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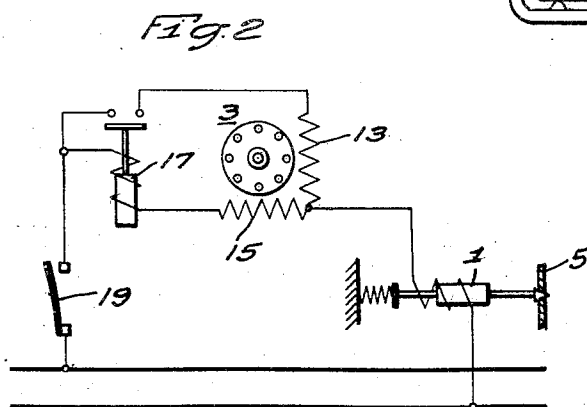
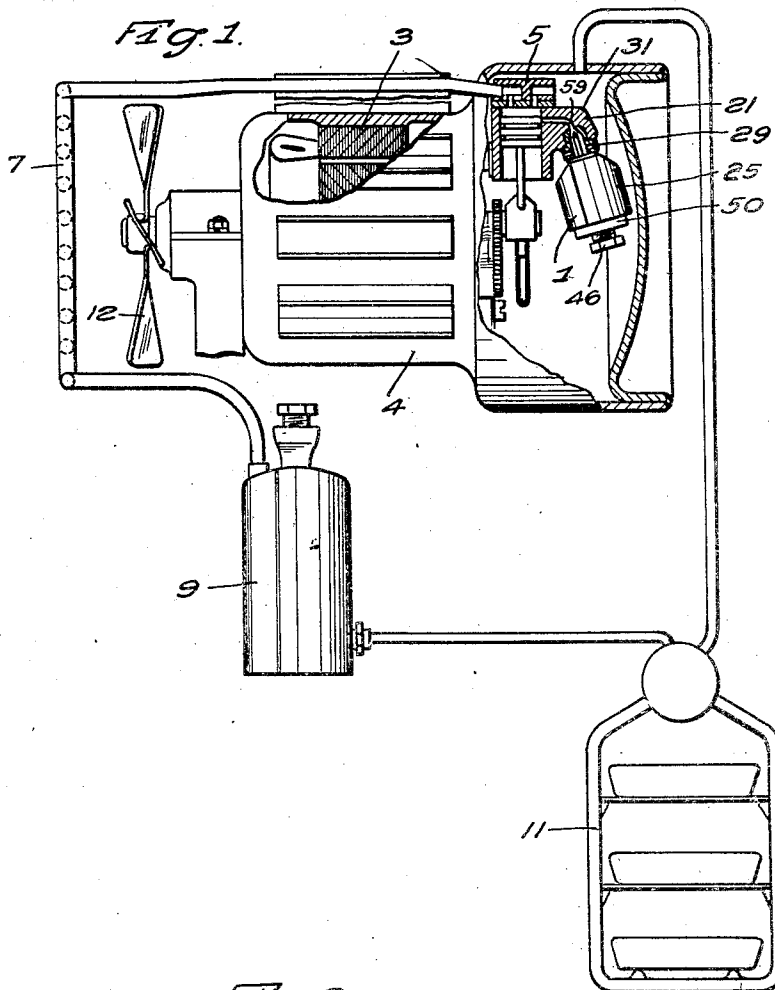
F. L. TARLETON

2,007,388

VALVE CONSTRUCTION

Filed Sept. 15, 1931

2 Sheets-Sheet 1



WITNESSES.

E. A. McElroy
W. M. Carr *Silver*

INVENTOR

Frederic L. Tarleton.

