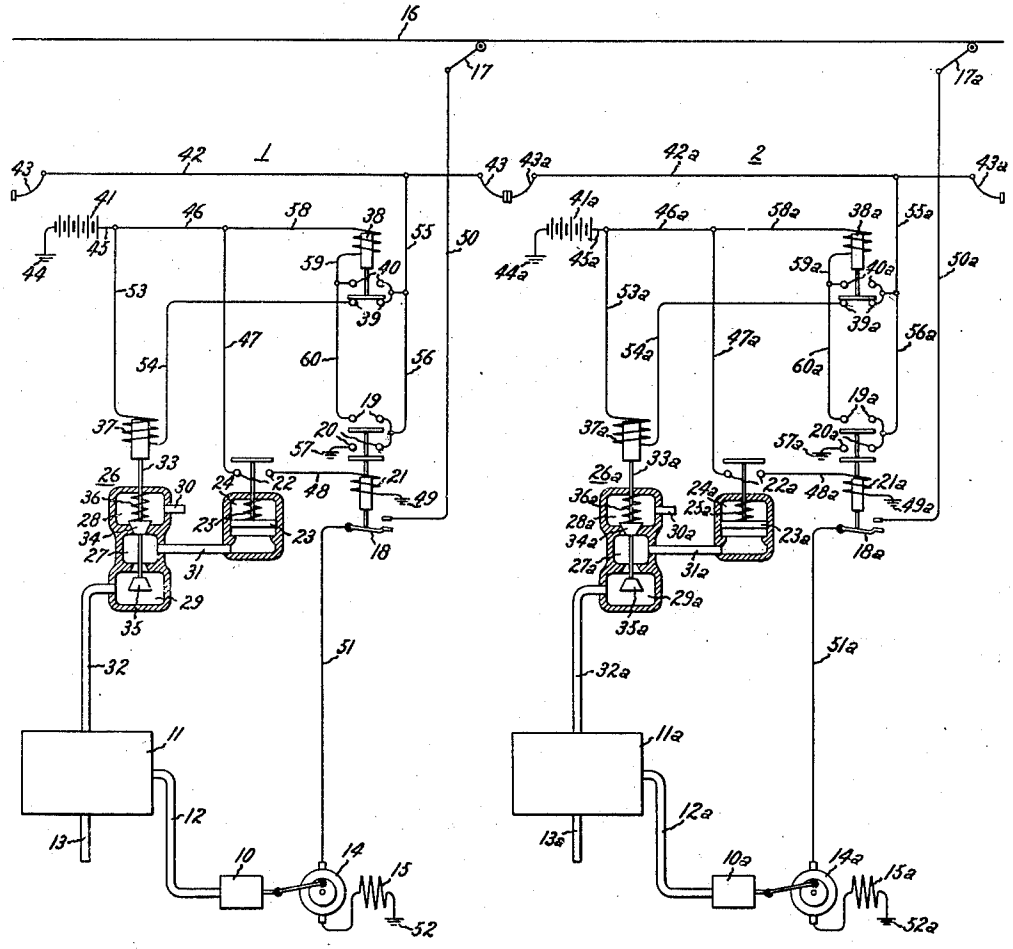
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COMPRESSOR SYNCHRONIZING SYSTEM

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COMPRESSOR SYNCHRONIZING SYSTEM

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Our invention relates to control systems for motor-driven compressors, more particularly to systems for synchronizing the control of a plurality of pneumatically connected motor-driven compressors, and has for an object the provision of a simple and reliable control system of this character.

Although our invention is not limited thereto, it is particularly applicable to compressed-air braking systems for multiple-unit trains in which each train unit is provided with a motor-driven compressor connected to a reservoir and with a complete control equipment therefor.

When a plurality of train units are coupled together for multiple-unit operation, the reservoirs on the various train units are connected together by means of equalizer pipe sections provided with hose connections between the units. In such multiple-unit systems, the total compressor capacity often exceeds the capacity of the hose connections, particularly when the hose connections are provided with the usual restrictions in order to prevent a complete loss of pressure in case one of the hose connections should burst. The limitations presented by the hose connections in the free exchange of air between the reservoirs on the separate train units may therefore result in a considerable difference in pressure between the various reservoirs.

