Sept. 21, 1948. J. FELSER, JR 2,449,740

PRESSURE UNLOADER FOR COMPRESSORS

Filed Aug. 14, 1947

FIG. 1.

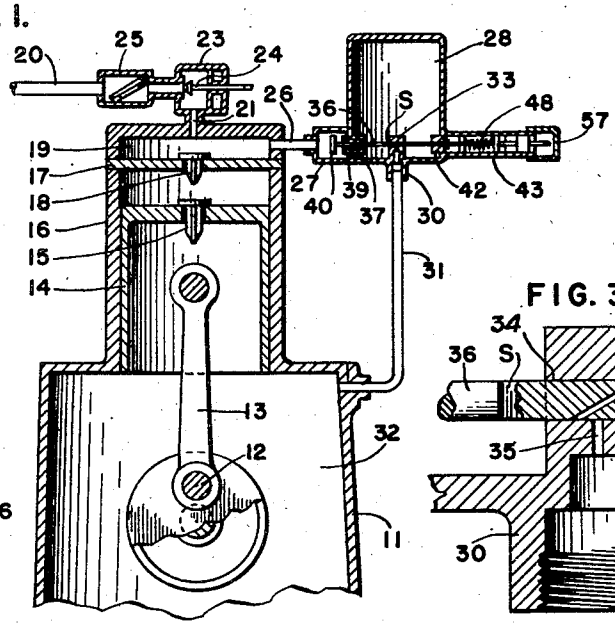

FIG. 3.

FIG. 5.

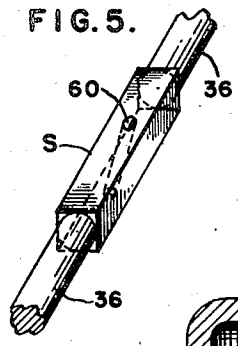

FIG. 4.

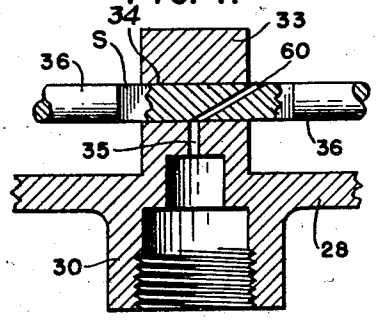

FIG. 2.

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PRESSURE UNLOADER FOR COMPRESSORS

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7 Claims. (Cl. 230—21)

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This invention relates to unloaders for gas compressors and particularly to mechanism of the character used in mechanical refrigeration apparatus that is operated by an electrical motor. The purpose of this invention is to eliminate the necessity for the motor to have a high starting torque; in other words, to reduce the starting load on the motor so as to be negligible. In a majority of buildings where mechanical refrigeration units are made use of, the starting current used by electrical motors that provide the motive power for such units, causes a momentary voltage drop. In many cases where a sub-normal voltage condition exists, the motor cannot develop the necessary output to overcome the initial resistance offered by the compressor load with the result that the motor does not turn over. This usually results in blown fuses or possibly injury to the motor. By the use of this invention, which is embodied in a pressure unloading device for the compressor, starting resistance is removed or dissipated so that the motor can easily handle the reduced starting load. This, in turn, effects a substantial saving in electric current bills.

An object of this invention is to provide means for reducing pressure induced resistance in the head or discharge side of the motor-driven compressor of the refrigeration unit by means of a sensitive regulating device that may be accurately adjusted to act so that when the motor comes to rest, pressure in the head of the compressor or on the discharge side thereof, will be lowered to a negligible point. This is accomplished by utilizing the normal slight drop in pressure in the head of the compressor that takes place when the compressor stops. It is this normal drop in pressure when the compressor (and its driving motor) stops, that is the factor which operates the pressure unloader of this invention.

