

Jan. 4, 1944.

W. J. McCOY, JR

2,338,451

COMPRESSOR CONTROL

Filed Dec. 12, 1941

4 Sheets-Sheet 1

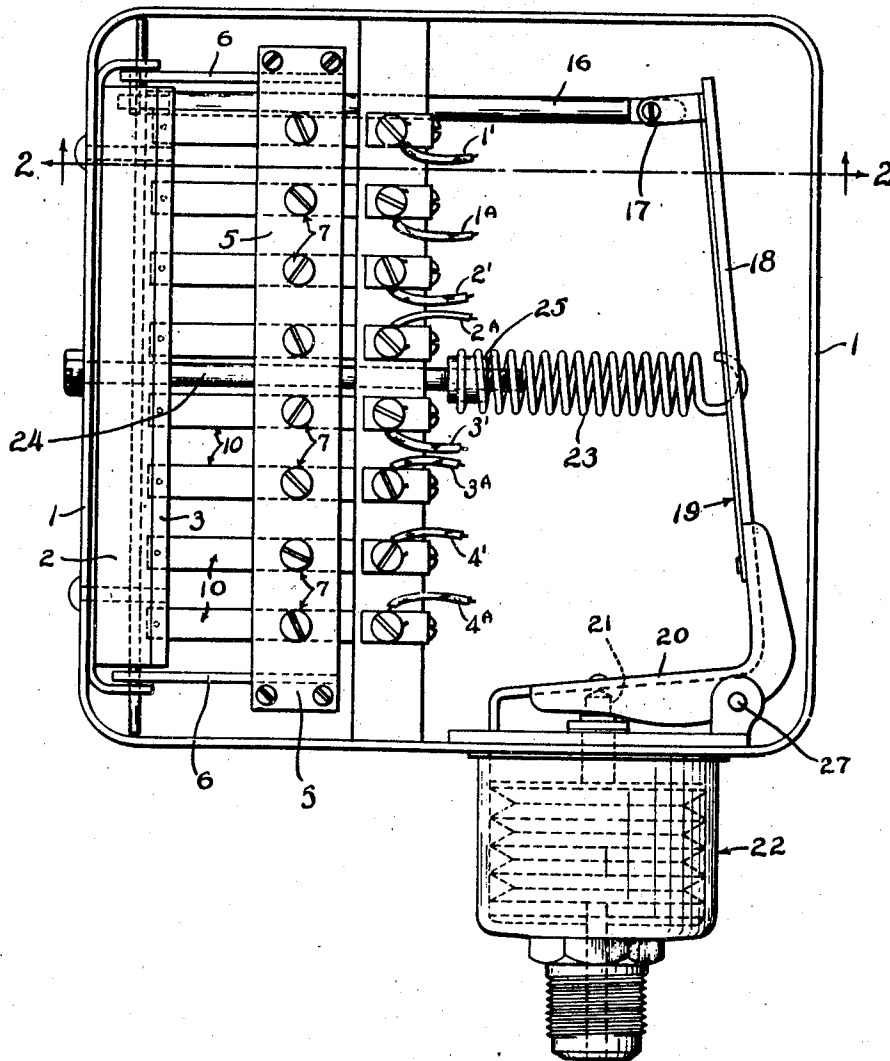


Fig. 1

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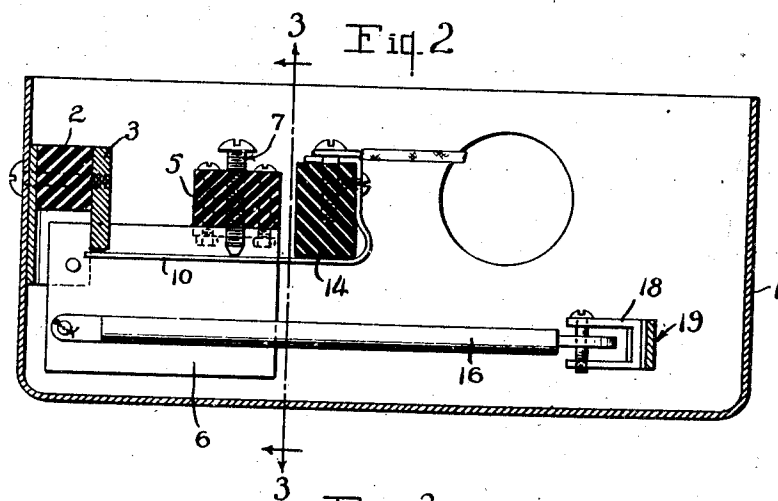
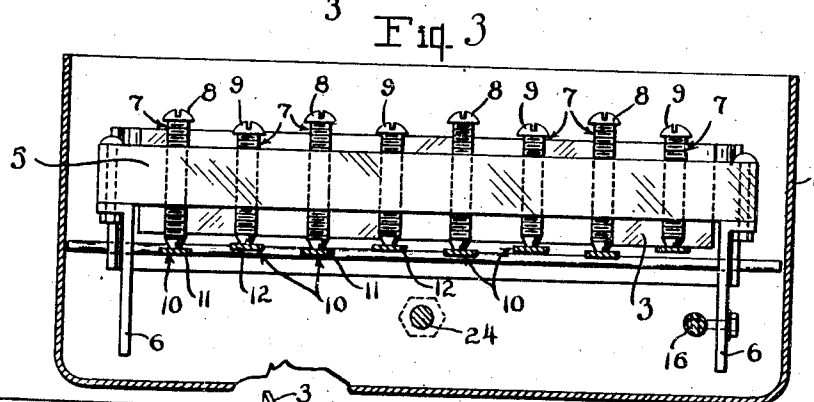
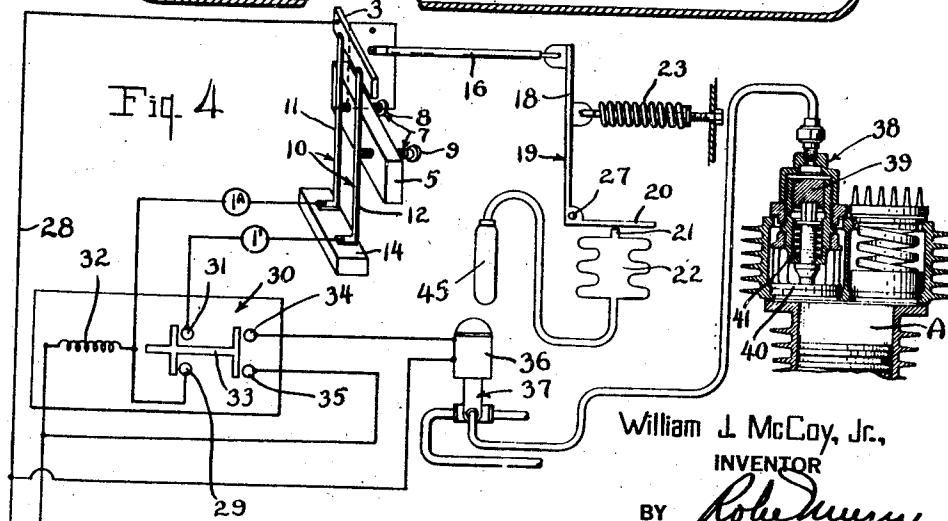
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COMPRESSOR CONTROL

