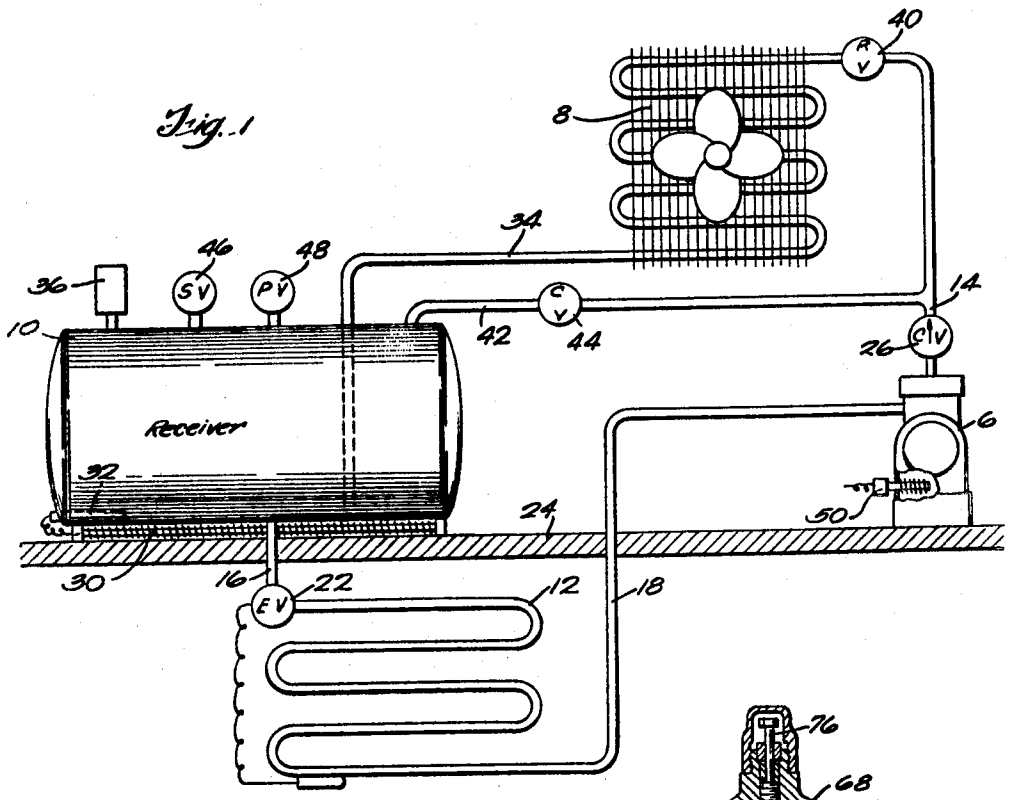
Nov. 18, 1969 E. J. KOCHER ET AL 3,478,533

CONTROL FOR AIR COOLED CONDENSERS

Filed March 8, 1968

Fig. 1



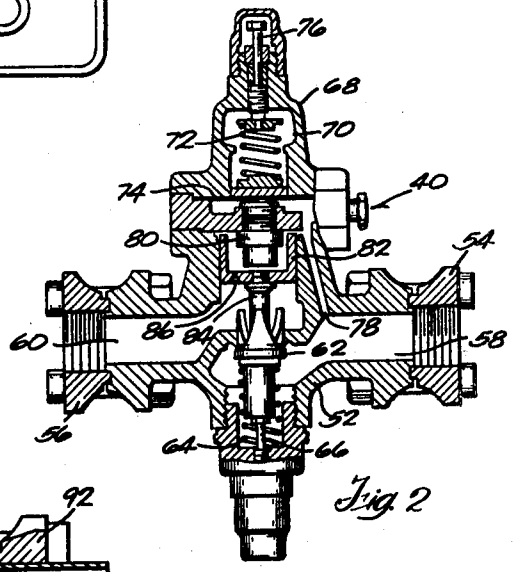
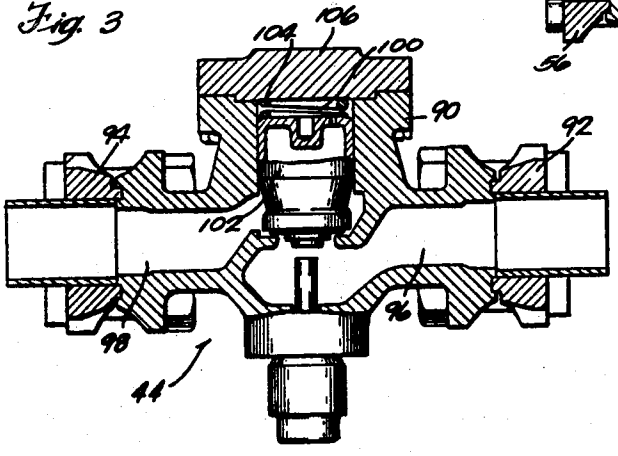


