

July 24, 1962

O. H. KAMINKY
COMPRESSOR UNLOADER

3,046,368

Filed March 31, 1960

2 Sheets-Sheet 1

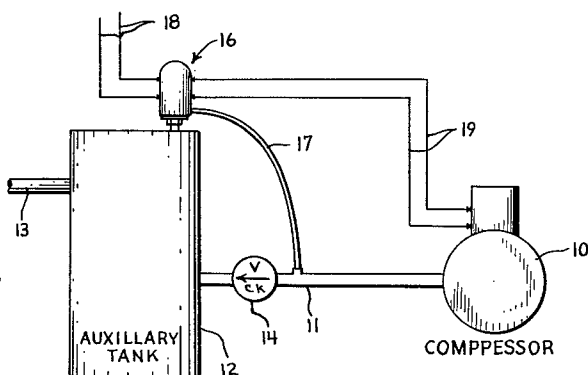


FIG. 1

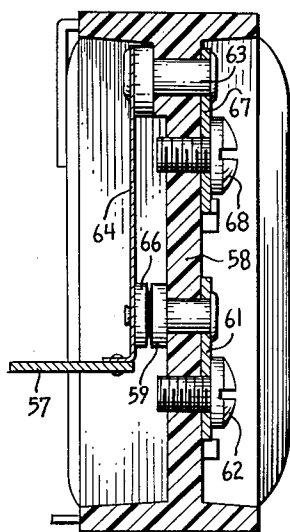


FIG. 5

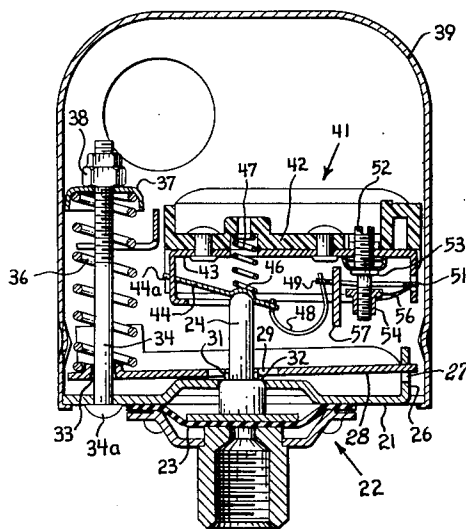


FIG. 2

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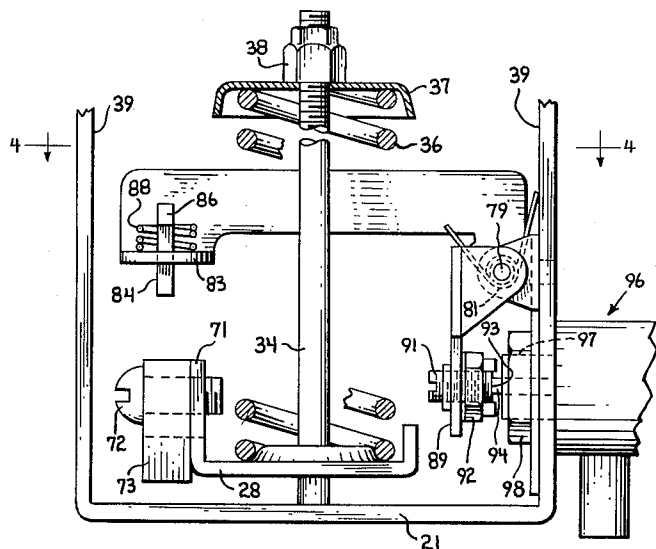


