REFRIGERANT CHARGING MEANS AND METHOD

Inventor: William Wagner, c/o Watsco, Inc., 1800 W. 4th Ave., Miami Beach, Fla. 33018

Filed: Sept. 13, 1971

Appl. No.: 179,854

U.S. Cl. ..................... 62/77, 62/149, 62/292, 62/511
Int. Cl. ........................ F25b 45/00
Field of Search .......... 62/77, 149, 292, 62/160, 511

References Cited
UNITED STATES PATENTS

2,214,698 9/1940 Kelly......................... 62/292

Primary Examiner—Meyer Perlin
Attorney—Stoll and Stoll

ABSTRACT

Means and method for introducing an optimum charge of refrigerant into a refrigeration or air conditioning system. When the system is charged to optimum capacity there is a melting of frost, which indicates when the charging operation is to be stopped. This is accomplished by converting a liquid refrigerant to a saturated vapor and feeding the saturated vapor into the low side of the refrigeration or air conditioning system.

7 Claims, 13 Drawing Figures
REFRIGERANT CHARGING MEANS AND METHOD

BACKGROUND OF THE INVENTION

1. Field of the Invention

Domestic and commercial refrigeration and air conditioning systems.

2. Description of the Prior Art

One conventional procedure for charging or recharging a refrigeration or air conditioning system is a two-phase or two-step procedure involving both liquid and vapor refrigerant. In the first phase, liquid refrigerant is introduced into the high (discharge) side of the system. In this operation, the refrigerant container is inverted to insure a liquid flow. When the pressure equals the refrigerant container is turned right side up. In the second phase of the procedure, vaporized refrigerant is added to the low (suction) side of the system until it is fully charged.

Referring to the practice of introducing liquid refrigerant into the high side of the system, a standard textbook in the industry, "Modern Refrigeration and Air Conditioning" by Althouse, Turnquist and Bracciano (The Goodheart-Willcox Company, Inc., publisher, copyright 1968, page 589) comments as follows:

"Although it is not usually recommended, some servicemen do put liquid refrigerant into the high pressure side of the system. This is a dangerous practice because dynamic hydraulic pressures are possible which may rupture the lines, and cause considerable damage. However, this system can be used to put the initial charge into a system if done very carefully."

In the second phase of the procedure, as the liquid refrigerant vaporizes in the refrigerant container and flows as a vapor into the refrigeration or air conditioning system, the container temperature lowers and freezing occurs. This reduces the pressure in the container and results in a flow slow-down or stoppage. This condition may be overcome by heating the refrigerant container. However, unless great care is taken, excessive heat may be applied (as with a torch) and the refrigerant container may be caused to explode. Service manuals invariable contain strong warnings against the application of excessive heat, e.g., "Never use a direct flame or a heater to warm containers and never heat the containers to more than 125°F."

The second phase of the operation is slow and time consuming when conducted in accordance with recommended technique, but servicemen are frequently tempted to accelerate the operation by hazardous methods. Thus, to increase the flow of vapor refrigerant into the low side of the system, the upright refrigerant container is sometimes rocked from side to side. Here too the service manuals contain a cautionary note: "CAUTION - Never turn container into a position where liquid refrigerant will flow into system."

In another conventional method of charging a refrigeration or air conditioning system, the introduction of refrigerant is limited to the low side of the system. The refrigerant container is held in right-side-up position and the refrigerant is allowed to vaporize and to flow only as a vapor into the system. As is the case with the second phase of the first mentioned procedure, this is a slow process. To discourage servicemen from adopting hazardous alternatives to the prescribed technique, and to prevent damage to the compressor and a dangerous rise in oil level, the service manuals warn against improper use of the refrigerant container, thus: "CAUTION - Container must not be inverted and care must be taken that liquid refrigerant does not enter the [low side of the] system. This would cause damage to reed valves in compressor." The above-mentioned textbook, "Modern Refrigeration and Air Conditioning", page 589 contains a more explicit warning: "IT IS VERY IMPORTANT THAT LIQUID REFRIGERANT NOT BE ALLOWED TO REACH THE COMPRESSOR. The liquid is not compressible and the compressor valves, and even the bearings and rods, may be ruined if the compressor should pump liquid."

