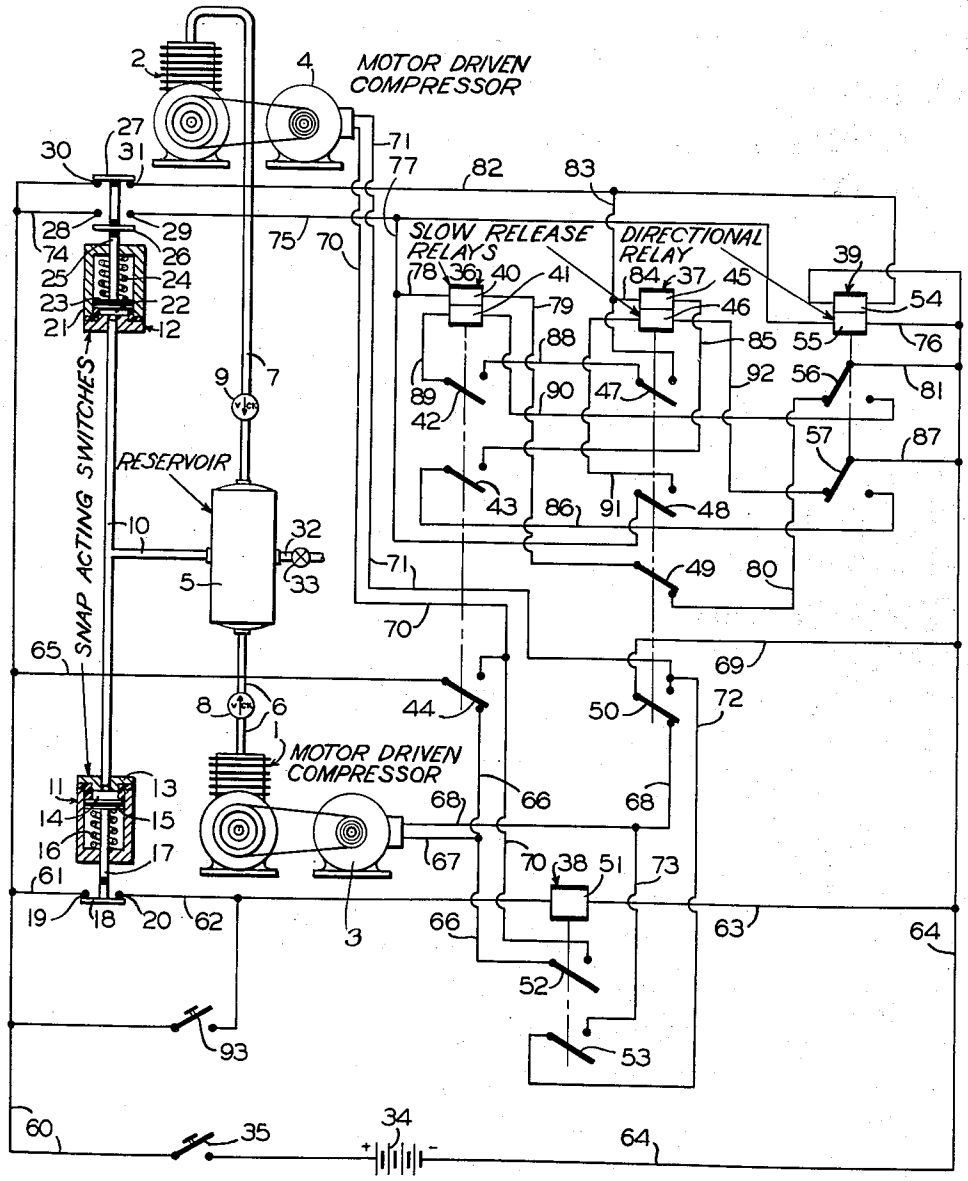
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CONTROL APPARATUS FOR DUAL COMPRESSORS

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CONTROL APPARATUS FOR DUAL COMPRESSORS

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This invention relates to compressor control apparatus and more particularly to apparatus for controlling dual motor-driven compressors that supply fluid under pressure to a common storage reservoir.

