

March 18, 1952

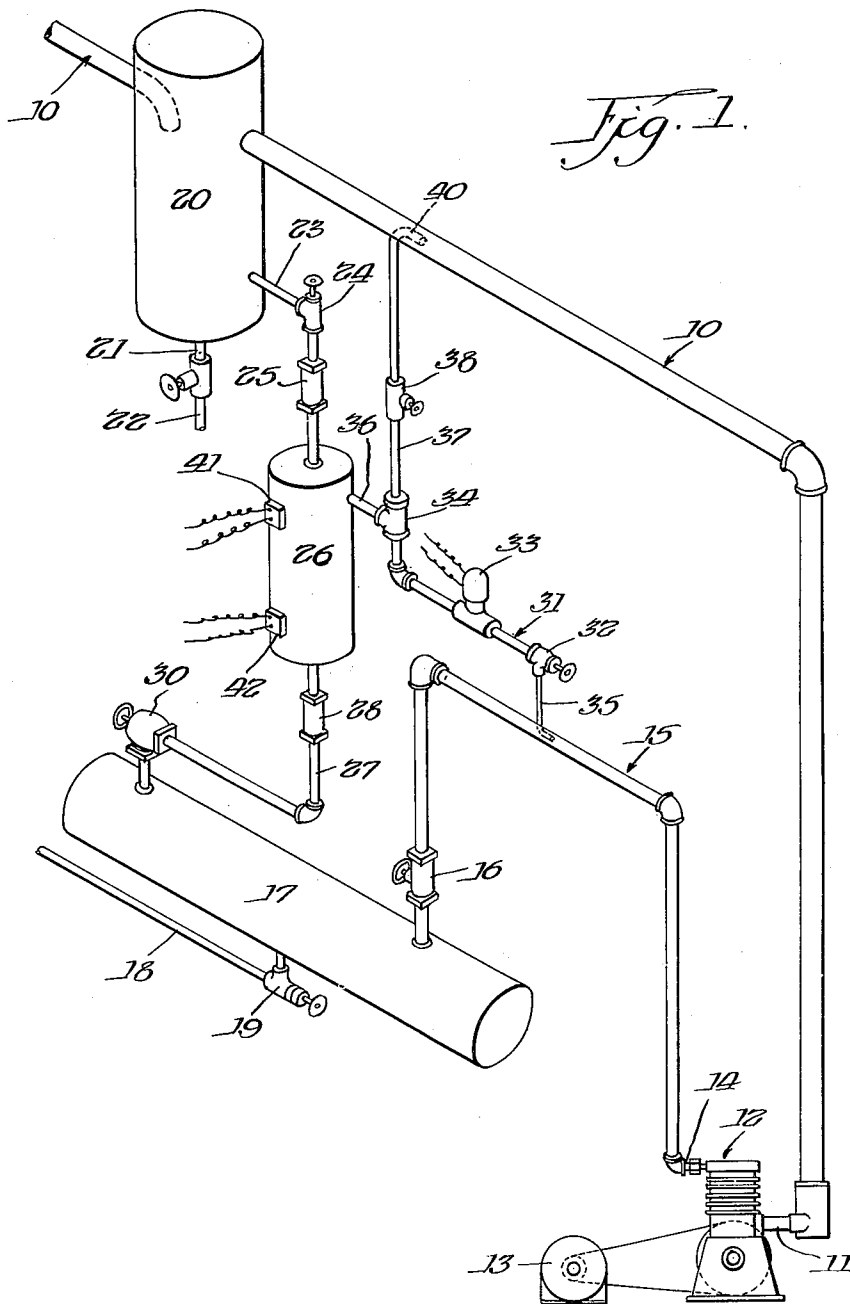
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2,589,859