FIG. 3

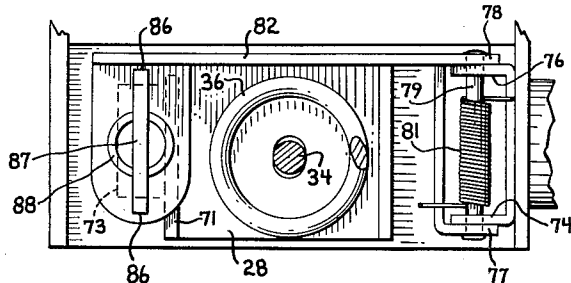


FIG. 4

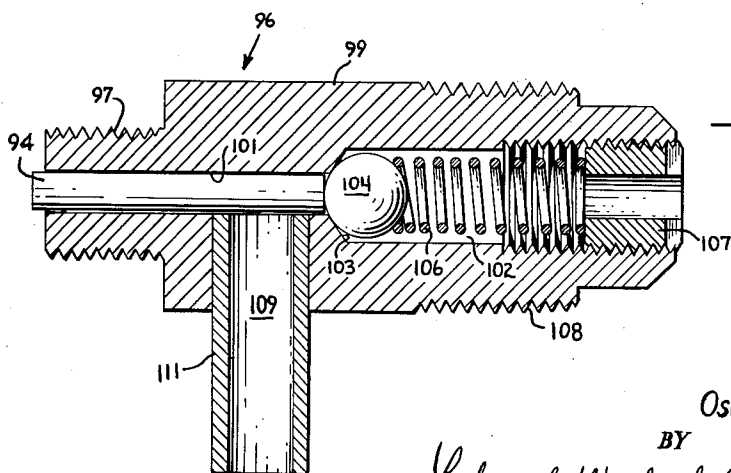


FIG. 5

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COMPRESSOR UNLOADER

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11 Claims. (Cl. 200—81)

This invention relates to a control for air compressors or the like and in particular to a combined pressure responsive control switch for a compressor and an unloader valve attachment which permits the compressor to start against atmospheric pressure, that is, under no-load condition.

Compressed air supply systems normally include a compressor and a pressure tank with the interior of the tank being connected to the high pressure side of the compressor. A service line extends from the tank to the various locations where the air under pressure is to be utilized. The compressor is conventionally controlled by a pressure switch which responds to the pressure within the tank to start the compressor when a predetermined low pressure exists in the tank and to stop the compressor when the tank pressure is returned to the desired level. A check valve in the line between the compressor and the tank prevents the tank from relieving its pressure by back-flow through the line.

In such installations it is highly desirable that the compressor be started, as required by the pressure switch or control, against atmospheric pressure rather than against tank pressure or cut-off pressure. In the prior art devices this requirement has been met by providing a solenoid operated venting valve for the portion of the tank-compressor line which is between the check valve and the compressor with the solenoid being operated by the pressure switch. A further solution has been to provide a bleed or venting valve in the tank-compressor line which is mechanically linked directly to the pressure switch operating member. Both of these arrangements have disadvantages, the solenoid operated venting valve is relatively costly, and if the venting valve is operated by the switch operating member, the available force for operating the venting valve is relatively small.

The latter arrangement referred to above has the further disadvantage that the operating range of the venting valve is not independent of the operating range of the pressure switch. Generally, it is desirable that the venting valve be opened after the pressure switch cuts out or opens the circuit to the compressor and that the venting valve be closed prior to reclosing of the circuit to the compressor. Thus as the pressure in the tank falls subsequent to having reached the cut-out setting of the pressure switch, the venting valve should be opened and remain open as the tank pressure falls until the tank pressure reaches a value somewhat greater than the cut-in setting of the pressure switch whereupon the venting valve should be closed. The compressor will then start against atmospheric pressure but will immediately work against tank pressure. The venting valve may thus be seen to require a narrower operating differential than the pressure switch. Since various operating conditions may require that the cut-out point of the pressure switch be adjusted over a relatively wide range, it will be evident that the operating point of the venting valve must also be adjustable to maintain the desired coordination between the venting valve and the pressure switch.

It is an object of the present invention to provide a combined pressure switch and venting valve in which both components are operated by a single pressure responsive element and have independently adjustable operating points.