Another feature of this invention is to provide the pressure unloader for the compressor with a pressure-responsive valve that will close positively when the compressor is operating, so that during that time the unloader is inoperative, but meanwhile will permit the pressure existing within the unloader to be equalized or in equilibrium with the suction- or inlet-side of the compressor. A further feature of the invention resides in the specific means for controlling the unloader to operate precisely when predetermined conditions are encountered.

In a refrigeration unit that is motor-driven, the motor drives a compressor which compresses the refrigerant gas of the refrigeration unit. The

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compressed and condensed gas liquefies and circulates through refrigerating coils, wherein it expands and vaporizes, thus absorbing heat from the space to be refrigerated. The heat-bearing expanded gas is conducted back to the compressor, subsequently compressed, cooled, and condensed, and thus caused to give up its entrained heat. Becoming a liquid, it is then ready for recirculation through the refrigerating coils. This continues until the temperature within the refrigerator has been lowered to a pre-determined degree and a thermostat or other controlling device operates to stop the motor and in turn, the compressor that it drives. When the temperature in the refrigerator rises above the pre-determined degree, the thermostat or other controlling device starts the motor but it is at this point that when the motor attempts to re-start, it encounters the substantial resistance offered by the pressure residual in the discharge side of the compressor which places on the motor a significant starting torque that causes an abnormal or peak quantity of current consumption by the motor.

This invention proposes to smooth out this peak of current consumption by reducing the starting load on the motor through the medium of reducing the pressure residual on the discharge side of the compressor. In other words, when the motor stops, the pressure on the discharge side of the compressor is automatically relieved by the unloader of this invention, so that when the motor is re-started, it operates freely because only the piston of the compressor has to be moved initially since there is no initial pressure resistance encountered by that piston. As soon as the piston of the compressor gets into operation, the unloader automatically functions to permit the piston to begin compressing refrigerant gas, but not until the motor has gained enough momentum to carry it along without encountering excessive or peak torque. More particularly, when the compressor stops, some of its pressure is permitted to enter the unloader so that there is a reduced pressure equilibrium between the discharge side of the compressor and the unloader. After the motor starts up, the valve connecting the discharge side of the compressor and the unloader is closed, and the resulting slightly super-pressure in the unloader is returned to the inlet or suction side of the compressor, whereupon the pressure in the unloader returns to normal, namely, suction or operating pressure. Thus the pressure conditions within the unloader are characterized by three phases;

(1) when the motor and compressor are operating, pressure in the unloader is low and equal to the suction or operating pressure; (2) when the motor and compressor stop, pressure in the unloader is high because of the influx thereinto of the high pressure from the discharge side of the compressor; and (3) when the motor and compressor start up, pressure in the unloader drops as its high pressure is fed to the inlet side of the compressor until pressure in the compressor gradually returns to normal suction or operating pressure. The transition from each one of these phases to the other, in a cyclic manner, is automatically controlled. Other objects and features of advantage will appear as this invention proceeds.

The best embodiment of this invention now known to me, has been chosen for illustration in the accompanying drawings, but it is to be understood that the embodiment is shown solely in an illustrative sense, and not a limiting one because obviously changes can be made in arrangement of the parts and in details of construction, without departing from the ambit of the appended claims.

In the accompanying drawings, Figure 1 is a vertical sectional view taken through the piston station of the compressor of a refrigeration assembly and showing associated piping and the unloader of this invention. Fig. 2 is a vertical sectional view taken through the unloader of this invention. Fig. 3 is fragmentary detail of the sleeve **33** with the rod **36** in valve closing position. Fig. 4 is similar to Fig. 3 except that the valve is shown open. Fig. 5 is an isometric fragmentary view of the valve rod **36** and its squared portion S.