SUCTION LINE LIQUID RETURN TRAP

Filed Nov. 12, 1948

4 Sheets-Sheet 1



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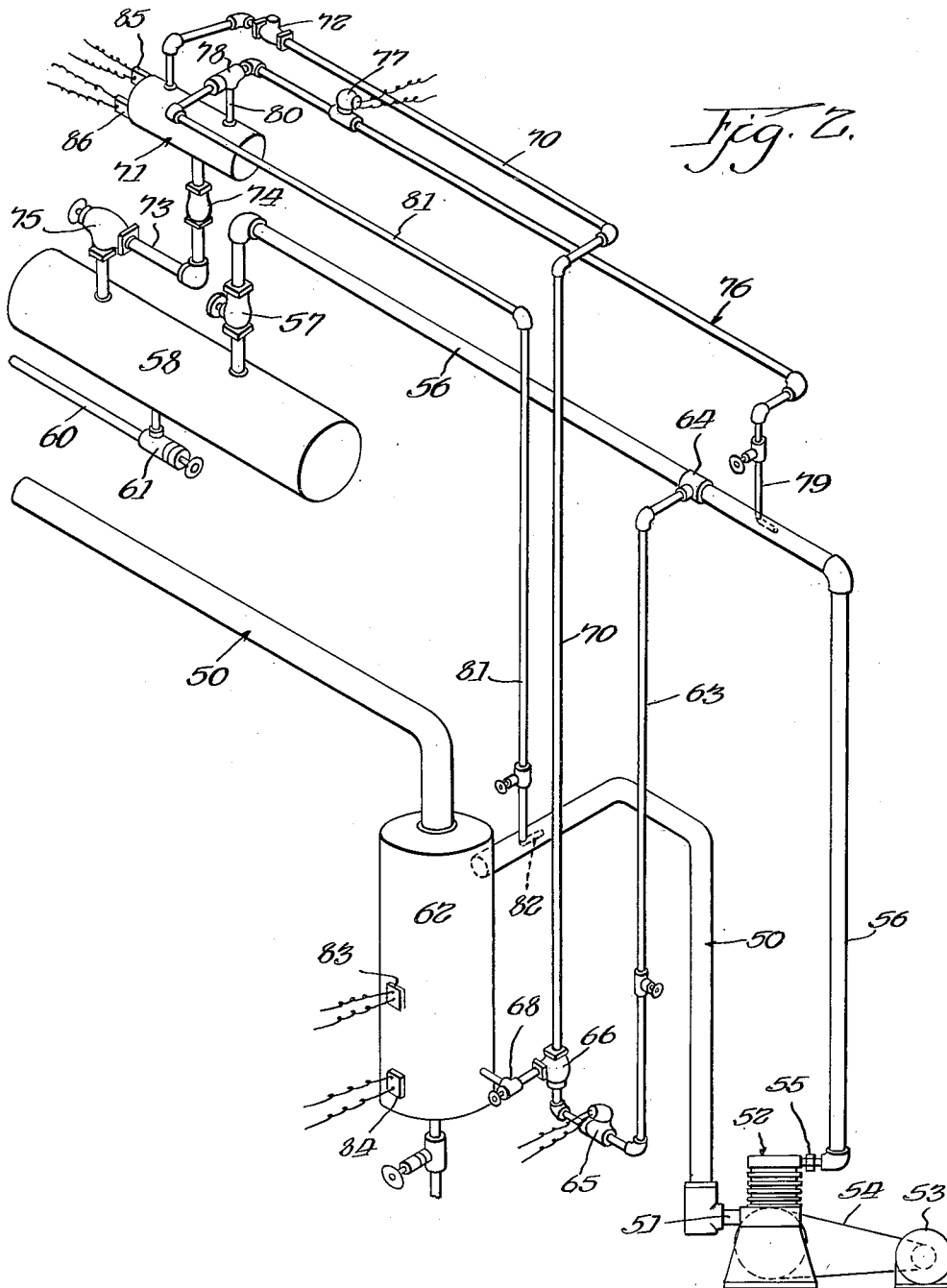
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SUCTION LINE LIQUID RETURN TRAP

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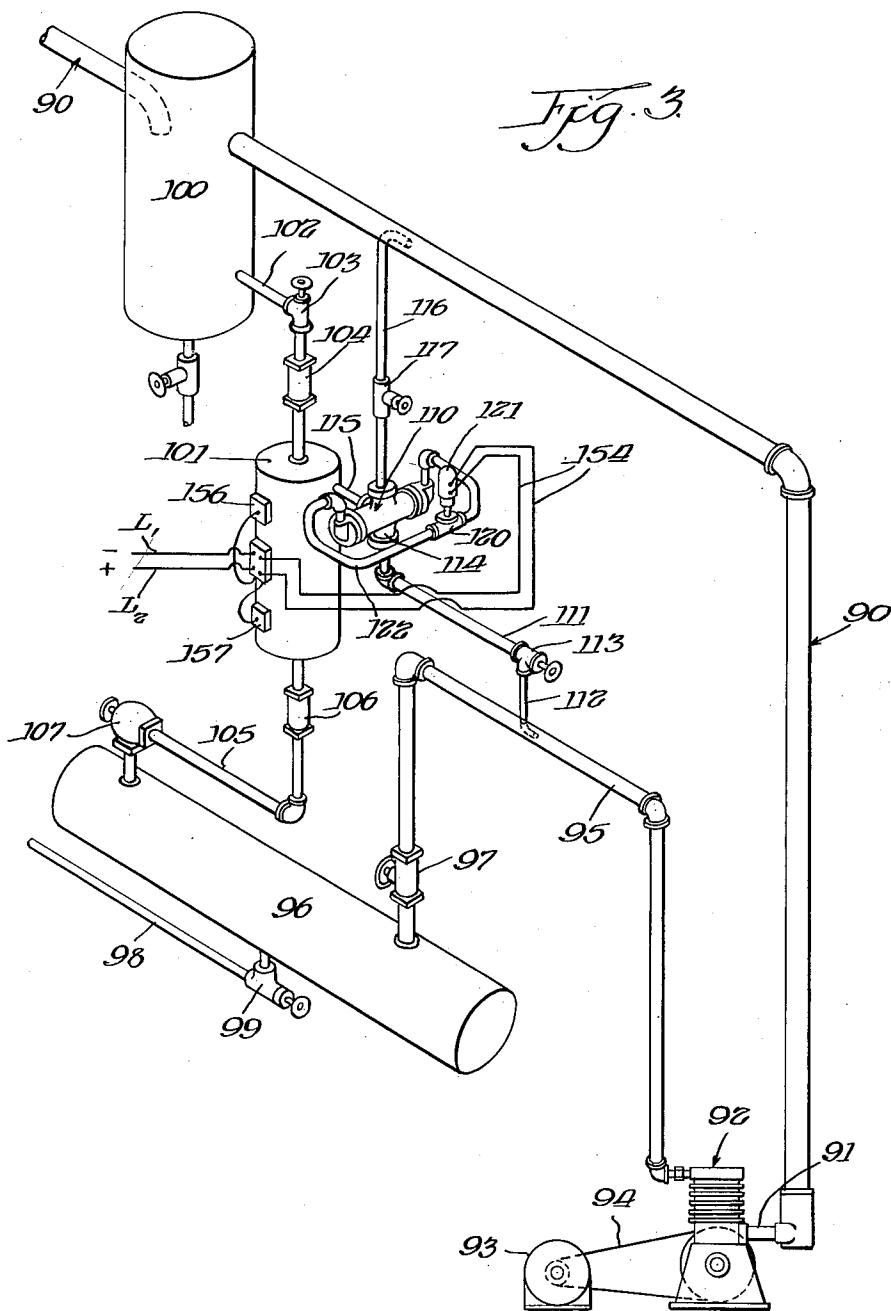
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SUCTION LINE LIQUID RETURN TRAP