SUMMARY OF THE INVENTION

The present invention provides a refrigerant charging means and method for charging a saturated vapor refrigerant into the low pressure side of a refrigeration or air conditioning system. Basically, liquid refrigerant is conducted through a restrictor device to convert it to a saturated vapor and the saturated vapor is then fed into the low side of the system while the compressor is operating. Since the refrigerant enters the compressor as a saturated vapor (as distinguished from a liquid) it does not damage the compressor. Since the refrigerant leaves the refrigerant container as a liquid (as distinguished from a vapor or gas) frosting and drop in container pressure are avoided. There is no need, therefore, of heating the refrigerant container and no danger that the container will explode.

The refrigerant charging procedure which is herein described and claimed is a relatively fast procedure, since it is based on the principle of handling the refrigerant as a liquid and as a saturated vapor (as distinguished from an unsaturated vapor or gas) and conducting it under pressure from the refrigerant container to the refrigeration or air conditioning system. More specifically, the claimed procedure entails the following steps: (a) removing the refrigerant from the refrigerant container in its liquid phase and under pressure, (b) converting it under pressure into a saturated vapor, and (c) feeding the saturated vapor, still under pressure, into the low side of the refrigeration or air conditioning system. Tests conducted on fifteen refrigeration and air conditioning units ranging in size from 1/12 HP to 5 HP showed a 50 to 80 percent reduction in charging time over the conventional methods above described.

An optimum charge is visibly indicated by the appearance and disappearance of frost on the suction line of the refrigeration or air conditioning system. Determination of the optimum charge for each individual system is important, since the characteristics of the same model compressor (and system as a whole) will vary from one unit to another. This is true of new equipment direct from the production lines. Clearances of the operating parts of the compressors usually vary sufficiently, within tolerance ranges, to vary their operating and efficiency (flow and thermal) characteristics. This is equally true of other components of refrigeration and air conditioning systems, e.g., capillary tube restrictors and expansion valves. Moreover, the characteristics of refrigeration and air conditioning systems which have been in operation for extended periods of time will further vary, both by reason of their use and by reason of occasional abuse. Thus, the pumping capability of a compressor will change over a period of a few years due to loss of compression because of wear.
or a decrease in torque of the motor which drives the compressor. For example, a compressor which is rated 2 H.P. and operates for a period of two or three years suffers sufficient wear and deterioration of its working parts to reduce its efficiency to a rating of only 1 ½ - 1 ¾ H.P. As a result, the initial theoretical recommended refrigerant charge for any specific unit can be as much as 10 percent higher than it actually requires for balanced operation.

It is evident that the reduced efficiency of a compressor, by reason of prolonged use or other causal or contributory factors, will result in a refrigerant charge which is greater than the capacity of the compressor, and hence a wet and relatively ineffective evaporator, producing the effect of an overcharged system. To correct this condition, the excess refrigerant should be purged (or restriction added to the restrictor device), but however this condition is corrected the unit no longer has its original B.T.U. rating.

When a refrigeration or air conditioning system requires recharging, the service engineer will charge the system in accordance with the manufacturer’s specifications. Frequently it is discovered that the system appears overcharged, and excessive refrigerant is therefore purged until the proper frost or balance occurs. If weighed, the excess refrigerant may prove to be as much as 10 percent of the original charge. This will also account for the fact that sight glasses may show an undercharge when the system is fully charged to the manufacturer’s specification.

Using the visual indication means provided by the charging procedure herein claimed, both partially charged and completely evacuated systems can be charged properly for good operating performance without otherwise measuring (weighing) the amount of refrigerant which is added to the system.