It has heretofore been proposed to provide synchronizing means for interconnecting the compressor control equipments on the various train units during multiple-unit operation. Previously-known synchronizing systems, however, have usually been arranged to start and to stop all of the compressors substantially simultaneously. One well-known type of synchronizing system, for example, includes means for starting all of the motor-driven compressors substantially simultaneously when the pressure in any one reservoir drops below a predetermined value, and means for stopping all of the motor-driven compressors only when all of the reservoirs have been charged to a predetermined pressure, that is, the last reservoir to reach the predetermined pressure controls the stopping of all of the motor-driven compressors. It will be apparent that when such a synchronizing system is employed, some of the reservoirs may be charged beyond the predetermined pressure, and the consequent operation of the relief valves will result in a waste of air and power.

While it is desirable that all of the compressors be started substantially simultaneously to prevent excessive load on some of the individual compressors, it is also desirable that each of the compressors shall be stopped when the associated reservoir is charged to the predetermined pressure. Accordingly, it is a further object of our invention to provide a synchronizing system for a plurality of interconnected motor-driven compressors which will be effective to start all of the compressor motors substantially simultaneously and which will thereafter be rendered ineffective, each of the compressor motors being thereafter controlled entirely by its separate control equipment.

In accordance with one embodiment of our invention, a plurality of interconnected motor-driven compressors each of which is provided with separate pressure-responsive means for controlling the compressor motor in accordance with the pressure set up by the associated compressor, are provided with a control system which comprises synchronizing means for operating all of the pressure-responsive devices independently of pressure conditions to energize all of the compressor motors when any one of the separate pressure-responsive devices operates in response to a drop in pressure. Means are also provided whereby the synchronizing means is thereupon disabled to permit each compressor motor to be controlled thereafter solely in accordance with the pressure set up by the associated compressor.

More specifically, the control system comprises a series of magnetic valves arranged normally to connect each of the pressure-responsive devices to the associated reservoir, and energizable to connect each of the pressure-responsive devices to exhaust for operation independently of the pressures in the reservoirs. Means are provided for energizing all of the magnetic valves through a synchronizing wire in response to operation of any of the pressure-responsive devices upon a drop in reservoir pressure, whereby all of the compressor motors are energized substantially simultaneously. Associated with each compressor and responsive to operation of the pressure-responsive device therefor, is a relay arranged to interrupt the energizing circuit for the associated magnetic valve, whereby each compressor motor is thereafter controlled solely by its associated pressure-responsive device in accordance with the pressure in the associated reservoir. Each of the relays is arranged to establish a holding circuit through the synchronizing wire in order to prevent reenergization of the magnetic valve until all of the compressor motors have been deenergized by the separate pressure-responsive devices.

For a more complete understanding of our in-

vention, reference should now be had to the drawing, the single figure of which is a diagrammatic illustration of a control system embodying our invention.

Referring now to the drawing, for purposes of illustration, we have shown our invention in one form as applied to a pair of locomotives or train units indicated respectively by the reference numerals 1 and 2, although it will of course be understood that control systems embodying our invention are applicable to any number of train units connected for multiple-unit operation. The train unit indicated by the reference numeral 1 is provided with a motor-driven compressor 10 arranged to charge a reservoir 11 through a pipe 12, the reservoir being provided with an outlet pipe 13 which may be connected to any suitable compressed-air system such, for example, as the system shown somewhat diagrammatically in Patent No. 1,493,261 issued May 6, 1924 to William S. H. Hamilton.

As shown, the compressor motor comprises an armature 14 and a field winding 15 connected in series circuit relation and energizable from a supply line 16 through a trolley 17 and a control switch 18. The control switch 18 is provided with two pairs of interlock contacts 19 and 20 and with an operating winding 21, the energization of which is controlled by a pair of contacts 22 connected in circuit therewith and arranged to be controlled by a pressure-responsive device comprising a piston 23 which is movable within a cylinder 24 in accordance with the pressure in the cylinder against the biasing force of a spring 25.

