

May 19, 1936.

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2,040,964

UNLOADER VALVE FOR FLUID COMPRESSORS

Original Filed Sept. 15, 1931 2 Sheets-Sheet 1

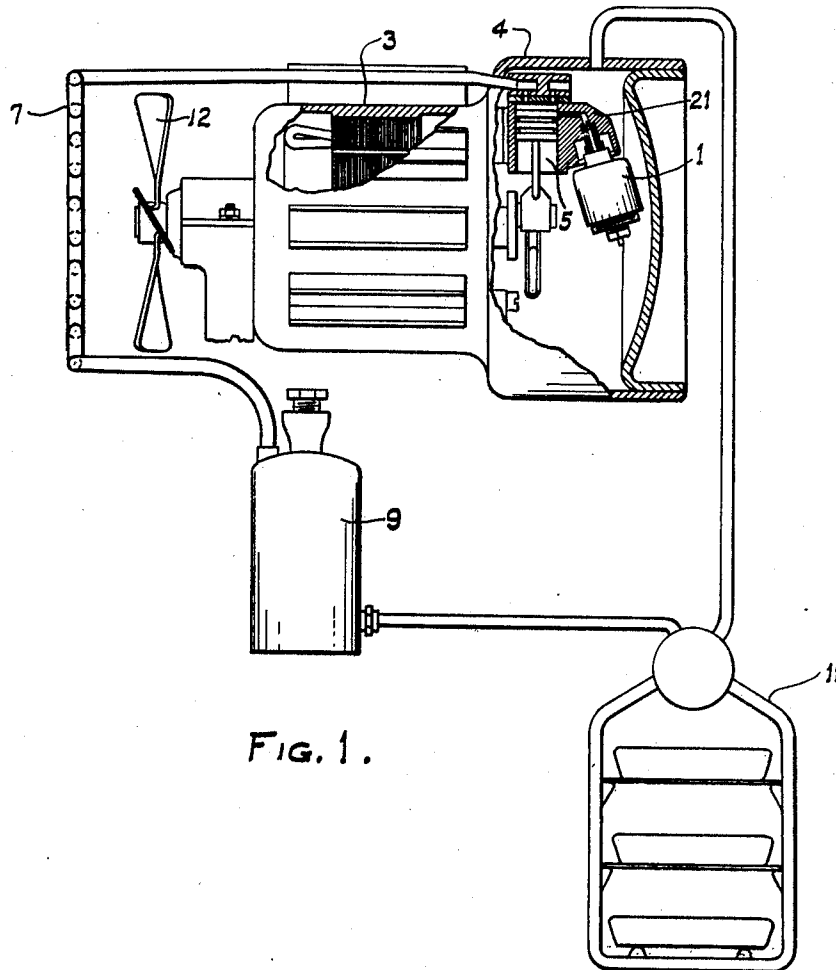


FIG. 1.

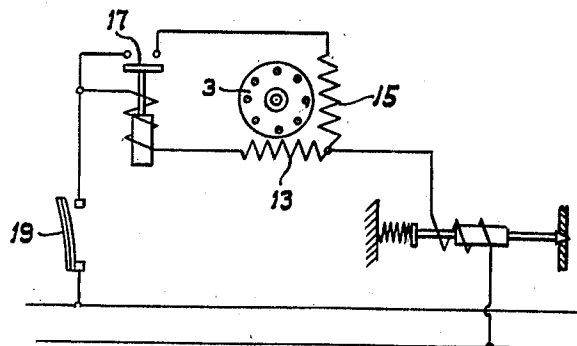


FIG. 2.