The operation of the present invention may be briefly stated as follows: Liquid refrigerant - for example, Refrigerant 12 is caused to flow through a restrictor device which converts the liquid refrigerant to a saturated vapor and meters such saturated vapor into the refrigeration or air conditioning system adjacent the low pressure or suction side of the compressor. As the quantity of refrigerant increases in the system, the flow of saturated vapor refrigerant into the system will decrease. The restrictor device is designed with greatest resistance to flow than is encountered in the return suction line from the evaporator, thereby causing this decrease in the flow of saturated vapor refrigerant into the system.

During the process of conducting saturated vapor refrigerant into the system, expansion of the saturated vapor will occur and cause frosting of the suction line between the low side of the compressor and the point of energy of the saturated vapor refrigerant. Some frost will also be in evidence on the restrictor device itself and on the line or hose connection between the restrictor device and the suction line of the system, depending upon ambient conditions.

Initially, the quantity of saturated vapor refrigerant at the point of entry into the refrigeration or air conditioning system and its expansion within the system produce a greater thermal effect than the refrigerant gas which returns from the evaporator through the suction line. A properly designed system with proper charge for efficient and safe operation provides for the suction line gas coming from the evaporator to be approximately 15° above the saturated vapor temperature. The metering operation of the restrictor device will result in a sufficiently low saturated vapor temperature (relative to the temperature of the suction line gas returning from the evaporator) to maintain the frost on the suction line between the point of entry of the saturated vapor and the low side of the compressor until the suction line gas reaches volume adequate to satisfy the displacement of the compressor. When this condition is attained, that is, when sufficient suction line gas returns from the evaporator to satisfy the requirements of the compressor, the introduction of saturated vapor refrigerant into the system will be reduced by the restrictor device to a very small quantity. At this phase of the charging procedure, the suction gas returning from the evaporator becomes the dominant thermal factor at the low side of the compressor, and this causes the frost to melt on the section of suction line which lies between the said low side of the compressor and the point of entry of the saturated vapor refrigerant. Concurrently with the defrosting of the suction line, the flow of saturated vapor refrigerant into the system is stopped manually, and the system will then have a full and optimum charge of refrigerant for efficient and safe operation.

The invention is not limited to any particular types of restrictor devices. Any conventional restrictor device or any device which is capable of functioning as a restrictor to convert liquid refrigerant to a saturated vapor may be used for the purposes of this invention. Examples of restrictor devices which are suitable for the invention are the screw, capillary and orifice types which are illustrated in the drawing. Other devices capable of restricting the flow of liquid refrigerant, such as a needle-type valve, may also be used in connection with the present invention. The sole test is whether the device is capable of restricting and metering the flow of a liquid refrigerant and converting it to a saturated vapor. For the purposes of the claims, a device capable of performing these functions is designated "refrigerant restrictor".

An important feature of the invention resides in the provision and use of a check valve in or in connection with the restrictor device. The purpose of the check valve is to by-pass the restrictor device when a vacuum is drawn on the refrigeration or air conditioning system prior to charging.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a schematic view showing a conventional refrigeration or air conditioning system and a charging mechanism connected thereto, including the charging means which is herein described and claimed.

FIG. 2 is a view of a screw-type restrictor device which may be used in the charging means herein claimed.

FIG. 3 is an inside view of said restrictor device, its outer shell being shown in longitudinal section.

FIG. 4 is a longitudinal section through the entire restrictor device.

FIG. 5 is a transverse section on the line 5—5 of FIG. 4.

FIG. 6 is a transverse section on the line 6—6 of FIG. 4.

FIG. 7 is a transverse section on the line 7—7 of FIG. 4.
FIG. 8 is a longitudinal section through a capillary tube type restrictor device which may be used in the charging means herein claimed.

FIG. 9 is a transverse section therethrough on the line 9—9 of FIG. 8.

FIG. 10 is a transverse section on the line 10—10 of FIG. 8.

FIG. 11 is a longitudinal section through an orifice-type restrictor device which may be used in the charging means herein claimed.

FIG. 12 is a transverse section on the line 12—12 of FIG. 11.

FIG. 13 is a transverse section on the line 13—13 of FIG. 11.

