June 3, 1958 E. J. KOCHER ET AL 2,836,966

LIQUID REFRIGERANT TRANSFER SYSTEM

Filed July 15, 1955 2 Sheets-Sheet 1

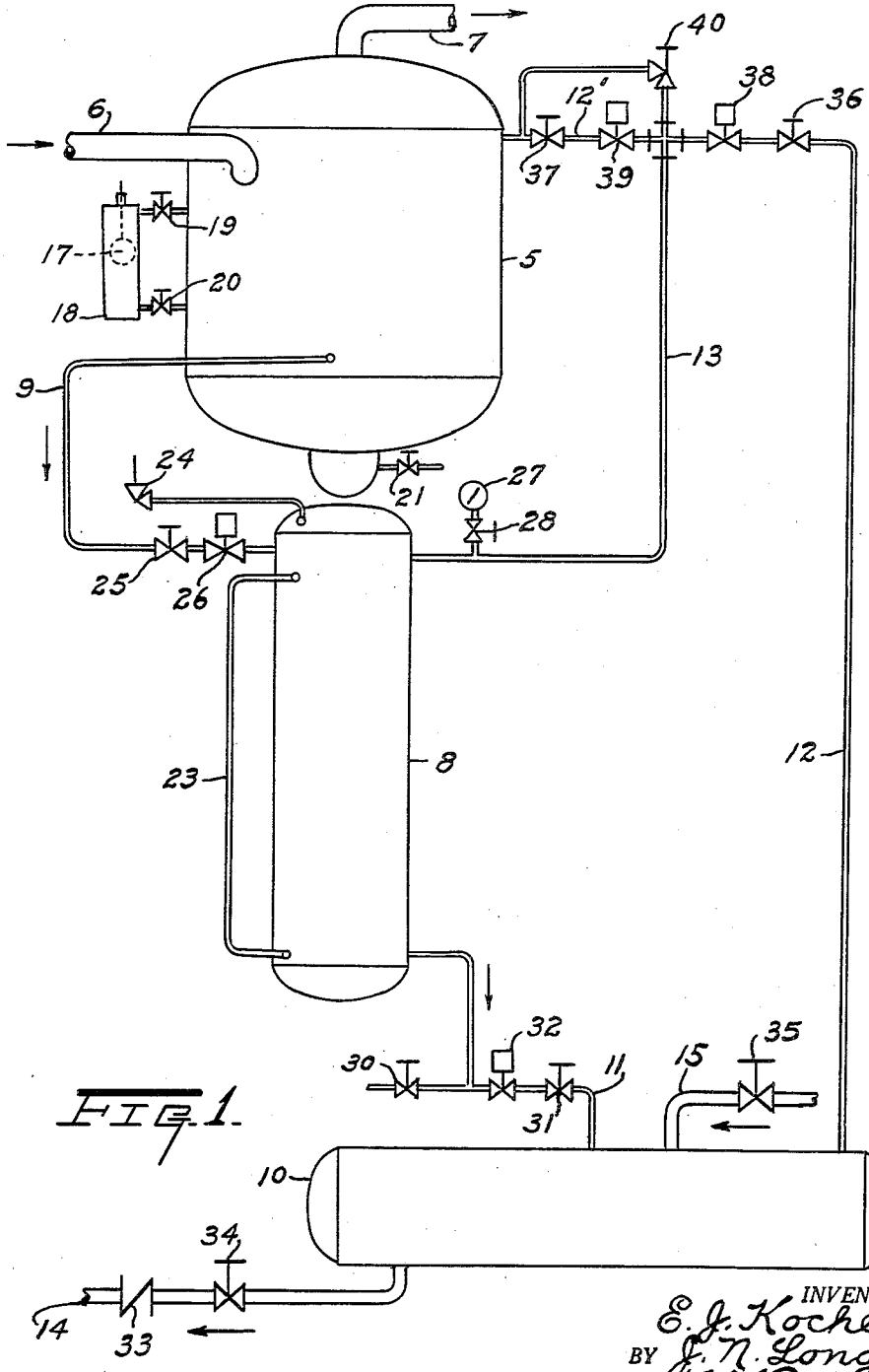


FIG. 1.