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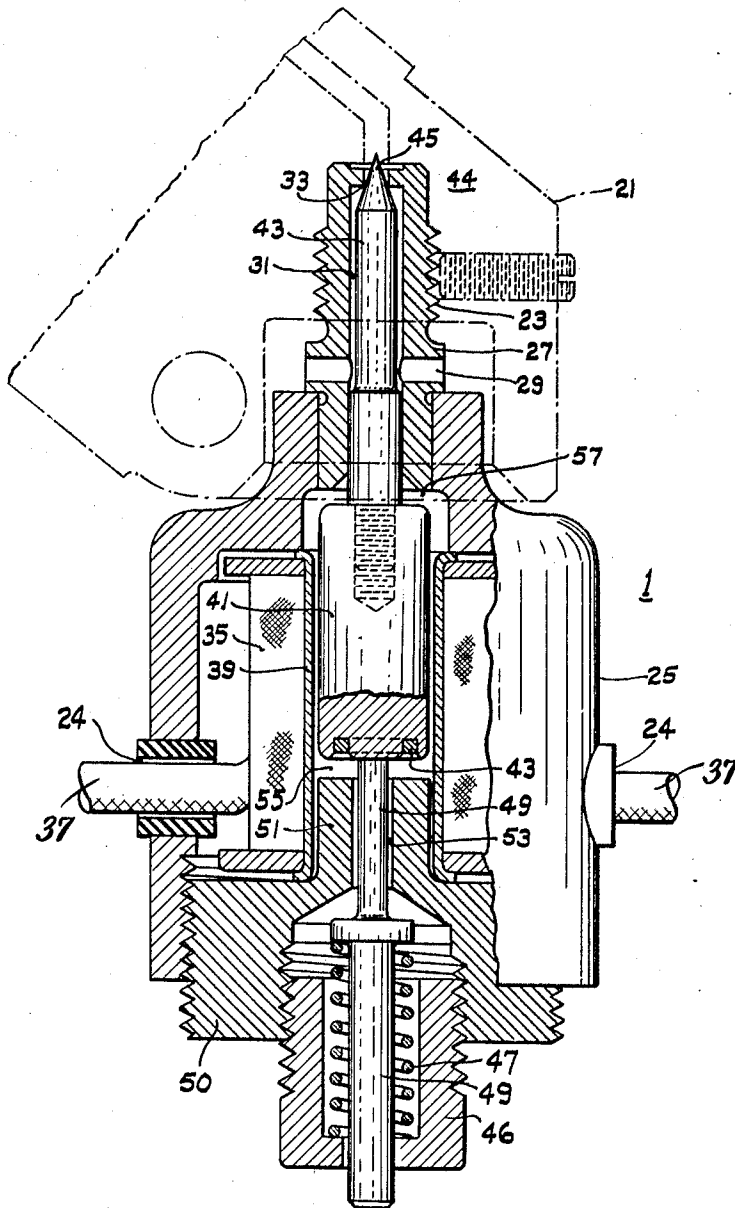


FIG. 3.

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UNLOADER VALVE FOR FLUID
COMPRESSORS

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Original application September 15, 1931, Serial
No. 562,882. Divided and this application Oc-
tober 28, 1932, Serial No. 640,105

5 Claims. (Cl. 137—139)

My invention relates to valve construction, and particularly to the construction of unloader valves for fluid compressors. This application is a division of my application Serial No. 562,882, filed September 15, 1931 for Valve construction.

Unloader valves for fluid compressors are provided in order that the current drawn by the electric motor which drives the compressor is below a predetermined maximum by effecting a direct and open communication between the high and low sides of the refrigerating system so that the suction and discharge pressures shall be equalized. Small refrigerator motors which are usually of the split phase induction type generally draw more than 15 amperes on starting and under overload if the load of the compressor is not modified by the unloader. Underwriter's Regulations do not allow more than 20 amperes to be drawn from the usual 110 volt house line, and an unloader is therefore provided. At other periods, the pressure in the high side of the compressor may become excessive, and unless an unloader is provided to release the excessive pressure, an overload is carried by the motor.

The present unloader, therefore, serves to bypass fluid pumped by the compressor from the high to the low side of the system on starting, by means electrically responsive to the current drawn by the motor driving the compressor, and at other times maintains a tight seal between the high and the low sides of the system. Electrically responsive unloaders connected to the compressor motor include a winding and a plunger on the unloader, and a valve operated by the movements of the plunger. The flux established by the winding is controlled by the current drawn by the motor and the reluctance of the magnetic circuit has heretofore usually been constant. The unloader valve also serves as a blow-off valve assisted by the flux in the valve winding when unduly high pressures are present in the compressor.