DESCRIPTION OF PREFERRED EMBODIMENTS OF THE INVENTION

Referring now to the details of the invention as illustrated in FIG. 1, it will be seen that a container 10 containing a refrigerant in a liquid state is connected to a restrictor device 12 through a conventional charging mechanism 14 and said charging mechanism is connected through said restrictor device to the low pressure side of a refrigeration or air conditioning system 16.

More particularly, container 10 is connected to a manually controlled valve mechanism 18 which controls the flow of refrigerant from the container to the charging mechanism 14 through a charging line 20. This charging line is connected to a manifold 22 having two ports, 24 and 26 respectively, and two manually controlled valves 28 and 30, respectively, which control the flow through said ports. A line 32 connects port 24 to a valve 34 adjacent the high pressure side of compressor 36. Restrictor device 12 is connected to port 26 of the charging mechanism and a line 38 connects said restrictor device to a valve 40 adjacent the low pressure side of said compressor. Also connected to manifold 22 is a pair of pressure gauges 42 and 44, respectively, which measure the pressures on the high and low sides of the system when valve 18 is closed.

Refrigeration or air conditioning system 16 comprises compressor 36, condenser 46 and evaporator 50, and all of the other conventional components of a refrigeration or air conditioning system, including a discharge line 52 between the high side of the compressor and condenser 46, a liquid line 56 between said condenser 46 and evaporator 50, a filter drier 48 and a capillary tube restrictor device 58 in said liquid line, and a suction line 60 between the evaporator and the low side of the compressor. It will be noted that valve 34 is connected to discharge line 52 and valve 40 is connected to suction line 60. These valves may be of the line-tap variety.

Charging mechanism 14 may be conventional and may be used in conventional manner. With particular reference to the operation of the present invention, this mechanism may be used to charge or recharge, or replenish the charge of, a conventional refrigeration or air conditioning system such as system 16 shown in the drawing. In this operation valve 28 is closed, and valve 30 is opened as indicated in FIG. 1. A flow of refrigerant from container 10 and through valve 18 and charging line 20 would therefore enter manifold 22 and pass through valve 30, port 26, restrictor device 12, line 38 and valve 40 into the low side (suction line 60) of the system. To do this, in accordance with the principles of this invention, refrigerant container 10 is inverted, as shown in FIG. 1, and valve 18 is opened. A flow of liquid refrigerant under pressure is thereby assured, and the liquid refrigerant will flow through the charging mechanism and into restrictor device 12, where it will be converted into a saturated vapor. The saturated vapor will then pass through line 38 and valve 40, into the low side of the system (suction line 60).

As the saturated vapor enters the low side of the system, its expansion causes frosting of the suction line between valve 40 and the compressor. The flow will continue freely until the charge builds up in the system and back pressure is applied to the restrictor device through line 38. This back pressure increases in direct proportion to the increased charge in the suction line and as the back pressure continues to increase it ends to restrict and decrease the flow from the restrictor device. When the pressure in the suction line is stabilized in the system, the flow of refrigerant into the system should be manually shut off. When the flow of refrigerant from restrictor device 12 and line 38 into suction line 60 diminishes relative to the flow from evaporator 50 to the compressor through said suction line, a point is reached when the frost on the suction line between valve 40 and the compressor begins to melt. Melting continues until the refrigerant flow in the refrigeration system is stabilized, and at that point the frost completely disappears, thereby visually signaling completion of the charging operation and the existence of an optimum charge in the system.

Restrictor device 12 shown in FIG. 1 of the drawing exemplifies three restrictor devices which are specifically illustrated in FIGS. 2—13 of the drawing and also all other flow restrictor devices (e.g., needle valve restrictor devices) which may be used in the performance of this invention.

Referring now to screw-type restrictor device 70 shown in FIGS. 2—7 of the drawing, it will be observed that it comprises a generally cylindrical shell 72 having a helically threaded element 74 disposed therein, an inlet fitting 76 at one end of the shell, an outlet fitting 78 at the opposite end of the shell, and a check valve 80 between the inlet fitting 76 and the threaded element 74.