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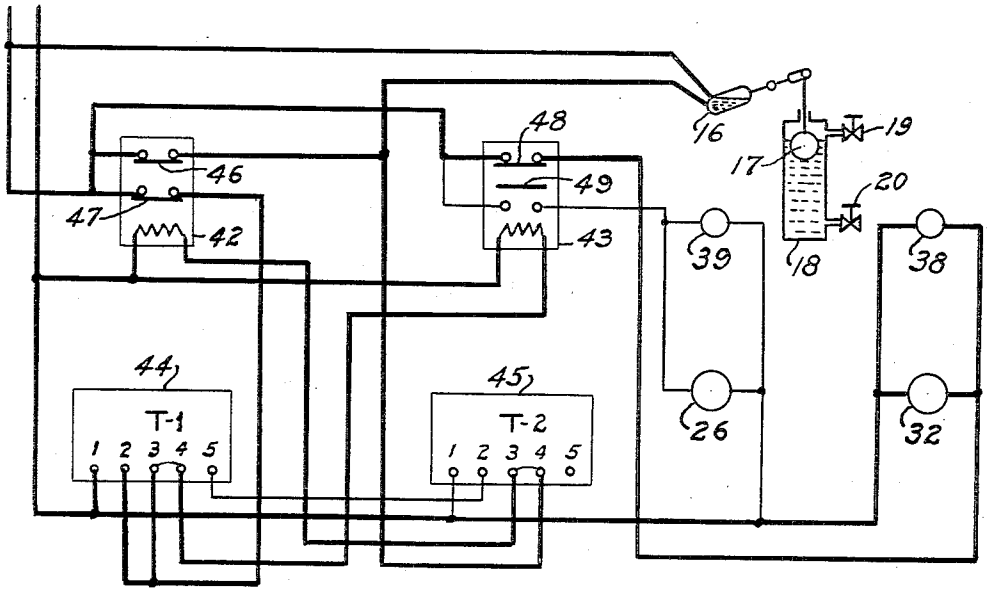


FIG. 2.

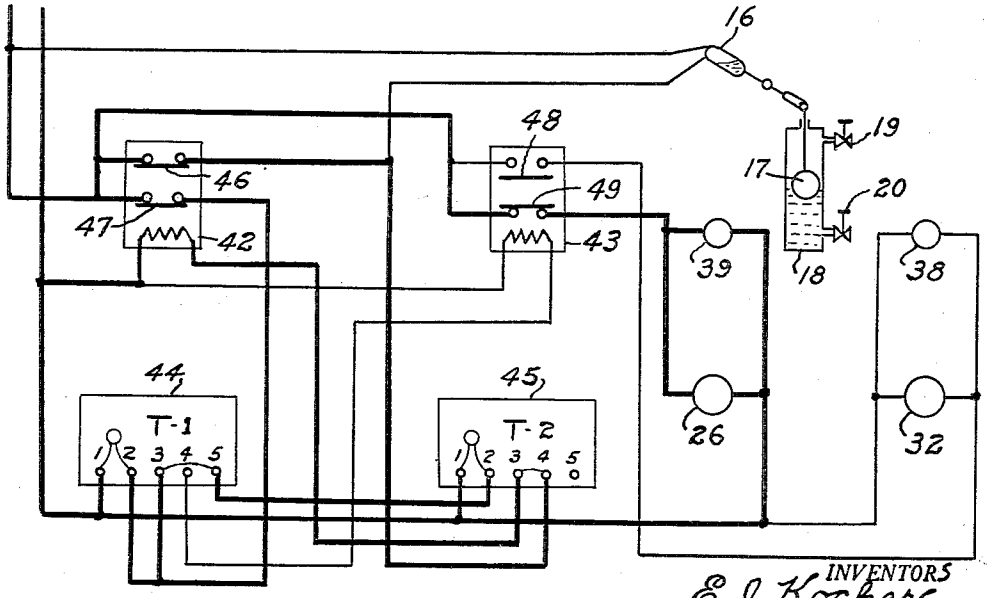


FIG. 3.

