Oct. 26, 1943. R. E. GOULD ET AL 2,332,711

REFRIGERATING APPARATUS

Filed Oct. 29, 1940

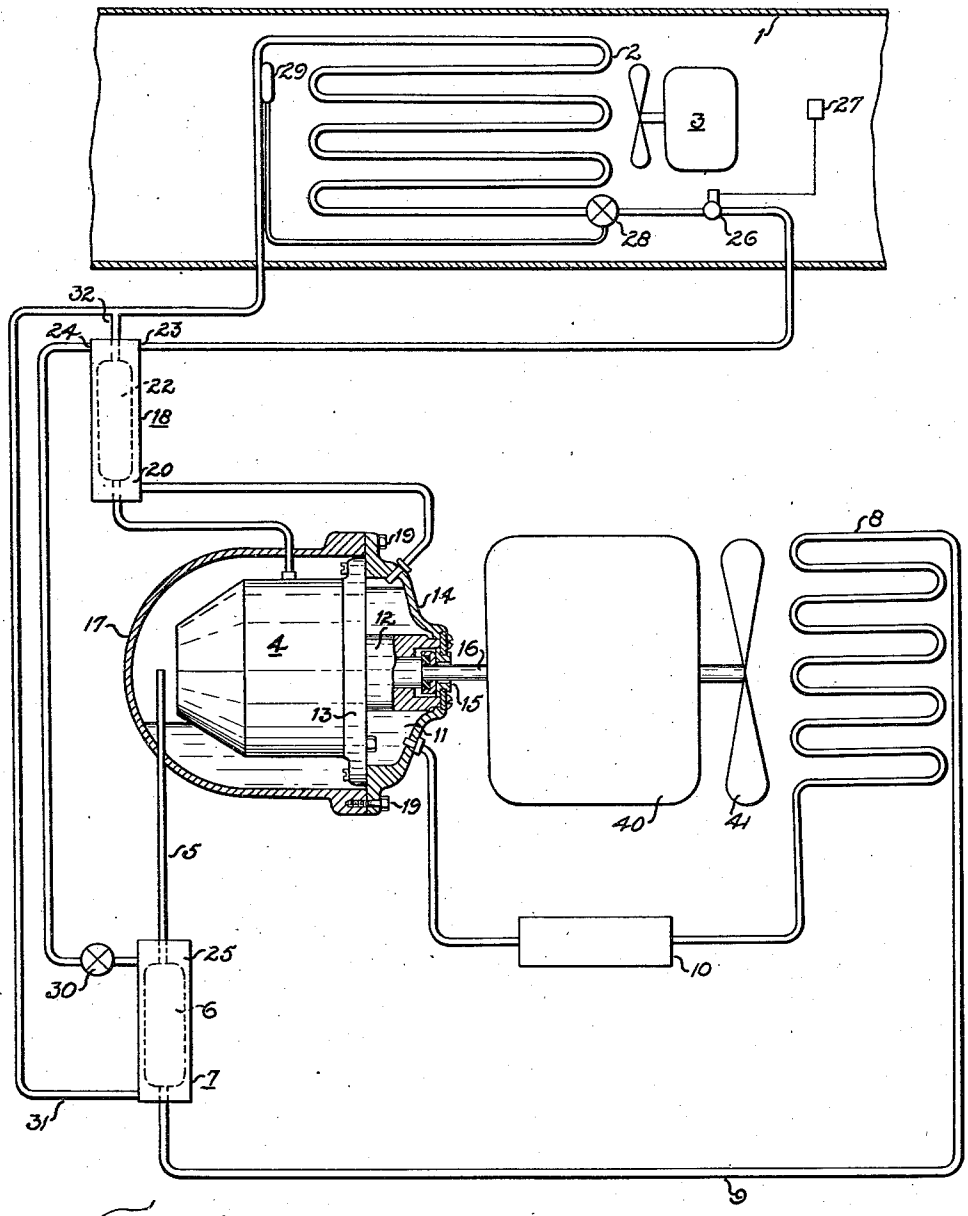


Fig. 1

INVENTOR.
Richard E. Gould and Charles H. Kenney
BY Spencer, Hardman & Fehr.

Patented Oct. 26, 1943 2,332,711

UNITED STATES PATENT OFFICE

2,332,711

REFRIGERATING APPARATUS

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

Application October 29, 1940, Serial No. 363,317

7 Claims. (Cl. 62—115)

This invention relates to refrigerating apparatus and more particularly to refrigerating apparatus in which an internal combustion engine is used for driving the refrigerant compressor.

One object of this invention is to provide an improved system in which a continuously running Diesel engine, or the like, is direct-connected to a refrigerant compressor whereby the compressor is adapted to be operated continuously irrespective of refrigeration requirements.

A further object of this invention is to provide means for cooling and lubricating the compressor when no refrigeration is supplied to the evaporator.

Another object of this invention is to provide improved means for by-passing the main evaporator when no refrigeration is required.