Means are usually provided on the unloader for reseating the valve thereof tightly when the current drawn by the motor falls below a predetermined value. Separate means are also usually provided to maintain the valve in its closed position against pressure in the compressor, until a predetermined maximum pressure is attained, when the valve opens mechanically assisted by the motor current, and the fluid pumped by the compressor, therefore, is by-passed until the pressure therein is reduced.

Heretofore, the means for reseating the valve under low current conditions and the means for

releasing high pressures in the compressor have been separate resilient members which are not adjustable except in that members of different strength are utilized.

The responsiveness of the unloader to the current drawn by the motor in such valves is dependent upon the force of the resilient member acting on the valve and the reluctance of the magnetic circuit established; neither of which are adjustable.

It is, therefore, necessary with this type of unloader that it be manufactured within fine limits so that the resilient members operate when desired, and reseal the valve when current or pressure drop below a predetermined maximum. It has been found in this type of unloader that the valve often sticks because the spring adapted to reseal the valve after the current drawn by the motor has fallen to a safe value does not exert enough force to overcome the magnetic forces left in the unloader valve and the compressor pressure, thus leaving the valve open and the high and low sides of the refrigerating system directly connected.

It is, therefore, an object of my invention to provide a magnetically operated compressor unloader in which a single means overcomes a predetermined value of flux in the magnetic circuit of an unloader, and pressure in the compressor and controls the pressure of the compressor at which the unloader operates assisted by the value of flux in the magnetic circuit, and which also assists in determining the value of flux necessary to operate the valve.

It is another object of my invention to provide means for adjusting the unloader valve so that the pressure at which it blows off may be easily predetermined.

It is still another object of my invention to provide means whereby the reluctance of the magnetic circuit of an electrically responsive unloader valve may be easily adjusted, thereby partially controlling the flux necessary to actuate the armature of the valve.

It is another object of my invention to provide a single means for reseating an overload valve responsive to surges on an electric motor and to control the blow-off pressure valve of the valve construction.

It is a further object of my invention to maintain the reluctance of the magnetic circuit of an electrically responsive overload valve at a higher value than that of a complete magnetic metal circuit.

It is still a further object of my invention to

connect an unloader valve for a compressor in series with both the starting and running windings of the motor driving the compressor so that it will be directly responsive to the current drawn by the motor.

It is still another object of my invention to provide an unloader in which the reluctance of a magnetic circuit included therein may be adjusted as well as the blow-off pressure, and in such a manner that the blow-off pressure may be adjusted after the reluctance of the circuit is determined, and also so that as the reluctance is increased, the blow-off pressure is decreased, and when the reluctance is decreased, the blow-off pressure is increased.

Other objects and advantages of my invention will become apparent from the following description and drawings, wherein:

Fig. 1 is a view partly in section of a refrigerating machine which utilizes my unloader;

Fig. 2 is a schematic wiring diagram of a refrigerating system control including a magnetically-operated unloader valve; and,

Fig. 3 is a cross-sectional view of my unloader constructed in accordance with an embodiment of my invention.

In order to carry out the objects of my invention, I provide an unloader valve which has two adjustable screw plugs in the bottom thereof, and also provide a permanent air gap in the magnetic circuit of the unloader. One of the plugs adjusts another air gap, thereby varying the reluctance of the magnetic circuit and the necessary travel of the plunger and therefore partially controlling the flux required to actuate the armature or plunger of the unloader to open the valve thereof. The second adjustable plug adjusts the value of the blow-off pressure of the unloader valve by varying the force of a resilient member contained therein acting on the plunger of the unloader by means of a shaft extending through the first plug, which spring also reseats and assists in predetermining the flux and pressure necessary to actuate the plunger including the movable portion of the valve when the forces in the unloader due to the amount of current passing through the unloader windings and the pressure in the compressor reach certain values partly predetermined by the reluctance of the magnetic circuit.

