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COMPRESSOR SYSTEM

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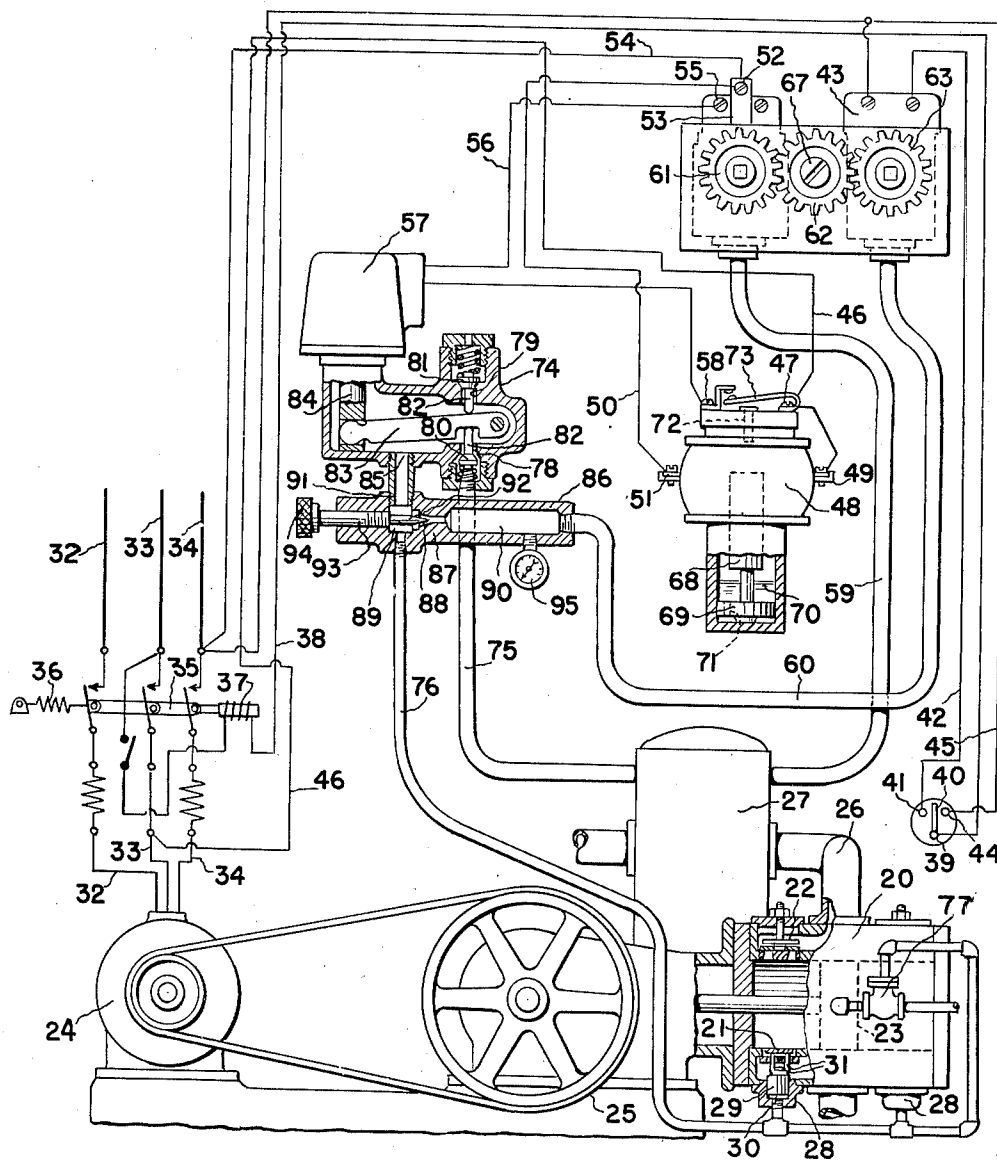


FIG. 1.