In order selectively to subject the movable piston 23 either to the pressure in the reservoir 11 or to exhaust, we provide a magnetic valve 26 which is of a well-known type and comprises a valve casing having dividing walls arranged to form a central compartment 27 and two end compartments 28 and 29 respectively. As shown, the end compartment 28 is connected to exhaust by means of a pipe 30, the central compartment 27 is connected to the cylinder 24 by means of a pipe 31, and the other end compartment 29 is connected to the reservoir 11 by means of a pipe 32. A movable valve stem 33 is provided with spaced-apart valve heads 34 and 35 and is normally biased to the position shown in the drawing by a spring 36, in which position the cylinder 24 is subjected to the pressure in the reservoir 11. It will be apparent that when the valve stem 33 is moved to its upper position against the biasing force of the spring 36, the valve head 35 will be operated to close the connection between the cylinder 24 and the reservoir 11, and the valve head 34 will be operated to open the connection between the cylinder 24 and the exhaust pipe 30. The magnetic valve 26 is provided with an operating winding 37, the energization of which is controlled by a relay 38 having a plurality of pairs of contacts 39 and 40.

In addition, the control equipment for the train unit 1 includes a suitable source of control energy such, for example, as the battery 41, and a synchronizing wire 42 the opposite ends of which are provided with coupling members 43.

The arrangement of the motor-driven compressor and the control equipment therefor on the train unit indicated by the reference numeral 2 is identical with the equipment just described, and it is believed that a complete understanding of our invention may now be had from a description of the operation of the system as a whole, during which description the same reference numerals followed by the letter "a" will be used to designate corresponding parts on the train unit 2.

In the drawing, the various devices of the control equipments are shown in the respective positions corresponding to normal pressure conditions in the reservoirs 11 and 11a. It will be assumed now that the train unit 1 is the leading unit, in which case it will be understood that the supply of air to the braking system of the train will be controlled by a brake valve on that unit, which will tend to lower the pressure in the reservoir 11 more quickly than in the reservoir 11a. It will further be assumed that the braking system for the train has been so operated as to cause a drop in pressure in the reservoir 11 below the predetermined minimum.

Upon such a decrease in pressure in the reservoil 11, the movable piston 23 will be forced downward by the spring 25 to close the contacts 22 and establish an energizing circuit for the operating winding 21 of the control switch 18. This energizing circuit may be traced from the battery 41, through the conductors 45, 46 and 47, the contacts 22, the conductor 48 and the operating winding 21 to the ground connection 49 and by way of the ground connection 44 to the other side of the battery. As soon as the operating winding 21 is energized, the control switch 18 will be closed to energize the armature 14 and the field winding 15 of the compressor motor, the energizing circuit for the motor extending from the supply line 16 through the trolley 17, the conductor 50, the switch 18, the conductor 51, the motor armature 14 and the field winding 15 to the ground connection 52. It will be remembered that in order to prevent excessive load on the compressor 10, it is desirable to energize the driving motor for the compressor 10a substantially simultaneously with the driving motor for the compressor 10, and accordingly we provide synchronizing means for energizing the compressor motor on the train unit 2 independently of the pressure in the reservoir 11a.

Simultaneously with the closure of the switch 18, the interlock contacts 20 are closed to establish an energizing circuit for the operating winding 37a of the magnetic valve 26a, which circuit may be traced from the battery 41a, through the conductors 45a and 53a, the operating winding 37a, the conductor 54a, the relay contacts 39a, the conductor 55a, the synchronizing wires 42a and 42, the conductors 55 and 56, the interlock contacts 20, and by way of the ground connections 57 and 44a to the other side of the battery 41a. Upon energization of the operating winding 37a, the valve stem 33a of the magnetic valve 26a is operated to its upper position to connect the cylinder 24a of the pressure-responsive device to exhaust and consequently, the movable piston 23a is forced downward by the spring 25a to close the contacts 22a and energize the operating winding 21a of the control switch 18a independently of the pressure in the reservoir 11a.

