25 disposed in a non-pressure chamber 26 at its opposite side. The piston 23 is operatively connected, by means of such as a piston rod 27, to the switch 16 and the pressure chamber 24 is connected by means of a fluid pressure conduit 28 and branches thereof to the reservoir 4 so that reservoir pressure will be present constantly in said pressure chamber. The initial compression of the spring 25 is such relative to the area of piston 23 exposed to pressure of reservoir fluid in pressure chamber 24 that said piston will move from the repose position in which it is shown in the drawing toward chamber 26 to cause opening of the switch 16 when the pressure of fluid in the reservoir 4 has been re-established at a desired level. In response to reduction in reservoir pressure in chamber 24 to a certain value, the spring 25 will return the piston 23 to its repose position in which it is shown in the drawing with the switch 16 again closed.

For controlling operation of the compressor unloader device 6, the control apparatus is provided with a solenoid valve device 30 which comprises a valve portion 31 having formed in a suitable casing a supply chamber 32 connected to the reservoir 4 via the conduit 28, and having a delivery chamber 33 connected via a conduit 43 and a volume chamber 44 to the unloader control conduit 7. A supply valve 34 disposed in supply chamber 32 is cooperable with an opening in a partition 35 to control communication between the supply chamber 32 and the delivery chamber 33. The valve 34 is biased by a spring 36 toward an unseated position in which it is shown in the drawing in engagement with a stop element 37. The valve 34 is operably connected to a solenoid by the usual linkage such as a rod 39 extending from the valve into the solenoid to serve as a reciprocable armature. One terminal of the solenoid 38 is constantly connected electrically to one of the motor wires 10 by means of a wire 40, while the opposite terminal of said solenoid 38 is connected to another of the motor wires 10 via a wire 41, a switch 42 and a wire 43. When the solenoid 38 is energized, action of the spring 36 is overcome to cause the valve 34 to move to a seated position closing off communication between the supply chamber 32 and the delivery chamber 33, while deenergization of the solenoid 38 allows the spring 36 to open said valve and again connect the chambers 32, 33 one to the other.

The switch 42 is attached for reciprocable movement with the rod 27 coincident with the switch 16 and is arranged to be disposed in a closed position in which it is shown in the drawing establishing electrical circuit through the solenoid 38 when the piston 23 is in its repose position as aforescribed.

The switch 42 will be actuated to an open position disconnecting the wires 41 and 43 electrically one from the other by movement of piston 23 in response to attainment of a certain pressure of fluid in chamber 24, as aforescribed.

For controlling release of fluid under pressure from the compressor unloader control conduit 7, a release valve device 45 is provided associated for convenience

with the pressure responsive device 17. The device 45, for sake of illustration, schematically may comprise a casing having formed therein two chambers 47, 48, separated by a partition 49; the chamber 47 being constantly connected to a branch of the conduit 43, and the chamber 48 being constantly connected to atmosphere by way of a port 50 in the casing. A release valve 51, disposed in chamber 47 and attached to rod 27, is arranged to control communication between the chambers 47, 48 via an opening in the partition 49. The valve 51 attains an unseated position opening chamber 47 to chamber 48, as shown in the drawing when piston 23 assumes its repose position. The rod 27 extends through a suitable opening in casing 46 and carries the valve 51 to a seated position when said rod is caused to move with piston 23 in response to attainment of a certain pressure of reservoir fluid in chamber 24 as aforescribed.

Operation

Assume that the switch 15 is open so that electrical circuit through the solenoid 13 in the line starter 8 is interrupted and the solenoid therefore deenergized with the respective switches 9 consequently in their open position in which they are shown in the drawing. With the line starter switches 9 open, the motor wires 10 will be disconnected from the line wires 11 and the compressor motor 3 and therefore compressor 1 will be idle, with consequently no fluid under pressure being generated for supply to the reservoir 4 which, we will assume is void of fluid under pressure at this time.

With reservoir 4 void of fluid under pressure, the piston 23 in the pressure responsive device 17 will be in its repose position in which it is shown in the drawing, with rod 27 so disposed that switches 16 and 42 will be closed, and release valve 51 will be open.

The closed switch 42 at this time has no effect on solenoid 38 which will be deenergized by reason of the motor wires 10 being disconnected from the line wires 11. With the solenoid 38 deenergized, the valve 34 will be held open by spring 36 so that the reservoir 4 will be void of fluid under pressure as assumed, by virtue of connection to atmosphere, via conduit 43 and, in device 45, chamber 47, unseated valve 51 chamber 48 and port 50.