In railway service many uses have been found for multiple compressor systems as for example in pneumatically operated railway switches where it is essential to have a constant supply of air pressure to provide sufficient pressure to close switch points against the resistance of ice or dirt. In such instances, two motor-driven compressors are provided with a single source of energy such as a battery to drive the compressors one at a time, by manually selecting one compressor for operation and the other for standby for a period of time and then manually alternating the standby and operational compressors after said period of time of, for example, one month.

According to this invention there is provided circuitry and apparatus including a plurality of multiple contact relays for automatically effecting operation of the different compressors of a dual compressor system alternately to avoid prolonged use and wear of one compressor relative to the other. The apparatus functions also to automatically effect operation of both compressors simultaneously during periods of peak demand and to automatically effect double-duty operation of one compressor in the event of failure of the other.

The accompanying single figure drawing is a diagrammatic view, partly in section, showing one embodiment of the above-described control apparatus as applied to a dual compressor system for supplying fluid under pressure to a common supply reservoir.

Description

Referring to the drawing, there is shown a dual compressor system comprising two compressors 1 and 2 driven by electric motors 3 and 4 respectively, for supplying fluid under pressure to a common storage reservoir 5 via pipes 6 and 7, check valves 8 and 9 being interposed in pipes 6 and 7 respectively, to prevent backflow from said reservoir 5. A control pipe 10 is connected to the reservoir 5 for supplying fluid under reservoir pressure therefrom to a pair of fluid pressure responsive switches 11 and 12 of the snap-action type.

The pressure switch 11 is shown herein diagrammatically as comprising a casing 13 defining a chamber 14 in which a piston 15 is slidably positioned such that supply of fluid under pressure in chamber 14 moves the piston 15 downward (as shown in the drawing) against the biasing force of a spring 16. A piston rod 17 is connected to the piston 15 and extends downward and out of the casing 13, a contact member 18 being carried in insulated relation by the piston rod such that when fluid pressure in chamber 14 decreases below a predetermined pressure the spring 16 will move the piston 15, piston rod 17 and connected contact member 18 upward such that the contact member 18 engages a pair of stationary contacts 19 and 20. When the fluid pressure in chamber 14 exceeds the aforementioned predetermined pressure, the piston 15 is

moved downward causing the contact member 18 to move by snap-action out of engagement with said contacts 19 and 20.

The pressure switch 12 is also of the snap-action type and similarly to the pressure switch 11 is shown diagrammatically as having a casing 21, a chamber 22, piston 23, spring 24 and piston rod 25. The piston rod 25 carries a pair of contact members 26 and 27 in insulated relation thereto such that when the fluid pressure in chamber 22 decreases below a certain pressure, the piston 23, piston rod 25 and the contact members 26 and 27 move downward to a position where the member 26 moves out of engagement with a pair of stationary contacts 28 and 29, and the contact member 27 moves into engagement with a pair of stationary contacts 30 and 31. Conversely, when the fluid pressure in chamber 22 increases above said certain pressure, the piston 23, piston rod 25 and contact members 26 and 27 move upward to a position where the contact member 26 engages the contacts 28 and 29 and contact member 27 moves out of engagement with contacts 30 and 31.

A delivery line 32 is attached to the reservoir 5 and adapted with a regulator valve 33 to regulate delivery of fluid under pressure from said reservoir 5 to an operating apparatus (not shown), as for example pneumatically operated railway switches.

The electric circuitry for controlling operation of the compressor driving motors 3 and 4 includes a source of supply such as a battery 34, a manually operated starting switch 35, slow-release relay 36, slow-release relay 37, relay 38 and a directional relay 39, all interconnected with the contact members 18, 26 and 27 of the pressure switches 11 and 12 by various wires hereinafter described.

