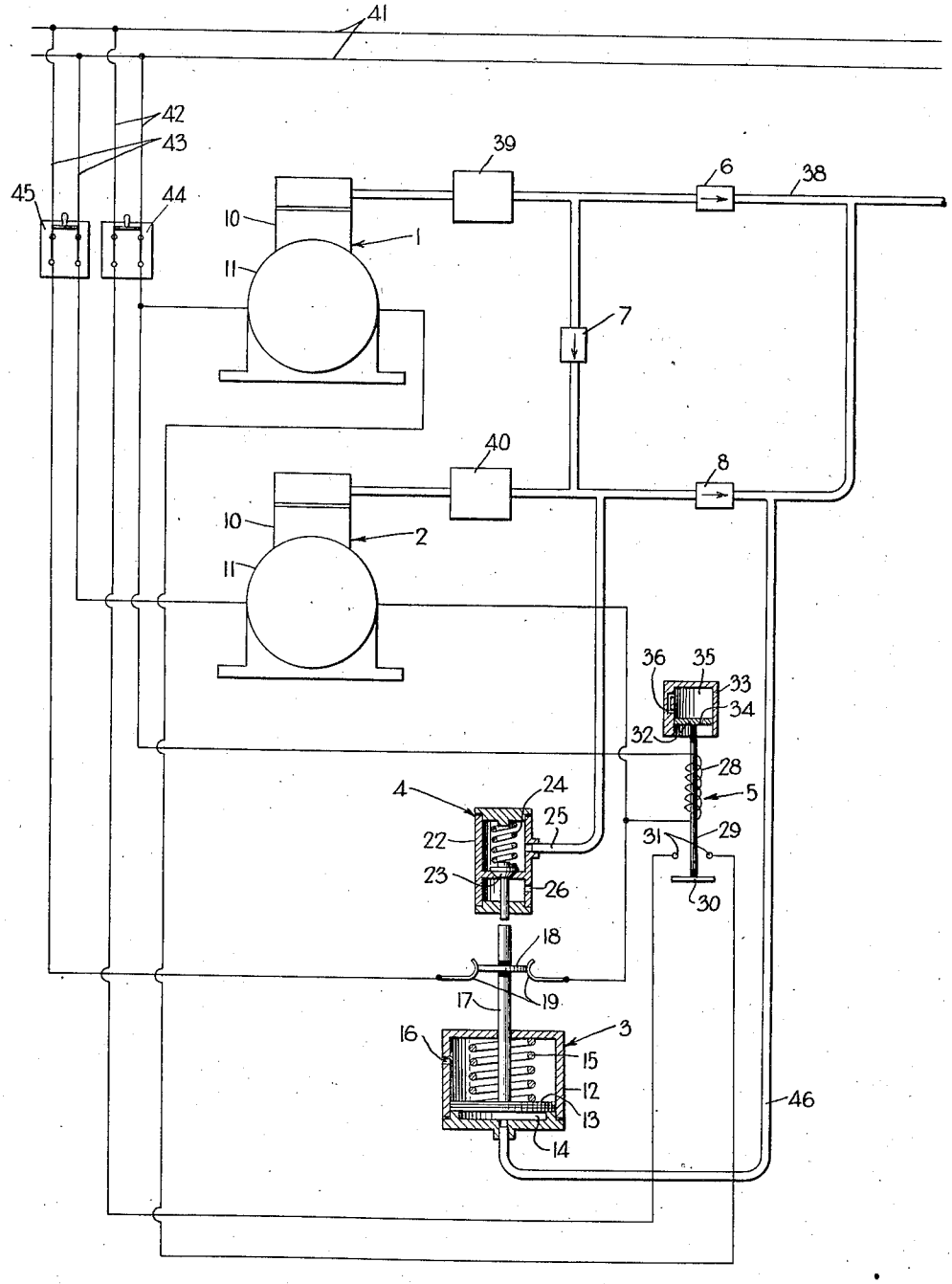
Sept. 15, 1942. P. L. CRITTENDEN 2,295,775

COMPRESSOR CONTROL APPARATUS

Filed Oct. 31, 1940



INVENTOR
PHILIP L. CRITTENDEN
BY A. M. Higgins
ATTORNEY

Patented Sept. 15, 1942

2,295,775

UNITED STATES PATENT OFFICE

2,295,775

COMPRESSOR CONTROL APPARATUS

Philip L. Crittenden, Edgewood, Pa., assignor to The Westinghouse Air Brake Company, Wilmerding, Pa., a corporation of Pennsylvania

Application October 31, 1940, Serial No. 363,661

17 Claims. (Cl. 230—18)

This invention relates to compressor control apparatus, and more particularly to apparatus for controlling a plurality of compressors arranged to deliver air under pressure to a single pipe line or storage reservoir.