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LIQUID REFRIGERANT TRANSFER SYSTEM

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6 Claims. (Cl. 62—3)

The present invention relates in general to improvements in the art of refrigeration, and relates more particularly to improvements in systems adapted to automatically return liquid refrigerant delivered from the low pressure or discharge side of an evaporator or cooling coil to the high pressure side or supply line thereof, while preventing the liquid from entering and damaging the gaseous refrigerant compressor of the refrigerating plant.

The primary object of our invention is to provide an improved liquid refrigerant transfer system which is simple in construction and highly effective in operation.

It has heretofore been proposed to provide various types of systems for automatically separating and returning liquid refrigerant delivered with gaseous refrigerant at the discharge or suction side of the evaporators or cooling coils of refrigeration plants to the high pressure feed line, before such liquid refrigerant has had an opportunity of entering the main compressor with the vapor. In most of these prior systems the mixed liquid and gaseous refrigerant delivered from the cooling units, is deposited within an accumulator from the top of which free vapor is withdrawn directly by the compressor suction line, while the liquid refrigerant collecting at its bottom is periodically returned to the high pressure side of the evaporators with the aid of valves or other transfer mechanism. In some of these prior systems liquid refrigerant delivered by gravity from the accumulator is passed through a transfer drum to the main high pressure receiver of the plant by means of special valves associated directly with the transfer drum and adapted to periodically seal the transfer drum from the accumulator and to connect the drum interior with the high pressure side of the evaporators so as to force the confined liquid into the receiver. While this prior type of so-called gravity transfer system has been used commercially with various kinds of valves applied to the transfer drum, it has proven too complicated and unreliable and has required too much attention in order to maintain it in operating condition with any degree of success, see Patent No. 2,655,008, granted October 13, 1953.

It is therefore an important object of the present invention to provide an improved single drum liquid refrigerant transfer system in which the transfer control mechanism is associated directly with the accumulator and thus insures more reliable automatic functioning of the system.

Another important object of this invention is to provide an improved system for automatically transferring liquid refrigerant from the suction to the high pressure side of the evaporators of a refrigeration plant while by-passing the main compressor, with the aid of extremely simple but effective valves.

A further important object of the invention is to provide an improved assemblage of simple elements for utilizing gravity and the pressure differential in a refrigeration system, to automatically return the liquid refrigerant delivered from the cooling units to the inlet side thereof without the aid of pumps, ejectors or similar mechanisms.

Still another important object of our invention is to provide improved automatically functioning electrical control devices operable directly by variations of the level of liquid refrigerant in the accumulator of a refrigeration system and with the aid of a single float actuated control valve to transfer the liquid from the low to the high pressure sides of the evaporators.

These and other more specific objects and advantages of the invention will be apparent from the following detailed description.

A clear conception of the several features constituting our present improvement and of the construction and operation of a typical liquid refrigerant return system embodying the invention, may be had by referring to the drawings accompanying and forming a part of this specification wherein like reference characters designate the same or similar parts in the various views.

Fig. 1 is a diagrammatic illustration of a typical commercial liquid refrigerant return system adapted to cooperate with a refrigeration plant having the usual refrigerant circulating compressor for receiving gaseous refrigerant from the low pressure side of one or more evaporators and for delivering liquid refrigerant to a receiver communicationg with the high pressure inlets of the evaporators;

Fig. 2 is a wiring diagram of one type of electrical equipment for controlling the transfer system of Fig. 1 showing the active current conductors and switches in heavy solid lines during each normal transfer of the liquid refrigerant from the transfer drum; and

Fig. 3 is a similar wiring diagram of the same equipment, but showing the active current conductors and switches in heavy solid lines during the time set for drainage of liquid refrigerant from the accumulator to the transfer drum.