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4 Sheets-Sheet 2



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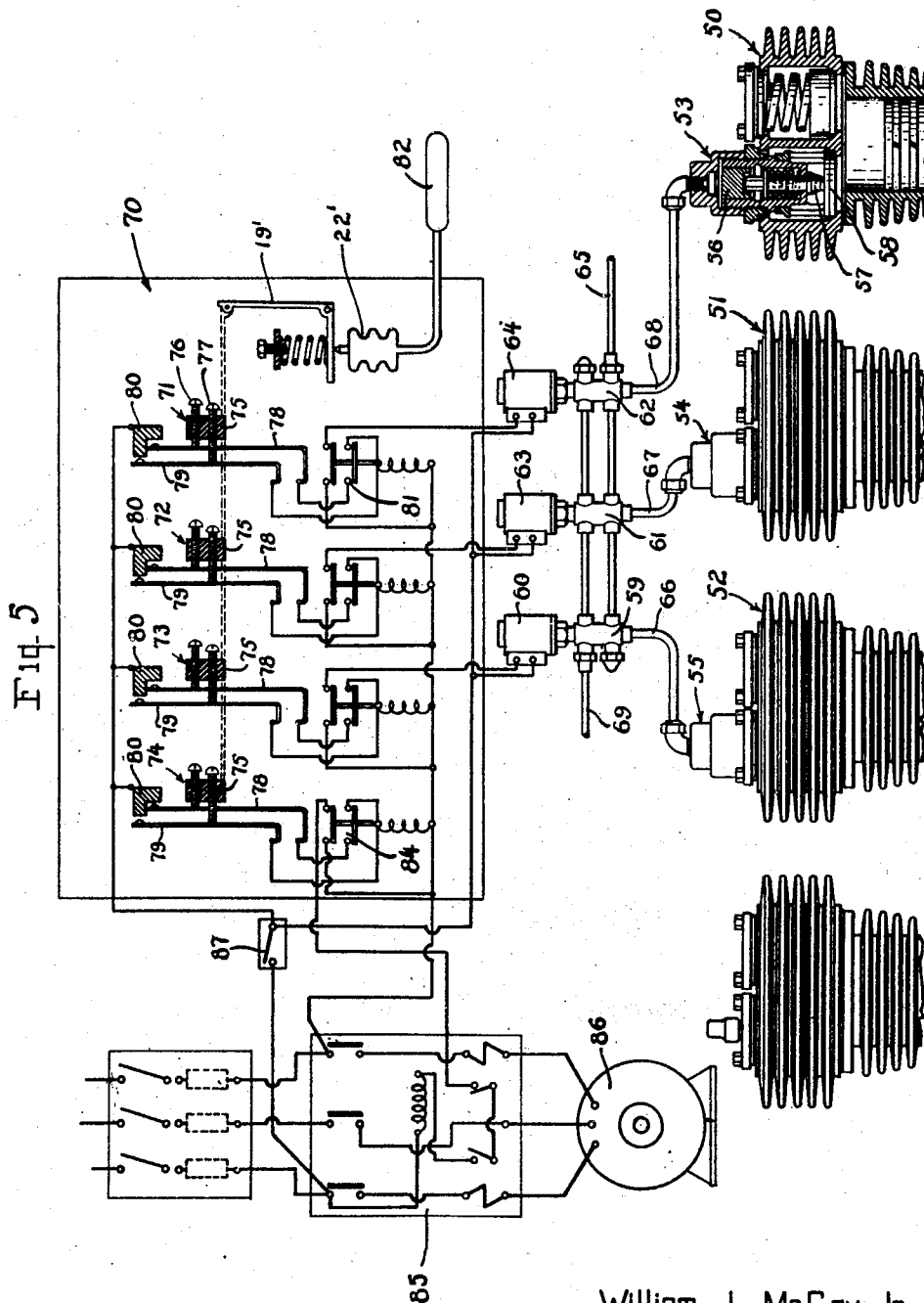
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COMPRESSOR CONTROL