In many compressor installations it is desirable to employ two or more relatively small compressors instead of a single large compressor, because with two or more compressors the number to be operated may be varied in accordance with the demand for compressed air. That is to say, if the demand for compressed air is low one small compressor may be able to supply that demand, but if the demand is high then two or more compressors may be required. By an arrangement of multiple compressors certain economies of operation can therefore be realized.

If in a multiple compressor arrangement, as just referred to, the compressors are driven by electric motors, very high starting current will result if all of the compressors are started up simultaneously and under load. High starting currents, with consequent momentary lowering of the supply voltage, are to be avoided if possible, and it is therefore an object of the present invention to provide an arrangement whereby two or more compressors may be started up substantially simultaneously without causing intolerable disturbances in the electrical supply line.

More specifically, it is an object of this invention to provide a control arrangement for multiple compressors, so arranged that the compressors are started up serially, and in an unloaded state, with a sufficient interval of time between the starting of one compressor and the starting of the next so that the disturbance in the electrical supply line is never at any one time more than that due to one compressor starting up.

Further objects of the invention will be apparent from the description which follows, which has reference to the attached single figure in the drawing illustrating one form that the invention may take.

Referring now to the drawing, I have for simplicity shown only two compressor units 1 and 2, a control apparatus comprising a pressure operated switch device 3, an unloading valve device 4 and a time delay relay device 5. In addition I have included three check valve devices 6, 7 and 8. Other parts illustrated will be referred to more fully hereinafter.

The compressor units 1 and 2 are preferably duplicates, and as illustrated each comprises a reciprocating type compressor 10 and a driving motor 11 suitably connected to the compressor.

The pressure operated switch device 3 comprises a casing 12 in which is disposed a piston 13 subject on one side to pressure of air in a chamber 14 and on the other side to the force of a spring 15, which is disposed in a chamber always open to the atmosphere by way of a port 16.

The piston 13 has attached thereto a stem 17, which carries insulated therefrom a contact 18 adapted to bridge two stationary contacts 19 when the piston 13 is in its lowermost position, as shown.

The unloading valve device 4 comprises a casing 22 having disposed therein a valve 23 which is urged toward seated position by a spring 24. When in seated position the valve 23 closes communication between a pipe 25 and an exhaust port 26, and when unseated opens this communication.

The time delay relay device 5 comprises essentially a solenoid or winding 28 containing a central aperture in which is disposed a plunger 29. The lower end of this plunger carries insulated therefrom a contact 30 which is adapted in its uppermost position to bridge stationary contacts 31.

The upper end of the plunger 29 has attached thereto, and magnetically insulating therefrom, a piston 32 which is slidable in the bore of a casing 33. The piston 32 contains a small restricted port 34 providing communication between chamber 35 above the piston and the atmosphere below the piston.

The arrangement just described, including the piston 32, is intended to provide a cushioning or dashpot action for the upward movement of the plunger 29, as will be obvious. The movement of the plunger 29 upwardly will therefore be slow, and by suitably proportioning the parts a definite time interval delay may be produced between the time of energizing the solenoid 28 and the bridging of contact 30 with contacts 31.

To insure that contact 30 shall firmly engage contacts 31 at the end of the upward movement of the plunger 29, a by-pass passage 36 has been provided in the casing 33. As the plunger 29 and the piston 32 move upwardly the motion will be slow until the lower edge of piston 32 has uncovered the lower part of passage 36, whereupon the pressures above and below piston 32 will be equalized and the force exerted by solenoid 28 being then unopposed will cause contact 30 to firmly engage contacts 31.