It is a further object of the present invention to provide

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a combined pressure switch and venting valve in which a pressure responsive element operates the pressure switch and a one-way clutch connection exists between the pressure responsive element and the venting valve whereby the venting valve is operated only as the element moves in response to decreasing pressure.

A further object of the present invention is to provide a device of the type referred to in which the range of movement of the pressure responsive element between the cut-out setting and cut-in setting of the pressure switch is greater than the range of movement of the pressure responsive element required to open and close the venting valve.

A further object of the present invention is to provide a relatively simple compressor unloader or venting valve structure which may be incorporated into a pressure switch for operating an air compressor or which may be completely separate from a conventional pressure switch and operated from a separate pressure responsive element.

The full nature of the invention will be understood from the accompanying drawings and the following description and claims:

FIG. 1 is a schematic illustration of an air compressor system into which the control of the present invention may be incorporated.

FIG. 2 is a side sectional view of a control embodying the present invention.

FIG. 3 is a fragmentary end view of the control shown in FIG. 2.

FIG. 4 is a fragmentary sectional view taken generally along the line 4—4 of FIG. 3.

FIG. 5 is a side sectional view of the venting valve.

FIG. 6 is a side sectional view of one of the switches forming a part of the control.

Referring initially to FIG. 1 there is shown a conventional air compressor 10 connected by means of a pipe 11 to an auxiliary tank 12 having a service outlet line 13. A check valve 14 is interposed between the compressor and the tank. Mounted on the tank and indicated generally at 16 is the control of the present invention. A vent tube 17 connects a point on the pipe 11 upstream of the check valve with a venting valve incorporated in the control 16 and subsequently described in detail. The control 16 includes switching means which function to connect the power electrical input lines 18 to the control input lines 19 whenever the pressure in the tank 12 falls below a predetermined value. The switching means in the control 16 further functions to disconnect the compressor from the power line 18 whenever the pressure in the tank 12 attains a predetermined maximum value.

The control of the present invention will now be described in detail with reference to FIGS. 2-5. Referring initially to FIG. 2, the control includes a base 21 having attached thereto a power element indicated generally at 22. The power element is of conventional type and includes a flexible diaphragm 23 and the thrust pin 24 which extends through an aperture in the base 21. A tab 26 is struck upwardly from the base and is apertured at 27 to accommodate and form a fulcrum for the extending end of a primary lever 28. The central portion of the primary lever is provided with an elongated aperture 29 and the portions of the lever outboard of the aperture are depressed, as indicated at 31, to provide an abutment which engages a shoulder 32 formed on the pin 24. The free end of the lever is provided with a flanged aperture 33 through which a pin 34 extends. The pin extends through a registering aperture in the base 21 and is provided with a head 34a. The annular flange bounding the aperture 33 serves to retain the lower end of a range spring 36, the upper end of the spring being retained by a cap 37. A nut 38, adjustably positionable upon the threaded upper end

of the pin 34, provides a means for adjusting the spring pressure urging the lever 28 downwardly.

The base 21 has attached thereto or integrally formed therewith two spaced case members or side walls 39. Centrally within the case there is disposed a switching means indicated generally at 41. The switching structure includes a plate 42 formed of insulating material carrying a bracket 43 on its under face. An arm 44 is provided with a tab 44a which extends through an aperture in a depending portion of the bracket, the arm 44 being thereby pivotally supported. The upper end of the thrust pin 24 engages an appropriately formed portion 46 of the arm 44 and a compression spring 47 extends between the portion 46 and the under face of the plate 42, the spring functioning to hold the arm 44 against the pin. The free end of the arm 44 pivotally supports one end of a C-shaped resilient member 48 whose other end is pivotally connected to the free end of a second arm 49. A tab 51 extends from the opposite end of the arm 49 and is accommodated within an aperture in the adjacent depending portion of the bracket 43.