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4 Sheets-Sheet 3



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COMPRESSOR CONTROL

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4 Sheets-Sheet 4

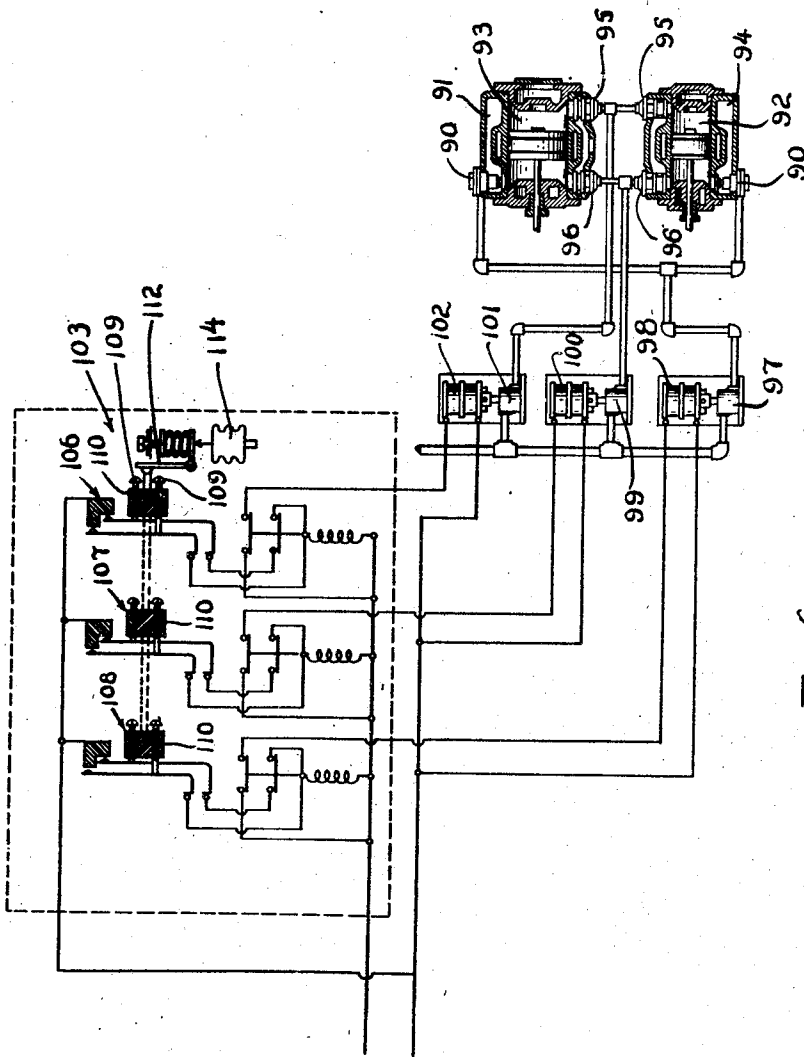


Fig 6

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2,338,451

COMPRESSOR CONTROL

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Application December 12, 1941, Serial No. 422,635

22 Claims. (Cl. 230—31)

This invention relates to air or gas compressors, and more particularly to a loading and unloading mechanism therefor.

An object of the present invention is to provide a novel, relatively simple, and inexpensive mechanism of positive action which will eliminate all hunting or vascillating action of the unloading mechanism and which is particularly adaptable for controlling the loading and unloading of a single or multiple cylinder compressor employed in a refrigeration system or otherwise.

The present invention is also adaptable for controlling the loading and unloading of a multi-stage variable capacity compressor in predetermined percentages of its capacity, such loading and unloading being automatically controlled by temperature at the point being cooled, or by pressure of the fluid compressed, in accordance with the load demands upon the compressor, thereby maintaining practically constant the suction pressure, receiver pressure, or temperature produced by the system in which the compressor is incorporated.

Another object of the present invention is to provide, in a compressor control system, a multi-point mechanism for controlling operation of the unloader of the compressor, which provides individual control of cut-in and cut-out points for each separate step of compressor loading and unloading, and whereby, upon slight variation in the load demand on the compressor, an initial step towards operation of the unloader will be performed, and upon continuance of said variation of load demand for a short interval, the second or final step in the control will occur, which will complete the circuit through the unloader mechanism, resulting in unloading the compressor in the percentage of its capacity controlled by the unloader operated. In instances of a single stage compressor, the compressor will be completely unloaded upon operation of the unloader. When the variance in the load demand has been met or complied with, the control mechanism acts reversely in two steps, first providing the initial step, and after a short interval, in the event the load demand conditions remain the same, performing the second step and completing the reverse operation of the unloading mechanism. Thus, any "hunting" action occasioned by "fluctuating" variation in the load demand will be absorbed in the control mechanism without transmission to the unloader or to the compressor.

A further object of the present invention is to provide, in a compressor control mechanism as specified, adjustable means whereby the device

may be adjusted to be responsive to different degrees of variation in the load demand, and which, due to its high degree of adjustability and sensitivity, will permit narrowing of the differential between the steps of unloading and loading of the compressor over the differentials required in approved types of unloader mechanisms now on the market, with a consequent more accurate and positive maintenance of predetermined load requirements of the compressor.

A still further object of the present invention is to provide a compressor control mechanism as specified in which the adjustable means controlling the different degrees of variation in load demand to which the loading and unloading of the compressor is responsive are constructed and arranged to permit overlapping of the steps of control of the compressor, so that the total range covered by the several steps is materially less than that required with the same differential in each step when operated in sequence without overlapping. Also, one in which the "cut-in" and "cut-out" points for each step of control are individually adjustable, whereby each step of loading or unloading may incorporate a differential required to satisfy operating conditions without regard to the differential of other steps in the loading and unloading cycle.