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SUCTION LINE LIQUID RETURN TRAP

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4 Sheets-Sheet 4

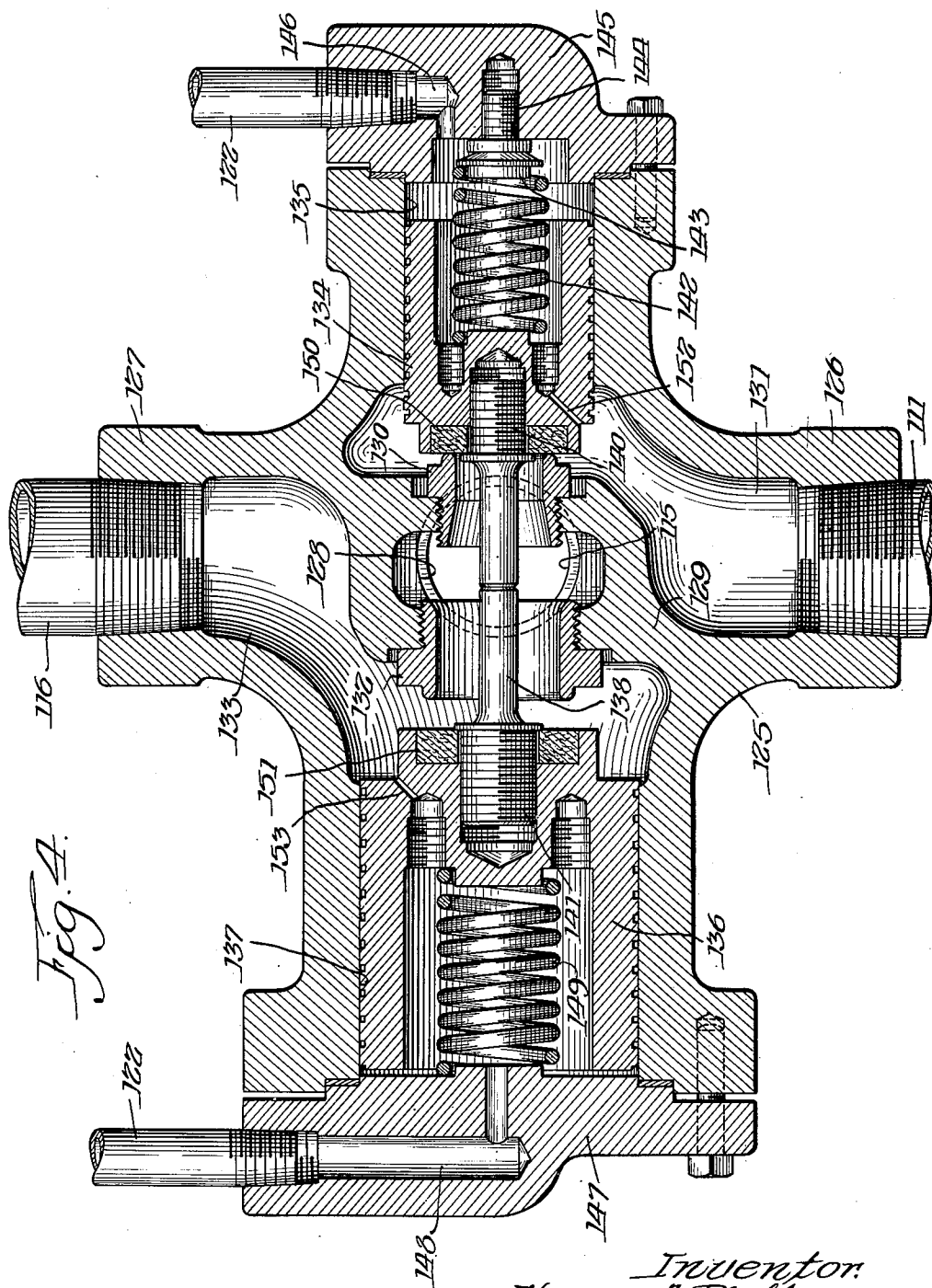


Fig. 4.