Fig. 2

Fig. 3



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CONTROL FOR AIR COOLED CONDENSERS

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U.S. Cl. 62—196 1 Claim

ABSTRACT OF THE DISCLOSURE

An automatically operable all-weather control for refrigeration systems embodying an outside condenser which is exposed to changes in atmospheric temperature and especially winter conditions.

BACKGROUND

In the refrigeration and air conditioning field, it has become common practice to use air-cooled condensing equipment instead of water-cooled systems. While these air-cooled systems have become exceedingly popular, they do present a problem with respect to the control of head pressure during low temperature ambient air operation.

For example, head pressure of air-cooled units is directly responsive to the temperature of ambient air, and while head pressure is high in warm weather, it is very low in cold weather. Thus, as the ambient air temperature drops across the condenser, the pressure drops in the entire high side of the system, and the expansion valve feeds less and less refrigerant to the evaporator until finally no refrigeration takes place due to the lack of pressure differential across the expansion valve.

In efforts to control this problem, several methods have heretofore been adopted. One of the more widely used is a modulated bypass system which employs a control valve for holding back the discharge pressure causing it to flow through a pressure-actuated modulating valve to give instant pressure in the receiver. As the discharge pressure builds up to the setting of the control valve, excess liquid travels to the condenser and builds up pressure in the condenser to keep the system running. In another winterizing arrangement, a constant pressure regulating valve is installed in the condenser return, and as the ambient air temperature drops and the discharge temperature falls below the setting of the valve, it closes to thereby restrict refrigerant flow from the condenser. Another system employs a pressure regulating valve between the compressor and condenser, a reverse acting regulating valve in the bypass between the compressor discharge and the condenser return, and a check valve between the condenser and the bypass for preventing pressure from returning to the condenser up the return line.

Other winterizing systems use an electrically heated receiver mounted above the condenser so that there is always warm liquid present of sufficient pressure to feed the evaporator, the valving and piping arrangement being such that hot gas is pushed into the filled condenser forcing cool liquid into the receiver under pressure for mixing with the heated liquid which is then fed to the evaporator.

All of the systems hereinabove described utilize the principle of flooding the condenser to limit its efficiency for low ambient temperature operation. However, the use of modulating arrangements in an effort to control head pressure during operation fails to give proper control when the unit is shut down, resulting in various start-up difficulties due to crankcase foaming, short cycling and the like. Also, experience has shown rather prevalent

valve leakage as well as undesirable equipment requirements. Furthermore, with an elevated receiver, condenser capacities are oftentimes considerably less than the rated capacity due to the backup of liquid, and generally speaking, the prior systems have required relatively complicated and unreliable equipment.

SUMMARY

An object of the present invention is to provide an improved refrigeration system employing an air-cooled condenser and adapted for efficient year-around operation in all types of weather and which obviates the aforesaid disadvantages and objections.

Another object of this invention is to provide an improved refrigeration or air conditioning system embodying an air-cooled or evaporative condenser and in which a heated receiver is mounted below the condenser to permit free drainage of the condenser during summer months when full condenser capacity is essential.

A further object of the invention is to provide an improved refrigeration system which utilizes an air-cooled condenser and which has provision for the maintenance of high side pressure during shutdown, whereby liquid is forced from the receiver up into the condenser to fill the same.

Still another object of the present invention is to provide a refrigeration or air conditioning system employing an air-cooled condenser with improved automatically operable means for maintaining adequate receiver pressure at all times, regardless of the ambient temperature, to feed the evaporators while restricting the flow of liquid from the condenser until the pressure in the condenser reaches that of the receiver, thus providing for normal operating conditions.

These and other objects and advantages of the invention will become apparent from the following detailed description.

THE DRAWINGS

A clear conception of the construction and mode of operation of a typical refrigeration system embodying the present invention will be had by referring to the drawing accompanying and forming a part of this specification wherein like reference characters are used to identify the same or similar parts.