With these and other objects in view, as may appear from the accompanying specification, the invention consists of various features of construction and combination of parts, which will be first described in connection with the accompanying drawings, showing a compressor control of the preferred form embodying the invention, and the features forming the invention will be specifically pointed out in the claims.

In the drawings:

Figure 1 is a plan view of the improved compressor unloader control.

Figure 2 is a section on the line 2—2 of Figure 1.

Figure 3 is a cross-section on the line 3—3 of Figure 2.

Figure 4 is a diagrammatic view illustrating the compressor control mechanism for controlling the loading and unloading of one cylinder of a compressor.

Figure 5 is a diagrammatic view, partly in section, showing a multiple control system for controlling stopping and starting, and loading and unloading, of a multi-stage, multiple cylinder compressor, in various percentages of the capacity of the compressor.

Figure 6 is a diagrammatic view, partly in section, of a modified form of control system for

controlling the loading and unloading of a multi-stage compressor.

Referring more particularly to the drawings, wherein the unloading governor or control mechanism per se is shown, in Figures 1 to 3, the governor or control mechanism per se includes a suitable supporting casing or housing 1, which has a contact carrying bar 2 rigidly secured thereto, on which a contact plate 3 is attached or supported. The supporting bar 2 is of insulating material.

A second, movable supporting bar 5, of insulating material, is movably supported from the bar 2 by means of the pivoted carrying elements 6. The bar 5 has a plurality of contact operating members 7 adjustably carried thereby, which are arranged in pairs or sets, each set comprising an "on" contact operating member 8 and an "off" contact operating member 9. Any desired number of the adjustable contact operating members 7 may be provided, depending upon the number of circuits to be controlled, i. e., the number of steps of predetermined percentages of the capacity of the compressor in which the compressor is loaded or unloaded.

The contact operating members 7 cooperate with spring contacts 10, which are likewise arranged in pairs, constituting an "on" contact 11 and an "off" contact 12. The contacts 10 are carried by a bar 14, of suitable insulating material, and they are connected in the electrical circuit controlling the loading and unloading of a compressor, as will be hereinafter more specifically referred to in connection with Figures 4, 5 and 6 of the drawings.

The bar 5, and consequently the contact operating members 7, are moved in response to pressure or load demand variations, by means of a bar 16, which is pivotally connected, as shown at 17, to the arm 18 of a bell-crank 19. The arm 20 of the bell-crank 19 is engaged and operated by the contact operating member 21 of a pressure actuated structure 22. This pressure actuated structure 22 may be of any approved type, which may be purchased upon the open market, and its specific construction forms no part of the present invention. The action of the pressure actuated member 22 is opposed by a spring 23, which is connected to the arm 19 and anchored to the casing 1 in any suitable manner, as by the adjusting screw 24. A suitable mechanism 25 is provided for adjusting the tension of the spring 23.

Adjustment of the mechanism 25 to vary the tension of the spring 23 determines the control point at which the load demand upon the compressor will actuate the bar 5 and consequently effect a loading or unloading step on the compressor, and it may be regulated independently of adjustment of the operating member 7.

In the diagrammatic illustration in Figure 4 of the drawings the improved compressor unloading mechanism or control is shown as applied to a single stage compressor, preferably of the type used in refrigeration, wherein the loading and unloading of the compressor, as indicated at A, is a single step operation, i. e., a stop and start unloader.

When the pressure in the system associated with the compressor A falls, increasing the load demand on the compressor, the pressure element 22 will be operated or collapsed, which will permit the bell-crank 19 to be moved upon its pivot 27, by pressure of the spring 23, until such time as the arm 20 is again engaged by the actuating

element 21 of the pressure element 22. This first or initial movement of the bell-crank 19 caused by engagement of the actuating element 21 with the arm 20 will move the pivotally supported bar 5 and contact operating member supported thereby sufficiently to permit the contact strip 12 to engage the contact bar 3, which bar is connected to one side of the electrical current supply line as by the wire 28. As the load demand increases, being registered by a drop in pressure in the system, the pressure actuated member 22 further collapses or recedes, permitting the spring 23 to move the movable bar 5 another step, which moves the contact operating element 8 a sufficient distance to permit the "on" contact 11 to engage the contact strip or bar 3. The contact 11 is connected to one pole, namely the pole 29, of an electrical relay 30, of approved construction, while the contact 12 is connected to the contact 31 of the contact relay. The contact 11 is also connected to one pole of the solenoid coil 32 of the relay 30, so that when the contact 11 engages the bar 3 a circuit will be closed through the solenoid coil 32, which will act upon the movable circuit closing element 33 of the relay 30, moving it into engagement with the contacts 29 and 31. At the same time that the circuit is closed through the contacts 29 and 31, the movable element 33 will close the circuit through the contacts 34 and 35, and consequently through the solenoid structure 36 of the distributor valve structure 37. The operation of the distributor valve structure 37 will control delivery of actuating pressure fluid to the unloading mechanism 38 of the compressor A, permitting operation of the unloading mechanism 38 to unload the compressor.

Any suitable type of unloading mechanism may be provided for use on the compressor A without departing from the spirit of the present invention, and the drawings (Figure 4) show one of many conventional types of unloader mechanism.

