

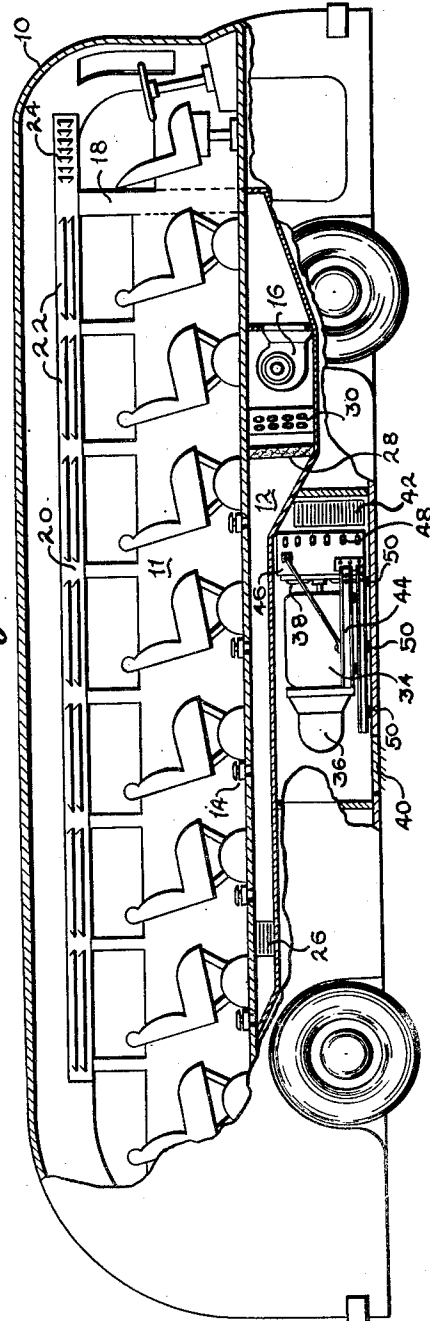
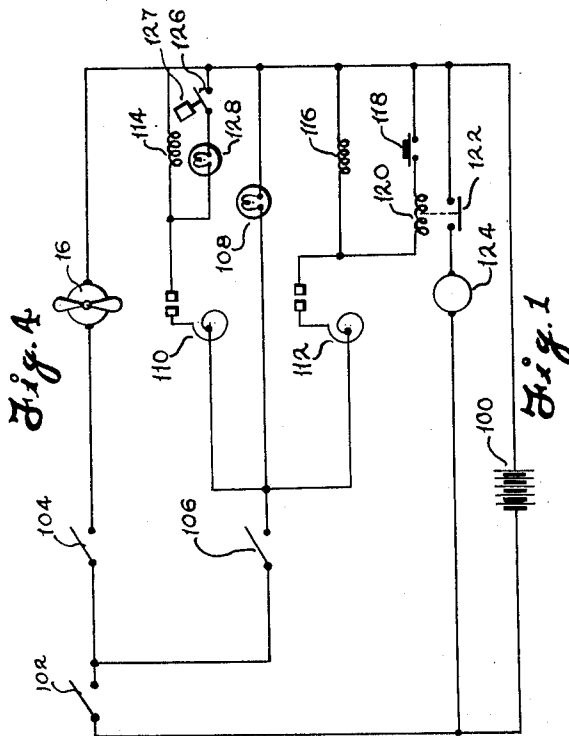
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R. E. GOULD ET AL
REFRIGERATING APPARATUS