Referring now to the drawings, the reference numeral **11** indicates the casing of the compressor, **12** the motor-driven crankshaft, **13** the connecting rod, **14** the compressing reciprocating piston valved at **15** as usual, **16** the cylinder in which piston **14** operates, and **17** the cylinder head valved as at **18**, **19** indicates the high pressure gas-receiving chamber on the discharge side or end of the compressor **11** for receiving the compressed refrigerant gas. The compressed gas is conducted through a conduit or piping assembly or line **20** to the place where refrigeration is to be effected. This conduit or line is connected at **21** with the chamber **19** on the discharge side or end of the compressor, and has in the line a discharge service valve casing **23** of the general type indicated, with a usual reciprocable manual shut-off valve **24** therein within the discharge service valve casing **23**. This discharge service valve has nothing to do with the function or successful operation of the pressure unloader of this invention. All reciprocating compressors (with a few exceptions) are equipped with discharge service valves for the purpose of isolating the compressor from the rest of the system when the occasion requires; such as repairs to the compressor, testing, etc. **25** indicates a check valve in the line **20** disposed beyond or on the downstream side of the service valve **23**. **26** indicates a conduit leading from the high pressure chamber **19** on the discharge side of the compressor that leads to a pressure receiving fitting **27** on the unloader casing **28**. The casing **28** is provided with a fitting **30** on the bottom thereof connected with a conduit or line **31** leading to the low pressure or suction side **32** of the compressor **11**. Aligned with the fitting **30** and upstanding within the casing **28**, is a sleeve-like protuberance or member **33** having a squared

bore **34** transversely thereof, which bore is connected by a small escape duct **35** communicating with the interior of the fitting **30** and its conduit **31** to the lower pressure or suction side **32** of the compressor.

Slidably or reciprocably mounted in the bore **34** of the sleeve member **33**, is a horizontally disposed rod or valve stem **36** that has a variety of functions. Rod **36** has a squared body portion S for non-rotatably sliding in or through the squared bore **34**. The rod extends through a boss **37** in the wall of the unloader casing **28**, which boss has a series of perforations or ports **38** extending therethrough and arranged generally in a circle around the bore **39** in the boss **37**. On the outside of the boss **37** but within the fitting **27** is an upstanding flange or valve seat **39'**, against which seats and unseats a valve disc **40** that is carried by the reciprocable rod **36**. The other end of the rod **36** passes through the bore **41** of another boss **42** on the other side wall of the unloader casing **28** and extends into an elongated fitting **43** on the casing. **45** indicates a limit stop or washer for controlling or limiting the extent of movement of the rod to the left in Fig. 2.

The rounded end **46** of the rod **36** has bearing against it a cup-shaped, flanged spring seat member **47** against which presses a coiled tension spring **48**. The spring **48** also presses against another flanged cup-shaped seat member **49** that is held in position by the rounded end **51** of an adjusting screw **52** that screws through a bushing **53**, packing **54**, packing gland **55**, and packing nut **56**. The adjusting screw **52** extends beyond the elongated fitting **43** to provide for its ready adjustment, and this extension is covered, (when the screw is not being adjusted) by a screw cap **57**. **60** indicates a slantingly disposed passage extending more or less transversely through rotation-preventing squared body S of the rod **36** so that it forms a valve opening and closing device carried by the rod **36** (and held aligned by the squared portion S) for opening the small duct **35** into the interior of the unloader casing **28** when the rod **36** is in its extreme position to the right in Fig. 2, whereas the small duct **35** is closed when the rod is in its extreme left position in Fig. 2. In other words, when the valve disc **40** is off its seat **39'** and thus open, the valve passage **60** of the rod **36** is so positioned with respect to the duct **35** that the latter is closed (see also Fig. 3). Conversely, when the rod **36** is to the right and the valve passage **60** opens the duct **35** (see also Fig. 4), the valve disc **40** is seated on its seat **39'** and closed. Thus, when high pressure from the conduit **26** (Fig. 1) flows into the unloader casing because the valve disc **40** is unseated, such pressure cannot escape from the unloader casing because the valve passage **60** is closed and the escape duct **35** is sealed off. On the other hand, when the valve disc **40** is seated and closed, pressure from within the unloader casing **28** can escape because valve passage **60** communicates with the escape duct **35**.