Slow-release relay 36 consists of upper winding 40 and lower winding 41, two front contacts 42 and 43 and a front and back contact 44. The term "front contact" refers to a contact that is actuated from an open to a closed position when the armature of the relay is picked up. The term "back contact" refers to a contact which is restored to a closed positon from an open position when the armature of the relay is dropped out.

Slow-release relay 37 consists of upper winding 45 and lower winding 46, two front contacts 47 and 48, a back contact 49 and a front and back contact 50.

Relay 38 has a single winding 51 and two front contacts 52 and 53.

Directional relay 39 consists of an upper winding 54, lower winding 55 and two directional contacts 56 and 57.

Operation

In order to follow the succession of operations, it should be assumed that initially both the electric motors 3 and 4 are deenergized, the switch 35 is open and the reservoir 5 and correspondingly the chambers 14 and 22 of the respective pressure switches 11 and 12 are all supplied with fluid under atmospheric pressure only, a condition to be understood as zero pressure for operating purposes. With the condition as just stated, the spring 16 of pressure switch 11 will position the contact member 18 into engagement with the contacts 19 and 20, a position hereinafter referred to as closed position. In the zero pressure condition stated above, the spring 24 of pressure switch 12 moves contact member 26 to an open position (out of engagement with contacts 28 and 29) and moves contact member 27 to a closed position (engaging contacts 30 and 31).

The operation of the apparatus will be described through one complete cycle having three phases: (1) initial starting or first phase, (2) first compressor operation or second phase, and (3) second compressor operation or third phase.

To initially start the compressor system in the first

phase, switch 35 is closed thereby completing a circuit from the positive side of battery 34 via a wire 60, wire 61, contact member 18 in its closed position, wire 62, the winding 51 of relay 38, wire 63 and return wire 64 to the negative side of battery 34 thereby energizing and picking up the relay 38. With relay 38 energized and picked up, the contacts 52 and 53 thereof will be actuated to a closed position to complete a starting circuit for each of the motors 3 and 4.

The starting circuit for motor 3 can be traced from the positive side of battery 34 via wire 60 and closed switch 35 to wire 65, contact member 44 of relay 36 in its back or closed position due to the relay 36 not being energized, wire 66, wire 67, motor 3, wire 68, contact member 50 of relay 37 in its back-closed position due to the relay 37 not being energized, and wire 69 to the return wire 64 and thence to the negative side of battery 34.

The starting circuit for motor 4 can be traced from the positive side of battery 34 via wire 60 and closed switch 35 to wire 65, contact member 44 of relay 36 in its back-closed position due to the relay 36 not being energized, wire 66, contact member 52 of relay 38 in its closed position, wire 70, motor 4, wire 71, wire 72, contact 53 of relay 38 in its picked-up or closed position, wire 73, wire 68, contact member 50 of relay 37, in its back-closed position, and wire 69 to the return wire 64 and thence to the negative side of the battery 34.

It can thus be seen that in the first or initial starting phase, the starting circuits for both motors 3 or 4 are completed to thereby cause both compressors 1 and 2 to run simultaneously. It may be noted here that in the first phase of operation a circuit (described hereinafter) is completed to energize the top winding 54 of relay 39, however, no purpose for such is served at this phase of the cycle of operation. When the pressure of fluid in the reservoir 5 and consequently the chamber 14 of switch 11 builds up to a first predetermined cutout pressure sufficient to overcome the force of spring 16 acting on piston 15, such fluid pressure will cause the piston 15 to move downward to effect operation of the contact member 18 to its open position, which in turn interrupts the circuit for energizing the winding 51 of relay 38 to cause the contacts 52 and 53 to be restored to open position to initiate the second phase of operation. In its open position, contact 53 interrupts the previously-described circuit for energizing the motor 4 and compressor 2 is thus stopped, the continuance of fluid pressure buildup in the reservoir 5 being thereafter effected by the single compressor 1 only.