An adjusting screw 52 is threaded through the bracket 43 and extends freely through a suitably elongated aperture in the arm 49. The adjusting screw is provided with a collar or upper abutment 53 and has threaded on its lower end a member 54 having an annular flange 56. The arm 49 may be pivotally moved about its connection to the bracket 43 within the clearance provided by the abutments 53 and 56. Rotating the screw 52 serves to position the member 54 and thus vary the clearance between the abutments 53 and 56. Attached to the arm 49 is a vertically disposed plate 57 which extends sidewardly beyond the plate 42.

The portion of the switching means visible in FIG. 2 has disposed on both sides thereof a switch of the type shown in FIG. 6. This switch structure generally includes a flanged plate 58, formed of suitable insulating material, and carrying a fixed contact 59. A conductor lug 61 receives a terminal screw 62, thereby providing a means for wiring the contact 59 into a suitable circuit. A conductive rivet 63, extending through the plate 58, mounts a flexible blade 64 carrying a movable contact 66 at its outer end. A conducting lug 67 accommodates a terminal screw 68, providing a means for connecting suitable wiring to the movable contact 66. The outer end of the blade 64 is riveted or otherwise suitably fastened to the plate 57, referred to in describing FIG. 2. While only one switch is shown in FIG. 6, it will be understood that switches, identical to that described with reference to FIG. 6, are disposed closely adjacent to and on opposite sides of the switch operating structure described with reference to FIG. 2.

The structure so far described does not in itself form a part of the present invention, the switch structure per se and the pressure responsive operator being of conventional design. With the control mounted on the tank served by the compressor, as indicated schematically in FIG. 1, it will be understood that the pressure below the diaphragm 23 reflects the pressure within the tank 12. With the pressure responsive operator 22 and the switch structures in their positions of FIGS. 2 and 6, it will be understood that the pressure in the tank is below the cut-out setting of the control. The switch contacts are closed and the compressor is running. As the pressure in the tank rises, the thrust pin 24 will move upwardly and, as the cut-out point of the control is reached, the element 48 will be moved over center to snap the free end of the plate 57 sharply downwardly. Movement of the plate 57 serves to separate the contacts 66 and 59 (FIG. 6) in the switching structures, thereby shutting down the compressor. As the pressure in the tank 12 falls because of, for example, subsequent withdrawals from the tank, the pin 24 will move downwardly until the cut-in setting of the control is reached. At the cut-in setting the arm 49, and consequently the plate 57 will be moved sharply upward

to reclose the contacts 59 and 66 of the switching structures and again start the operation of the compressor. Since the upward movement of the pin 24 is opposed by the force exerted by spring 36, it will be evident that the cut-out setting of the control may be varied by adjusting the nut 38. Since the abutment 56 limits the downward motion of the arm 49, it will be understood that the operating differential of the control, that is, the separation in terms of pressure between the cut-out and cut-in points, may be varied by adjusting the vertical position of the member 54. The pressure switch mechanism just described is conventional and, as hereinafter described, the venting valve and its actuating mechanism utilize the primary lever 28 of the pressure switch. It should be kept in mind that the venting valve and its actuating mechanism might also be placed in a separate control utilizing a primary lever 28 and a pressure responsive actuator 22. The pressure switch, as just described, might thus be physically separated from the venting valve and mechanism. The scope of the present invention is intended to include both such arrangements.

