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Garland

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[54] **CONDENSER PRESSURE CONTROL APPARATUS**

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[52] **U.S. Cl.** **62/85,** 62/149, 62/174, 62/196

[51] **Int. Cl.**.....**F25b 41/00**

[58] **Field of Search**.....62/195, 196, 149, 62/174, 85, 475

[56] **References Cited**

UNITED STATES PATENTS

2,951,350	9/1960	Etherington	62/149
3,499,298	3/1970	Norton	62/174

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[57] **ABSTRACT**

Non-condensable gas in a storage chamber is introduced into a refrigeration system to maintain condenser pressure above a desired minimum, and is permitted to escape from the refrigeration system back to the storage chamber to relieve high condenser pressures. Pressure responsive switches monitor the high side of the refrigeration system and control the flow of the non-condensable gas into and out of the refrigeration system.

6 Claims, 2 Drawing Figures

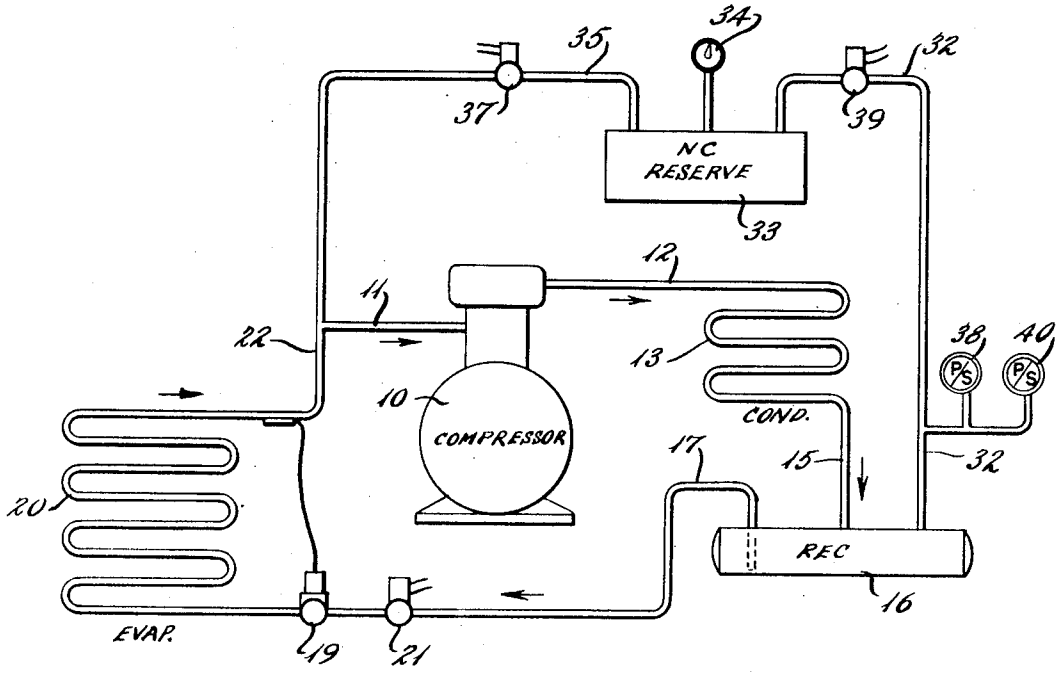
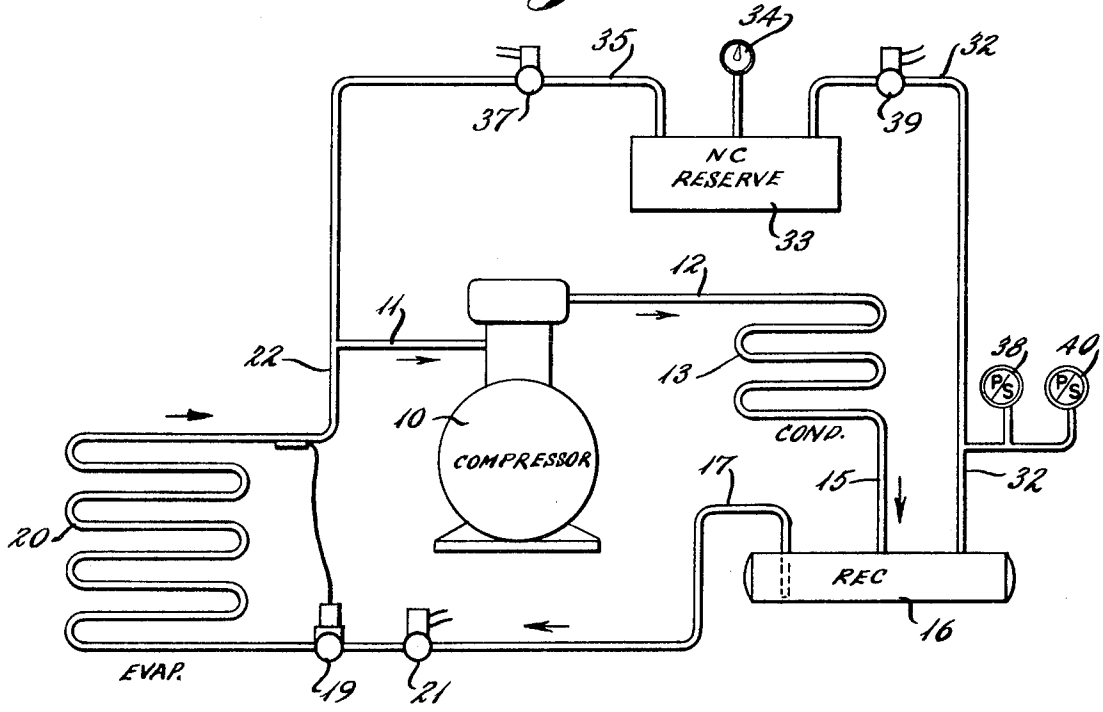