From the arrangement described, it will be apparent that the time delay relay device will after

energization of solenoid 28 operate with a definite time interval delay to cause engagement of contacts 30 and 31. When the solenoid 28 is deenergized contacts 30 and 31 will be disengaged promptly, passage 36 being arranged to provide for this, and thereafter the plunger 29 will return slowly to its lowermost position.

The check valve devices 6, 7 and 8 are preferably duplicates of each other and may be of the usual construction. In the present instance they are connected in pipe lines so as to provide a one-way flow of air under pressure as indicated by the arrows thereon. Check valve 6 is disposed between the compressor unit 1 and what I shall term a pressure delivery pipe 38, which is connected to either a storage reservoir or a consuming device, and which hereinafter shall be taken to represent a chamber to which both compressor units deliver air under pressure.

The check valve 8 is connected between compressor unit 2 and the pressure delivery pipe 38, and the check valve device 7 is connected between the two compressor units.

In order to accomplish the objects of the invention, it is necessary that the pipe adjacent and connected to each compressor device comprise a more or less definite volume, and for this reason I have indicated as being disposed in the pipe line connected to the compressor unit 1 a chamber 39 and similarly in the pipe line connected to the compressor unit 2 a like chamber 40. These chambers may be in the form of reservoirs and are provided for permitting the compressors to start up substantially unloaded, as will appear presently. It is important to note that each chamber is connected between a compressor unit and the associated check valve device 6 or 8; and that the check valve device 7 provides a one-way communication from the chamber 39 to the chamber 40. The aforementioned pipe 25 is connected to the pipe line from the compressor unit 2 ahead of the check valve device 8.

Electric power for operating the motors 11 may be obtained from power supply line 41. Each motor 11 is preferably supplied from this power line by independent circuits, that to the compressor unit 1 being by way of branch supply line 42 and that to the compressor unit 2 being by way of branch supply line 43. These branch supply lines are controlled respectively by manually operated switch devices 44 and 45. It will be observed that the branch supply line 43 has one conductor thereof passing through the contacts of the pressure operated switch device 3, whereas one conductor of the branch line 42 passes through the contacts of the time delay relay device 5.

Further details of the invention will be best understood from a description of operation thereof, which now follows:

Operation

In the embodiment illustrated the parts are shown in the positions that they occupy at the instant of starting up of the apparatus, i. e., at the instant following closing of the two switch devices 44 and 45. Upon closing of switch 45 a circuit is immediately established to the motor 11 of the compressor unit 2 and it immediately begins to supply air under pressure to the pressure delivery pipe 38, this air under pressure being first delivered to the chamber 40 and by way of check valve device 8 to the pipe 38. Previous to the starting of compressor unit 2 the chamber 40 will have been exhausted of any air under pressure which may have been therein, so that when the compressor starts up it delivers air to this chamber against substantially no back pressure. The power thus required to start the compressor is a minimum.

Upon closing of the two switches 44 and 45 the solenoid 28 of the time delay relay device 5 is energized, as will be obvious from the circuits illustrated. As before explained, however, this relay device operates with a definite time delay interval, which for present purposes may be assumed to be of the order of thirty seconds. Therefore, after the elapse of this time interval contact 30 will engage stationary contacts 31, and thus cause power to be supplied to the motor 11 of the compressor unit 1, which unit will start up and deliver air under pressure to the pressure line 38 by way of chamber 39 and check valve device 6. The chamber 39 will have been previously exhausted of any air pressure so that compressor unit 1 starts up substantially unloaded, as did compressor unit 2.

When after a period of operation the two compressor units have established in pipe 38 a predetermined pressure, this pressure will, due to connection between the pressure operated switch device 3 and pipe 38 by way of pipe 46, cause piston 13 to move upwardly and disengage contact 18 from contacts 19. The opening of these contacts will interrupt the circuit to both the motor of the compressor unit 2 and the solenoid 28 of the time delay relay device 5, which will promptly disengage contact 30 from contact 31. It will thus be apparent that both compressor units will stop immediately and substantially simultaneously.

When the piston 13 in the pressure operated switch device 3 moves upwardly the stem 17 engages the stem of the valve 23 in the unloading valve device 4, causing valve 23 to be unseated. Unseating of valve 23 opens communication between pipe 25 and exhaust port 26. From the arrangement shown it will be evident that chambers 39 and 40 are then exhausted to the atmosphere, the check valve 7 permitting flow in the proper direction from the chamber 39. The two check valves 6 and 8 prevent back flow of air under pressure from the pressure delivery pipe 38.