Referring particularly to FIGS. 3-5, the venting valve and its actuating mechanism will now be described. As may be seen in FIG. 3, the primary lever 28 has one side portion extended to provide a vertical flange 71. Rigidly attached to the flange by means of a screw 72 is a small U-shaped permanent magnet 73. The opposite side wall 39 of the case has a bracket rigidly secured thereto providing inwardly extending ears 74 and 76. Overlying the ears 74 and 76 is a bracket having ears 77 and 78. Registering apertures in the ears accommodate a pivot pin 79. A torsion spring 81 encircles the pin and its ends bear against the bracket providing the ears 77 and 78 and against the adjacent side wall. The ear 78 has a sidewardly extending portion providing a secondary lever 82. The secondary lever, at its free end, is provided with a tab 83 which extends into overlying relation with the magnet 73. The tab 83 carries a magnetically permeable member which includes an armature bar 84 spanning the pole face of the magnet 73. The bar 84 is provided with integral, vertical legs 86 which extend freely through spaced apertures in the tab 83 and are joined by an integral cross member 87. The cross member serves to retain a compression spring 88 whose lower end is bolted against the tab 83.

The bracket portion adjacent the ear 77 is provided with a downwardly extending portion 89 which has adjustably mounted thereon an abutment screw 91, the nut 92 providing a means whereby the abutment 93 formed by screw 91 may be locked in adjusted position with relation to the extending portion 89.

The abutment 93 engages one end of a push rod 94, the rod extending into a venting valve assembly indicated generally at 96. The venting valve assembly has a threaded end portion 97 which extends through an aperture in the case side wall 39, and is mounted thereon by means of a nut 98. The venting valve assembly is shown in detail in FIG. 5 and includes a housing 99 having a tubular bore 101 which freely accommodates the push rod 92. The right-hand end of the housing (as viewed in FIG. 5) is provided with an enlarged bore 102 coaxial with the bore 101, the junction between the two bores providing the inclined seat or shoulder 103. Disposed within the bore 102 is a ball closure 104 which is biased into engagement with the seat 103 by means of a compression spring 106. The upper end of the compression spring bottoms against a threaded insert 107. The exterior of the housing is threaded as indicated at 108 and the adjacent end of the housing is formed so as to accommodate a conventional compression fitting. The line 17 of FIG. 1 is connected to this end of the housing. Intermediate the length of the bore 101 the housing is provided with a radially extending aperture 109 which accommodates a tube 111. The extending end of the tube 111 is adapted to be connected to a tube (not shown) which leads to

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a suitable location for discharging air moving past the ball check valve formed by the closure 104 and the seat 103.

The operation of the complete control may now be described by assuming that the parts are initially in the positions shown in the drawings. Under these conditions the switching means is closed and the condenser is in operation, delivering air under pressure to the tank 12. As the pressure in the tank rises, and approaches the cut-out setting of the control, the primary lever 28 will move the magnet 73 upwardly as viewed in FIG. 3. Prior to attainment of the cut-out pressure, the magnet will pick up the armature 84. The spring 88 and the spring 106 in the valve assembly are proportioned so that this slight downward movement of the armature results in compression of the spring 88 and does not move the push rod 94 so as to open the valve formed by the assembly 96. As the pressure continues to rise, the thrust pin 84 and lever 28 will continue to move upwardly until the cut-out point is reached, whereupon the switching means will be opened and the compressor will be shut down. It should be noted that during this rising pressure condition, the valve formed by the assembly 96 remains closed.

With the compressor shut down, assuming withdrawals from the tank 12, the pressure in the tank will start to fall and the thrust pin 24 and the free end of lever 28 will consequently move downwardly. As the magnet 73 moves downwardly, it will carry the armature 84 with it and will pivot the secondary lever 82 counterclockwise about its pivot pin 79. The rightward movement of the abutment 93 will force the push rod 92 further into the valve assembly 96 to move the closure 104 away from the seat 103. This opening of the valve formed by the assembly 96 serves to vent the pipe 11 to atmosphere through the tube 111 of the valve assembly. It should be noted that this opening of the venting valve occurs as the pressure in the tank decreases and at a point determined by the adjustment of the abutment 93. As the free end of the lever 28 continues to move downwardly as a result of continued decrease in tank pressure, the inability of the secondary lever 82 to move further in a counterclockwise direction causes the magnet to release the armature 84, whereupon the spring 106 in the venting valve assembly again forces the closure 104 against the seat 103 to close the venting valve. This reclosure of the venting valve occurs before the thrust pin 24 and the free end of the lever 28 reach the cut-in position of the switch means. Upon further downward movement of the thrust pin 24 and the free end of lever 28, the cut-in position will be reached and the switching means will be closed to restart the compressor. As the pressure in the tank rises the venting valve will, of course, be maintained closed by the spring 106.