In the second phase of operation, compressor 1 after being initially started (as just described) continues to effect a build-up of fluid under pressure in reservoir 5 and chamber 22 of the pressure switch 12 until said pressure reaches a predetermined operating pressure prescribed by the normal demands of the operating apparatus (not shown) for which the fluid under pressure is supplied. When the so-called operating pressure is supplied to the chamber 22 of pressure switch 12, the fluid pressure acting on the piston 23 is sufficient to compress the spring 24 and thereby move contact member 27 to open position and contact member 26 to its closed position. Contact 26 in its closed position completes a circuit for energizing the lower winding 55 of relay 39, said circuit extending from the positive terminal of battery 34, via closed switch 35, wire 60, wire 74, contact member 26 in closed position, wire 75, winding 55, and wire 76 to the return wire 64 and thence to the negative terminal of the battery 34. With the lower winding 55 of relay 39 thus energized, the contacts 56 and 57 are moved to their left-hand closed position, as shown in the drawing. The cooperation of the contact 56 of relay 39 in its left-hand closed position and the closed contact member 26 of pressure switch 12 completes a circuit for energizing the top winding 40 of slow-release relay 36, said circuit extending from the positive terminal of the battery 34, via closed switch 35, wire 60, wire 74, closed contact member 26, wire 75, wire 77, wire 78, winding 40, wire 79, closed back contact 49 of relay 37, wire 80, contact 56 in its left-hand closed position and wire 81 to the return wire 64 and thence to the negative terminal of the battery 34. With the winding 40 of relay 36 energized as just described, the relay 36 will be actuated to its picked-up position, thereby closing front contacts 42 and 43 and moving contact 44 from its back closed position to its front closed position. The moving of contact 44 to its front closed position interrupts the previously-described circuit for energizing the motor 3, such that the compressor 1 will be stopped as was the compressor 2 with the previously-described deenergization of relay 38, thereby completing the second phase of operation.

The completion of the second phase of operation finds both compressors 1 and 2 stopped and the reservoir 5 fully charged to an operating pressure. With continued normal supply of fluid under pressure to the operating apparatus (not shown) for use thereof, the pressure in reservoir 5 and likewise in chamber 22 of pressure switch 12 is reduced to a first predetermined cut-in pressure at which the forces of the spring 24 of the pressure switch 12 overcomes the fluid pressure forces acting on piston 23 thereby moving the piston downward to effect operation of contact member 26 to its open position and contact member 27 to its closed position, a condition initiating the third phase of operation as described hereinafter.

In the third phase of operation, the opening movement of contact member 26 interrupts the previously-described circuits for energizing the lower winding 55 of relay 39 and the top winding 40 of relay 36. Contact member 27 when in its closed position completes a circuit for energizing the top winding of relay 39, said circuit including the positive terminal of battery 34, closed switch 35, wire 60, contact member 27 in closed position, wire 82, winding 54 of relay 39 and thence by wire 64 to the negative terminal of battery 34. With the top winding 54 of relay 39 energized, the contacts 56 and 57 are moved to their respective right-hand closed positions. The cooperation of the contacts 57 of relay 39 in its right-hand closed position, the closed contact member 27 of pressure switch 12 and the closed front contact 43 of slow-release relay 36 (described hereinafter) completes a circuit for energizing the top winding 45 of relay 37. The circuit for energizing top winding 45 of relay 37 extends from the positive terminal of battery 34, via closed switch 35, wire 60, closed contact member 27, wire 82, wire 83, wire 84, winding 45, wire 85, closed contact 43 of slow-release relay 36 (maintained closed for a predetermined time interval after deenergization of relay 36 due to the slow-release characteristic thereof), wire 86, contact 57 in its right-hand closed position, and wire 87 to the return wire 64 and thence to the negative terminal of the battery 34. With the winding 45 of relay 37 energized as just described, the relay 37 is energized to its picked-up position in which front contacts 47 and 48 are actuated to picked-up or closed positions, back contact 49 is actuated to open position, and contact 50 is moved to its front closed position. With contact 47 of relay 37 in closed position as just described, a circuit is completed for energizing the lower winding 41 of relay 36 and effecting pick-up thereof. The circuit for energizing winding 41 extends from the positive terminal of battery 34, via closed switch 35, wire 60, closed contact member 27, wire 82, wire 83, closed contact 47 of relay 37, wire 88, closed contact 42 of slow-release relay 36 (maintained closed for a predetermined time interval after deenergization of relay 36 due to the slow-release characteristic thereof), wire 89, winding 41, wire 90, contact 56 of relay 39 in its right-hand closed position, and wire 81 to the return wire 64 and thence to the negative terminal of the battery 34. It can thus be seen that the slow-