The operation of the apparatus herein shown and described, is as follows: so long as the motor-driven compressing piston **14** is operating, refrigerant gas is compressed and flows forwardly through compression or high-pressure chamber **19**, through conduit **21**, service valve **23**, check valve **25** and line **20**. Upon stoppage of the motor-driven piston **14**, pressure in the high-pressure chamber **19** falls just sufficiently so that the spring **48** is no longer overcome but can function

to slide rod 36 to the left and press open the valve disc 40 from its seat 39' while sealing escape duct 35, thus allowing pressure from the chamber 19 to enter the interior of the unloader casing 28 through the ports 38, thus equalizing the pressure in the chamber 19 and the unloader, with the result that the pressure in both becomes significantly reduced due to the operation of Boyle's law. Therefore, if and when the motor-driven piston 14 is re-started, it encounters little or no resistance pressure in the chamber 19 and so has practically no starting torque. As soon as the piston begins to compress and pressure in chamber 19 rises to a degree sufficient to overcome spring 48, the valve disc 40 is seated and rod 36 moved to the right to unseal escape duct 35 by connecting it, through valve passage 60 in the rod, with the interior of the unloader casing 28. This permits the pressure in the casing 28 to unload itself by passing through fitting 30 and conduit 31 back to the low pressure or suction side 32 of the compressor. This cycle of operation is then repeated upon stoppage of the motor-driven piston. The exact time of operation of the reciprocable rod 36 to open its valve disc 40 and to close it, is controlled by the adjustment of the tension of spring 48.

When the compressor is operating, the head pressure, or pressure on the discharge side of the compressor (chamber 19) is substantially greater than when the compressor is at rest. This is due to a number of factors, the main one being: The pressure of a gas in a given space is determined by its temperature (Charles' law). It is obvious that when the heat-laden gas coming from the evaporator is compressed to a fraction of its former volume, the temperature will rise considerably, and consequently, the pressure also.

When the compressor comes to a rest, the temperature of the gas on the discharge side (chamber 19) will gradually lower to that of the room temperature. Heat will flow from a warmer to a colder mass until a balance in temperature is reached. Therefore, the pressure in chamber 19 will drop proportionately.

At a predetermined pressure (between the operating pressure and the pressure of the gas when the compressor is at rest and the gas cooled off) spring 48 overcomes the pressure on valve 40 and pushes valve 40 off its seat 39'. This allows the gas in chamber 19 to enter chamber 28 of the unloader, thus reducing the pressure in chamber 19 to a negligible degree.

I claim:

1. For use with a motor-driven gas condensing compressor having a suction side and a discharge side, a pressure unloading device characterized by a pressure receiving casing, a first conduit between the casing and the discharge side of the compressor, a second conduit between the casing and the suction side of the compressor, a valve controlling the first conduit, a valve controlling the second conduit, said valves being unitarily associated with a valve operating rod and so correlated than when one valve is open the other is closed, and spring means for moving the rod and its valves against pressure in the first conduit only when pressure in that conduit is less than the power of the spring means.

2. Apparatus according to claim 1, wherein one of said valves is a disc valve carried at one end of the rod.

3. Apparatus according to claim 1, wherein one of said valves is a sleeve valve and includes a duct slantingly disposed through the rod.

4. Apparatus according to claim 3 with means for preventing rotation of the reciprocable rod.

5. Apparatus according to claim 1, wherein one of said conduits terminates in a construction encircling the rod and the rod has as the valve for the latter conduit a duct slantingly disposed through the rod.

6. Apparatus according to claim 1, wherein the spring means has adjusting mechanism to apply thereto a predetermined pressure.

7. Apparatus according to claim 1, wherein the rod carries a disc valve at one end thereof and a sleeve valve in its middle section including a slantingly disposed duct through the rod and a sleeve through which the middle section of the rod is reciprocably mounted.

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