Referring specifically to the drawings for a detailed description of my invention, numeral 1 designates an unloader valve assembly which is disposed on a compressor 5 such as that of the refrigerating system shown in Fig. 1 which includes a motor 3, contained in a casing 4 with the compressor 5, a condenser 7, an expansion device 9, an evaporator 11, and a motor driven fan 12 which assists in cooling the condenser 7. The low pressure of the system prevails inside the casing 4.

The unloader 1 is preferably connected in series with the starting windings 13 and the running windings 15 of the motor 3, as shown in Fig. 2, which motor is controlled by a temperature responsive device 19, and a starting switch 17 which cuts out the starting windings 13 after the motor 3 comes up to speed.

The unloader valve 1 is disposed on the compressor head 21 by screw threads 23. The unloader comprises a preferably cylindrical casing 25 of a magnetic material and is provided with apertures 24 therein for the insertion of conductors. A member 27 of non-magnetic material is inserted in the top of the casing 25 which member 27 is threaded at 23, and embodies a trans-

verse aperture 29, opening into the low side of the refrigerating system, as well as a longitudinal aperture 31 connecting the high pressure side of system to the aperture 29 when the valve is opened. A valve seat 33 is also provided at the outer end of the member 27.

A winding 35 is inserted in the bottom of the casing 25, and the lead conductors 37 extend through the apertures 24 of the casing. The winding is provided with a spool of non-magnetic material 39 for reasons hereinafter explained.

A plunger 41 of magnetic material is inserted inside the winding 35, and is provided with an elongated portion 43 which has a needle 45 at the end thereof adapted to seat in the valve seat 33 and form a needle valve assembly 44. The plunger 41 is also preferably provided with a ring of non-magnetic material 43 in the bottom thereof, which is utilized as a shading coil to prevent chattering when the valve 44 is open.

A screw-threaded plug 46 containing a resilient member 47 supporting a shaft 49 which protrudes from the ends of the plug 46, is screwed into another screw-threaded plug 50 which is, in turn, screwed into the casing 25 and is provided with an extension 51 adapted to be inserted inside the winding 35. The plug 50 is also provided with an aperture 53 through which the shaft 49 extends and supports the plunger 41.

The plunger 41 is normally maintained in a raised position by the resilient member 47 and the shaft 49 so that the needle valve 44 is closed and two air gaps exist between the plunger and the casing 25, one at 55 and a permanent air gap at 57 because the member 27 is of non-magnetic material.

The unloader is adjusted to partially predetermine the amount of flux necessary to actuate the plunger 41 due to surges of current drawn by the motor 3, and to open the needle valve 44 by varying the air gap 55 and, therefore, the reluctance of the magnetic circuit through the windings 35, the air gaps 55 and 57, the plug 50 and the casing 25. The air gap 55 is varied by seating the needle valve 45 by compressing the resilient member 47 by turning the plug 46, and then turning the plug 50 inwardly or outwardly. Since the needle 45 is fixed, the distance between the plug 50 and the plunger 41 is changed, thus changing the reluctance.

By turning the plug 46 after the air gap 55 is adjusted, the resilient member 47 exerts greater or less force on the plunger 41 through the shaft 49 and, therefore, controls the blow-off pressure and also assists, together with the adjustable reluctance of the circuit, in controlling the amount of flux to be set up and maintained in the winding 35 to maintain the plunger 41 in the actuated or unactuated position and the valve needle 44 opened or closed. The plugs 46 and 50 are staked or in position when adjusted.

The permanent air gap 57 keeps the reluctance of the magnetic circuit at a relatively high value, and, therefore, the current in the winding 35 need not drop to a very low value before the needle 44 is reseated. The plunger 41 is less likely, therefore, to stick open due to flux in the windings 35 and residual magnetism in the magnetic circuit.

When an overload occurs on the motor 3, the windings 35 of the unloader 1 are energized sufficiently to pull down the plunger 41 and the needle 45 to open the needle valve 44. Fluid is bypassed from the high to the low pressure side of the refrigerating system through aperture 59 in the compressor block 21 leading from the high

pressure side through the valve 44, aperture 31 and out of the apertures 29 of the non-magnetic member 27 into the low pressure side of the system inside the casing 4. When the current falls below a value predetermined by the adjustment of the air gap 55 and of the resilient member 47, the force thereof overcomes the forces tending to hold the plunger 41 in its actuated position, and the valve 44 is again closed, thus forming a tight seal between the high and low pressure sides of the system.