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UNITED STATES PATENT OFFICE

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SUCTION LINE LIQUID RETURN TRAP

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5 Claims. (Cl. 62—3)

1

The invention relates to refrigerating systems and has reference more particularly to improvements especially designed for such systems for protecting the compressor thereof from liquid refrigerant such as would otherwise return to the compressor in the suction line.

An object of the invention is to provide improved apparatus for accumulating liquid refrigerant that may be returning in the suction line of a refrigerating system and in utilizing the high pressure refrigerant gas to deliver the accumulated liquid refrigerant to the high pressure side of the system, thereby by-passing and protecting the compressor of the system.

More specifically an object of the invention is to provide a suction line return device for accumulating liquid refrigerant returning in the suction line and which will be automatic in its operation of utilizing high pressure refrigerant gas from the discharge side of the compressor to pump said liquid refrigerant from its point of accumulation to a trap above the receiver so that the liquid refrigerant can be delivered to the receiver by a gravity feed augmented by pressure.

A further object of the invention is to provide apparatus as described for protecting the compressor of refrigerating systems from an overflow of liquid refrigerant and which will employ the ejector method for pumping the liquid refrigerant to the trap above the receiver.

Another object of the invention is to provide a suction line return trap for liquid refrigerant which will operate automatically by employing electric means controlled by the level of the liquid in the trap for controlling the pumping action of the high pressure refrigerant gas.

With these and various other objects in view, the invention may consist of certain novel features of construction and operation as will be more fully described and particularly pointed out in the specification, drawings and claims appended hereto.

In the drawings which illustrate an embodiment of the invention, and wherein like reference characters are used to designate like parts:

Figure 1 is a perspective view of apparatus illustrating a refrigerating system to which the improvements of the invention have been applied;

Figure 2 is a perspective view of a modification of the invention and which illustrates application of the modified structure to a conventional refrigerating system;

Figure 3 is an elevational view of a refrigerating system incorporating the improvements of

2

the invention modified by a novel type of three-way valve for controlling the gaseous refrigerant to and from the trap; and

Figure 4 is a longitudinal sectional view of the new three-way valve showing the structure of the same.

Referring to Figure 1 of the drawings, which shows a preferred embodiment of the invention, it will be seen that the suction line 10 for returning the evaporated refrigerant from the evaporators, not shown, has connection at 11 with the compressor 12. Said compressor is conventional in construction and in operation, being driven by the electric motor 13 by means of an endless belt as shown. The compressor at its inlet end 11 receives the low pressure gaseous refrigerant which has been evaporated in the evaporators and by operation of the compressor the pressure of this gaseous refrigerant is increased with a corresponding increase in temperature. The high pressure discharge side of the compressor has connection at 14 with the high pressure gaseous refrigerant line 15, said line having interposed therein the hand valve 16 and which connects with receiver 17.

The cylinder 17 forms a combination receiver and condenser so that the high pressure gaseous refrigerant from the discharge line 15 is condensed to a liquid form and stored in the receiver until ready for use, for which purpose the receiver is provided with a liquid refrigerant line 18 connecting with the receiver at the bottom thereof and which is provided with the hand valve 19. The line 18 conducts the liquid refrigerant to the evaporators of the refrigerating system and following evaporation of the refrigerant to produce the desired refrigerating effect the same is returned to the compressor through the suction line 10, thus completing the cycle.

The invention provides improved apparatus for collecting liquid refrigerant in the suction line of the system and returning the same to the receiver, thus protecting the compressor of the refrigerating system which is not adapted to handle slugs of liquid refrigerant with any degree of success. More particularly, the apparatus of the invention employs the high pressure refrigerant gas as a pumping medium to facilitate conveyance of the liquid refrigerant from the suction line to the receiver. As shown in Figure 1, an accumulator drum designated by numeral 20 is interposed in the suction line 10 at a point conveniently in advance of the compressor and the returning liquid refrigerant in the suction line 10 is thus collected by the accumulator drum

with the evaporated refrigerant, however, continuing on and being returned to the compressor. The accumulator is provided with the drain 21 having the hand operated valve 22 for draining oil from the drum. The pipe 23 has connection with the accumulator drum 20 at a point adjacent the bottom thereof, said pipe including the hand valve 24 and a check valve 25. The depending end of the pipe 23 connects with the top of a trap 26 which initially receives the liquid refrigerant from the accumulator drum 20. The drain 27 leading from the bottom of the trap 26 is equipped with the check valve 28 and a hand valve 30. The drain connects with the receiver 17.