2,338,931

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3 Sheets-Sheet 1



INVENTORS

Richard E. Gould and
Charles F. Homan
BY Spencer, Hardman & Lake
ATTORNEYS

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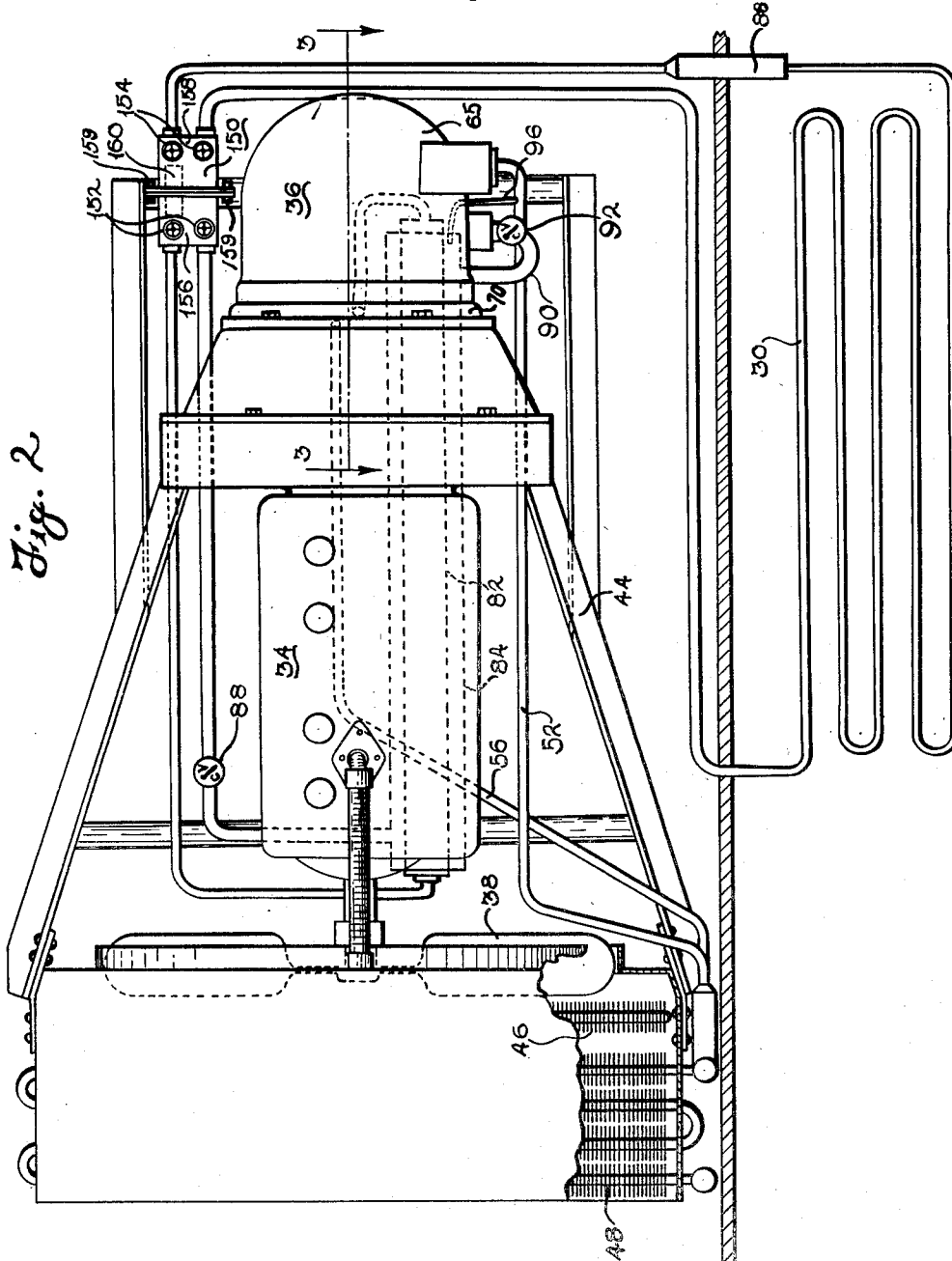
R. E. GOULD ET AL

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REFRIGERATING APPARATUS

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3 Sheets-Sheet 2



INVENTORS
Richard E. Gould and
Charles F. Henney
BY Spencer, Hardman & Fehr
ATTORNEYS