The unloader mechanism in Figure 4 comprises a pressure actuated piston 39 which, when pressure is delivered against the piston through the three-way distributor valve structure 37, will be actuated to hold open the suction valve 40 of the compressor, to unload the compressor. When it is desired to load the compressor, the distributor valve 37 is operated to permit the bleeding of pressure fluid from the unloader mechanism 38, which will relieve the suction valve 40 of the compressor and permit it to act in its usual manner. It is to be understood, of course, that pressure fluid for actuating the unloader 38 may be derived from any suitable source (not shown).

When the pressure builds up in the system with which the compressor A is associated, this pressure, acting upon the pressure element 22, operates it to move the bell-crank 19 against the tension of the spring 23. The first step of such action results in the moving of the contact 11 out of engagement with the contact bar 3. The circuit through the relay 30, however, is held through the "off" contact 12, so that the solenoid 36 of the distributor valve 37, and the distributor valve 37, remain in their positions to load the compressor. As the pressure in the line builds up further, the gradual expansion of the pressure element 22 operates the bell-crank farther, which moves the "off" contact 12 out of engagement with the bar 3 and completely breaks the circuit through the relay 30 and solenoid 36, permitting actuation of the valve 37 to load the compressor.

The degree of length of time of the "hold-over" action of the governor may be controlled by variation in adjustment of the contact operating members 8 and 9, and likewise the increments in which the compressor is unloaded may be varied by adjustment of these contact operating members 8 and 9.

In Figure 4 of the drawings the circuit is shown as being a temperature controlled circuit. That is, the pressure actuated element 22 is operated by a thermal element 45 of any approved type, which may be purchased upon the open market, and thus this system shown in Figure 4 is particularly adaptable for use in refrigerating systems.

In Figure 5 of the drawings a multiple control for a multiple cylinder compressor used in a refrigerating system is shown. In such systems it is usual to use a thermostatic control, which is actuated by the temperature of the medium being cooled, as the primary control for the loading and unloading mechanism. In some such installations the compressor loading is controlled from suction pressure. When the suction pressure or the cooled medium temperature falls, the load on the compressor is decreasing and it is necessary to unload the compressor or compressors in steps corresponding to the falling of the suction pressure or temperature of the medium being cooled. Should the load decrease sufficiently, that is, below a predetermined point, the structure shown in Figure 5 of the drawings shuts down or stops the compressor, consequently stopping refrigeration. Then, when the temperature of the medium being cooled rises, with a resultant rise in the suction pressure, causing a load increase on the compressor, the latter is restarted and gradually loaded in steps or percentages of its capacity, proportional to the demand as indicated by the rise in suction pressure, or in temperature of the medium being cooled.

In Figure 5 of the drawings a four cylinder compressor is illustrated, three cylinders of which, namely cylinders 50, 51 and 52, are equipped with unloading devices, 53, 54 and 55, of the same type as the unloading device 38 shown in Figure 4 of the drawings. The unloading device 53 comprises a pressure actuated piston 56, which operates the mechanism 57, which in turn controls operation of the suction valve 58 for controlling the loading and unloading of the cylinder 50 of the multi-cylinder compressor structure. The delivery of actuating pressure fluid to the pressure actuated unloading mechanism 53 is controlled by a three-way valve 62, which is actuated by a solenoid 64, while the delivery of actuating pressure to the unloading mechanisms 54 and 55 of the cylinders 51 and 52 is controlled by three-way valves 61 and 59. The pressure fluid employed for actuating the unloading mechanisms 53, 54 and 55 may be derived from any suitable supply source (not shown), such as from the discharge manifold of the compressor system, and it is fed to the various three-way valves 59, 61 and 62 through the inlet pipe 65. From said valves it is delivered to the unloading mechanisms through the respective pipes 66, 67 and 68. These pipes 66, 67 and 68 also serve as return pipes for the actuating pressure fluid to permit it to bleed from the various unloading mechanisms, through the respective three-way valves, and out through the outlet 69, which may deliver it to any suitable point, or to the suction manifold of the system (not shown).

The energizing and de-energizing of the solenoids 60, 63 and 64, and consequently the control of the loading and unloading of the various compressor cylinders, is in turn controlled by the governor or control mechanism 70, which is shown diagrammatically in Figure 5, but is of the same construction as shown in Figures 1 to 3 inclusive of the drawings.

The governor mechanism 70 includes a series of units 71, 72, 73 and 74, which are of the same construction as the unit shown in Figure 4 of the drawings. Each of these individual units comprises a movable bar 75, which carries the adjustable contact actuating members 76 and 77, which engage the movable contacts 78 and 79, respectively, for moving these contacts out of engagement with the contact bar 80, or permitting them to move into engagement with the contact bar 80, to make or break a circuit through the electrical relay 81, and consequently through the respective solenoid which is connected in circuit with the individual unit. As, for example, the unit 71 is connected in circuit with the source of electrical supply and the solenoid 64, so that the unit 71 will control operation of the solenoid 64, the three-way valve 62, and the unloading mechanism 53, for controlling the loading and unloading of the compressor cylinder 50. Likewise, the unit 72 is connected in circuit with the source of electrical supply, the solenoid 63, valve 61, and unloading mechanism 54 for controlling the loading and unloading of the compressor 51. The unit 73 is connected in circuit with the source of electrical current supply, and with the solenoid 60, for actuating the three-way valve 59 to control operation of the unloading mechanism 55, which controls the loading and unloading of the compressor cylinder 52.