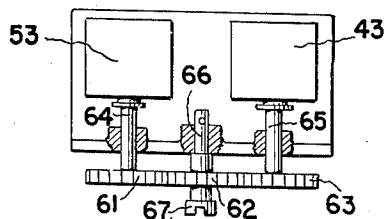


FIG. 2.

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COMPRESSOR SYSTEM

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2 Claims. (Cl. 230—4)

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This invention relates to compressor systems, and more particularly to a regulator for controlling the operation of an air or gas compressor.

One object of the invention is to control automatically the operation of a compressor, whereby the compressor is loaded and unloaded during periods of heavy air demand and the motor driving the compressor is stopped and restarted during periods of light air demand.

Another object is to cause the operation of the start-stop controller to be dependent upon the operation of the load controller.

A further object is to synchronize the adjustment of the opening pressures of the load switch and the start-stop switch.

Another object is to provide a means for indicating the air demand load on a compressor.

Other objects will be in part obvious and in part pointed out hereinafter.

In the accompanying drawings in which similar reference numerals refer to similar parts,

Figure 1 is a side elevation, partly broken away, of a compressor system embodying the present invention in which, for clearness sake, the regulating devices are enlarged in comparison with the compressor, and

Figure 2 is a top view of a detail of the regulating mechanism shown in Figure 1.

Referring more particularly to the drawings and at first to Figure 1, a compressor designated, in general, by 20 is shown as having the usual inlet valve 21 and discharge valve 22, controlling their respective ports, and a reciprocating piston 23 which is driven by an electric motor 24 through the power transmission mechanism 25. Compressed air from the compressor 20 passes through the discharge valve 22 into an air line 26 which conveys it to a receiver 27.

Located adjacent the inlet valves 21 are conventional type air operated unloaders 28 which consist of a piston 29 adapted to slide into a chamber 30 into which compressed air is conveyed to push the piston 29 and its projecting arms 31 toward the inlet valve 21. The arms 31 are adapted to bear against the operable parts of the valve 21 holding such parts unseated and consequently effecting the unloading of the compressor when compressed air is supplied to the chamber 30.

Power is supplied to the motor 24 through three main line conductors 32, 33 and 34 into which is connected a main switch 35 for the motor. The switch 35 is normally held open by a spring 36 and is closed by the operation of a solenoid 37 connected to the switch 35. A conductor 38 connected on the power side of the switch 35 to the main conductor 33 is provided to convey current through the coil of the solenoid 37 and further leads to a contact 39 on the selector switch 40. The switch 40 may be moved such that it contacts the terminal 41 which is connected to a conductor 42 leading to a pressure switch 43, or such that it contacts a terminal 44 connected to

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a conductor 45 which is joined to the main line conductor 34 on the power side of the switch 35.

Connected to the main conductor 33 on the motor side of the switch 35 is a conductor 46 which leads through a terminal 47 on a time-delay relay 48 to a second terminal 49 connected to the energizing coil of the relay 48. A conductor 50 connected to the terminal 51 of the energizing coil of the relay 48 leads to a terminal 52 on a pressure responsive switch mechanism 53, and the circuit is completed by a conductor 54 connected to the terminal 52 and to the main line conductor 34 on the power side of the switch 35. Secured to a second terminal 55 on the switch 53 is a conductor 56 which has the energizing coil of a solenoid 57 connected thereto and ultimately leads to a terminal 58 on the relay 48.

The pressure switches 43 and 53 may be of any conventional type wherein the electrical connection is opened when the pressure reaches a predetermined value and is again completed when the pressure drops to a predetermined value. However, the pressure ranges of the two switches are considerably different. Since the switch 43 operates during periods of light air demand and controls the start-stop operation of the driving motor 24, its operating pressure range is comparatively large, for example between fifteen and twenty-five pounds. The pressure switch 53, however, electrically controls the loading and unloading of the compressor and consequently operates during periods of heavy air demand. Thus, its pressure range is relatively small, say two to five pounds. The pressure switch 53 is operated directly by receiver pressure and is connected to the receiver by a conduit 59. The switch 43 receives its operating pressure fluid through a conduit 60 which conveys a portion of the fluid operating the compressor unloaders 28 to the switch 43.