It will now be apparent that the compressors on the two train units are operating to charge the associated reservoirs and while there will be some interchange of air between the reservoirs 11 and 11a, it will be remembered that the restriction in the equalizer pipe is such as to cause one of the reservoirs to be charged to the required pressure prior to the other reservoir. As hereinbefore mentioned, each compressor motor

should therefore be deenergized when the associated reservoir is charged to the required pressure and accordingly, the above described synchronizing means must be disabled to permit individual control of the compressor motors.

This disablement of the synchronizing means is accomplished by the relays 38 and 38a, the contacts 39 and 39a of which are connected in the energizing circuits of the magnetic valves 26 and 26a respectively. As shown, the interlock contacts 19a which close simultaneously with the switch 18a are arranged to establish an energizing circuit for the relay 38a which may be traced from the battery 41a through the conductors 45a, 46a and 58a, the operating winding of the relay 38a, the conductors 59a and 60a, the contacts 19a, the contacts 20a and by way of the ground connections 57a and 44a to the other side of the battery. The contacts 39a are thereupon opened to deenergize the winding 37a, and the valve stem 33a of the magnetic valve 26a is returned by the spring 36a to the position shown in the drawing, in which position the piston 23a of the pressure-responsive device is again subjected to the pressure in the reservoir 11a and will be operated to deenergize the winding 21a of the switch 18a when the pressure in the reservoir 11a reaches the desired value. Similarly, the relay 38 is energized upon operation of the switch 18 to interrupt the energizing circuit of the operating winding 37 so as to prevent a false operation of the magnetic valve 26.

It will be apparent now that unless means are provided for maintaining the synchronizing means in the disabled condition, the relay 38a will be deenergized when the interlock contacts 19a and 20a are opened upon deenergization of the switch 18a and consequently, the magnetic valve 26a will be energized through the previously traced circuit to cause an immediate reenergization of the switch 18a. Accordingly, the contacts 40a of the relay 38a are arranged to establish a holding circuit for the relay, which may be traced from the battery 41a through the conductors 45a, 46a and 58a, the operating winding of the relay 38a, the conductor 59a, the contacts 40a, the conductor 55a, the synchronizing wires 42a and 42, the conductors 55 and 56, the interlock contacts 20 and by way of the ground connections 57 and 44a to the other side of the battery. This holding circuit for the relay 38a will be interrupted only when the control switch 18 is opened upon the attainment of the required pressure in the reservoir 11.

It will be apparent now that since the separate control equipments on the two train units are identical throughout, the operation will be exactly the same in case the reservoir 11a is the first to suffer a decrease in pressure and is the last to be charged to the required pressure. It will also be obvious that our improved control system may be applied to any number of train units, in which case all of the magnetic valves would be energized through the synchronizing wire upon operation of any of the pressure-responsive devices to energize the associated compressor motor, and all of the relays corresponding to the relays 38 and 38a would be energized to disable the synchronizing means by interrupting the energizing circuits for the magnetic valves, each of the relays being arranged to establish a holding circuit therefor which would be interrupted only when the last control switch is deenergized.

While we have shown a particular embodiment of our invention, it will be understood, of course, that we do not wish to be limited thereto since many modifications may be made and we, therefore, contemplate by the appended claims to cover any such modifications as fall within the true spirit and scope of our invention.

What we claim as new and desire to secure by Letters Patent of the United States is:

1. A control system for a plurality of interconnected motor-driven compressors comprising in combination, separate means for controlling the energization of each compressor motor in accordance with the pressure set up by the associated compressor, synchronizing means responsive to motor energizing operation of any one of said separate control means for operating the remaining control means to energize all of the compressor motors substantially simultaneously, and means responsive to said operation of said control means for disabling said synchronizing means whereby each of said compressor motors is thereafter controlled solely in accordance with the pressure set up by the associated compressor.