The closed switch 16 has no effect on the starter switch solenoid 13 at this time because of the open switch 15 in series with it.

The open release valve 51 vents the unloader control conduit 7 to atmosphere via volume chamber 44, conduit 43, and chambers 47, 48 in device 45 so that unloader device 6 will be conditioned to allow for compression of air by operation of the compressor.

Assume now that it is desired to operate the compressor-motor system with automatic motor cut-off and compressor unloading when the desired reservoir pressure has been attained. The switch 18 will be allowed to remain open and the switch 15 will be closed to effect energization of the line starter solenoid 13 through supply of electrical energy from the respective line wire 11, wire 19, closed switch 15, wire 20, the closed switch 16 in pressure responsive device 17, and the wire 21.

In response to its energization as above, the solenoid 13 will effect closure of the respective switches 9, thereby connecting the motor wires 10 to the line wires 11, whereupon the motor 3 is brought into operation for driving the compressor 1 for supplying compressed air via check valve 5 to the reservoir 4.

Immediately upon receipt of electrical energy from line wires 11 by motor wires 10, such electrical energy will be conducted through the solenoid 38 in device 30 via wire 43, the closed switch 42, and wires 41 and 40 to energize said solenoid and close valve 34 so that such fluid under pressure as generated by operation of the compressor 1 cannot escape to atmosphere via device 30, conduit 43 and the unseated release valve 51 in device 17 and therefore such fluid under pressure delivered by the

compressor will flow to the reservoir 4 where pressure of fluid will be increased.

When the pressure of fluid in the reservoir 4 is thus increased as above and thereby attains a desired value, such pressure as experienced in pressure chamber 24 in device 17 will cause the piston 23 to move rod 27 such that the release valve 51 will be closed to prevent communication of conduit 43 to atmosphere; switch 16 will be opened to cut off supply of electrical energy to the line starter solenoid 13 which thus will become deenergized and allow spring 9a to open the switches 9, disconnecting the motor wires 10 from the line wires 11, thereby terminating operation of motor 3 and compressor 1; and switch 42 will be opened to interrupt electrical circuit through the solenoid 38 of device 30, which solenoid thus will become deenergized, if not otherwise deenergized by virtue of cut-off of electrical energy to motor wires 10, and the spring 36 will then be allowed to open valve 34, whereupon fluid under pressure from reservoir 4 will flow via conduit 28, the open valve 34 in device 30, conduit 43, and volume chamber 44 to the unloader control conduit 7 to cause the unloader device 6 to unload the compressor 1 preparatory to operating same again.

With switches 15 and 18 remaining closed and open, respectively, with the motor 3 idle and the compressor 1 unloaded, when the pressure of fluid in the reservoir 4 drops below a certain value by supply of such fluid under pressure to devices (not shown), such pressure as reflected in chamber 24 in device 17 will allow spring 25 to return the piston 23 to its repose position in which it is shown in the drawing, with resultant substantially simultaneous opening of the release valve 51, and closing of switches 16 and 42.

Closing of switch 16 will effect energization of the line starter solenoid 13 to cause closure of switches 9 for connecting the motor wires 10 to the line wires 11 and thereby supplying electrical energy for operating motor 3 driving compressor 1.

Closure of switch 42 will establish electrical connection between the solenoid 38 in the device 30 and the motor wires 10, which, when said wires have been supplied with electrical energy via the line starter as above, will cause energization of said solenoid to close the valve 34, thereby preventing communication between the unloader control pipe 7 and the reservoir 4, to allow fluid under pressure to vent from said control pipe when the release valve 51 in device 45 is opened as above mentioned.

Venting of fluid under pressure from the unloader control pipe 7, to allow the unloader device 6 to condition the compressor 1 to deliver compressed air to the reservoir 4, occurs by way of the volume chamber 44, conduit 43, and in device 45, the chamber 47, the open release valve 51, chamber 48 and port 50.

Since the release valve 51 is opened at substantially the same time that switch 16 closes to bring motor 3 into operation, it is the purpose of the volume chamber 44 to provide such volume of fluid under pressure as will delay depletion of fluid under pressure in the unloader control conduit 7 by way of the release valve 51 when opened, to give the motor 3 time to come up to speed before the compressor is loaded.

Now assume that it is desired to bring the motor-compressor system into operation with automatic unloading of the compressor 1 and continuous operation of the motor 3; both switches 15 and 18 are then moved to closed position.

Closure of the switch 15 will cause energization of the line switch solenoid 13 via the closed switch 18 which bypasses switch 16 in device 17 to connect the motor wires 10 to the line wires 11 for operating the motor 3.