While the invention has been illustrated as showing only the essential parts of the improved transfer system and as depicting the control valves and other equipment diagrammatically only, it should be understood that the improved system is adapted for cooperation with various types of refrigeration plants having any number of evaporating units and a compressor for circulating the refrigerant through the evaporators and that these valves and other equipment may be of various formations adapted to properly perform their intended functions.

Referring to the drawings, the typical liquid refrigerant return system shown, comprises in general, an accumulator 5 having the low pressure discharge line 6 leading from the evaporators of a refrigeration plant in open communication with its upper portion and also having the suction line 7 of the main refrigerant circulating compressor likewise communicating with its uppermost portion; a liquid refrigerant transfer drum 8 disposed below and being connected near its upper portion with a lower portion of the accumulator 5 by a drain conduit 9; a high pressure liquid refrigerant receiver 10 having its medial portion connected to a lower portion of the transfer drum 8 by a drain line 11 and its top portion connected with upper portions of the accumulator 5 and of the transfer drum 8 by equalizing conduits 12, 12', 13 respectively, while its lower portion is connected to the high pressure evaporator inlet line by a conduit 14 and its top portion is also connected to the compressor discharge by a conduit 15; and various control valves and electrical equipment for effecting normal operation of the liquid transfer system.

The accumulator 5 is provided with an electric switch 16 of the mercury tumbler or of any other suitable type operable by a float 17 or the like, movable by varia-

tions in level of the liquid refrigerant directly confined within the accumulator, and this switch 16 constitutes the primary automatic control element for the liquid refrigerant transfer system. The float 17 may be confined and guided for movement within a chamber 18 communicable with the accumulator interior past manually manipulable valves 19, 20 and the lowermost portion of the accumulator 5 is provided with another manually manipulable valve 21 for effecting drainage of obnoxious substances such as oil.

As shown, the transfer drum 8 which is disposed at a lower level than the accumulator 5, is disposed approximately upright, and has a telltale indicator 23 associated therewith. The uppermost portion of the drum 8 is provided with a pipe having an automatic safety valve 24 applied thereto, and the conduit 9 which connects the lower portion of the accumulator 5 with the upper portion of the drum 8 has a manual shut-off valve 25 and an electrically actuated automatic solenoid valve 26 therein. A pressure gauge 27 may also be applied to the transfer drum 8 through the conduit 13 or otherwise, and this gauge 27 may be provided with a manual shut-off valve 28 as shown.

As shown, the high pressure liquid refrigerant receiver 10 is disposed below the transfer drum 8 and the drain line 11 which connects the medial portion of the receiver 10 with the lower end of the transfer drum 8 is provided with a manual drain valve 30, with a manual shut-off valve 31, and with an electrically actuated automatic solenoid valve 32. The receiver 10 which is also adapted to receive high pressure liquid refrigerant from the main refrigerant circulating compressor through the conduit 15 in a well known manner, is adapted to deliver high pressure liquid refrigerant to the evaporators as required, through the conduit 14 and past an expansion valve 33, and the conduit 14 is also preferably provided with a manual shut-off valve 34 while the conduit 15 may be provided with a similar valve 35.

The pressure equalizing lines 12, 13 which connect the upper portion of the receiver 10 with the upper portion of the transfer drum 8 has a manually operable shut-off valve 36 therein, and also has one electrically actuated automatic solenoid valve 38 therein, and the pressure equalizing line 12' which connects the upper portion of the accumulator 5 with the lines 12, 13 is also provided with a manually operable shut-off valve 37 and with a solenoid valve 39. The line 12' in advance of the valve 37 is connected to the junction of the lines 12, 13 by a by-pass conduit having another manually operable valve 40 therein adapted to be opened for pump out purposes only. All of the manual shut-off valves 19, 20, 25, 31, 36 and 37 are normally open, while the valves 24, 28, 30 and 40 are normally closed, but the solenoid valves 26, 32, 38 and 39 are automatically operable and controllable by the switch 16 and the electrical equipment cooperating therewith.