release characteristic of relay 36 holds the contact 42 thereof closed for a predetermined period of time sufficient to permit the above-described self-holding circuit to be established to maintain relay 36 energized and maintain the contacts thereof in their respective front closed positions. With contact 50 of relay 37 in its front closed position due to the just-described energization of top winding 45 of relay 37, and the contact 44 of relay 36 maintained in its front closed position as just described, a circuit is completed to energize the motor 4 and run the compressor 2, thereby initiating the third phase of operation.

The circuit for energizing motor 4 in the third phase extends from the positive terminal of battery 34, via closed switch 35, wire 60, wire 65, contact 44 in its front closed position, wire 70, motor 4, wire 71, contact 50 in its front closed position, and wire 69 to the return wire 64 and thence to the negative terminal of the battery 34.

The third phase of operation is completed when operating fluid pressure is reached in the reservoir 5 and chamber 22 of pressure switch 12 due to the operation of compressor 2. When the pressure in chamber 22 is at operating pressure, the piston 23 will move against the forces of spring 24 to effect opening of contact member 27 and closing of contact member 26, thereby interrupting the previously-described circuit for energizing the top winding 54 of relay 39, and reestablishing the previously-described circuit for energizing the lower winding 55 of relay 39 to cause the contacts 56 and 57 to move to their left-hand closed position as shown. The opening of contact member 27 also interrupts the previously-described circuits for energizing the lower winding 41 of relay 36 and the upper winding 45 of relay 37, however, the relay 37 is not deenergized because the closing of contact member 26 establishes a circuit for energizing the winding 46 of relay 37 and thereby maintains relay 37 energized and picked-up. The circuit for energizing winding 46 of relay 37 extends from the positive terminal of battery 34, via closed switch 35, wire 60, wire 74, closed contact member 26, wire 75, wire 77, closed contact member 48 of relay 37 (maintained closed for a predetermined time interval after deenergization of winding 45 of relay 37 due to the slow-release characteristic thereof), wire 91, winding 46, wire 92, contact member 57 in its left-hand closed position, and wire 81 to the return wire 64 and thence to the negative terminal of battery 34. With the winding 46 energized, the relay 37 is maintained energized and picked-up, such that contacts 47 and 48 remain closed, 49 remains open, and 50 remains in its front closed position. With contact 50 of relay 37 in its front closed position, the previously-described circuit for energizing motor 4 is maintained intact for the short interval of time that the slow-release relay 36 remains picked-up due to the slow-release characteristic thereof, after which, the relay 36 drops out and correspondingly contact 44 thereof moves to its back closed position to effect interruption of the previously-described circuit for energizing motor 4 and thereby stop compressor 2.

It can thus be seen that with termination of the third phase of operation, resulting from the attainment of operating pressure in reservoir 5, compressor 2 is stopped and thus at this time neither compressor 1 or 2 is running. After continued normal supply of fluid under pressure to the operating apparatus (not shown) for use thereof, the pressure in the reservoir 5 and likewise in chamber 22 of pressure switch 12 is reduced to the first predetermined cut-in pressure thereby effecting downward movement of the piston 23 to cause opening of contact member 26 and closing of contact member 27 to reinitiate the second phase of operation previously described.

It can thus be seen that after the first phase or initial starting of both compressors simultaneously, the normal cycle of operation is merely the repeated alternating operation of compressor 1 and compressor 2 at a frequency regulated by the demand of the operating apparatus (not shown).