Still another object of this invention is to provide means for improving the efficiency of the refrigerating apparatus.

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

In the drawing:

The drawing diagrammatically shows our invention as applied to a refrigerating system.

As disclosed in the drawing, the reference numeral 1 designates an air duct or a cabinet through which air to be conditioned is circulated. Reference numeral 2 designates an evaporator mounted in the path of the air flowing through the duct 1. The air is circulated by means of a fan unit 3, which may be energized from any suitable source of electrical energy (not shown). The reference numeral 4 designates a conventional rotary compressor which discharges compressed refrigerant into the casing 17 from whence the compressed refrigerant enters the line 5 which leads to the inner passage 6 of the heat interchanger 7. The refrigerant leaving the inner passage 6 is conveyed to the condenser 8 through the line 9. The compressed refrigerant is condensed within the condenser 8 and thereafter flows into a conventional receiver 10. Liquid refrigerant from the receiver 10 is circulated through the compressor cooling chamber 11.

As shown in the drawing, the compressor casing comprises two sections 14 and 17 which are secured together by means of the cap screws 19. The end wall 13 of the compressor 4 separates the interior of the casing into two separate chambers. The chamber 11 surrounds the main compressor shaft bearing 12 which may be formed integrally with the end wall 13 whereby the liquid refrigerant entering the chamber 11 serves to cool the main bearing 12 and also serves to cool the compressor mechanism through the wall 13. A shaft seal 15, of conventional construction, is provided at the point where the main shaft 16 passes through the casing 14. By virtue of the location of the shaft seal 15, the shaft seal is also kept cool by the refrigerant flowing through the chamber 11.

Inasmuch as a portion of the liquid refrigerant entering the chamber 11 may be converted into vapor by the heat generated by the compressor mechanism and the shaft seal, the refrigerant leaving the chamber 11 is caused to discharge into the outer chamber 20 of the heat interchanger 18. As will be pointed out hereinafter, the relatively cold refrigerant vapor leaving the evaporator 2 flows through the inner passage 22 of the heat interchanger 18 whereby the refrigerant vapor entering the outer chamber 20 is recondensed before leaving the chamber 20. The outer chamber 20 is provided with two outlets. A first outlet 23 leads to the main evaporator 2. A second outlet 24 leads to the outer chamber 25 of the heat interchanger 7. The flow of refrigerant from the chamber 20 to the evaporator 2 is controlled by a valve 26 which in turn is controlled by the thermostat 27 which may be located either in the return air stream, as shown, or in the conditioned space. The valve 26 is adapted to be closed whenever the thermostat 27 indicates that the air flowing through the duct 1 does not require further cooling. In addition to the valve 26, a conventional thermostatic expansion valve 28 is provided for controlling the flow of liquid refrigerant to the evaporator 2 whenever cooling is required. The thermostatic expansion valve 28 is of conventional construction and includes the usual thermostatic element 29 placed adjacent the outlet of the evaporator for closing the valve 28 whenever the liquid refrigerant reaches the evaporator outlet.

The flow of refrigerant from the chamber 20 to the chamber 25 is controlled by a conventional expansion valve 30 which is set to open at a much lower pressure than the valve 28. The calibration of the valves 28 and 30 is such that substantially all of the refrigerant flows through the evaporator 21 at all times when refrigeration is required and the only time that the valve 30 is open is when one or both of the valves 26 and 28 are closed. Upon opening of the valve 30, in response to a subnormal suction pressure, a prede-

termined amount of liquid refrigerant will be bypassed around the evaporator 2 into the outer chamber 25 to the heat interchanger 7. This liquid refrigerant will be vaporized when coming in contact with the relatively hot compressed refrigerant gas flowing through the inner chamber 6 of the heat interchanger 7. The refrigerant vaporized in the chamber 25 is conveyed through the passage 31 to the inlet 32, of the chamber 22. Inasmuch as the refrigerant vapor flowing through the passage 31 will be relatively cool, it will serve to condense any refrigerant vapor which may enter the chamber 20.

One purpose of providing the interchanger 18 is to make sure that all of the refrigerant flowing either to the expansion valve 28, or to the expansion valve 30, is in liquid form so that the valves will operate properly. It has been found that valves of this type do not operate properly when refrigerant vapor is mixed with the refrigerant supplied to the valves.

By virtue of the above described arrangement it is apparent that the system will cause a certain amount of refrigerant to be circulated by the compressor at all times even though no refrigerant is supplied to the evaporator 2. Inasmuch as it is frequently desirable to operate the compressor continuously, it is important that a certain minimum amount of refrigerant be circulated at all times so as to provide a constant supply of liquid refrigerant for cooling the compressor. The amount of refrigerant passed by the valve 30 is equal to the amount which must be circulated by the compressor at all times so as to prevent damage to the compressor from overheating or the like. Inasmuch as modern compressors rely upon the circulation of refrigerant through the compressor for supplying lubrication to the compressor, it is also important, from the lubricating standpoint, to circulate a certain minimum amount of refrigerant through the compressor at all times when the compressor is in operation.