FIGURE 1 is a diagrammatic view illustrating a typical refrigeration system having an air-cooled condenser and embodying the present improvements;

FIGURE 2 is an enlarged vertical section through a typical back pressure regulating valve employed in the system; and

FIGURE 3 is a similarly enlarged vertical section through a typical spring loaded check valve as also used in the system.

DETAILED DESCRIPTION

Referring to the drawing, the system illustrated therein comprises, in general, a compressor **6**, an air-cooled condenser **8**, a receiver **10**, and an evaporator or cooling coil **12**. The condenser **8** is connected with the high pressure discharge side of the compressor **6** by a refrigerant supply line **14**, and the cooling coil **12** communicates at its inlet end with the receiver **10** via conduit **16** and at its outlet end with the low pressure inlet side of the compressor via conduit **18**.

The compressor **6** is of any suitable type adapted to receive spent gaseous refrigerant from the cooling coils **12** through the suction line **18** and to compress and deliver the same under high pressure through the supply line **14** to the condenser **8**. A thermostatically controlled expansion valve **22** at the inlet end of the cooling coil or evaporator **12** controls the operation of the compressor **6** according to demand. The condenser **8** is of the air-

cooled or evaporative type located exteriorly of the wall **24** so as to be exposed to the ambient atmosphere, and the capacity of the condenser **8** is therefore variable dependent upon weather conditions. In the embodiment shown, the compressor **6** and receiver **10** are also located outside, but they may be located interiorly if desired. A one-way check valve **26** is interposed in the high pressure discharge line **14** to prevent backup, and the condenser **8** and evaporator **12** may be provided with the usual refrigerant flow control valves, not shown.

In accordance with the present invention, the receiver **10** is mounted below the condenser **8**, and the condenser is accordingly free-draining during the summer months when full condenser capacity is a requirement. Also, the receiver **10** is heated externally by a suitable heater **30** which may, in practice, be in the nature of a heating blanket controlled by a thermostat **32** extending into the receiver. The thermostat **32** is adjustable and can be set for the proper temperature to maintain sufficient high side pressure during shutdown to force the liquid from the receiver **10** up into the condenser **8** by way of a conduit **34** and thereby fill the condenser. Mounted on the receiver **10** is a suitable float-actuated liquid level gauge **36** for indicating the level of refrigerant in the receiver, and initially the receiver should be charged to approximately one-half full with a sufficient amount of liquid being maintained therein at all times to submerge the bottom of the line **34** in order to permit liquid to be forced into the condenser **8** while also providing an adequate liquid supply in the receiver under high pressure conditions for quick response on start-up.

Interposed in the high pressure line between the compressor **6** and the condenser **8** beyond the check valve **26** is back pressure regulating valve **40** which may be of any suitable commercially available type such as that shown, for example, in FIGURE 2. The valve **40** is adjustable, and when the system starts up, this main regulating valve **40** remains closed until the pressure reaches the set pressure of the valve whereupon the valve will open and permit high pressure gas to be forced into the condenser. The receiver **10** is also placed in communication with the high pressure line **14** between the check valve **26** and pressure regulating valve **40** by means of a conduit **42**, and a spring loaded check valve **44** is interposed in this conduit. The spring loaded check valve **44** may likewise be of any suitable type such as that shown in detail in FIGURE 3 which is also commercially available. The receiver **10** may also be provided with a safety valve **46** and a purge valve **48** in accordance with customary practice.

Referring to FIGURE 2, the pressure regulating valve shown therein by way of example comprises a valve body or housing **52** coupled to the line **14** by threaded coupling members **54, 56** and having inlet and discharge ports **58, 60**, respectively, with a valve seat therebetween. The body **52** contains a main valve disc **62** constantly urged toward seated position by a spring **64** and guided in its movement on a stem **66**. A valve bonnet **68** is secured to the body **52** and contains a chamber **70** housing a spring **72** reacting against the top of a diaphragm **74** spanning the lower end of chamber **70**, the compression of the spring being adjustable by a stem **76** threaded in the bonnet **68**. The bottom face of the diaphragm **74**, in turn, is exposed to the inlet pressure port **58** by way of a restricted passage **78**, and the diaphragm **74** is normally seated against a pilot assembly **80** by the action of the spring **72** until there is a sufficient build-up of pressure below the diaphragm to overcome the spring **72**. A power piston **82** is positioned for sliding movement below the pilot assembly **80** and carries a valve actuating stem **84**.