Fig. 1



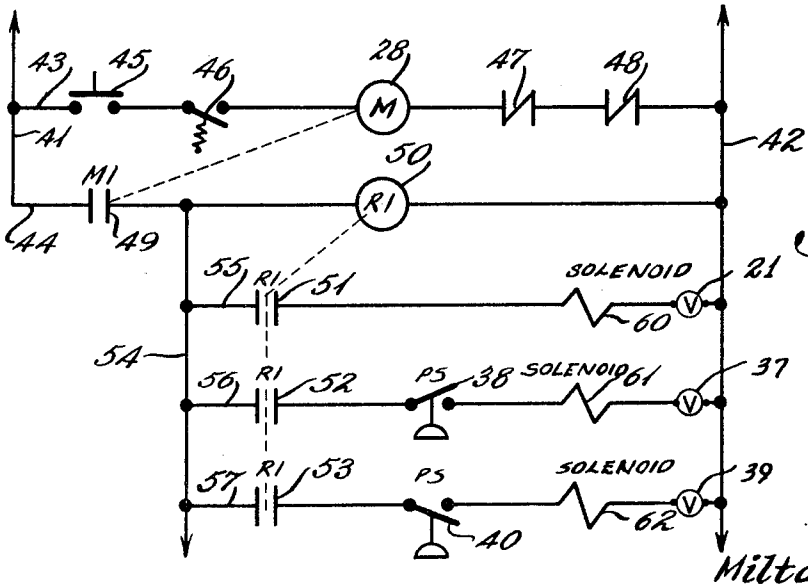


Fig. 2

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CONDENSER PRESSURE CONTROL APPARATUS

BACKGROUND OF THE INVENTION

1. Field of the Invention

This application relates to control of pressures within the high side of a refrigeration system. Specifically, it relates to apparatus for introducing a non-condensable gas into the high side of a refrigeration system and permitting the escape of the same from the system in order to maintain condenser pressure at a desired level.