As the drawing clearly shows, threaded element 74 comprises a hollow cylinder, open at both ends, and helically threaded on its outer surface. Threaded element 74 snugly fits within cylinder shell 72 and its helical thread engages the inner wall of said shell to form a helical channel 82 between said threaded element 74 and said shell 72. It will now be evident that communication between inlet fitting 76 and outlet fitting 78 may take place either through helical channel 82 or bore hole 84 which extends axially through threaded element 74.

The function of check valve 80 is to close off bore hole 84 when it is desired to limit communication between said inlet and outlet fittings to said helical channel 82 and any conventional check valve capable of performing this function may be used. However, in the preferred form of the invention, check valve 80 is a magnetic valve which consists of a magnetically responsive disc 86 serving as the valve member proper, an annular seat 88 therefor formed at the inlet end of threaded element 74 and a magnet 90 situated in or adjacent said seat 88 to attract disc 86 and to hold it in closed position against said seat. This prevents a flow.
through bore hole 84 from inlet fitting 76 to outlet fitting 78.

On the opposite side of disc 86 from magnet 90 is a disc retainer 92. This retainer may assume various forms, for example the form of a ring 94 with stud elements 96 projecting therefrom in the direction of disc 86. Shell 72 is crimped or rolled to form annular external grooves 98 and 100, respectively, on opposite sides of ring 94. Internally, these annular grooves form annular beads which engage the opposite sides of ring 94 and hold it securely in place within shell 72. Back pressure upon disc 86 will dislodge the disc from magnet 90 and seat 88 and cause it to engage stud elements 96. This will open threaded element 74 for an internal flow through bore hole 84. This condition will (before charging) when a vacuum is drawn on the refrigeration or air conditioning system 16.

Inlet fitting 76 is, of course, firmly secured to the inlet end 72a of shell 72. Said inlet fitting has a bore hole 76a formed therethrough, and at its inlet end, said bore hole is enlarged and provided with screw threads 76b. Basket screen 102 is provided at the outlet end of said fitting, extending across bore hole 76a. By the same token, outlet fitting 78 is firmly secured to the outlet end 72b of shell 72. A bore hole 78a is formed through fitting 78, and a basket screen 104 is secured to said fitting at its inlet end across said bore hole. It will be understood that inlet fitting 76 may be coupled to a complementary fitting secured to manifold 22 at port 26, and outlet fitting may be joined to line 38 in conventional manner.

In the operation of the restrictor device last above described, refrigerant container 10 is inverted as shown in FIG. 1 to insure a flow of liquid refrigerant (as distinguished from a vapor or a gas) therefrom. The container is, of course, pressurized, since the refrigerant is contained therein in liquid form, and its normal or natural state at room temperature is that of a gas. A pound of liquid Refrigerant 12 expands to 3.8 cubic feet of vapor at room temperature, i.e., 68° Fahrenheit. When valve 18 is opened, the liquid refrigerant will flow under pressure from said container 10, through said valve, charging line 10, manifold 22, port 26 and restrictor device 70. Since the pressure would now be on the opposite side of valve disc 86 from magnet 90, said valve disc will be held against the valve seat 88 both by magnetic attraction and hydraulic pressure. This will close off bore hole 84 through the threaded element 74 and communication between the inlet and outlet ends of the restrictor device will be confined to helical channel 82. Since the liquid refrigerant will now be caused to flow through said helical channel, its flow will be restricted and metered to the extent dictated by the cross-sectional dimensions of said helical channel and its length, and sufficient to convert the liquid refrigerant to a saturated vapor.

As an illustration, threaded element 74 may be 1.055 inches in over-all (thread crest) diameter, 1.875 inches long, with twelve threads or convolutions per inch, the helical channel defined by the thread describing a 60° triangle in cross-section, with a depth of 0.037 inch. These figures are, of course, purely illustrative, and intended only to exemplify the dimensional characteristics of a conventional restrictor device capable of converting a liquid refrigerant such as Refrigerant 12 into a saturated vapor. As the refrigerant flow through helical channel 82 under the pressure exerted by inverted pressurized container 10, it will be transformed into a saturated vapor and will leave the restrictor device through the outlet fitting 78 in that form.