The functioning of the pressure operated switch device 3 upon attainment of the desired pressure in pipe 38 thus acts to stop both compressor units and to exhaust both unloading chambers 39 and 40.

When the pressure in pipe 38 falls below the said predetermined value the piston 13 in the pressure operated switch device 3 move downwardly, first permitting valve 23 in the unloading valve device 4 to seat, and then causing engagement of contacts 18 and 19. This will result in starting up of first compressor unit 2 and then after an interval of time the compressor unit 1. Due to the previous exhausting of both of the unloading chambers 39 and 40 each compressor will start up substantially unloaded.

It will thus be obvious that the invention provides for the serial starting of a plurality of compressors, so as to cause a minimum of disturbance in the electrical supply system, and also provides that when each compressor starts it starts up substantially unloaded.

While I have described my invention with particular reference to a specific embodiment it is not my intention to limit it to this embodiment

alone nor otherwise than according to the spirit and scope of the appended claims.

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

1. In a compressor control apparatus, in combination, a pipe, a plurality of compressors operative to deliver fluid under pressure to said pipe, means including unloading chambers connected to each of said compressors and operative to unload the compressors when starting up, means for controlling starting and stopping of said compressors in accordance with the pressure delivered to said pipe, and means operative while the compressors are stopped for venting said unloading chambers to render them effective when the compressors are started up.

2. In a compressor control apparatus, in combination, a pipe, a compressor operative to deliver fluid under pressure to said pipe, an unloading chamber connected to the compressor and in which the compressor initially delivers fluid when starting up, means for starting and stopping the compressor in accordance with the pressure delivered to said pipe, and means for venting said unloading chamber during the time the compressor is stopped.

3. In a compressor control apparatus, in combination, a pressure delivery pipe, two unloading chambers, two compressors each being operative to deliver fluid under pressure to said pressure delivery pipe through one of said unloading chambers, means operative when the pressure in said pipe is above a predetermined value for stopping said compressors and when the pressure in said pipe is below said predetermined value for starting up said compressors, and means controlled by the last said means for maintaining said unloading chambers vented to the atmosphere while the compressors are stopped.

4. In a compressor control apparatus, in combination, a pressure delivery pipe, a compressor, an unloading chamber connected between said compressor and said pressure delivery pipe, a check valve device connected between said chamber and said pipe and operative to prevent flow from said pipe to said chamber, means for venting said chamber to the atmosphere at selected times, and means controlled by the pressure in said pipe for controlling said last means.

5. In a compressor control apparatus, in combination, a pipe, an unloading chamber, a compressor for supplying fluid under pressure to said pipe by way of said unloading chamber, means for preventing back flow of fluid under pressure from said pipe to said chamber, a normally closed valve operative when open to vent said chamber to the atmosphere, and means operative a predetermined pressure in said pipe for opening said valve.

6. In a compressor control apparatus, in combination, a pipe, an unloading chamber, a compressor for supplying fluid under pressure to said pipe by way of said unloading chamber, means for preventing back flow of fluid under pressure from said pipe to said chamber, a normally closed valve operative when open to vent said chamber to the atmosphere, a switch device operative to control starting and stopping of said compressor, and means governed by the pressure in said pipe for controlling operation of said switch device and said valve.

7. In a compressor control apparatus, in combination, a pipe, two compressors operative to supply fluid under pressure to said pipe, unloading chambers connected to each compressor and operative to substantially unload each compressor during starting operation thereof, switch means operative to start up first one compressor and then after a delayed time interval the other compressor, valve means operative to vent the unloading chambers to the atmosphere when the compressors are stopped, and means controlled by the pressure in said pipe for controlling both said switch means and said valve means.

8. In a compressor control apparatus, in combination, a pipe, two compressors operative to deliver fluid under pressure to said pipe, unloading chambers connected to said compressors and operative to unload them during starting operation, normally closed valve means operative when opened to vent said unloading chambers to the atmosphere, switch means operative to first start up one compressor and then after a delayed time interval the other compressor, and pressure operated means responsive to the pressure in said pipe and operative below a predetermined pressure in said pipe to actuate said switch means to cause starting up of said compressors and operative above said predetermined pressure to actuate said switch means to stop said compressor and to open said valve.