While in the diagrammatic Figure 5 the units 71, 72, 73 and 74 are shown as individual units, this illustration is of course diagrammatic, and merely for the purpose of more clearly illustrating the invention. In actual practice and construction, the multi-point control or governor 70 shown in Figure 5 will be constructed the same as the control shown in Figures 1 to 3 of the drawings, where only a single bar 5 is shown, which carries the plurality of sets of adjustable actuating members 8 and 9, corresponding to the members 76 and 77 shown in Figure 5. A pair of such actuating members is provided for each of the solenoids and for the stop and start control of the compressor, controlled by the unit 74 in Figure 5. The operation of the governor 70 is identical with the operation hereinabove described. The bar 75 is moved to make or break electrical circuits through the respective solenoids, etc., by the operation of the pressure actuated member 22', which is in turn actuated by a thermal device 82. The pressure actuated member 22' operates a lever 19' which moves the bar 75. The sequence of energizing or de-energizing of the solenoids is controlled by the adjustment settings of the respective actuating members 76 and 77, so that the various three-way valves will be actuated in the desired or predetermined sequence, dependent upon the respective settings of said actuating members.

In the construction shown in Figure 5 of the drawings, the last unit, 74, in the series of units, and consequently the last one operated in the unloading sequence, and the first one operated in the loading sequence, is connected in circuit, through the electrical relay 84, with the switch structure 85, which controls the stopping and

starting of the electrical motor 86 of the compressor. Thus, when the contacts 78 and 79 of the unit 74 are actuated, they will make or break the circuit to the motor 86 to stop or start the compressor. A hand switch 87 may be connected in the circuit between the source of electrical supply and the various solenoids 80, 83 and 84 to permit manual cutting in or cutting out of the system.

Figure 6 shows a multi-stage control for controlling the loading and unloading of a compressor in a plurality of predetermined percentages of its capacity. In this view a multiple cylinder compressor is shown in which the first step of unloading is by operation of the unloading mechanisms 90, which open the crank ends of the compressor cylinders 91 and 92 to clearance pockets 93 and 94. The second step in unloading is the closing of the crank ends of the compressor cylinders to the clearance pockets, and the opening or operation of the suction valves 95 of the head ends of the cylinders, to permit the unloading of the head ends of the cylinders. For complete unloading of the compressor, the suction valves 96 at the crank ends of the cylinders are held open, thus allowing the compressor to by-pass from crank end to suction end and operate completely unloaded. The unloading valves or mechanisms 90 are operated by pressure from a suitable source (not shown), the delivery of which to the unloading mechanisms is controlled by distributor valve 97, which is operated by a solenoid 98. The delivery of pressure operating fluid to operate the unloading mechanisms of the suction valves 96 is controlled by a distributor valve 99, which is actuated by solenoid 100, while the delivery of pressure actuating fluid to and from the unloading mechanism acting upon the suction valves 95 is controlled by a distributor valve 101, which is in turn operated by a solenoid 102.

The energizing of the solenoids 98, 100 and 102, and consequently the operation of the distributor valves 97, 99 and 101, is controlled by a multi-point control mechanism such as is shown in Figures 1 to 3 of the drawings.

In this Figure 6 of the drawings, the control mechanism, generically indicated by the numeral 103, is shown diagrammatically, for purposes of illustration, but it is to be understood that it would be constructed in accordance with Figures 1 to 3 of the drawings, and the various steps in the loading and unloading operations of the compressor structure would be controlled and timed by the setting of the contact actuating members 104 and 105 in each of the respective units of the multi-point control mechanism 103. The various units 106, 107 and 108 of the control mechanism 103 are identical in construction with the units of the control or governor 70 shown in Figure 5, and with the structures shown in Figures 1 to 4 of the drawings. Each unit comprises a pair of contact actuating members 109 which are carried by the bar 110. The bar 110 corresponds to the bar 5 shown in Figures 1 to 3 of the drawings, and the actuating members 109 in each set or unit are adjusted to provide any desired sequence in the loading and unloading operations of the compressor. By incorporating the proper number of normally opened and normally closed contacts on the relays, practically any unloading combination of the compressor may be had, such as providing single operation of the clearance pockets, combined operation of the clearance pockets and suction unloaders, or individual operation of the

suction unloaders to provide for operation of the compressor in any of the numerous increments of its capacity.

In the construction shown in Figure 6 of the drawings, the bar 110 is actuated through the medium of the leverage or link structure 112, by the pressure actuated member 114. This pressure actuated member 114 is preferably connected to the discharge (not shown) of the compressor structure so that the loading and unloading of the compressor will be controlled by variations in the load demand upon the compressor occasioned by the use of the fluid compressed. In all other respects this system shown diagrammatically in Figure 6 operates identically with the structure shown in Figures 1 to 3 of the drawings and heretofore described.

It will be understood that the invention is not to be limited to the specific construction or arrangement of parts shown, but that they may be widely modified within the invention defined by the claims.

What is claimed is:

1. The combination with an air or gas compressor, of control valves for controlling the loading and unloading of the compressor in steps of fractional parts of its full capacity, electrically operated means for controlling operation of said valves, circuit closing means controlling the energizing of said electrically operated means, said circuit closing means embodying a pair of actuating members for each step of unloading, said actuating members operable in sequence of predetermined intervals for providing delay in energizing or de-energizing of said electrically operated means, and means operated by variances in the load demand on the compressor for operating said actuating members.

2. The combination with an air or gas compressor, of control valves for controlling the loading and unloading of the compressor in steps of fractional parts of its full capacity, electrically operated means for controlling operation of said valves, circuit closing means controlling the energizing of said electrically operated means, said circuit closing means embodying a pair of actuating members for each step of unloading, said actuating members operable in sequence of predetermined intervals for providing delay in energizing or de-energizing of said electrically operated means, said actuating members being adjustable to vary the delay interval between the successive operation of the actuating members in each pair.