BY

William H. Swezey
ATTORNEY

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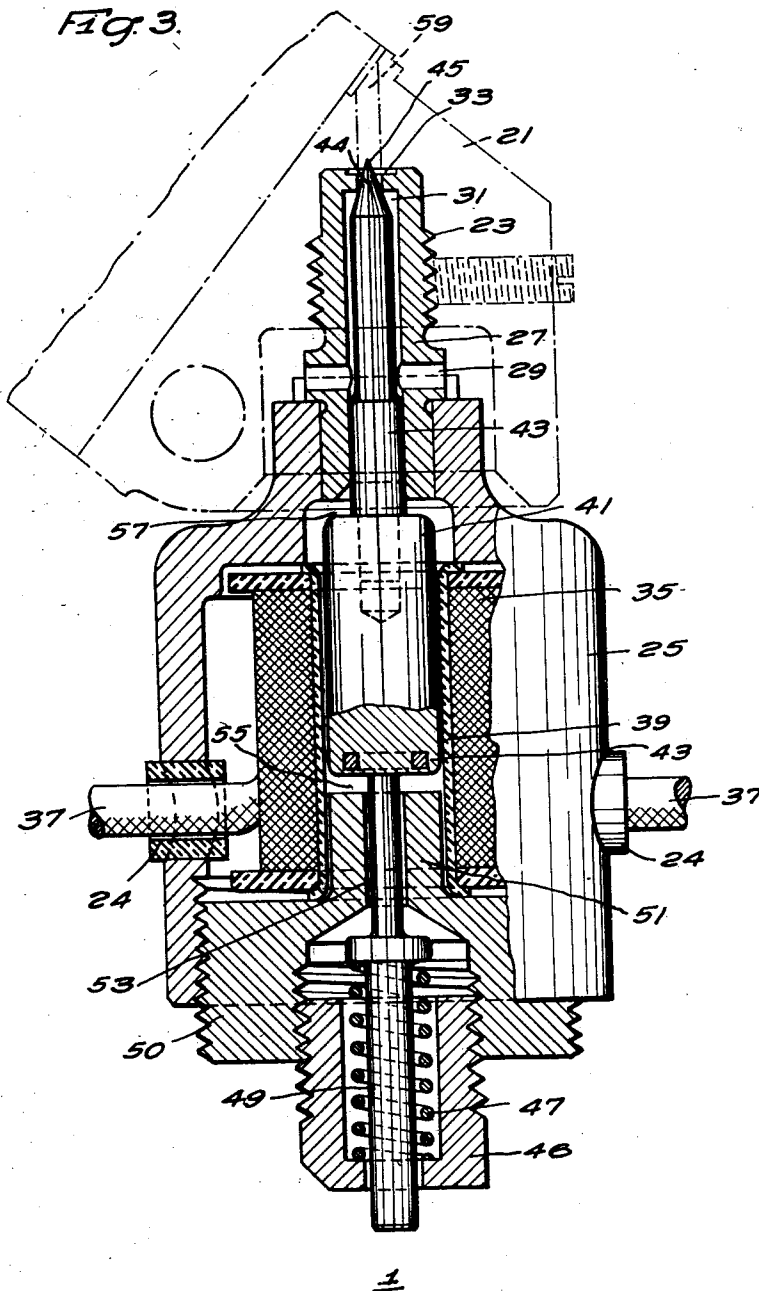
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VALVE CONSTRUCTION

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WITNESSES.

E. A. M. S. S. S.
W. H. C. S. S. S.

INVENTOR

Frederic L. Tarleton.

BY

William J. Sweeney
ATTORNEY

UNITED STATES PATENT OFFICE

2,007,388

VALVE CONSTRUCTION

Frederic L. Tarleton, Springfield, Mass., assignor
to Westinghouse Electric & Manufacturing
Company, a corporation of Pennsylvania

Application September 15, 1931, Serial No. 562,882

14 Claims. (Cl. 230—22)

My invention relates to valve construction, and particularly to the construction of unloader valves for fluid compressors.

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. Underwriters' regulations do not allow more than 15 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 bypassed 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 is 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 value of the valve.

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:

Figure 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 valve 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 provided with apertures 24 therein for the insertion of conductors, in the top of which is inserted a member 27 of non-magnetic material which is threaded as explained at 23, and in which a transverse aperture 29 is provided, 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 and a valve seat 33.

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 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 45 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 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 sys-

tem 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.

When an excessive pressure appears 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 bypassed 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 disposes the needle 45 in the valve seat 33.

The unloading device per se is claimed in applicant's divisional application, Serial No. 640,105, filed October 28, 1932.

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 as my invention:

1. In combination, a motor, a compressor, an unloader device for said compressor comprising means responsive electrically to current surges on said motor for actuating said unloader, means for adjusting said unloader device so that said unloader device operates on predetermined loads on said motor, means actuated by the pressure in the compressor assisted partly by the load on the motor to actuate the unloader device and means for adjusting the device so that it operates on predetermined pressures in the compressor.