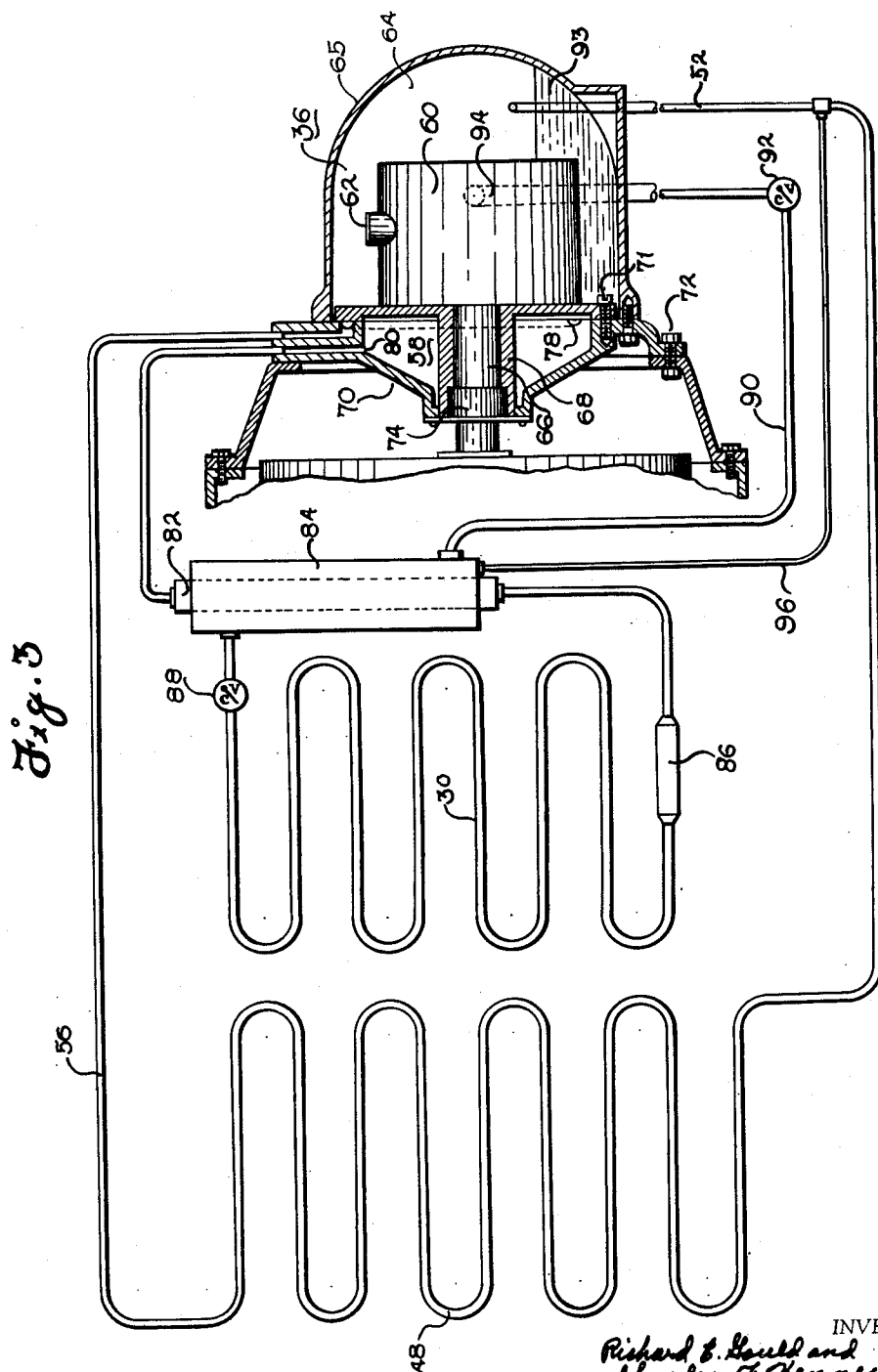
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3 Sheets-Sheet 3



INVENTORS
Richard E. Gould and
Charles F. Kenney
BY
Geneser, Hardman & Fitch
ATTORNEYS

UNITED STATES PATENT OFFICE

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REFRIGERATING APPARATUS

Richard E. Gould and Charles F. Henney, Dayton,
Ohio, assignors to General Motors Corporation,
Dayton, Ohio, a corporation of Delaware

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3 Claims. (Cl. 62—115)

This invention relates to refrigerating apparatus and more particularly to refrigerating apparatus adapted to condition the air for the passenger compartment of a vehicle or the like.

One object of this invention is to provide an improved refrigerant liquefying unit in which the compressor may be directly driven from an internal combustion engine.

Still another object of this invention is to provide an improved shaft seal arrangement for use with a high speed compressor.

A further object of this invention is to provide an improved arrangement for cooling the shaft seal by means of liquid refrigerant.

A still further object of this invention is to provide means for recondensing refrigerant which may have been evaporated in cooling the shaft seal.

Another object of this invention is to provide an improved control circuit for use in the above mentioned refrigerating system.

It is also an object of this invention to improve upon the general arrangement of parts in a refrigerating system of the type adapted to be mounted on a vehicle.

Another object of this invention is to provide an improved means for unloading the compressor so as to facilitate cranking of the compressor engine.

Still another object of this invention is to utilize one chamber of a heat interchanger as an unloading chamber.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings, wherein a preferred form of the present invention is clearly shown.