2. Description of the Prior Art

Various methods for controlling pressure within the high side of refrigeration units have been devised to increase the efficient functioning of such units. In the U.S. Pat. No. 3,499,298 to Norton, a non-condensable gas is stored under pressure in a chamber which is connected to the high side of a refrigeration apparatus by a fluid line. During normal operation, the fluid line is continuously open. Thus, no automatic means is provided to relieve condenser pressure by isolating the non-condensable gas from the refrigeration unit.

SUMMARY OF THE INVENTION

The present invention is an apparatus for controlling condenser pressure in a compression refrigeration unit. A storage tank for non-condensable gas is provided together with fluid lines which connect the storage tank to the refrigeration unit. Pressure responsive switches monitor condenser pressure in the refrigeration unit and operate control valves which regulate gas flow through the fluid lines. When condenser pressure falls to a desired minimum, a pressure switch causes a first valve to open and permit introduction of non-condensable gas into the high side of the refrigeration unit thereby raising the condenser pressure. This valve is closed by the pressure switch when condenser pressure rises to a predetermined level.

When condenser pressure rises to a desired maximum, a pressure switch causes another pressure valve to open and permit the flow of non-condensable gas from the high side of the refrigeration unit back into the storage tank thereby relieving condenser pressure. This valve is closed when condenser pressure falls to a predetermined level which indicates that substantially all of the non-condensable gas but substantially none of the refrigerant vapor has passed out of the refrigeration unit. Non-condensable gas may not again re-enter the refrigeration unit until condenser pressure drops to the desired minimum at which the first valve is caused to open. When the non-condensable gas is thus isolated, it cannot operate to boost condenser pressures.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic showing the invention.

FIG. 2 is an electrical diagram.

DESCRIPTION OF THE PREFERRED EMBODIMENT

A refrigeration system as shown in FIG. 1 has a compressor **10** powered by an electric motor **28.** The compressor draws refrigerant vapor through suction line **11** and discharges it into line **12** on the high side of the system. The vapor is liquefied in condenser **13** and passes through line **15** to receiver **16.** From the bottom of the receiver **16** the flow is through line **17** and expansion valve **19** into the low side of the system including evaporator **20,** evaporator discharge line **22,** and suction line **11.** When the compressor is shut off, a solenoid controlled valve **21** in fluid line **17** is closed in order to keep the evaporator **20** from becoming flooded.

In accordance with the invention, a condenser pressure maintaining device is incorporated in the refrigeration system described above. The pressure maintaining device includes a reserve tank **33** which is initially charged with a stable non-condensable gas, such as dry nitrogen. The pressure of the non-condensable gas in the reserve tank **33** is less than the desired maximum condenser pressure, for example, less than 200 PSIG but greater than the rated evaporator pressure of for example 50 PSIG in a refrigeration system using freon **22.** The volume of the reserve tank **33** is large enough so that when the non-condensable gas is introduced into the refrigeration system, the reserve tank pressure does not drop to 50 PSIG. Accordingly, the reserve tank volume may, for example, equal the sum of the volumes of the condenser **13** and receiver **16** with a non-condensable gas pressure of 150 PSIG.

A fluid line **35** connects the top of the reserve tank to the compressor suction line **11.** Gas flow through line **35** is controlled by a solenoid operated valve **37** in line **35.** A second fluid line **32** connects the top of reserve tank **33** to the top of the receiver **16.** A solenoid operated valve **39** controls flow through line **32.** An adjustable pressure operated switch **38** is provided to monitor condenser pressure and accordingly is suitably connected in line **32.** This switch controls the operation of solenoid valve **37.** Similarly a second adjustable pressure switch **40** is provided to monitor the pressure in line **32** and to operate solenoid valve **39.** A pressure gauge **34** is provided to monitor the reserve tank **33.** Thus the pressure maintaining device, according to the invention, provides a reserve compartment for non-condensable gas under pressure and such gas may pass out of the reserve tank through line **35** to the suction line **11** or into the reserve tank through a receiver attached line **32.**