2. In combination, a motor, a compressor, an unloader device for said compressor comprising means responsive electrically to current surges on said motor for actuating said unloader, and means responsive to excess pressures in the compressor for actuating the unloader, said unloader device including an air gap and a spring for actuating the device in one direction, means for adjusting said unloader device so that the effect of the air gap and spring are overcome at predetermined loads on said motor and pressures in said compressor, respectively, to operate the unloader.

3. In combination, a motor including starting and running windings, a compressor, an unloader device for said compressor connected in series with said starting and running windings and responsive to surges of current through said motor, a plunger actuated by a magnetic circuit established by said current, and means for adjustably determining the reluctance of said magnetic circuit before said plunger is actuated.

4. A motor, a compressor, an unloader device responsive to predetermined loads on said motor

and pressures in said compressor including a magnetic circuit and a resilient member, means for adjusting the reluctance of said magnetic circuit, means for adjusting the force exerted by said resilient member to adjust blow-off pressure, said last means adapted to adjust blow-off pressure at a constant reluctance in said magnetic circuit, and said first means being also adapted to decrease the blow-off pressure necessary to operate said unloader when said reluctance is increased, and to increase the blow-off pressure necessary to operate said unloader when said reluctance is decreased.

5. In a compression refrigerator, a compressor, an electric motor for driving the compressor, and an unloader for unloading the compressor, said unloader including means responsive to the compression pressure to unload the compressor and means responsive to the magnitude of current flow in the motor at starting to unload the compressor, said last-named means being also responsive to the combination of overload current and pressure to unload the compressor.

6. In a compression refrigerator, a compressor, an electric motor for driving the compressor, an unloader for unloading the compressor, said unloader including means responsive to compression pressure to unload the compressor, means responsive to the magnitude of current flow in said motor at starting to unload the compressor, said last-named means being also responsive to overload current in said motor to unload the compressor, and means for adjusting both the current responsive unloading means and the pressure responsive unloading means.

7. In a compression refrigerator, a compressor, an electric motor for driving the compressor, means for relieving compression of the compressor including a means responsive to compression pressure, and means responsive to an underspeed condition of the motor to render the unloader effective to relieve compression of the compressor.

8. In a compression refrigerator, a compressor, an electric motor for driving the compressor, means for relieving compression of the compressor including means responsive to compression pressure, and means responsive to a surge of current in the motor upon starting to render the unloader effective to relieve compression of the compressor.

9. In a compression refrigerator, a compressor, an electric motor for driving the compressor, means for relieving compression of the compressor including means responsive to compression pressure, and means responsive to a surge of current in the motor upon starting to render the unloader effective to relieve compression of the compressor, said pressure responsive means and said current responsive means including a common operating element for relieving compression of the compressor.

10. In combination, an electric motor having a running winding and a phase-distorting winding arranged to be energized from a source of current supply, solenoids connected in series with said windings, one of said solenoids being connected to close the circuit of said phase-distorting winding for starting said motor and means associated with the other of said solenoids for relieving the load of said motor during starting.

11. In combination, an electric motor adapted for operation from a single phase alternating current source of supply, running and starting windings operatively associated with said motor, solenoids connected in series with said windings,

one of said solenoids being connected to control the circuit of said starting winding during the starting of said motor and a valve controlled by the other of said solenoids, said last mentioned solenoid being arranged to operate said valve to relieve said motor of its load during starting.

12. In combination, a single phase alternating current motor having a plurality of windings, one of said windings being a main running winding, a relay connected in series with said main running winding, a solenoid connected in series with another of said motor windings, load-relieving means operable by said solenoid, said relay being connected to close the circuit of said solenoid and a source of current supply during the starting of said motor, whereby said solenoid is energized and caused to operate said load-relieving means for substantially relieving the motor of its load.

13. An automatic load control device for electric motors having a starting circuit and a running circuit, a solenoid connected into said run-

ning circuit, circuit closing means operatively associated with said solenoid, said solenoid being adjusted to operate said circuit closing means only during the starting of said motor, connections between said circuit closing means and said starting winding, whereby said starting winding is connected into circuit through the operation of said solenoid, a solenoid connected in series with said starting winding and an unloader valve operatively associated with said last mentioned solenoid, said unloader valve being arranged to relieve the load from said motor during the energization of said starting winding.

14. In combination, a motor including starting and running windings, a compressor, and an unloading device for said compressor connected in series with said starting and running windings and responsive to surges of current through said motor for rendering the unloading device effective.

FREDERIC L. TARLETON.