If an excessive pressure is built up in the compressor, the same resilient member 47 is forced open due to pressure on the needle 45 assisted in part by the current drawn by the motor 3, and when the pressure is reduced by gas being by passed from the high to the low pressure side of the system through the aperture 31 and the apertures 29 in the unloader 1, the resilient member 47 again forces the needle 45 into the valve seat 33.

From the foregoing description, it will be readily seen that I have provided an unloader valve for a fluid compressor which is adjustable for determining electrical operating values, and which, therefore, need not be manufactured within particularly close limits. I have also provided for a single means for reseating an unloader valve when it has been actuated electrically, because connected in series with the motor windings, or mechanically, due to excessive pressure in the compressor, which means is adjustable and also assists in determining the electrical and mechanical operating values of the unloader valve.

Although I have shown and described a specific embodiment of my invention, it is understood that modifications and changes may be made by those skilled in the art without departing from the spirit and scope of the appended claims.

I claim:—

1. In an unloader device, a magnetic circuit including fixed and movable elements and defining therebetween at least one air gap, a valve comprising fixed and movable portions, said movable portion being movable with the movable element of the magnetic circuit, means for varying the air gap and the travel of said magnetic circuit movable member, said magnetic circuit elements being so arranged and constructed that an air gap exists therebetween when said movable element of the magnetic circuit has responded to a flux predetermined by said air gap varying means, and means for overcoming the flux in said circuit acting on said movable magnetic circuit member when said flux drops below a predetermined value, the air gap varying means being adapted to adjustably control the relative values of combined pressure and current required to actuate said movable portion of said valve.

2. In an unloader valve, a magnetic plunger, a valve comprising movable and fixed members, said movable member being associated with said

plunger, a casing for enclosing the aforesaid elements, means for establishing a magnetic circuit through said plunger and casing, at least one air gap between said plunger and casing, means for varying said air gap and, therefore, the flux necessary to actuate said plunger so that some air gap is always present in said circuit, and a single means for seating said movable valve portion, for assisting in adjusting the flux in said circuit necessary to actuate said plunger and for permitting said movable valve portion to be reseated under predetermined conditions.

3. In an unloader valve, a magnetic plunger, a valve comprising movable and fixed members, said movable member being associated with said plunger, a casing for enclosing the aforesaid elements, means for establishing a magnetic circuit through said plunger and casing, at least one air gap between said plunger and casing, means for varying said air gap and, therefore, the flux necessary to actuate said plunger so that some air gap is always present in said circuit, and a single means for seating said movable valve portion, for assisting in adjusting the flux in said circuit and the pressure on said movable valve member to actuate said plunger and for permitting said movable valve portion to be reseated under predetermined conditions.

4. In an unloader device, a valve, means for establishing magnetic flux in the device, varying in accordance with the current impressed on said means for establishing flux, a magnetic circuit for said flux comprising a casing and a magnetic plunger attached to and adapted to open said valve when actuated, adjustable means for predetermining the reluctance of said magnetic circuit, means tending to maintain approximately the predetermined reluctance in said magnetic circuit when said plunger is actuated by a current value partially determined by the reluctance of said magnetic circuit, means for overcoming the flux in said circuit acting on said plunger when said current falls below a predetermined value, and means assisted by said magnetic circuit for permitting said valve to open under conditions other than those establishing said predetermined actuating current.

5. In an unloader device, the combination of a magnetic circuit including fixed and movable elements defining an air gap therebetween, a valve comprising fixed and movable portions, said movable portion of the valve being movable with the movable element of the magnetic circuit, resilient means for biasing the movable portion of the valve in one direction, adjustable means for varying the air gap and the travel of the movable element of the magnetic circuit and a second adjustable means for adjusting the bias of the resilient means, both of said adjustable means being assembled together as a unit and in turn attached in operative relation to the unloader device.

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