In the drawings:

Fig. 1 is an elevational view with parts broken away showing the arrangement of the elements on a bus;

Fig. 2 is a top view showing the general arrangement of the refrigerant liquefying unit;

Fig. 3 is a fragmentary sectional view taken on the line 3—3 of Fig. 2, showing diagrammatically the refrigerant flow circuit; and

Fig. 4 is a diagrammatic view showing the electrical controls for the refrigerating apparatus.

In designing air conditioning apparatus for use on a bus or the like, it is important to conserve on space and weight and at the same time, it is also important to provide refrigerant liquefying apparatus, which requires a minimum amount of servicing from time to time. It is also important to design the refrigerating apparatus so

that the refrigerant liquefying mechanism may be disconnected from the refrigerant evaporator without disturbing the supply of refrigerant in the system and without contaminating the interior of the refrigerant flow path.

In Fig. 1, of the drawings, we have shown a preferred embodiment of our invention in which the reference numeral 10 is used to designate a conventional passenger bus having a main passenger compartment 11. An air duct 12 is provided beneath the floor of the passenger compartment and communicates with the passenger compartment 11 through return air passages 14 provided in the floor of the passenger compartment 11. The air to be conditioned is circulated through the duct 12 by means of a blower unit 16 mounted within an enlarged portion of the duct 12. The blower unit 16 withdraws air from the passenger compartment 11 through the openings 14 and discharges the air into a vertical duct 18 which communicates with a horizontally disposed air duct 20 mounted directly above the normal head room of the bus. The duct 20 is provided with louvers such as 22 for directing air into the main passenger compartment and louvers 24 for directing air into the driver's compartment located at the front of the bus. While only one set of air ducts 18 and 20 can be seen in Fig. 1, it is to be understood that a similar set is provided on the other side of the bus whereby the conditioned air discharges into the passenger compartment from both sides of the bus. The desired amount of fresh air may be introduced into the duct 12, through the fresh air grille 26 provided in the side wall of the bus. The mixture of fresh air and recirculated air is caused to flow through an air filter 28 and a refrigerant evaporator 30 also located in the enlarged portion of the air duct 12.

Liquid refrigerant is supplied to the evaporator 30 by the refrigerant liquefying apparatus mounted beneath the air duct 12. The refrigerant liquefying apparatus comprises an internal combustion engine 34 which is direct connected to a rotary compressor unit 36. The internal combustion engine 34 also drives a fan 38 which circulates air in through the inlet 42 and out through the outlet 40. The internal combustion engine 34 and its associated elements are mounted on a frame 44 which also supports the engine radiator 46 and the refrigerant condenser 48. The frame 44 is removably and resiliently mounted on the bus by means of a plurality of rubber-like mountings.

Referring now to Fig. 3 in which the refrigerant flow circuit is diagrammatically shown, it is

apparent that the compressed refrigerant leaving the compressor 36 via the line 52, first enters the condenser 48 in which the compressed refrigerant vapor is converted into liquid refrigerant. The liquid refrigerant leaves the condenser 48 through the line 56. The liquid refrigerant flowing in line 56 discharges into a shaft seal cooling chamber 58 through the opening 78 located adjacent the bottom of the chamber 58. As shown in Fig. 3, the compressor 36 comprises a conventional rotary compressor unit 60 which discharges the compressed refrigerant at 62 into the chamber 64 formed by the outer shell 65. The compressor operating shaft 66 which is an extension of the engine shaft, is supported in a bearing element 68 secured to the casting 70 by means of bolts 71. The member 70, in turn, is bolted to the engine housing by means of bolts 72.

In order to simplify this disclosure, the details of the gaskets which are used for sealing the joints between the main compressor casing 65 and the elements 68 and 70 have been omitted. It is to be understood, however, that the joints between these elements are refrigerant tight. In order to prevent the escape of refrigerant along the shaft 66, a conventional shaft seal unit 74 has been provided. Inasmuch as shaft seals of this general type are old and inasmuch as the specific details of the shaft seal are immaterial, the details of the shaft seal structure have not been shown.