3. The combination with an air or gas compressor, of control valves for controlling the loading and unloading of the compressor in steps of fractional parts of its full capacity, electrically operated means for controlling operation of said valves, circuit closing means controlling the energizing of said electrically operated means, said circuit closing means embodying a pair of actuating members for each step of unloading, said actuating members operable in sequence of predetermined intervals for providing delay in energizing or de-energizing of said electrically operated means, means operated by variances in the load demand on the compressor for operating said actuating members, said actuating members being adjustable to regulate the degree of variance in load demand on the compressor required for each step of loading and unloading of the compressor.

4. The combination with an air or gas com-

pressor, of control valves for controlling the loading and unloading of the compressor in steps of fractional parts of its full capacity, electrically operated means for controlling operation of said valves, circuit closing means controlling the energizing of said electrically operated means, said circuit closing means embodying a pair of actuating members for each step of unloading, said actuating members operable in sequence of predetermined intervals for providing delay in energizing or de-energizing of said electrically operated means, means operated by variances in the load demand on the compressor for operating said actuating members, said actuating members of each pair being independently adjustable to vary the delay interval between the successive operation of the actuating members in each pair and also being adjustable to regulate the degree of variance in load demand on the compressor required for each step of loading and unloading of the compressor.

5. The combination with an air or gas compressor, of control valves for controlling the loading and unloading of the compressor in steps of fractional parts of its full capacity, electrically operated means for controlling operation of said valves, circuit closing means controlling the energizing of said electrically operated means, said circuit closing means embodying a pair of actuating members for each step of unloading, said actuating members operable in sequence of predetermined intervals for providing delay in energizing or de-energizing of said electrically operated means, means operated by variances in the load demand on the compressor for operating said actuating members, said actuating members being independently adjustable to vary the delay interval between the successive operation of the actuating members in each pair, and means adjustable independently of said actuating members to regulate the degree of variance in load demand on the compressor required for actuating said actuating members.

6. The combination with an air or gas compressor, of means for loading and unloading said compressor, electrically operated means controlling operation of said loading and unloading means, circuit closing means for controlling energizing of said electrical means, said circuit closing means embodying a pair of movable contacts, and contact actuating members operated by variances in the load demand on the compressor for moving said contacts, said actuating members moving said contacts in sequence and arranged whereby a predetermined time delay will be occasioned between the successive movement of the contacts occasioning a delay in the operation of the electrically operated means after the initial impulse of load variation on the compressor.

7. The combination with an air or gas compressor, of means for loading and unloading said compressor, electrically operated means controlling operation of said loading and unloading means, circuit closing means for controlling energizing of said electrical means, said circuit closing means embodying a pair of movable contacts, contact actuating members operated by variances in the load demand on the compressor for moving said contacts, said actuating members moving said contacts in sequence and arranged whereby a predetermined time delay will be occasioned between the successive movements of the contacts occasioning a delay in the operation of the electrically operated means after the ini-

tial impulse of load variation on the compressor, said actuating members being adjustable to vary the delay interval between the successive movements of the actuating members.

8. The combination with an air or gas compressor, of means for loading and unloading said compressor, electrically operated means controlling operation of said loading and unloading means, circuit closing means for controlling energizing of said electrical means, said circuit closing means embodying a pair of movable contacts, contact actuating members operated by variances in the load demand on the compressor for moving said contacts, said actuating members moving said contacts in sequence and arranged whereby a predetermined time delay will be occasioned between the successive movements of the contacts occasioning a delay in the operation of the electrically operated means after the initial impulse of load variation on the compressor, said actuating members being adjustable to regulate the degree of variance in load demand on the compressor required for each step of loading or unloading of the compressor.

9. The combination with an air or gas compressor, of means for loading and unloading said compressor, electrically operated means controlling operation of said loading and unloading means, circuit closing means for controlling energizing of said electrical means, said circuit closing means embodying a pair of movable contacts, contact actuating members operated by variances in the load demand on the compressor for moving said contacts, said actuating members moving said contacts in sequence and arranged whereby a predetermined time delay will be occasioned between the successive movements of the contacts occasioning a delay in the operation of the electrically operated means after the initial impulse of load variation on the compressor, said actuating members being adjustable to regulate the degree of variance in load demand on the compressor required for each step of loading or unloading of the compressor, and means adjustable independently of said actuating members to regulate the degree of variance in load demand on the compressor required for actuating said actuating members.

10. The combination with an air or gas compressor, of means for loading and unloading said compressor, electrically operated means controlling operation of said loading and unloading means, circuit closing means for controlling energizing of said electrical means, said circuit closing means comprising a pair of movable contacts connected in the circuit of said electrically operated means so that both must be operated to make or break the circuit to the electrically operated means, and an independent actuating member for each of said contacts, said actuating members arranged to provide a time interval between the successive movements of the contacts, and means actuated by variance in the load demand on the compressor for operating said actuating members.

11. The combination with an air or gas compressor, of means for loading and unloading said compressor, electrically operated means controlling operation of said loading and unloading means, circuit closing means for controlling energizing of said electrical means, said circuit closing means comprising a pair of movable contacts connected in the circuit of said electrically operated means so that both must be operated to make or break the circuit to the electrically

operated means, an independent actuating member for each of said contacts, said actuating members arranged to provide a time interval between the successive movements of the contacts, means actuated by variance in the load demand on the compressor for operating said actuating members, and said actuating members being adjustable independently for varying the length of said time interval.