It is often desirable and necessary to change the upper operating pressures of the two switches, and further it is imperative that the relative difference between such pressures be kept practically constant at all times. To this end the switches 43 and 53 are provided with a gear train consisting of three gears 61, 62 and 63. The gears 61 and 63 are connected to the adjusting shafts 64 and 65 of the pressure switches 53 and 43, respectively, and the main adjusting gear 62 is fixed on an idler shaft 66. The outer end of the shaft 66 has a slotted head portion 67 thereon to facilitate the rotational movement of the main gear 62 which in turn moves each of the gears 61 and 63 the same amount, thereby making possible the synchronous adjustment of the operating pressures of the pressure switches 43 and 53.

The switch 53 controls the circuit containing the time-delay relay 48 and the load controlling solenoid 57. The essential purpose of the time-delay relay is to delay the action of the solenoid 57 and consequently to delay the loading of the

compressor for a predetermined time after the driving motor 24 is started. The relay 48 is shown as being of the oil dash-pot type, wherein the movement of a core 68 into its energized coil is impeded by a piston 69 which is connected to the core and normally rests at the bottom of an oil well 70. A small hole 71 is provided through the piston 69 to restrict the passage of oil from one side of the piston to the other and thus delay movement of the core 68 into the coil. After this delay, the core, on moving into its coil, hits a pin 72 projecting into the top of the relay 48. The upward movement of the pin 72 closes the contacts of a switch 73 attached to the top of the relay and connected into the circuit containing the solenoid 57.

To control the flow of fluid to the compressor unloaders 28 and a water cut-off valve 77 for the compressor, a valve mechanism 74 is connected between a pipe 75 from the receiver 27 and a conduit 76 leading to the unloaders 28 and the water cut-off valve 77. The valve mechanism 74 includes an inlet port 78 and an atmospheric exhaust port 79 having spring-pressed check valves 80 and 81, respectively, adapted to seat therein. Each valve has a stem 82 whose end rests against a pivoted arm 83 pivotally connected to a core extension 84 of the solenoid 57. The valve mechanism 74 is provided with a third port 85 into which is connected means for conveying pressure fluid to the unloaders 28. When the solenoid 57 is deenergized and thus the arm 83 is pivoted downwardly, pressure fluid is permitted to flow into the valve mechanism through the open port 78 and out through the port 85 to the unloaders 28. At such times the valve 81 is held seated by its spring, shutting off the atmospheric exhaust port 79. When the solenoid 57 is energized, the core extension 84 is raised thus moving the pivoted arm 83 upwardly such that the exhaust valve 81 is unseated and the inlet valve 80 is seated by its spring to shut off the flow of air from the receiver 27. With opening of the exhaust port 79 the air operating the unloaders 28 escapes to the atmosphere and the compressor is loaded.

Connected between the conduit 76 and port 85 is a bleeder valve mechanism 86 for allowing some of the pressure fluid passing to the unloaders 28 to flow into a conduit 89 and subsequently to the switch 43 for operating same. The bleeder mechanism consists of a housing 87 having a conical shaped port 88 located between two chambers 89 and 90. The chamber 89 is connected to the valve mechanism 74 by a conduit 91 threaded into the port 85 and further opens into the conduit 76 leading to the compressor unloaders 28. The chamber 90 has an opening into which is connected the conduit 89 leading to the pressure switch 43.