After the saturated vapor refrigerant leaves restrictor 70, it will flow through line 38 and valve 40 into the low side (suction line 60) of the refrigeration or air conditioning system 16.

Turning now to the second illustrative form of restrictor device which may be used in practicing the present invention, restrictor device 110, shown in FIGS. 8-10 of the drawing, is of the capillary type, comprising a generally cylindrical shell 112, a helically coiled capillary tube 114 encased within the shell, an inlet fitting 116 at the inlet end of the shell, an outlet fitting 118 which may be integral with the outlet end of the shell, and a magnetic check valve 120 mounted within the shell between the inlet fitting 116 and the inlet end 122 of the capillary tube. Once again, the use of a magnetic valve is purely illustrative and other conventional check valves may be used in its place and stead.

It will be noted that the inlet end 122 of the capillary tube is supported by an annular element 124 which is positioned between an annular shoulder 126 in shell 112 and inlet fitting 116. Valve seat 128 of check valve 120 is formed on annular element 124 and magnet 130 of said check valve is supported by said annular element. A basket screen 132 is mounted on inlet fitting 116, and valve disc 134 is disposed between said basket screen 136 is mounted between the outlet end 138 of the capillary tube and the outlet fitting 118.

The operation of restrictor device 110 may be understood from the foregoing description of the operation of restrictor device 70. The liquid refrigerant passes under pressure from container 10, through valve 18, into and through charging line 20, manifold 22, port 26 and inlet fitting 116 of restrictor device 110. It then passes through basket screen 132 and capillary tube 114 and thence through basket screen 136 and outlet fitting 118. As the liquid refrigerant passes through the capillary tube it is converted into a saturated vapor and it leaves the restrictor device in that form. It is also in that form that the refrigerant is introduced through lines 38 and 60 into the low side of the refrigeration or air conditioning system shown in FIG. 1.

The following specifications relating to capillary tube 114 illustrate a capillary tube restrictor device capable of functioning to convert Refrigerant 12 from liquid to saturated vapor form: Capillary tube 114 has an O.D. of 0.083 inch, and an I.D. of 0.031 inch. It is 36 inches long and wound into 11 coils having an O.D. of 1.050 inches.

The third illustrated form of restrictor device which may be used in connection with the present invention is shown in FIGS. 11, 12 and 13. Restrictor device 140 is of the orifice type. It comprises a generally cylindrical shell 143, a magnetic check valve 144 mounted therein, an inlet fitting 146 at the inlet end of said shell, and an outlet fitting 148 at the outlet end of said shell. A check valve, for example magnetic check valve 144, performs the dual functions of a flow restrictor and back pressure relief valve.

More particularly, magnetic check valve 144 includes an annular member 150 which is secured by means of cramped formations 152 and 154 to the inner wall of shell 142. A valve seat 156 is formed on one side of annular member 150, and a magnet 158 is secured
to said annular member within said valve seat. Valve disc 160 is disposed between valve seat 156 and a disc retainer 162 which is held in place in shell 142 by means of crimped formations 164 and 166 formed therein. It will of course be understood that valve disc 160 and disc retainer 162 are situated on the inlet side of annular member 158, that is, between said annular member and inlet fitting 146. It will be noted that mounted on the outlet side of said annular member 150, that is between said annular member and outlet fitting 148, is a basket screen 170.

It will now be observed that valve disc 160 has a pinhole opening 172 formed therein. It is this opening which functions to restrict the flow of liquid refrigerant sufficiently to convert the refrigerant to a saturated vapor. Once again, the flow of refrigerant follows the circuit indicated in FIG. 1 and described in connection with the screw-type restrictor device 70 and the capillary tube type restrictor device 110.

The foregoing is descriptive of preferred forms of the invention, and they are not to be construed as limiting the invention. Any form of flow restrictor device may be used, whether built into, or separate from, the refrigeration or air conditioning system, provided that a flow of saturated vapor refrigerant is directed into the low side of the system.