12. The combination with an air or gas compressor, of means for loading and unloading said compressor, electrically operated means controlling operation of said loading and unloading means, circuit closing means for controlling energizing of said electrical means, said circuit closing means comprising a pair of movable contacts connected in the circuit of said electrically operated means so that both must be operated to make or break the circuit to the electrically operated means, an independent actuating member for each of said contacts, said actuating members arranged to provide a time interval between the successive movements of the contacts, means actuated by variance in the load demand on the compressor for operating said actuating members, and said actuating members being adjustable to regulate the degree of variance in load demand on the compressor required for each step of loading or unloading of the compressor.

13. The combination with an air or gas compressor, of means for loading and unloading said compressor, electrically operated means controlling operation of said loading and unloading means, circuit closing means for controlling energizing of said electrical means, said circuit closing means comprising a pair of movable contacts connected in the circuit of said electrically operated means so that both must be operated to make or break the circuit to the electrically operated means, an independent actuating member for each of said contacts, said actuating members arranged to provide a time interval between the successive movements of the contacts, means actuated by variance in the load demand on the compressor for operating said actuating members, said actuating members being adjustable independently for varying the length of said time interval, and means adjustable independently of said actuating members to regulate the degree of variance in load demand on the compressor required for operating said actuating members.

14. The combination with an air or gas compressor, of means for loading and unloading said compressor, electrically operated means controlling operation of said loading and unloading means, circuit closing means for controlling energizing of said electrical means, said circuit closing means including a stationary contact bar, a pair of movable contacts, a movable bar, means operated by variances in load demand on the compressor for moving said movable bar, and actuating members carried by said bar for moving said movable contacts.

15. The combination with an air or gas compressor, of means for loading and unloading said compressor, electrically operated means controlling operation of said loading and unloading means, circuit closing means for controlling energizing of said electrical means, said circuit closing means including a stationary contact bar, a pair of movable contacts, a movable bar, means operated by variances in load demand on the compressor for moving said movable bar, and actuating members carried by said bar for moving said

movable contacts, said actuating members being adjustable relative to said bar for varying the degree of variance in load demand on the compressor required to move the contacts.

16. The combination with an air or gas compressor, of means for loading and unloading said compressor, electrically operated means controlling operation of said loading and unloading means, circuit closing means for controlling energizing of said electrical means, said circuit closing means including a stationary contact bar, a pair of movable contacts, a movable bar, means operated by variances in load demand on the compressor for moving said movable bar, and actuating members carried by said bar for moving said movable contacts, said actuating members being adjustable relative to each other to provide a variable time delay between the movement of the contacts.

17. The combination with an air or gas compressor, of means for loading and unloading said compressor, electrically operated means controlling operation of said loading and unloading means, circuit closing means for controlling energizing of said electrical means, said circuit closing means including a stationary contact bar, a pair of movable contacts, a movable bar, means operated by variances in load demand on the compressor for moving said movable bar, actuating members carried by said bar for moving said movable contacts, said actuating members being adjustable relative to each other to provide a variable time delay between the movement of the contacts, and means applying restraining pressure on said means which is operated by variances in the load demand.

18. The combination with an air or gas compressor, of means for loading and unloading said compressor, electrically operated means controlling operation of said loading and unloading means, circuit closing means for controlling energizing of said electrical means, said circuit closing means including a stationary contact bar, a pair of movable contacts, a movable bar, means operated by variances in load demand on the compressor for moving said movable bar, actuating members carried by said bar for moving said movable contacts, said actuating members being adjustable relative to each other to provide a variable time delay between the movement of the contacts, means applying restraining pressure on said means which is operated by variances in the load demand, and means for varying the restraining pressure applied to said load-demand variance-operated means to regulate the degree of variance in load demand required to move said bar.

19. The combination with an air or gas compressor, of means for loading and unloading said compressor, electrically operated means controlling operation of said first-mentioned means, an electric circuit including circuit closing means for controlling energization and de-energization of the respective electrically operated means, and means operated by variance in the load demand on the compressor for actuating said circuit closing means, the respective circuit closing means being so constructed and arranged as to operate with a delayed action after initiation of either their circuit opening or closing operations.

20. The combination with an air or gas compressor, of means for loading and unloading said compressor, electrically operated means controlling operation of said first mentioned means, an electric circuit including circuit closing means

for controlling energization and de-energization of said electrically operated means, and means operated by variance in the load demand on the compressor for actuating said circuit closing means, said circuit closing means being so constructed and arranged as to operate with a delayed action after initiation of either the circuit opening or closing operation.

21. The combination with an air or gas compressor, of means for loading and unloading the compressor, electrically operated means for controlling the operation of said first-mentioned means, an electric circuit including circuit closing means for controlling energization and de-energization of the respective electrically operated means, said circuit closing means comprising a first contact connected in said circuit, a pair of movably mounted contacts for each of said electrically operated means and connected in said circuit for co-action with said first contact, adjusting means for the respective movably mounted contacts for adjusting the same relatively to each other in each pair or each pair relatively to the other pairs and with respect to said first contact, and means operated by variance in load demand on the compressor for shifting said movably mounted contacts relatively to said first contact.

22. The combination with an air or gas compressor, of means for loading and unloading the compressor, electrically operated means for controlling the operation of said first-mentioned means, an electric circuit including circuit closing means for controlling energization and de-energization of the respective electrically operated means, said circuit closing means comprising a first contact connected in said circuit, a support, a pair of flexible contacts for each of said electrically operated means and connected in said circuit for co-action with said first contact, said flexible contacts being carried by said support, a carrier means mounted for movement relatively to said first contact and provided with adjusting screws for the respective flexible contacts for adjusting the latter relatively to each other in each pair or each pair relatively to the other pairs and with respect to said first contact, and means operated by variance in load demand on the compressor for shifting said carrier means and said adjusting screws relatively to said flexible contacts for shifting the latter relatively to said first contact.

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