If, while the motor 3 is thus brought into operation, the device 17 is in the position in which it is shown in the drawing as a result of reduced reservoir pressure, with

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switches 16, 42 consequently closed and release valve 51 open, electrical energy supplied to the motor wires 10 will flow via the closed switch 42 to energize solenoid 38 and close valve 34, thereby preventing communication between reservoir 4 and the unloader control conduit 7 vented to atmosphere via volume chamber 44, conduit 43 and the unseated release valve 51.

With the control conduit 7 vented, the unloader device 6 will be conditioned to load the compressor 1 so that the compressor in turning over with the motor 3 in operation will deliver fluid to the reservoir 4 and thereby increase pressure of fluid therein.

Again, in response to attainment of a certain desired pressure of fluid in the reservoir 4, the device 17 will respond to move rod 27 to open switches 16, 42 and to close the release valve 51.

Opening of the switch 42 will effect deenergization of the solenoid 38 to unseat valve 34 for supplying fluid under pressure to conduit 43 and, via chamber 44, to the unloader control pipe 7 for causing device 6 to unload the compressor 1.

At the same time, closure of the release valve 51 will prevent escape of the fluid under pressure supplied to the conduit 43 as above described.

Opening of the switch 16 with switch 18 closed has no influence on the line starter solenoid 13 which will remain energized by supply of electrical line energy via wire 19, switch 15, wire 20, the closed switch 18 and the wire 21, so that the motor 3, hence compressor 1, will continue to operate ineffectively without supplying compressed air to the reservoir 4.

When the reservoir pressure drops a certain degree, the device 17 will respond to close switch 42 for energizing solenoid 38 to close valve 34 for preventing loss of reservoir fluid via the release valve 51 which is opened at the time said switch is closed.

Opening of the release valve 51 will vent the fluid under pressure from the unloader control conduit 7 to cause the device 6 to again load the compressor 1 being constantly operated by the continuously running motor 3.

The system may be shut down intentionally by opening switch 15 to deenergize line starter solenoid 13 for opening switches 9 to stop the motor 3.

It should be pointed out that the reservoir 4 will vent to atmosphere via open valve 34 and release valve 51 when the system is shut down during operation of the compressor under load by opening switch 15; the compressor operates under load at reduced reservoir pressure by virtue of repose position of piston 23 in which release valve 51 is open to vent unloader control conduit 7 to allow unloader device 6 to load the compressor, and when electric current is cut-off to motor wires 10 at this time, solenoid 38 becomes deenergized and allows valve 34 to be unseated, thereby connecting reservoir 4 to conduit 43, thence to atmosphere via open valve 51.

The reservoir 4 thus will become void of fluid under pressure, and when the system is again brought into operation, even though the unloader control pipe 7 is vented via said open valve 51 and the unloader device 6 therefore conditioned to load the compressor 1, the com-

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pressor at time of starting will in effect be unloaded by virtue of absence of back pressure in reservoir 4 against which it has to pump.

Summary

Thus it will be seen that I have provided a relatively simple and improved apparatus for controlling operation of a motor-compressor system.

Having now described my invention, what I claim as new and desire to secure by Letters Patent, is:

1. A fluid compressor system comprising a storage reservoir, a fluid compressor for supplying fluid under pressure to said reservoir, a compressor unloader device responsive to pressurization and depressurization of a compressor unloader control conduit to unload and load, respectively, said compressor, electric motor means operatively connected to said compressor, motor wires connected to said motor, line wires from a source of electrical energy, switch means having an operating solenoid and effective upon energization and de-energization, respectively, of said solenoid for connecting and disconnecting said motor wires to and from said line wires, circuit means connected to said line wires controlling energization and de-energization of said solenoid including a first switch and a second switch connected in series one with the other, an unloader-control supply valve biased toward an open position to establish supply connection of said unloader control conduit to said reservoir and operable to a closed position to disestablish said supply connection, supply valve actuating solenoid means energizable to close said supply valve, circuit means connected to said motor wires for controlling energization and de-energization of said valve actuating solenoid means including a third switch, an unloader-control vent valve operable to open and closed position to establish and disestablish, respectively, connection of said unloader control conduit to the atmosphere, and a movable abutment mechanically connected to the second and third switches and to said vent valve, said abutment being biased toward a position in which the second and third switches are closed and said vent valve is open and being operable responsively to pressure of fluid in said reservoir above a certain value to open the second and third switches and to close said vent valve.

2. The combination as set forth in claim 1, including a fourth switch connected in parallel with said second switch, and a volume chamber means constantly open to said unloader control conduit to delay loading of the compressor upon starting of the motor driving same.

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