It will be noted that only a one-way clutch connection thus exists between the venting valve and the thrust pin 24 of the pressure responsive operator. The venting valve is actuated to open position only during a portion of the decreasing pressure stroke of the pin 24 and this portion of the pin stroke lies within the total stroke of the pin between the cut-out and cut-in points of the switching means. The compressor thus starts against atmospheric pressure, the pipe 11 having been vented to atmosphere, but since the venting valve is closed at the time the compressor starts, the compressor immediately supplies air under pressure to the tank 12.

The control of the present invention may thus be seen to operate the switching means and venting valve from a single pressure responsive operator, although the pressure switch and venting valve might be separated and operated by separate pressure responsive operators. The venting valve operates through a pressure range which is different from the pressure range through which the switching means is operated. Since the venting valve is operated directly from the thrust pin 24 of the pressure responsive operator, and not from the arms 44 or 49 of the switch-

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ing means, a relatively large force is available for operating the valve. It will be evident that while a permanent magnet-armature type of connection between the levers 28 and 82 has been described, other types of one-way yielding connections might also be utilized within the scope of the present invention.

While the invention has been disclosed and described in some detail in the drawings and foregoing description, they are to be considered as illustrative and not restrictive in character, as modifications may readily suggest themselves to persons skilled in this art and within the broad scope of the invention, reference being had to the appended claims.

The invention claimed is:

1. A control comprising an operator responsive to pressure variations, switching means operable by said operator between a predetermined cut-out point on increasing pressure and a predetermined cut-in point on decreasing pressure, a valve biased to closed position, a primary lever movable by said operator, a secondary lever movable to open said valve against its bias, a permanent magnet and a cooperating armature respectively carried by said levers, said levers being positioned so that said magnet picks up said armature as said operator moves in response to increasing pressure but prior to attaining said switch cut-out point, and said secondary lever is moved to open said valve as said operator subsequently moves in response to decreasing pressure, said armature breaking from said magnet to disconnect said levers and permit said valve to reclose as said operator continues to move in response to decreasing pressure but prior to attaining said switch cut-in point.

2. A control comprising an operator responsive to pressure variations, a switching means operable by said operator between a predetermined cut-out point on increasing pressure and a predetermined cut-in point on decreasing pressure, a valve biased to closed position, a primary element movable by said operator, a secondary element movable to open said valve against its bias, a permanent magnet and a cooperating armature respectively carried by said elements, said elements cooperating so that said magnet picks up said armature as said operator moves in response to increasing pressure but prior to attaining said switch cut-out point, and said secondary element is moved to open said valve as said operator subsequently moves in response to decreasing pressure, said armature breaking from said magnet to disconnect said elements and permit said valve to reclose as said operator continues to move in response to decreasing pressure but prior to attaining said switch cut-in point.

3. A control comprising an operator responsive to pressure variations, switching means operable by said operator between a predetermined cut-out point on increasing pressure and a predetermined cut-in point on decreasing pressure, a valve biased to closed position, a primary lever movable by said operator, a secondary lever movable to open said valve against its bias, clutching means adapted when engaged to join said levers for movement in unison and when disengaged to permit said levers to move independently, said clutching means engaging as said operator moves in response to increasing pressure but prior to attaining said switch cut-out point, subsequent movement of said operator in response to decreasing pressure thereby initially moving said secondary lever to open said valve and subsequently disengaging said clutching means to permit said venting valve to reclose prior to attaining said switch cut-in point.