Referring to Figs. 2 and 3, the electrical equipment for controlling the actuation of the solenoid valves 26, 32, 38 and 39 comprises a pair of double throw magnetic relays 42, 43 and a pair of automatic reset timers 44, 45 cooperable with these relays. As shown in Fig. 2 the tumbler switch 16 has been closed by the rising liquid refrigerant within the accumulator 5, closing relay 42 which is provided with a pair of movable contacts 46, 47 which have closed, closing the relay 43 which is provided with one movable contact 48 which has closed and with another movable contact 49 which is open, also starting timer 44 (T–1).

When the improved liquid refrigerant transfer system has been properly constructed and installed as above described, and the timers 44, 45 have been adjusted to effect the desired automatic functioning of the electrical equipment and solenoid valves 26, 32, 38 and 39, the normal operation of the system is as follows. As the mixed refrigerant from the evaporators enters the accumulator 5 through the conduit 6, the main compressor withdraws the free gases through the suction conduit 7 and the liquid refrigerant collects and rises within the accumulator thus causing the float 17 to move upwardly.

During this part of the cycle, liquid is drained from the transfer drum 8 to the receiver 10, solenoid valve 32 is open for liquid passage and solenoid valve 38 is open for equalizing pressure to the receiver. Magnetic relay 43 is energized through contacts 3 to 4 of timer 44 (T–1).

After liquid has drained from the transfer drum 8 to the receiver 10 timer 44 (T–1) runs out and the circuit from 3 to 4 of this timer is opened and simultaneously the circuit is closed from 3 to 5. Relay 43 is now deenergized which reverses the position of solenoid valves 39, 26, 38 and 32. Electrical energy is thereafter supplied to the control system as shown in Fig. 3, the heavy lines indicating the active part of the system. Solenoid valves 39 and 26 are then open connecting the transfer drum 8 with the accumulator 5. Timer 44 (T–1) has run out and has started the timer 45 (T–2) through contacts 3 to 5 of timer 44 (T–1). This timing period is arranged to let liquid in the accumulator 5 drain into the transfer drum 8 before the float actuated switch 16 can take control. If at the end of this timing period of timer 45 (T–2) liquid is still present in the bottom of accumulator 5 the float actuated switch 16 will start the cycle over and the control circuit will revert to the arrangement shown in Fig. 2. This will repeat as often as necessary until liquid is no longer present in the accumulator 5 at the end of timed cycle ending with timer 45 (T–2). If liquid is not present in accumulator 5 at the end of said timed cycle, the system will remain at rest with the solenoid valves 39 and 26 open to connect the accumulator 5 with the transfer drum 8 and during this period both the relays 42, 43 and the timers 44, 45 are inactive.

The improved liquid refrigerant return system is thus automatically controlled directly by variations in level of the liquid refrigerant collecting within the accumulator 5, and the cycle of operations will be automatically repeated indefinitely and at intervals depending upon the setting of the timers T–1 and T–2 of which the timer T–1 controls the delivery of liquid refrigerant from the transfer drum 8 to the receiver 10 while the timer T–2 controls the drainage of liquid refrigerant from the accumulator 5 into the transfer drum 8. The normal functioning of the system is at all times observable through the telltale indicator 23, and the various manually manipulable valves may be operated to make the transfer system inactive and to effect reconditioning thereof.

With the present improved system the efficiency is augmented by virtue of the fact that the transfer drum 8 is completely filled and emptied during each cycle of operation, whereas in prior systems in which the controls were applied to the transfer drum space was required within these drums in order to actuate the controls.

From the foregoing detailed description it will be apparent that the present invention in fact provides a simple but effective automatic liquid refrigerant return system which is operable with utmost precision directly by variations in liquid level within the accumulator. If liquid refrigerant is still present in the accumulator 5 at the end of a drainage period, the cycle of operations will repeat and will continue to do so until the liquid level within the accumulator is down to its lowest extent. When the drainage cycle has been completed, and the liquid level within the accumulator has dropped to its full extent, the return system will stop functioning until the level of the liquid within the accumulator rises, and after the system has once been properly started it will continue through at least one complete cycle and will always stop functioning in drainage position or until it is stopped manually after the usual alarm associated with the accumulator has sounded.