9. In a compressor control apparatus, in combination, a pipe, two compressors, two unloading chambers one connected to each of said compressors, two check valve devices one connected between each of said unloading chambers and said pipe and being operative to prevent back flow of pressure from said pipe to said chamber, a first switch device controlling operation of one compressor, a second switch device for controlling operation of the other compressor and being itself controlled by operation of the first switch device, means including a normally closed valve operative when opened to vent both unloading chambers to the atmosphere, a pressure operated device connected to said pipe and operative below a predetermined pressure in said pipe to close said first switch device and thereby causing operation of said second switch device also, and being operative above said predetermined pressure in said pipe to open said first switch device and to thereby cause opening of said second switch device and also being operative to effect opening of said valve.

10. In a compressor control apparatus, in combination, two compressors operative to deliver fluid under pressure to a chamber, an electric circuit through which current is supplied to operate one compressor, a second electric circuit through which current is supplied to operate the other compressor, a switch device for opening and closing the first circuit, a second switch device for opening and closing the second circuit and being controlled by the first switch device and being also operable with a time delay action, and means controlled by the pressure of fluid delivered by the compressor for controlling operation of the first switch device.

11. In a compressor control apparatus, in combination, a chamber, a plurality of compressors operable to deliver fluid under pressure to said chamber, means operable once it has been set in operation to start up first one compressor and then another only after the elapse of a predetermined interval of time, and means controlled by the pressure of fluid in said chamber for controlling said last means.

12. In a compressor control apparatus, in com-

bination, a chamber adapted to confine fluid under pressure, two compressors operable to supply fluid under pressure to said chamber, governor means operable once it has been set in motion to start first one compressor and then the other only after the elapse of a fixed interval of time, and means governed by the pressure in said chamber for controlling said governor means.

13. In a compressor control apparatus, in combination, a pressure delivery pipe, two compressor units operable to deliver fluid under pressure to said delivery pipe, switch means constructed and arranged to have a fixed cycle of operation, said switch means being effective once it has been set in operation to start one compressor unit immediately and to start the other compressor unit only after the elapse of a predetermined time interval, and means controlled by the pressure of fluid in said pressure delivery pipe for controlling said switch means.

14. In a compressor control apparatus, in combination, a pipe, two compressors operative to deliver fluid under pressure to said pipe, and cooperatively associated switch elements constructed and arranged to control said compressors in a fixed cycle of operation, said elements including a first switch device operative when closed to start up one compressor, a delayed action switch device set in operation in response to the closing of the first switch device but operative only after a predetermined interval of time to start up the second compressor, and means for controlling opening and closing of the first switch device.

15. In a compressor control apparatus, in combination, a pipe, two compressors operative to deliver fluid under pressure to said pipe, and cooperatively associated switch means constructed and arranged to control said compressors in a fixed cycle of operation, said means comprising a first switch device operative when closed to start up one compressor, a delayed action switch device set in operation in response to closing of the first switch device but operative only after a predetermined interval of time to start up the second compressor, and pressure operated means for controlling opening and closing of the first switch device, said pressure operated means being subject to the pressure in said pipe.

16. In a compressor control apparatus, in combination, a pipe, a plurality of compressors operative to deliver fluid under pressure to said pipe, unloader means associated with each of said compressors and operable to unload the compressors when starting up, means for controlling starting and stopping of said compressors in accordance with the pressure delivered to said pipe, and means operative while the compressors are stopped for conditioning said unloader means to render same effective when the compressors are started up.

17. In a compressor control apparatus, in combination, a pipe, two compressors operative to supply fluid under pressure to said pipe, unloader means associated with each compressor and constructed and arranged to be conditioned for unloading each compressor during starting operation thereof, switch means operative to start up first one compressor and then after a delayed time interval the other compressor, means operative when the compressors are stopped to condition said unloader means for subsequent operation, and means controlled by the pressure in said pipe for controlling both said last mentioned means and said switch means.

PHILIP L. CRITTENDEN.