In the event of excessive demands for fluid under pressure by the operating apparatus (not shown), failure of one compressor to run, or leakage, etc., the fluid pressure in the reservoir 5, chamber 22 of pressure switch 12, and chamber 14 of pressure switch 11 may be reduced to a second predetermined cut-in pressure lower in degree than the previously-mentioned first predetermined cut-in pressure (for effecting operation of pressure switch 12). When the fluid pressure is reduced to the second predetermined cut-in pressure, the spring 16 of pressure switch 11 will move the piston 15 thereof upwardly (as shown in the drawing) to effect closure of the contact member 18. With contact member 18 of pressure switch 11 closed, a previously-described circuit is completed to energize and pick up relay 38 and close contacts 52 and 53 thereof to thereby complete circuitry (previously described in initial starting) for energizing both motors 3 and 4 and effecting operation of both compressors 1 and 2 simultaneously to meet the mentioned excessive demands for fluid under pressure.

A manual switch 93 may be provided, as shown, which when closed bypasses the contact member 18 of pressure switch 11 at any time it is desired to run both compressors simultaneously without regards to pressure in the switch chambers and reservoir 5.

The opening of switch 35 will stop operation of both compressors.

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

1. A dual-compressor installation comprising in combination, a first compressor having a first driving motor means and a second compressor having a second driving motor means, a common reservoir charged with fluid under pressure delivered by both said first and second compressors, a source of current supply, a first power circuit for said first motor means effective when energized to cause said first motor means to drive said first compressor, a second power circuit for said second motor means effective when energized to cause said second motor means to drive said second compressor, a first current-responsive control relay and a second current-responsive control relay, said first and said second control relays being operative cooperatively when deenergized to establish said first power circuit, said first and said second control relays being operative cooperatively when said first control relay is energized and said second control relay is deenergized to cause interruption of said first power circuit, said first and said second control relays being operative cooperatively when both are energized to establish said second power circuit, said first and said second control relays being operative cooperatively when said first control relay is deenergized and said second control relay is energized to cause interruption of said second power circuit, and means including pressure responsive switch means effective upon successive reductions of the pressure in said reservoir to below a certain value for so controlling energization and deenergization of said first and second control relays as to cause said control relays to establish said first power circuit and said second power consecutively and repeatedly, and effective upon successive increases of the pressure in said reservoir to above said certain value to interrupt said first power circuit or said second power circuit depending on which is established.

2. A dual-compressor installation comprising in combination, a first compressor having a first driving motor means and a second compressor having a second driving motor means, a common reservoir charged with fluid under pressure delivered by said first and second compressors, a source of current supply, a first power circuit for said first motor means effective when energized to cause said first motor means to drive said first compres-

sor, a second power circuit for said second motor means effective when energized to cause said second motor means to drive said second compressor, a plurality of current-responsive control relay means operative in cooperation with each other to control energization and deenergization of said first and second power circuits, a current-responsive selector relay having a first winding and a second winding effective when energized individually to cause said selector relay to assume different control positions respectively, and pressure responsive switch means having two positions effective upon successive reductions of the pressure in said reservoir to below a certain value to assume one position for energizing said first winding of said selector relay and jointly therewith effecting control of energization and deenergization of said control relays as to cause said control relays to establish said first power circuit and said second power circuit consecutively and repeatedly, and effective upon successive increases of the pressure in said reservoir to above

said certain pressure to assume a second position for energizing said second winding of said selector relay and jointly therewith effecting control of energization and deenergization of said control relays as to effect interruption of said first power circuit or said second power circuit depending on which is established.

References Cited in the file of this patent

UNITED STATES PATENTS

1,807,328	Warren	May 26, 1931
1,819,774	Durdin	Aug. 18, 1931
1,828,696	Woodford	Oct. 20, 1931
1,982,578	Durdin	Nov. 27, 1934
2,029,765	Durdin	Feb. 4, 1936
2,177,083	Sykes et al.	Oct. 24, 1939
2,246,940	Hood	June 24, 1941
2,812,110	Romanowski	Nov. 5, 1957