From the foregoing it will be seen that the accumulator drum and the receiver are connected by means in the form of pipes and conduits for conveying the liquid refrigerant accumulating in the drum to the receiver, thus by-passing the compressor. The liquid from the drum 20 naturally drains to the trap 26, it being understood that the hand valve 24 is open to permit such drainage. Also the check valve 25 is constructed to permit the liquid refrigerant to drain downwardly into the trap 26, the check valve closing only upon pressure developing in trap 26 so that the pressure can be maintained in the trap and leakage to the drum 20 prevented. The liquid refrigerant in the trap 26 will also have a tendency to drain through the check valve 28 in the drain 27 to the receiver. However, to augment such drainage the invention provides apparatus utilizing the high pressure refrigerant gas in line 15.

Said apparatus, as shown in Figure 1, essentially consists of an auxiliary line 31 equipped with the hand valve 32, a solenoid operated valve 33, and a three-way valve 34. A pipe 35 depends from hand valve 32 and enters the line 15, said pipe having its end bent in a direction upstream toward the flow of the high pressure refrigerant gas in line 15. The three-way valve 34 includes a horizontal connection 36 which joins the valve to the trap 26. The pipe 37 provides the vertical connection for the three-way valve, the same including the hand operated valve 38 and a bent terminal end 40 having location within suction line 10 with said bent end being directed downstream as regards the flow of the refrigerant gas in the suction line.

The solenoid valve 33 in the auxiliary line 31 is controlled by the photo switches 41 and 42. Such switches are located on the trap 26 and are actuated in accordance with the level of the liquid refrigerant in said trap. When the level of the liquid refrigerant reaches switch 41 said switch is actuated to cause energization of solenoid 33, opening the valve associated therewith.

With the solenoid valve open it will be seen that the high pressure refrigerant gas from line 15 will be permitted to flow through the auxiliary line 31 and upon reaching the three-way valve 34 the action of the gaseous refrigerant is such as to close off line 37 so that the high pressure gas flows through line 36 to the top of trap 26. The action of the high pressure gas on the check valve 25 is also such as to close the check valve with the result that pressure is applied to the liquid refrigerant in the trap, causing the same to flow through the drain 27 into the receiver. When the level of the liquid refrigerant reaches the position of switch 42 the switch is actuated to cause de-energization of the solenoid valve 33 with the result that the valve is caused to close. The flow

of the high pressure refrigerant gas from line 15 is thus terminated and the three-way valve 34 automatically opens, permitting the gas in the trap to escape through the vertical line 37. The bent terminal end 40, as a result of its direction downstream within suction line 10, produces a siphoning effect, drawing off the gas from the trap. The liquid refrigerant immediately begins to again accumulate in trap 26, the same draining by gravity from the accumulator 20 and when the level of the liquid reaches photo switch 41 the above described operations are repeated.

In the modification shown in Figure 2 the operation of the apparatus is basically similar to that disclosed in Figure 1. However, it will be seen that the trap and receiver have a location above the accumulator and in this modification the high pressure refrigerant gas from the discharge line of the compressor is additionally employed to pump the liquid refrigerant from the accumulator drum to the trap.

Referring more particularly to said figure, suction line 50 has connection at 51 with the compressor 52 driven by the electric motor 53 by means of the endless belt 54. The high pressure discharge side of the compressor has connection at 55 with the high pressure gaseous refrigerant line 56, said line having interposed therein the hand valve 57 and which connects with receiver 58. Said receiver may comprise a combination condenser-receiver. In any case, the high pressure gaseous refrigerant front discharge line 56 is condensed and stored in the receiver until ready for use, for which purpose the receiver is provided with the liquid refrigerant line 60, having the hand valve 61.

In this modification the accumulator drum 62 is interposed in the suction line 50 at a convenient point in advance of the compressor and it will be seen that said accumulator drum has a position below the receiver and the trap. It is therefore necessary to pump the liquid refrigerant from the drum to the trap for which purpose the present invention utilizes the high pressure gaseous refrigerant in line 56. Said line 56 is tapped by the auxiliary line 63 at 64, the said auxiliary line adjacent the accumulator drum including the solenoid operated valve 65 and having connection with the ejector 66. The ejector is connected by pipe 67 with the accumulator drum 62 so that the liquid refrigerant in the drum naturally drains through pipe 67 into the ejector 66. Upon reaching the ejector the liquid entrains with the high pressure refrigerant gas supplied by line 63 and the same is conveyed through line 70 which connects the ejector 66 with the trap 71. The check valve 72 interposed in line 70 facilitates the maintenance of pressure in the trap. The check valve therefore opens normally in a direction permitting flow of the gaseous refrigerant and entrained liquid refrigerant from the ejector to the trap but automatically closes when a predetermined pressure develops in the trap. The trap 71 is provided with the conventional drain similar to that shown in Figure 1, including drain pipe 73 having check valve 74 and the hand operated valve 75. The liquid refrigerant from the trap draining through 73 is delivered to the receiver 58.