FIG. **2** shows the electrical hookup for the refrigeration system and pressure maintaining device discussed above. Lines **41** and **42** are power lines which are connected by a pair of lines **43** and **44.** In line **43** are located in series a master control switch **45,** a thermostat switch **46,** a motor **28,** and motor overload breakers **47** and **48.** Along the line **44** are arranged in series a pair of contacts **49** that close when the motor begins operation, and a relay coil **50.** The relay coil **50** operates associated relay contacts **51, 52** and **53.**

A line **54** is interposed in line **44** between contacts **49** and relay coil **50** and has three branch lines **55, 56** and **57** connected to power line **42.** Solenoid **60** for operating valve **21** is located in branch line **55** in series with relay contact **51.** Solenoid **61** for operating valve **37** is located in branch line **56** in series with relay contact **52** and pressure switch **38.** Solenoid **62** for operating valve **39** is located on branch line **57** in series with relay contact **53** and pressure switch **40.**

The refrigeration system is started by closing master control switch **45** so that current may pass between lines **41** and **42** through thermostat switch **46,** normally closed at high temperatures, through compressor motor **28** activating the same, and through normally closed motor overload breakers **47** and **48.** When motor **28** starts operation, contacts **49** close thus activating relay coil **50** which closes associated relay contacts **51, 52** and **53.** Current flows through solenoid **60**

causing the valve 21 to open and also flows through to pressure activated switches 38 and 40 in series with solenoids 61 and 62 which operate valves 37 and 39, respectively.

During a certain period of the year, such as winter, ambient air temperatures surrounding the condenser 13 may be so low as to cause pressure within the high side of the refrigeration unit, i.e., condenser pressure, to fall below a desired minimum, as for example, below 150 PSIG. Below 150 PSIG, an insufficient pressure differential across expansion valve 19 exists and tends to deprive the evaporator of refrigerant.

At a preselected pressure of, say, 150 PSIG, pressure switch 38 is set to close causing the solenoid valve 37 to open so that the non-condensable gas in reserve chamber 33 is permitted to pass into suction line 11. The compressor 10 pumps the non-condensable gas into the high side together with refrigerant vapor from discharge line 22. In the high side the non-condensable gas displaces refrigerant vapors thereby raising the condenser pressure. As the refrigeration system continues to operate, the non-condensable gas moves through the condenser and accumulates in receiver 16 having a possible exit only through closed line 32 which leads back into the reserve tank 33.

After pressure within the high side of the refrigeration unit rises to a predetermined level, for example, about 160 PSIG, the pressure switch 38 is set to open and cause the solenoid valve 37 to close, thus stopping the flow of non-condensable gas from the reserve tank 33 into the suction line 11. Thus the partial pressure of the non-condensable gas introduced into the high side raises the condenser pressure by 10 pounds from 150 PSIG to 160 PSIG.

During summer, for example, high temperature ambient air conditions may cause condenser pressure to increase to 180 PSIG or higher. At a preselected pressure of, say, 180 PSIG, the pressure switch 40 is set to close causing solenoid valve 39 to open thereby relieving condenser pressure and allowing non-condensable gas trapped in the top of the receiver 16 to pass through line 32 and into the reserve tank 33. Solenoid valve 39 remains open continuously when ambient temperature conditions maintain a condenser pressure of 180 PSIG or higher thereby relieving condenser pressure into the reserve tank 33.

When solenoid valve 39 is open for an extended time, the pressures within the reserve tank 33 and receiver 16 tend to equalize. However, if substantially all of the non-condensable gas in the receiver has passed into the reserve tank but the reserve tank pressure is insufficient to balance the receiver pressure, refrigerant vapor may pass through line 32 and into the reserve tank until generally equal pressures are achieved. As condenser pressure decreases, refrigerant vapor within the reserve tank passes back into the receiver 16 since vapor pressure within the receiver 16 is lower than vapor pressure in the reserve tank 33. The non-condensable gas, however, tends to remain in the reserve tank 33.