2. A control system for a plurality of interconnected motor-driven compressors comprising in combination, separate means for controlling the energization of each compressor motor in accordance with the pressure set up by the associated compressor, synchronizing means responsive to motor energizing operation of any one of said separate control means for operating the remaining control means to energize all of the compressor motors substantially simultaneously, means responsive to said operation of said control means for disabling said synchronizing means whereby each of said compressor motors is thereafter deenergized solely in accordance with the pressure set up by the associated compressor, and means for maintaining said disabling means in effective position until all of said compressor motors have been deenergized by said separate control means.

3. A control system for a plurality of interconnected motor-driven compressors comprising in combination, a separate control switch for each compressor motor, each of said switches being movable between open and closed circuit positions for separately controlling the energization of the compressor motors, separate means for controlling each of said switches in accordance with the pressure set up by the associated compressor, synchronizing means responsive to closure of any one of said switches for effecting operation of the remaining separate control means to close all of said switches whereby all of said motors are energized substantially simultaneously, and means responsive to closure of said switches for disabling said synchronizing means whereby each of said switches is thereafter controlled solely in accordance with the pressure set up by the associated compressor.

4. A control system for a plurality of interconnected motor-driven compressors comprising in combination, a separate control switch for each compressor motor, each of said switches being movable between open and closed circuit positions for separately controlling the energization of the compressor motors, separate means for controlling each of said switches in accordance with the pressure set up by the associated compressors, synchronizing means responsive to closure of any one of said switches for effecting operation of the

remaining separate control means to close all of said switches whereby all of said motors are energized substantially simultaneously, means responsive to closure of said switches for disabling said synchronizing means whereby each of said switches is thereafter controlled solely in accordance with the pressure set up by the associated compressor, and means for maintaining said disabling means in effective position until all of said switches have been opened by said separate control means.

5. A control system for a plurality of motor-driven compressors supplying a plurality of connected reservoirs comprising in combination, separate means responsive to the pressure in each reservoir for controlling the associated compressor motor, synchronizing means responsive to operation of any of said control means on a decrease in pressure in the associated reservoir for operating the remaining control means to energize all of the compressor motors substantially simultaneously, and means responsive to said operation of said control means for rendering said synchronizing means ineffective whereby each of said compressor motors is thereafter deenergized solely in accordance with the pressure in the associated reservoir.

6. A control system for a plurality of motor-driven compressors supplying a plurality of connected reservoirs comprising in combination, separate means responsive to the pressure in each reservoir for controlling the associated compressor motor, synchronizing means responsive to operation of any of said control means on a decrease in pressure in the associated reservoir for operating the remaining control means to energize all of the compressor motors substantially simultaneously, means responsive to said operation of said control means for rendering said synchronizing means ineffective whereby each of said compressor motors is thereafter deenergized solely in accordance with the pressure in the associated reservoir, and means for maintaining said last-mentioned means in a position rendering said synchronizing means ineffective until all of said compressor motors have been deenergized by said separate control means.

7. A control system for a plurality of interconnected motor-driven compressors comprising in combination, a separate switch movable between open and closed circuit positions for controlling the energization of each compressor motor, separate means for controlling each of said switches in accordance with the pressure set up by the associated compressor, separate magnetic valve means for operating each of said control means independently of the pressure set up by the associated compressor, a synchronizing wire for interconnecting the control of said magnetic valve means, means responsive to closure of any of said switches for energizing said magnetic valve means through said synchronizing wire whereby the remaining separate control means are operated to close all of said switches substantially simultaneously, means associated with each of said switches and responsive to closure thereof for disconnecting said synchronizing wire from said valve means whereby each of said switches is thereafter controlled solely in accordance with the pressure set up by the associated compressor, and means for maintaining all of said last means in disconnecting position until all of said switches have been opened by said separate control means.

8. In a compressed air system employing a plurality of motor-driven compressors, the combination of individual control means for each compressor, synchronizing means interconnecting said individual control means for causing operation of all of said control means when any one thereof operates to energize its associated motor whereby all of said compressor motors are energized substantially simultaneously, and means responsive to operation of all of said control means for disconnecting said synchronizing means to return each of said motors to the control of its individual control means.

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