The liquid refrigerant draining from trap 71 is augmented by the high pressure gaseous refrigerant in line 56 in a manner similar in all respects to that as disclosed in connection with Figure 1. The auxiliary line 76 is equipped with a solenoid actuated valve 77 and said auxiliary line has connection with the three-way valve 78. At the

right hand end of the auxiliary line 76 the same is provided with a depending pipe 79 which enters the high pressure gaseous refrigerant line 56 and has its end bent in a direction upstream toward the flow of the high pressure refrigerant gas. The three-way valve 73 at the opposite end of the auxiliary line 76 includes a vertical connection 80, which connects the three-way valve to the trap 71. The third connection for the valve is provided by the line 81 which joins the valve to the suction line 50, the same entering the suction line and having its terminal end 82 bent in a direction downstream, as regards the flow of the refrigerant in the suction line.

In operation of the apparatus as shown in Figure 2, it will be understood that the solenoid valve 65 is controlled by the photo switches 83 and 84, being supported on the wall of the accumulator drum and having location within the drum so that the level of the liquid refrigerant actuates said switches. When the liquid refrigerant in the drum reaches switch 83 the solenoid valve 65 is energized and caused to open, admitting the high pressure gaseous refrigerant from line 56 to the ejector 66. The liquid refrigerant passed to the ejector by line 67 is thus conveyed to the trap 71 and the operation continues until the liquid level within the accumulator drum reaches switch 84. When this takes place switch 84 is actuated to de-energize the solenoid actuated valve 65, causing the same to close, whereupon the pumping of the liquid refrigerant to trap 71 is terminated.

The application of pressure to the liquid refrigerant in trap 71 is also automatically controlled by photo switches 85 and 86 supported by the trap and having location within the same so that the switches are actuated by the level of the refrigerant. When the liquid refrigerant in trap 71 reaches the level of switch 85 the solenoid actuated valve 77 is energized, causing opening of said valve and the admission of the high pressure refrigerant gas from line 56 to the trap. With the opening of valve 77 the three-way valve 73 automatically closes line 81 so that the pressure is prevented from escaping to the suction line. The pressure within the trap also automatically closes check valve 72, thus permitting the pressure to build up within trap 71 and effect drainage of the liquid refrigerant through 73 to reservoir 58. When the level within the trap reaches switch 86 the switch is actuated, causing de-energization of the solenoid actuated valve 77 whereupon the valve closes, terminating the flow of gaseous refrigerant from line 56.

The automatic draining of trap 71 as above described will alternate with the automatic pumping of the liquid by the ejector 66. To a large extent this is controlled by check valve 72 since the valve automatically closes line 70 when a predetermined pressure exists in the trap.

In Figure 3 a modified form of apparatus is shown, basically similar to Figure 1 but employing an improved form of three-way valve for controlling the flow of high pressure refrigerant gas into and from the trap. As shown in said figure the suction line 90 has connection at 91 with the compressor 92 driven by the electric motor 93 by means of the endless belt 94. The high pressure gaseous refrigerant line 95 has connection with the discharge side of the compressor and said line conducts the gaseous refrigerant to receiver 96, there being interposed in the line a hand valve 97 for controlling the flow of the gaseous refrigerant to the receiver.

Said receiver may comprise a combination condenser-receiver. In any case the high pressure gaseous refrigerant from discharge line 95 is condensed and stored in the receiver until ready for use, whereupon it is withdrawn by the liquid refrigerant line 98 having the hand valve 99.

In this modification the accumulator drum 100 is interposed in the suction line 90 at any convenient point in advance of the compressor, at which point the accumulator drum will have a position above the receiver and above the trap 101, the said trap having a connection with the accumulator drum by means of the pipe 102 which is provided with the hand valve 103 and the check valve 104. The returning liquid refrigerant in the suction line 90 is collected by the accumulator drum 100 and drawn off by pipe 102 which delivers the liquid refrigerant to the trap 101. A drain pipe 105 connects the bottom of the trap with the receiver 96 so that the liquid refrigerant is periodically pumped from the trap and delivered to the receiver through said drain pipe which is equipped with the check valve 106 and hand valve 107.

In the modification of Figure 3 any liquid refrigerant overflowing the evaporator and returning with the gaseous refrigerant in the suction line 90 will be collected by the drum and caused to by-pass the compressor, being delivered to the receiver in advance of the same, all as particularly pointed out in connection with the apparatus of Figure 1. For periodically pumping the liquid refrigerant from trap 101, using high pressure gaseous refrigerant in accordance with the invention, the present modification employs an improved form of three-way valve identified by numeral 110 and which is shown in sectional detail in Figure 4. An auxiliary gaseous refrigerant line 111 is provided with a depending pipe 112 which enters the gaseous refrigerant line 95 and has its end bent in a direction upstream toward the flow of the refrigerant in said line. The hand valve 113 controls the flow of gaseous refrigerant from pipe 112 to the auxiliary line 111. Said auxiliary line has connection at 114 with the three-way valve 110, which valve discharges to a delivery line 115 leading to the trap 101. The valve also has an exhaust line 116 which enters the suction line 90 having its end bent downstream with respect to the flow of the gaseous refrigerant in said suction line. Accordingly with respect to the three-way valve 110 the auxiliary line 111 constitutes the inlet supplying the valve with high pressure gaseous refrigerant. According to actuation of the valve mechanism within the three-way valve the gaseous refrigerant is delivered to line 115 and thus produces a pumping action on the liquid refrigerant in the trap 101, causing the same to flow to the receiver 96. Eventually the gaseous refrigerant in trap 101 is vented by actuation of the valve mechanism which connects the trap with the line 116. For control purposes the exhaust line 116 is provided with a hand operated valve 117.