The flow of air through the port 88 into the chamber 90 is controlled by a needle valve 92 which is adapted to seat against the conical surfaces of the port 88. The position of the valve in the port is adjusted by the movement of a threaded valve stem 93 which extends without the housing 87 and has a head 94 to facilitate the manual adjustment of the valve 92. In order to determine the pressure acting on the pressure switch 43, a pressure gauge 95 is connected into the chamber 90 of the bleeder mechanism 86.

Assuming there is air in the receiver 27 at normal operating pressure, the compressor system is put into operation using the automatic dual control by moving the switch 40 to connect the

contact 41. Thus, a circuit is completed through the solenoid 37, conductors 38 and 42, the pressure responsive switch 43, on through the conductor 45 to the main line conductor 34. When the coil of the solenoid 37 is energized, it closes the main switch 35 thus starting the driving motor and simultaneously causing current to pass through a closed circuit consisting of a conductor 46, the coils of the time-delay relay 48 and conductors 50 and 54 back to the main line conductor 34.

At this time the solenoid 57 is not energized consequently compressed air in the receiver 27 passes through the port 78 into the valve mechanism 74 and out into the conduit 76 which conveys it to the unloaders 28 and the water cut-off valve 77 of the compressor; and thus, even though the compressor piston is operating, the compressor is unloaded. However, after a short delay, during which time the driving motor 24 is brought up to speed and the coil of the time-delay relay 48 draws the core 68 into operating position, the switch 73 is closed, completing a circuit between the live conductors 46 and 54 consisting of the conductor 56, the solenoid 57, and the pressure switch 53.

When the solenoid 57 is energized, it moves the arm 83 upwardly to open the exhaust port 79 and allow the valve 80 to seat thus cutting off the flow of air from the receiver through the port 78. The compressor would now be loaded since the air operating the unloaders 28 escapes through the exhaust port 79 to the atmosphere. The compressor will then operate to build up a pressure in the receiver 27 to some predetermined maximum value. If at first it is assumed that the air demand on the compressor is great, this maximum value would correspond to the pressure set for opening the pressure responsive switch 53. When the receiver pressure reaches such value, the switch 53 opens, in turn opening the circuit containing the solenoid 57. The arm 83 will then be pivoted downward and compressed air will again flow through the valve mechanism 74 to the unloaders 28 and the water cut-off valve 77. Since the needle valve 92 is slightly unseated in the port 88, a portion of this air is permitted to pass through the port 88 into chamber 90 and to the switch 43. Thus, the pressure acting on the pressure switch 43 builds up slowly during periods when the compressor is unloaded.

As soon as the receiver pressure drops to a predetermined value the switch 53 closes and completes the circuit containing the solenoid 57. Thus the compressor is again loaded. The air operating the unloaders escapes through the exhaust port 79 and a portion of the air trapped in the chamber 90 bleeds back through the port 88 through the valve mechanism 74 to the atmosphere. Consequently the pressure on the switch 43 is continuously and slowly reduced during loaded periods of the compressor.

As long as the demand for air is great, the system will continue to operate on the loading-unloading cycle since the unloaded periods of the compressor will not be long enough to permit a sufficient amount of pressure fluid to bleed from the chamber 89 into the chamber 90 for increasing the pressure therein to a value that will cause the switch 43 to operate. However, if it is now assumed that the demand for air from the compressor becomes light, the compressor will remain unloaded for a considerable length of time during each load-unload cycle since re-

ceiver pressure would drop slowly. When the unloaded time of the compressor is of such length that the pressure in the chambers 89 and 90 will equalize, the pressure acting on the switch 43 is sufficient to cause that switch to open, and the system will now operate by automatically starting and stopping the driving motor.

Opening of the switch 43 breaks the circuit containing the solenoid 37 which in turn allows the main switch 35 to open, thereby cutting off the driving motor 24 and opening all the electrical circuits of the regulator. Since the pressure range of the switch 43 is comparatively large the compressor system will remain idle for a considerable length of time until the receiver pressure has dropped down to a value corresponding to the closing pressure of the switch 43. On closing of the switch 43, the original circuit containing the solenoid 37 is completed and the main switch 35 is closed. Current again flows through the switch 53 to the time-delay relay 48 and, after a delay, through the solenoid 57 in a manner previously described for again putting the system into operation.