4. A control for a compressor or the like comprising a primary lever, a pressure responsive operator acting on said primary lever, switching means operated by movement of said primary lever, said operator moving said primary lever in one direction on increasing pressure to a predetermined cut-out position of said switching means, biasing means acting on said primary lever to urge said primary lever in the other direction upon decreasing pres-

sure to a predetermined cut-in position of said switching means, a valve biased to closed position, a secondary lever movable to open said valve against its bias, a permanent magnet and cooperating armature carried respectively by said primary and secondary levers providing a one-way clutch connection between said levers, whereby said primary lever moves said secondary lever to open said valve only during the initial portion of its movement in said other direction upon a decrease in pressure.

5 5. A control for a compressor or the like comprising a primary element, a pressure responsive operator acting on said primary element, switching means operated by movement of said primary element, said operator moving said element in one direction on increasing pressure to a predetermined cut-out position of said switching means, biasing means acting on said primary element to urge said element in the other direction upon decreasing pressure to a predetermined cut-in position of said switching means, a valve biased to closed position, a secondary element movable to open said valve against its bias, a permanent magnet and cooperating armature carried respectfully by said primary and secondary elements providing a one-way clutch connection between said elements, whereby said primary element moves said secondary element to open said valve only during the initial portion of its movement in said other direction upon a decrease in pressure.

6. A control for a compressor or the like comprising a primary element, a pressure responsive operator acting on said primary element, switching means operated by movement of said primary element, said operator moving said element in one direction on increasing pressure to a predetermined cut-out position of said switching means, biasing means acting on said primary element to urge said element in the other direction upon decreasing pressure to a predetermined cut-in position of said switching means, a valve biased to closed position, a secondary element movable to open said valve against its bias, and a one-way clutch connection between said elements, whereby said primary element moves said secondary element to open said valve only during the initial portion of its movement in said other direction upon a decrease in pressure.

7. A control for a compressor or the like comprising a primary lever, a pressure responsive operator acting on said primary lever, said operator moving said primary lever in one direction on increasing pressure, biasing means acting on said primary lever to urge said primary lever in the other direction, a valve biased to closed position, a secondary lever movable to open said valve against its bias, a permanent magnet and cooperating armature carried respectively by said primary and secondary levers providing a one-way clutch connection between said levers, whereby said primary lever moves said secondary lever to open said valve only during the initial

portion of its movement in said other direction upon a decrease in pressure.

8. A control for a compressor or the like comprising a primary element, a pressure responsive operator acting on said primary element, said operator moving said element in one direction on increasing pressure, biasing means acting on said primary element to urge said element in the other direction upon decreasing pressure, a valve biased to closed position, a secondary element movable to open said valve against its bias, and a one-way clutch connection between said element, whereby said primary element moves said secondary element to open said valve only during the initial portion of its movement in said other direction upon a decrease in pressure.

9. In a control device, the combination of a pressure responsive actuator, a primary element, means for positioning said primary element in accordance with the position of said actuator whereby said primary element is moved in one direction on increasing pressure and in another direction on decreasing pressure, a secondary element movable to operate a control, and a means connecting said primary element and said secondary element to move said secondary element for operating said control only during movement of said primary element in one direction.

10. In a control device, the combination of a pressure responsive actuator, a primary element moved by said actuator in one direction on increasing pressure and in another direction on decreasing pressure, a secondary element movable to operate a control, and a device connecting said primary element and said secondary element to move said secondary element for operating said control only during a decrease in pressure.

11. In a control device, the combination of a pressure responsive actuator, a primary element moved by said actuator in one direction on increasing pressure and in another direction on decreasing pressure, said primary element adapted to operate a first control by movement to a cut-out position on increasing pressure, biasing means acting on said primary element to urge said element to a cut-in position, a secondary element movable to operate a second control, and a device connecting said primary element and said secondary element to move said secondary element for operating said control only during a decrease in pressure.

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