Actuation of the valve mechanism within the three-way valve can be controlled by the valve 120 which is operated electrically by the solenoid 121. The valve 120 is located in the bypass conduit 122 and in order to understand the utility of this bypass conduit it is necessary to understand the construction and operation of the improved three-way valve which will now be described.

Referring to Figure 4, the three-way valve includes a body portion 125 provided with an in-

let opening 126 to which the conduit 111 is secured and an outlet opening 127 to which the line 116 is secured. The third opening of the three-way valve is indicated by numeral 128 and the line 115 has connection with said opening. The partition 129 located within housing 125 provides a high pressure valve seat 130 located between the high pressure chamber 131 and the delivery opening 128 and a low pressure valve seat 132 located between the low pressure chamber 133 and the delivery opening 128. The piston 134, having location in the high pressure chamber 135, is relatively small in diameter compared to the much larger diameter piston 136 located in the low pressure chamber 137. The chambers are located in opposed relation at the respective ends of the valve body 125 and said pistons are operatively connected by the rod 138 which extends through the central openings in the valve seats 130 and 132, the valve rod at 140 having threaded connection with piston 134 and at 141 having threaded connection with piston 136. The piston 134 is centrally cored for receiving the coil spring 142 which at one end has contact with the piston and at its other end is supported by the adjustable support 143 threaded at 144 in its respective end 145 of the valve body portion 125. This end of the body portion is provided with the passage 146 to which is connected the bypass conduit 122.

The bypass conduit 122 extends to the opposite end 147 of the body portion and in connecting therewith has communication with passage 148 leading to chamber 137. The solenoid actuated valve 120 is located in the bypass conduit 122 to control the flow of gaseous refrigerant from chamber 135 to chamber 137. The piston 136 in said chamber 137 is cored for receiving the coil spring 149 which is confined between the end of the body portion and the piston. It will be observed that the coil springs 142 and 149 oppose each other and in accordance with the invention coil spring 142 is a relatively strong spring, whereas spring 149 is considerably weaker so that under normal conditions spring 142 controls and maintains the piston 134 in a direction toward the left, Figure 4, to thus hold the piston in contact with the valve seat 130, thereby closing off the chamber 131 and preventing the flow of high pressure gaseous refrigerant to the delivery pipe 115. The piston 134 may be provided with an insert 150 of steel or other suitable hard material for contact with the valve seat so as to take up wear and insure good sealing contact with said valve seat. With the spring 142 extended to maintain the piston 134 in contact with its seat it will be seen that piston 136 is located to the rear of its chamber with coil spring 149 under compression and the hardened insert 151 carried by the piston being located in spaced relation with the seat 132. Accordingly under normal conditions this low pressure side of the valve is open and the exhaust conduit 116 has connection with delivery pipe 115 and with the trap 101.

In accordance with the invention the piston 134 is provided with a bleed or leakage passage 152 connecting the interior of the piston and thus the chamber 135 with the high pressure gas chamber 131. Under normal conditions with the solenoid valve 120 closed, the high pressure gas will flow through the bleed passage 152 into chamber 135 and into the bypass conduit 122 connecting with this end of the body portion. However, chamber 137 is maintained at a low

pressure when the solenoid valve is closed since the bleed or leakage passage 153 in piston 136 connects the said chamber with the exhaust conduit 116. The bleed or leakage passages 152 and 153 in the pistons, respectively, may take other forms, as, for example, the pistons may have a loose fit in their respective chambers such as to allow flow of the gas past the pistons.

When the solenoid valve 120 is opened flow of gaseous refrigerant at an intermediate pressure will take place in the bypass conduit 122. This intermediate pressure builds up in chamber 137 behind piston 136 and said pressure acting in the same direction as the coil spring 149 will overcome spring 142, causing a movement of the pistons so that the valve seat 132 is closed and 130 is opened. It is of course understood that the coil springs are so adjusted that this intermediate pressure will accomplish reciprocating movement of the pistons in a direction toward the right as described. It will be found that the intermediate pressure of the gas flowing through the bypass conduit 122 will be approximately half the difference between the pressure on the high and low sides of the valve. Since the valve seat 130 is opened by movement of piston 134 to the right, the high pressure gaseous refrigerant will flow through opening 128 to the delivery pipe 115 which discharges the same to the trap 101. The action of this gaseous refrigerant on the liquid in the trap is to force the liquid refrigerant in the trap through check valve 106 and into the liquid receiver 96. The high pressure gaseous refrigerant is not admitted to the exhaust line 116 since the valve seat 132 is closed.