Inasmuch as shaft seals of all types will generate a certain amount of heat especially at high shaft speeds and inasmuch as it is desirable to provide a direct connection between the engine and the compressor and to operate the compressor at high speeds, it is important to provide some unfailing means for cooling the shaft seal 74. In order to cool the shaft seal 74 all of the liquid refrigerant leaving the condenser 54 is caused to flow directly into the chamber 58 surrounding the main compressor bearing and the shaft seal mechanism 74. The liquid refrigerant discharges into the cavity 58 at the point 78 and leaves the cavity at 80. Inasmuch as the heat generated is at times sufficient to vaporize a portion of the liquid refrigerant flowing through the cavity 58, the refrigerant leaving the cavity 58 is circulated through the inner section 82 of a heat interchanger 84 which also functions as a receiver for the condensed liquid refrigerant. The liquid refrigerant leaving 82 flows through a conventional fixed restrictor 86 before entering the evaporator 30. The fixed restrictor 86 may be any one of several well known types, such as a long length of small diameter capillary tubing or it may be of the type disclosed in Patent No. 2,063,745. A check valve 88 is provided at the outlet of the evaporator so as to prevent the reverse flow of the refrigerant back into the evaporator. The refrigerant vapor leaving the evaporator 30 is at a relatively low temperature and is passed through the heat interchanger 84 wherein it serves to cool the refrigerant flowing through the inner portion 82 of the heat interchanger. Any refrigerant which may have been evaporated in the chamber 58 is recondensed in the interchanger. The refrigerant vapor coming from the evaporator 30 flows from the heat interchanger 84, through pipes 90, check valve 92 and thence the inlet 94 of the pump 60. The check valve 92 prevents any of the lubricant 93 from backing up into the interchanger 84 during the "off" cycle.

Inasmuch as the compressor is direct connected to the internal combustion engine, it is desirable to provide means for unloading the compressor after each shut-down so as to avoid having to crank the engine when the compressor is under load. For this purpose, I have provided a small capacity by-pass line 96 between the compressor discharge line 52 and the outer chamber of the heat interchanger 84. The by-pass line 96 is in the form of a very small tube whereby the quantity of refrigerant by-passed through the line 96 does not materially reduce the capacity of the refrigerant system while the compressor is in operation. The small capacity by-pass does, however, serve to equalize the pressure between the compressor outlet line 52 and the heat interchanger 84 in a relatively short period of time during any period of shut-down. By virtue of the check valve 88, the equalization of pressure between the high side of the compressor and the low side of the compressor is limited to only a small portion of the refrigerant circuit.

Referring now to Fig. 4, in which the electrical control circuit is shown, the reference numeral 100 designates a storage battery which may be kept charged by the bus generator in the usual well known manner. Reference numeral 102 designates a manual switch which serves to turn on and off the entire air conditioning system. Reference numeral 104 designates a manual switch provided in the blower motor circuit. Upon closing of the switches 102 and 104, the blower motor 16 is energized and will continue to circulate air within the bus so long as the switches remain closed. Reference numeral 106 designates a manual switch which controls the main thermostats 110 and 112 which in turn control the operation of the internal combustion engine 34. Closing of the switches 102 and 106 also energizes a signal light 108 which may, for example, be mounted in the driver's compartment. Whenever the light 108 is lit this indicates that the switches 102 and 106 are both closed. The thermostat 110 is set to operate at a higher temperature than the thermostat 112. The thermostat 110 controls the circuit to solenoid coil 114 which when energized serves to increase the speed of the engine by opening the engine throttle so as to increase the capacity of the refrigerating system. The low temperature thermostat 112 is in series with the engine ignition coil 116. The thermostats 110 and 112 are preferably placed within the passenger compartment or in the return air stream. Upon closing of the thermostat 112, the ignition coil 116 is energized. In order to start the engine, however, it is necessary for the operator to manually close the normally open starter push button 118 which is arranged in series with the solenoid coil 120. Energization of the coil 120 closes the switch 122 which is arranged in circuit with the conventional engine starter motor 124. The starter motor 124 serves to crank the engine 34 in the usual well known manner. Just as soon as the engine 34 starts, the push button 118 is released so as to open the circuit to the starter motor at 122. As the engine 34 gains speed this automatically causes opening of the switch 126 arranged in series with the indicator light 128. The switch 126 may be of the type in which the air circulated by the engine fan 36 strikes a wind vane 127 carried by the switch 126 thereby opening the switch.

By virtue of the above arrangement, whenever

the temperature within the passenger compartment is above the temperature at which thermostat 110 is set, the signal lamp 128 is energized provided the engine 34 is not operating. This light, therefore, serves to let the operator know that conditioning is required and that he should push the starter button 118 so as to start the engine. Upon starting the engine, the indicator lamp will no longer be lit. If the temperature in the compartment drops below the setting of thermostat 110 the thermostat will open the circuit to coil 114 whereby the speed of the engine will be reduced. If operation of the engine 34 at the reduced speed provides more than the necessary amount of refrigeration, the temperature within the passenger compartment will finally drop below the value at which the thermostat 112 is set, whereby the circuit to the ignition coil 116 will be opened and the engine will be stopped. After each period of shut-down the thermostat 112 is the first to close, but inasmuch as it is not practical to crank the engine at too frequent intervals the operator does not restart the engine until the thermostat 110 is also closed at which time the signal lamp 128 gives the operator notice that the temperature in the passenger compartment is above the desired value and that the engine should be started. It is possible, however, for the operator to restart the engine, if desired, any time after the thermostat 112 has closed. If the engine is started before thermostat 110 is closed the engine will operate at the reduced speed since the coil 114 will not be energized under such conditions.