In operation, the back pressure regulator **40** is closed with the valve disc **62** seated as shown until the pressure in line **14** and inlet **58** exceeds preset pressure as determined by the adjustment of the stem **76**. Pressure in the inlet **58** is communicated to the lower side of the diaphragm **74**, and as the pressure rises, the diaphragm exerts force upwardly against the diaphragm spring **72**. When the pressure rises sufficiently above the preset pressure, the diaphragm is lifted from its seat on the pilot **80** permitting pressure from the chamber below the diaphragm to enter behind or on top of the power piston **82**. When the pressure acting on the power piston exceeds the pressure existing in the port **60** by a predetermined amount, the piston **82** is moved downwardly against the action of the spring **64**, thereby gradually unseating the main valve **62** and opening the inlet **58** to the outlet port **60**. Whenever the pressure existing in line **14** and inlet **58** drops below the preset pressure, the diaphragm **74** again moves downwardly to close the pilot seat. Then, as pressure above the piston **82** escapes through a small bleed port **86** to the port **60** on the downstream side of the regulator, the valve closing spring **64** gradually returns the valve disc **62** to closed position thus preventing refrigerant flow through the regulator and consequently causing the pressure in line **14** to remain up to the adjusted setting.

Referring now to FIGURE 3, the spring loaded check valve shown therein by way of illustration comprises generally, a valve body **90** secured in the line **42** as by means of coupling members **92, 94** and provided with inlet and outlet ports **96, 98**, respectively, with a valve seat therebetween. The valve body **90** has a bore **100** opening toward the valve seat, and a piston **102** is contained for sliding movement within this bore. The piston **102** is constantly urged toward the valve seat by a spring **104** confined between the top or back side of the piston and a cap or cover **106** closing the upper end of the bore. The piston valve **102** is accordingly maintained closed by action of the spring **104** which may be selected to exert a predetermined closing pressure, and when the pressure in the inlet **96** is sufficient to overcome the spring action, the valve piston **102** is raised from its seat and flow is permitted through the valve to the discharge port **98**. When the upstream and downstream pressures are equalized, the weight of the piston and action of the spring **104** will force the piston valve **102** against its seat and thereby stop further fluid flow through the valve.

During low temperature conditions, the condenser **8** tends to condense the gas rapidly and thereby reduce the pressure in the condenser to a point below the inlet pressure setting of the control valve **40**. When the pressure in the condenser **8** and the receiver **10** is reduced to a point below the setting of the spring loaded check valve **44**, this check valve will open and force discharge gas directly into the receiver **10**. This maintains adequate receiver pressure at all times sufficient to feed the evaporator or cooling coil **12** and the pressure in the receiver **10** restricts the flow of liquid out of the condenser **8** until the liquid has backed up in the condenser to a point wherein the condenser pressure matches the receiver pressure. There will then be a flow of gas into the condenser **8** and a flow of liquid out of the condenser at a rate sufficient to match the load requirements. Once the main valve **40** has been preset and the thermostat **32** controlling the heater **30** has been preset, the system will function automatically year around regardless of weather conditions. There is positive start-up of the system due to the pressure maintained by the heater **30** during compressor shutdown, and to provide for immediate start-up of the compressor **6** especially with the compressor located outside, it too may be provided with a thermostatically controlled heater **50** in the crankcase.

In actual tests, the control system has proven highly successful and has performed satisfactorily in ambient conditions of —20° F. and lower. While the invention has been illustrated and described as being incorporated in a system having a single evaporating or cooling coil adapted for use either for ordinary refrigeration or air conditioning purposes, it is not intended or desired to

limit the system by reason of such specific disclosure. It is also contemplated that specific descriptive terms used herein shall be given the broadest interpretation consistent with the disclosure and other types of commercially available pressure regulating valves and spring loaded check valves may be used in place of those specifically shown in FIGURES 2 and 3.

Various modes of carrying out the invention are contemplated as being within the scope of the following claims particularly pointing out and distinctly claiming the subject matter which is regarded as the invention.

We claim:

1. In a refrigeration system including a refrigerant compressor for supplying refrigerant under pressure through a supply line to the inlet of an atmospheric temperature responsive condenser, a liquid refrigerant receiver, and an evaporator connected at its inlet end with the receiver below the level of the liquid therein and

connected at its outlet end with the low pressure side of the compressor; a conduit communicating said receiver with the condenser, conduit means including a spring loaded check valve for connecting the receiver with the high pressure refrigerant supply line for pressurizing said receiver to force refrigerant liquid from said receiver into said condenser through said conduit and thermostatic means for heating the receiver to maintain a predetermined temperature therein.

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