Opening and closing of valve 120 is controlled electrically in accordance with the level of the liquid refrigerant in the trap 101. A source of electric current indicated by conductors L₁ and L₂ has connection through conductors 154 and 155 with the solenoid 121 which actuates said valve 120. A photo switch 156 is provided for energizing the solenoid when the liquid refrigerant in the trap reaches the level of said switch. A deenergizing photo switch 157 is provided for opening the electric circuit to the solenoid when the liquid refrigerant in the trap descends to the low level indicated by the position of this switch. The control of the valve 120 in the bypass 122 is therefore automatic and said valve functions to control the internal mechanism of the three-way valve 110 as described. Upon deenergization of the solenoid 121 valve 120 will close and the pistons 134 and 136 will be reciprocated to their initial left hand position. This takes place since the intermediate pressure existing within chamber 137 is terminated by the closing of valve 120. The gas within the chamber 137 is constantly bled through passage 153 to the exhaust line 116 and immediately upon closing of valve 120 this intermediate pressure is terminated so that the stronger coil spring 142 takes over and moves the pistons to their initial left hand position. The supply of the high pressure gaseous refrigerant is cut off and simultaneously the interior of trap 100 is connected to the exhaust line 116. With the parts in normal position again the apparatus repeats another cycle wherein the liquid refrigerant from the accumulator drum 100 drains to trap 101 gradually filling the trap to the level of the photo switch 150 whereupon the three-way valve is again actuated.

This application is a continuation-in-part of my copending application Serial No. 773,843 filed

September 13, 1947 and entitled Suction Line Liquid Return Trap which has become abandoned.

The invention is not to be limited to or by details of construction of the particular embodiment thereof illustrated by the drawings as various other forms of the device will of course be apparent to those skilled in the art without departing from the spirit of the invention or the scope of the claims.

What is claimed is:

1. In a refrigerating system including the conventional compressor having a suction line for returning evaporated refrigerant to the compressor and having a high pressure gaseous refrigerant line connecting with a receiver, the combination of an accumulator drum interposed in the suction line for collecting liquid refrigerant to prevent delivery of the same to the compressor, conduit means providing a passageway connecting the drum with the receiver for conveying said liquid refrigerant from the drum to the receiver, a trap included in said conduit means, ejector means utilizing the high pressure gaseous refrigerant for pumping the liquid refrigerant from the accumulator drum to the trap, and other means also utilizing the high pressure refrigerant gas by supplying the same to the trap to effect a flow of the liquid refrigerant under pressure to the receiver.

2. In a refrigerating system, as defined by claim 1, additionally including electric means located on the trap for controlling the supply of gaseous refrigerant to the same by the level of the liquid refrigerant in the trap.

3. In a refrigerating system including the conventional compressor having a suction line for returning evaporated refrigerant to the compressor and having a high pressure refrigerant line connected to a receiver, the combination of an accumulator drum interposed in the suction line for collecting liquid refrigerant, conduit means providing a passageway connecting the drum with the receiver, a trap included in said conduit means for receiving liquid refrigerant from the drum, a three-way valve having two operative positions, said valve in one position connecting the high pressure refrigerant line to the trap to supply said high pressure refrigerant thereto whereby to effect a flow of the liquid refrigerant in the trap to the receiver, and said valve in another position connecting the trap to the suction line for venting the trap.

4. In a refrigerating system including the conventional compressor having a suction line for returning evaporated refrigerant to the compressor and having a high pressure refrigerant line, the combination of an accumulator drum interposed in the suction line for collecting liquid refrigerant, conduit means providing a passageway connecting the drum with the high pressure refrigerant

ant line, a trap in the conduit means for receiving liquid refrigerant from the drum, check valves in the conduit means on each side of the trap to permit flow in one direction only from the drum through the trap to said line, means tapping the high pressure refrigerant line at a point upstream and connecting with the trap adjacent the top thereof for supplying high pressure refrigerant to the trap, whereby to effect flow of the liquid in the trap through the passageway to said line at a point downstream of said first mentioned point, valve means associated with said high pressure refrigerant supplying means for controlling the supply of said high pressure refrigerant to the trap, said valve means operating to vent the trap to the suction line when the supply of said high pressure refrigerant is stopped, and means controlling the operation of said valve means in accordance with the level of the liquid in the trap.

5. In a refrigerating system including the conventional compressor having a suction line for returning evaporated refrigerant to the compressor and having a high pressure refrigerant line, the combination of an accumulator drum interposed in the suction line for collecting liquid refrigerant to prevent delivery of the same to the compressor, conduit means providing a passageway connecting the drum with the high pressure refrigerant line for conveying liquid refrigerant from the drum to the line, a trap included in said conduit means for temporarily storing liquid refrigerant received from the drum, a single pipe leading from the top of the trap and which connects with the high pressure refrigerant line and with the suction line respectively, valve means in said single pipe having two operative positions, said valve means in one position connecting the high pressure refrigerant line to the trap to supply said high pressure refrigerant thereto whereby to effect a flow of the liquid refrigerant in the trap to the receiver, and said valve means in another position connecting the trap to the suction line for venting the trap.

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