After pressure within the high side of the refrigeration system falls a predetermined amount, for example, in this embodiment of the invention approximately 10 pounds below 180 PSIG to 170 PSIG, pressure switch 40 is set to open thereby causing solenoid valve 39 to close and shut off the flow of gas from the receiver 16 into the reserve tank 33 through line 32. Note that the ten pound decrease in condenser pressure relieves the partial pressure of the non-condensable gas introduced into the refrigeration system during cold weather operation. Thus the refrigeration system is purged of non-condensable gas with substantially no loss of refrigerant vapor.

As described above, the reserve tank 33 is closed off from the refrigeration unit after the condenser pressure drops from 180 PSIG to 170 PSIG. This enables the high side of the refrigeration unit to operate at normal pressures without the pressure boosting effect of the non-condensable gas until the condenser pressure again drops to 150 PSIG at which solenoid valve 37 is set to open. Compressor power requirements and wear on the various parts of the refrigeration system are decreased accordingly.

I claim:

1. In a refrigeration system having a high pressure side and a low pressure side, means for raising the pressure of refrigerant from the low pressure side to the high pressure side, and means for condensing and receiving condensed refrigerant in the high pressure side, the improvement comprising, means for maintaining the level of pressure in the condensing and receiving means within a predetermined range, said pressure level maintaining means comprising storage vessel means having a first connection to the low pressure side adjacent to the pressure raising means and a second connection to the receiving means, a gas which is non-condensable in the system within the storage vessel means, and first and second valve means for selectively opening and closing said first and second connections to permit selective release of the non-condensable gas from the vessel means into the pressure raising means for discharge into the condensing and receiving means when the pressure level therein is relatively low in order to raise it and for release of said gas from the receiving means back into the vessel means when the pressure level in the condensing and receiving means is relatively high in order to lower it.

2. The invention as defined in claim 1 in which the volume of the storage vessel means is sufficiently large to maintain the pressure of said non-condensable gas in said storage vessel means below a minimum pressure required for proper refrigerant flow from the high pressure side to the low pressure side, and above a rated low side pressure when the first and second valve means are selectively opened and closed.

3. The invention as defined in claim 1, and means responsive to the pressure in said receiving means for opening and closing said first and second valve means.

4. The invention as defined in claim 1, first and second means responsive to the pressure in said receiving means, means connecting said first pressure responsive means to said first valve means and means connecting said second pressure responsive means to said second valve means, whereby said first and second valve means are automatically operated in response to the pressure in said receiving means.

5. A compression refrigeration system having a high side and a low side,

a storage chamber for non-condensable gas, first and second fluid lines connecting said refrigeration system to said storage chamber,

first means responsive to a predetermined low pressure in said high side for opening said first fluid line and permitting entry of said non-condensable gas

into said high side to raise pressure in said high side above such predetermined low pressure, said first pressure responsive means operative to close said first fluid line at a selected pressure in said high side above said predetermined low pressure,

second means responsive to a predetermined upper pressure in said high side for opening said second fluid line to relieve pressure and permit escape of non-condensable gas from said high said when said high side pressure is above said selected pressure, said second pressure responsive means operative to close said second fluid line at a pressure in said high side below said pressure at which said second fluid line is opened but above said selected pressure.

6. The method of controlling the range of pressure level in the high side of a refrigeration system having a compressor and a low side, comprising providing an auxiliary housing for a non-condensable gas, continuously sensing the level of pressure in the high side, withdrawing non-condensable gas from the auxiliary housing into the low side, through the compressor and into the high side when the pressure level in the high side is below a predetermined level only to the extent necessary to raise the pressure to a predetermined operating level, and withdrawing the non-condensable gas from the high side directly into the auxiliary housing in response to a level of pressure in the high side which is above a predetermined level.

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