The reference numeral 40 designates any conventional compressor operating means such as an internal combustion engine or an electric motor. As shown in the drawing, the compressor operating means 40 also operates the condenser fan 41. In order to simplify this disclosure, no control means have been shown for controlling the operation of the compressor operating means 40 as any conventional control means may be employed. By virtue of the improved arrangement of the refrigerating system, the compressor operating means may be operated continuously at a high speed irrespective of refrigeration requirements without damage to the compressor. The arrangement is also suitable for use in a system in which an internal combustion engine is operated at high speeds part of the time and at low speeds part of the time without any regard for the refrigeration requirements. Since the refrigerant compressor may be operated at high speeds even when refrigerant is not being supplied to the evaporator without injury to the compressor mechanism, the system is also well adapted for use with a continuously running direct-connected electric motor.

For purposes of illustration we have shown a system in which the refrigerant flowing through the by-pass valve 30 is evaporated by flowing through the heat interchanger 7, whereas it is within the purview of this invention to evaporate this refrigerant by other means. When an internal combustion engine is used for operating the compressor, the exhaust gas or the hot engine jacket water could be used in evaporating the refrigerant flowing through the by-pass. The by-passed refrigerant could also be used in doing useful cooling such as freezing ice, cooling air or the like.

The valve 30 which is arranged in the by-pass line may, if desired, be adjusted so as to allow a predetermined amount of refrigerant to leak through the by-pass line even though the suction pressure is above the value at which the valve 30 moves to its fully open position. Leakage through the by-pass around the evaporator reduces the capacity of the evaporator whereby the valve 26 opens and closes less frequently. This causes smoother operation of the refrigerating system and, to a great extent, prevents frequent temperature fluctuations within the conditioned space.

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, a continuously running internal combustion engine for operating said compressor, a first evaporator, a second evaporator, a condenser, means for conveying liquid refrigerant from said condenser into thermal exchange with said compressor and thereafter in thermal exchange with refrigerant vapor leaving either one of said evaporators so as to recondense the refrigerant vaporized in thermal exchange with said compressor, and means for thereafter conveying said recondensed refrigerant to one of said evaporators.

2. In combination, a compressor having a casing through which a compressor operating shaft projects, shaft seal means for said shaft, a prime mover for driving said shaft, a condenser, an evaporator, a shaft seal cooling cavity, refrigerant flow connections between said evaporator, compressor, condenser and shaft seal cooling cavity, means for by-passing said evaporator, means for vaporizing refrigerant flowing through said by-pass, and means responsive to the suction pressure of said compressor for controlling the flow of refrigerant through said by-pass.

3. In combination, a compressor, a condenser, an evaporator, a compressor cooling cavity, refrigerant flow connections between said evaporator, compressor, condenser and compressor cooling cavity, valve means for preventing the flow of refrigerant to said evaporator, said refrigerant flow connections and said condenser being so constructed and arranged as to supply refrigerant to said compressor cooling cavity when said valve means prevents the flow of refrigerant to said evaporator and also when said valve means permits the flow of refrigerant to said evaporator.

4. In combination, a first evaporator, a second evaporator, refrigerant liquefying means including a condenser portion, means for conveying liquid refrigerant from said condenser portion into thermal exchange relationship with another portion of said refrigerant liquefying means and thereafter in thermal exchange relationship with refrigerant leaving either one of said evaporators so as to recondense the refrigerant vaporized while in thermal exchange relationship with said other portion, and means for thereafter

conveying said recondensed refrigerant to one of said evaporators.

5. In combination, a compressor, a condenser, an evaporator, refrigerant flow connections between said compressor, condenser and evaporator, means for by-passing refrigerant around said evaporator, means for passing the liquid refrigerant flowing to either said by-pass or said evaporator in thermal exchange with said compressor, valve means controlling the flow of refrigerant to said evaporator, valve means controlling the flow of refrigerant through said by-pass, and means for conveying refrigerant flowing through said by-pass in thermal exchange with refrigerant flowing from said compressor to said condenser.

6. In combination, a motor-compressor unit, a first evaporator, a second evaporator, a condenser, means for conveying liquid refrigerant from said condenser into thermal exchange relationship with a portion of said motor-compressor unit and thereafter into thermal exchange relationship with refrigerant vapor leaving one of said evaporators so as to recondense the refrigerant vaporized in thermal exchange with said compressor.

7. In combination, a compressor, means for operating said compressor, a first evaporator, a second evaporator, a condenser, means for conveying liquid refrigerant from said condenser into thermal exchange with said compressor and thereafter in thermal exchange with refrigerant vapor leaving either one of said evaporators so as to recondense the refrigerant vaporized in thermal exchange with said compressor, and means for thereafter conveying said recondensed refrigerant to one of said evaporators.

RICHARD E. GOULD.
CHARLES F. HENNEY.