At any time when the demand for air again may become great, the switch 53 will take over the control of the system since the unloaded periods of the compressor will again become too short for the pressure to build up in the switch 43 sufficiently to operate it ahead of the switch 53.

It will be noted then that when the demand for air is great the compressor will be continuously driven by the motor 24 but it will be loaded and unloaded so as to keep a practically constant pressure in the receiver 27. But when the demand for air becomes light, the system is shut down completely until the pressure on the switch 43 reaches a certain minimum value, at which time the system is again put into operation and will operate according to the air demand from the compressor.

If it is necessary to maintain a practically constant pressure in the receiver 27 for all load conditions, the switch 40 may be moved to connect the contact 44. This cuts out the operation of the start-stop controller 43 and allows the system to operate at all times under the control of the load-unload controller 53. The system would then constantly operate in a manner similar to that described above for periods of great air demand.

It must be remembered that, after the pressure is exhausted from the unloaders 28 and the compressor reloads, the air trapped in the pressure switch 43 and chamber 90 will also slowly leak out to atmosphere through the port 88 controlled by the needle valve 92 during the whole time the compressor is running loaded. Since the length of time that the compressor runs loaded and unloaded is a function of the air demand, the pressure on the switch 43 naturally varies. The pressure gauge 95 indicates this varying pressure on the switch 43 and in addition to being useful in setting the needle valve 92 to get the proper time interval for operation of the switch 43, this gauge also indicates the approximate air demand on the compressor. If the pressure of this gauge varies in a low range, say from ten to thirty pounds during the load-unload cycle, the air demand is rather great and the unloaded periods of the compressor are short. However, if the pressure on the gauge is of a high order, say eighty to ninety pounds during the load-unload cycle, then the air demand on

the compressor is low, and the unit would be about to operate under automatic start-stop control. The gauge 95 may be graduated such that it indicates directly either the pressure on the switch 43 or the air demand on the compressor.

It will be apparent to those familiar with the art that various modifications and changes may be made without departing from the spirit of the invention and the scope of the claims.

I claim:

1. A controlling system for compressors including in combination a compressor having unloading devices therefor, a driving motor for the compressor, a receiver connected to the outlet of the compressor to receive the compressor discharge, a controller in communication with the receiver and actuated by pressure fluid therein for valving pressure fluid to the compressor unloaders to unload the compressor whenever the fluid in the receiver has reached a predetermined value, a second controller in communication with the receiver and actuated by pressure fluid therein to stop the driving motor for the compressor at a predetermined value of the pressure fluid, and means between the receiver and the second-mentioned controller for throttling the flow of pressure fluid from the receiver to the second-mentioned controller so as to vary the time in which pressure of the fluid reaches the predetermined value.

2. A controlling system for compressors including in combination a compressor having unloading devices therefor, a driving motor for the compressor, a receiver connected to the outlet of the compressor to receive the compressor discharge, a valve connected between the receiver and the unloading devices for communicating the unloading devices alternately with the receiver and the atmosphere, a controller for the valve in communication with the receiver and actuated by the pressure fluid therein said controller actuating the valve to unload the compressor at an upper predetermined value of pressure fluid and to load the compressor at a lower predetermined value of pressure fluid, a controller for the driving motor connected between the valve and the unloading devices and actuated by pressure fluid from the receiver, said second-mentioned controller stopping the motor at a predetermined upper value of pressure fluid and starting the motor at a predetermined lower value of pressure fluid the differential between the two values being substantially greater than the differential between the two predetermined values of the first-mentioned controller, and means between the valve and the second-mentioned controller for selectively varying the flow of pressure fluid to the controller.

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