It should be understood that it is not desired to limit this invention to the exact details of construction and operation of the liquid refrigerant return system herein specifically shown and described, for various modifications within the scope of the appended claims may occur to persons skilled in the art.

We claim:

1. In a liquid refrigerant transfer system adapted for cooperation with a refrigerant circulating compressor communicable with the low pressure discharge and with the high pressure refrigerant supply lines of an evaporator, an accumulator for collecting liquid refrigerant from the evaporator discharge line, a liquid refrigerant transfer drum disposed below the accumulator, and means comprising a single liquid level actuated switch operable directly by variations of the liquid level within said accumulator to periodically transfer liquid refrigerant from the accumulator to the transfer drum and from the latter to the high pressure supply line.

2. In a liquid refrigerant transfer system adapted for cooperation with a refrigerant circulating compressor communicable with the low pressure discharge and with the high pressure refrigerant supply lines of an evaporator, an accumulator for collecting liquid refrigerant from the evaporator discharge line, a liquid refrigerant transfer drum disposed below the accumulator, conduit means connecting said transfer drum with said accumulator and with the high pressure refrigerant supply line, and means comprising a single float actuated switch operable directly by variations of the liquid level within said accumulator to periodically transfer liquid refrigerant through said conduit means from the accumulator to the transfer drum and from the latter to the high pressure supply line.

3. In a liquid refrigerant transfer system adapted for cooperation with a refrigerant circulating compressor communicable with the low pressure discharge and with the high pressure refrigerant supply lines of an evaporator, an accumulator for collecting liquid refrigerant from the evaporator discharge line, a liquid refrigerant transfer drum disposed below the accumulator, a receiver disposed below said transfer drum, and means comprising a single float actuated switch operable directly by variations of the liquid level within said accumulator to periodically transfer liquid refrigerant from the accumulator to the transfer drum and from the latter through said receiver to the high pressure supply line.

4. In a liquid refrigerant transfer system adapted for cooperation with a refrigerant circulating compressor communicable with the low pressure discharge and with the high pressure refrigerant supply lines of an evaporator, an accumulator for collecting liquid refrigerant from the evaporator discharge line, a liquid refrigerant transfer drum disposed below the accumulator, a receiver disposed below said transfer drum, conduit means connecting said transfer drum with said accumulator and with the high pressure refrigerant supply line through said receiver, and means comprising a single liquid level actuated switch operable directly by variations of the liquid level within said accumulator to transfer liquid refrigerant through said conduit means from the accumulator through said transfer drum and said receiver to the high pressure refrigerant supply line.

5. In a liquid refrigerant transfer system adapted for cooperation with a refrigerant circulating compressor communicable with the low pressure discharge and with the high pressure refrigerant supply lines of an evaporator, an accumulator for collecting liquid refrigerant from the evaporator discharge line, a liquid refrigerant transfer drum disposed below the accumulator, conduit means connecting said transfer drum with said accumulator and with the high pressure refrigerant supply line, solenoid valves in said conduit means, and a single float actuated switch operable directly by variations of the liquid level within said accumulator to periodically transfer liquid refrigerant through said conduit means and past said solenoid valves from the accumulator to the transfer drum and from the latter to the high pressure supply line.

6. In a liquid refrigerant transfer system adapted for cooperation with a refrigerant circulating compressor communicable with the low pressure discharge and with the high pressure refrigerant supply lines of an evaporator, an accumulator for collecting liquid refrigerant from the evaporator discharge line, a liquid refrigerant transfer drum disposed below the accumulator, a receiver disposed below said transfer drum, conduit means connecting said transfer drum with said accumulator and with the high pressure refrigerant supply line through said receiver, solenoid valves in said conduit means, and a single float actuated switch operable directly by variations of the liquid level within said accumulator to transfer liquid refrigerant through said conduit means and past said solenoid valves from the accumulator through said transfer drum and said receiver to the high pressure refrigerant supply line.

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