While I have disclosed two separate thermostats 110 and 112, it is within the purview of this invention to use a single thermostat which closes a first circuit to the ignition coil at one temperature and which closes a second circuit to the throttle control coil 114 at a slightly higher temperature. In order to simplify this disclosure we have shown switches 102, 104, 106 and 118 as manually operated switches whereas these switches may be operated in response to the temperature or humidity of either the outside air or the inside air.

In a refrigerating system of the type adapted to be installed on a bus, it is frequently desirable to remove the engine and the compressor unit from the bus for inspection and repair purposes. In order to facilitate the removal of the engine and the compressor unit from the bus without disturbing the refrigerant charge in the refrigerant circuit, a special separable connector 150 is provided, as shown in Fig. 2. The connector 150 includes a first dual valve housing 156 which carries a pair of manually operable valves 152 and a second dual valve housing 158 which carries a pair of manually operable valves 154. The housings 156 and 158 are normally held together by the bolts 159. The valves are normally open at all times when the refrigerating system is in operation but are adapted to be closed when it is desired to disconnect the evaporator from the rest of the system so as to make it possible to remove the rest of the system from the bus. The arrangement is such that the condenser 48, which is supported on the main frame 44 is removed along with the engine 34 and compressor 36. By closing the valves 152 and 154, the refrigerant connections between the evaporator and the rest of the system may be disconnected without disturbing the refrigerant and lubricant charge

within the system and without introducing any inert gas or moisture into the refrigerant circuit.

It is common practice in the refrigeration art to provide a drier cartridge somewhere in the refrigerant circuit for absorbing any water which may be found in the refrigerant system. Cartridges of this type are well known in the art and usually comprise a body of anhydrous calcium sulphate. These cartridges are of necessity small and can absorb only a limited amount of moisture. I have placed a removable cartridge 160 of this type between the two sections 156 and 158 of the connector 150 whereby upon disconnecting the refrigerant circuit at 150, the cartridge 160 becomes accessible and may be reactivated or replaced so that upon reconnecting the refrigerant system a new cartridge may be inserted which is capable of removing any moisture which may have found its way into the refrigerant circuit.

By virtue of the above described arrangement, the refrigerant liquefying apparatus may be disconnected from the evaporator any number of times without disturbing the refrigerant charge and without destroying the effectiveness of the drying cartridge.

While the form of embodiment of the invention as herein disclosed, constitutes a preferred form, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

What is claimed is as follows:

1. In combination, a compressor including a drive shaft, a shaft seal therefor and a shaft seal cooling cavity, a condenser, an evaporator, a heat interchanger including a first passage and a second passage, refrigerant flow connections for directing the compressed refrigerant leaving the compressor through the condenser, the shaft seal cooling cavity, the first passage of the heat interchanger, the evaporator, the second passage of the heat interchanger and thereafter into the inlet of the compressor, means preventing reverse flow of refrigerant from the second passage of said interchanger to said evaporator, and means for unloading said compressor including means for equalizing the pressure between the second passage of said heat interchanger and the outlet of said compressor.

2. In combination, a compressor including a drive shaft, a shaft seal therefor and a shaft seal cooling cavity, a condenser, an evaporator, a heat interchanger including a first passage and a second passage, and refrigerant flow connections for directing the compressed refrigerant leaving the compressor through the condenser, the shaft seal cooling cavity, the first passage of the heat interchanger, the evaporator, the second passage of the heat interchanger and thereafter into the inlet of the compressor.

3. In combination, a compressor including a drive shaft and a shaft seal therefor, a condenser, an evaporator, refrigerant flow connections between said compressor, condenser and evaporator, said refrigerant flow connections including means for conducting liquid refrigerant from said condenser into thermal exchange with said shaft seal and thereafter into thermal exchange with refrigerant vapor flowing from said evaporator to the inlet of said compressor.

CHARLES F. HENNEY.
RICHARD E. GOULD.