For the purposes of the claims, the term "liquid refrigerant" is intended to mean any conventional refrigerant which is in a gaseous state at ordinary room temperature and under atmospheric pressure. Such refrigerants are pressurized to reduce them to a liquid phase, and they are under pressure when maintained in such phase. Illustrative of such refrigerants are the various refrigerants made and sold by E. I. duPont de Nemours under the trademark FREON. Examples are the refrigerants which are designated R-11 (trichloromonomfluoromethane) and R-12 (dichlorodifluoromethane). R-12 has a boiling point of −21.79 Fahrenheit at atmospheric pressure. For the purpose of the claims the expression "substantial pressure" is intended to indicate the flow pressure of liquid refrigerant from an inverted container.

I claim

1. A method of charging a refrigeration or air conditioning system having a compressor, a condenser on the high pressure side of the compressor, and an evaporator on the low pressure side of the compressor, said method comprising the steps of:
   a. providing a flow of liquid refrigerant by removing the refrigerant in liquid phase and under pressure from a refrigerant container,
   b. converting all the removed liquid refrigerant to saturated vapor refrigerant by passing it under pressure through a refrigerant restrictor, and
   c. directing the saturated vapor refrigerant under pressure into the low pressure side of the refrigeration or air conditioning system while said system is in operation,
   d. thereby subjecting the saturated vapor refrigerant to the suction of the compressor and distributing it throughout the system.

2. The method of claim 1, wherein:
   a. the saturated vapor is caused to flow into the suction line of the system at a point of entry adjacent the low side of the compressor,
   b. whereby frost is caused to form on said suction line between the point of entry and the compressor, and
   c. stopping the flow of saturated vapor into the suction line when the frost melts.

3. In combination with a refrigeration or air conditioning system having a compressor, a condenser on the high pressure side of the compressor, a refrigerant charging means comprising:
   a. a flow source of liquid refrigerant under substantial pressure and external to said refrigeration or air conditioning system, said liquid refrigerant being normally gaseous at atmospheric pressure and room temperature,
   b. a refrigerant restricting means having an inlet end and an outlet end,
   c. connecting means between the flow source and the inlet end of said refrigerant restricting means to provide a flow of liquid refrigerant through said refrigerant restricting means under pressure,
   d. said refrigerant restricting means being adapted to convert all the liquid refrigerant removed from the flow source to a saturated vapor while passing through said refrigerant restricting means, and
   e. connecting means between the outlet end of the refrigerant restricting means and the low pressure side of the refrigeration or air conditioning system between the compressor and the evaporator to provide a flow of saturated vapor refrigerant under pressure into said system.

4. Refrigerant charging means in accordance with claim 4, wherein the refrigerant restricting means comprises:
   a. a hollow cylindrical body, and
   b. a helically threaded screw mounted therein,
   c. a helical channel being thereby provided between the screw and the hollow cylindrical body to conduct the liquid refrigerant in a helical path and restrict and meter its flow,
   d. thereby converting the liquid refrigerant to a saturated vapor.

5. Refrigerant charging means in accordance with claim 4, wherein the refrigerant restricting means comprises:
   a. a capillary tube which conducts the liquid refrigerant and restricts and meters its flow,
   b. thereby converting the liquid refrigerant to a saturated vapor.

6. Refrigerant charging means in accordance with claim 4, wherein the refrigerant restricting means comprises:
   a. a hollow body having an inlet and an outlet end, and
   b. a partition extending across the hollow body, internally thereof,
   c. an orifice being formed in said partition to provide communication between said inlet and outlet ends of the hollow body in order to conduct the liquid refrigerant therethrough and to restrict and meter its flow,
   d. thereby converting the liquid refrigerant to a saturated vapor.

7. Refrigerant charging means in accordance with claim 4, wherein:
   a. a bypass and a check valve are provided in the refrigerant restricting means,
   b. said check valve being operative to close the bypass during a charging operation and to open the bypass to permit a vacuum to be drawn on the refrigeration or air conditioning system.
Disclaimer
Hereby enters this disclaimer to all claims of said patent.
[Official Gazette June 19, 1979.]