Sept. 7, 1943. A. A. McCORMACK ET AL 2,328,824

REFRIGERATING APPARATUS

Filed Feb. 19, 1942 2 Sheets-Sheet 1

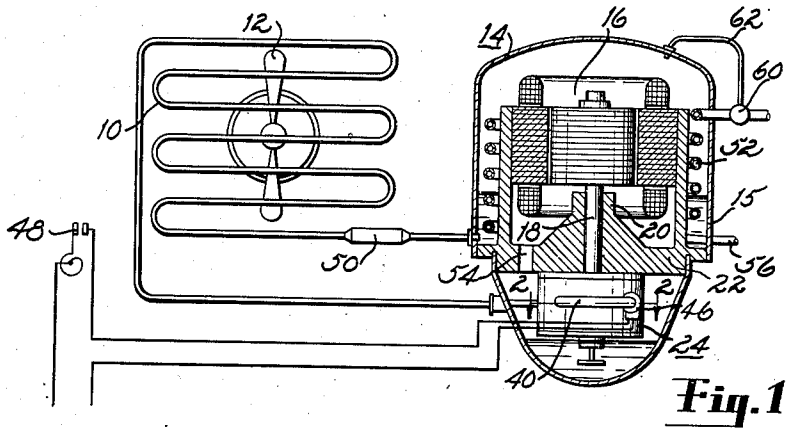

Fig. 1

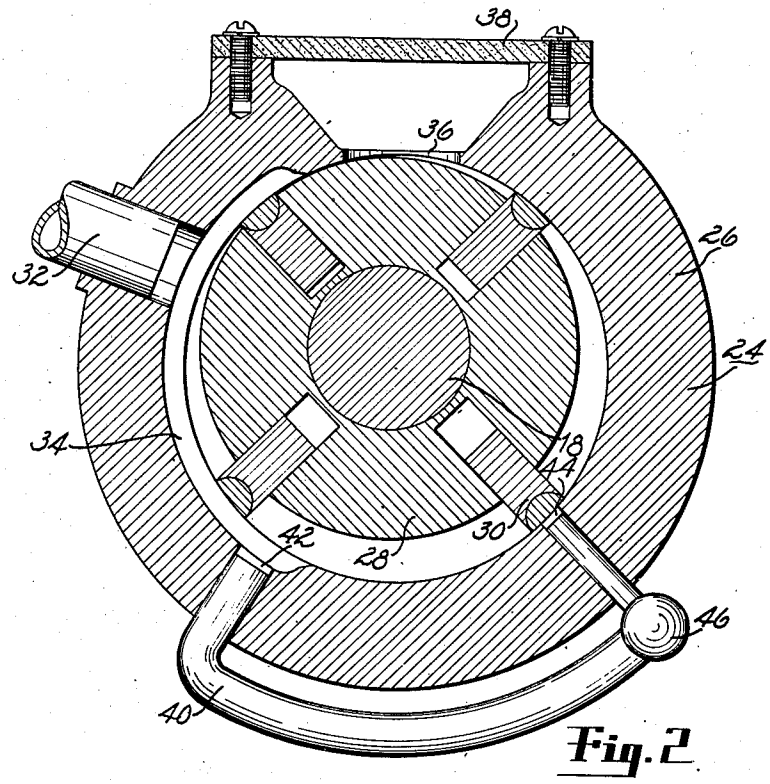

Fig. 2

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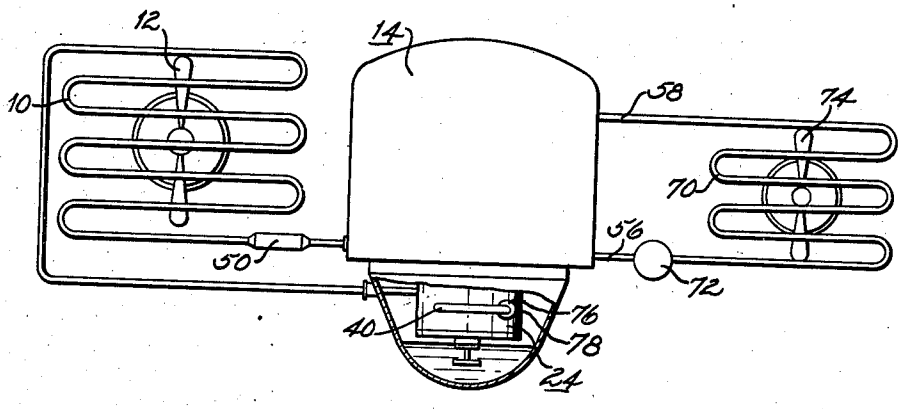

Fig. 3

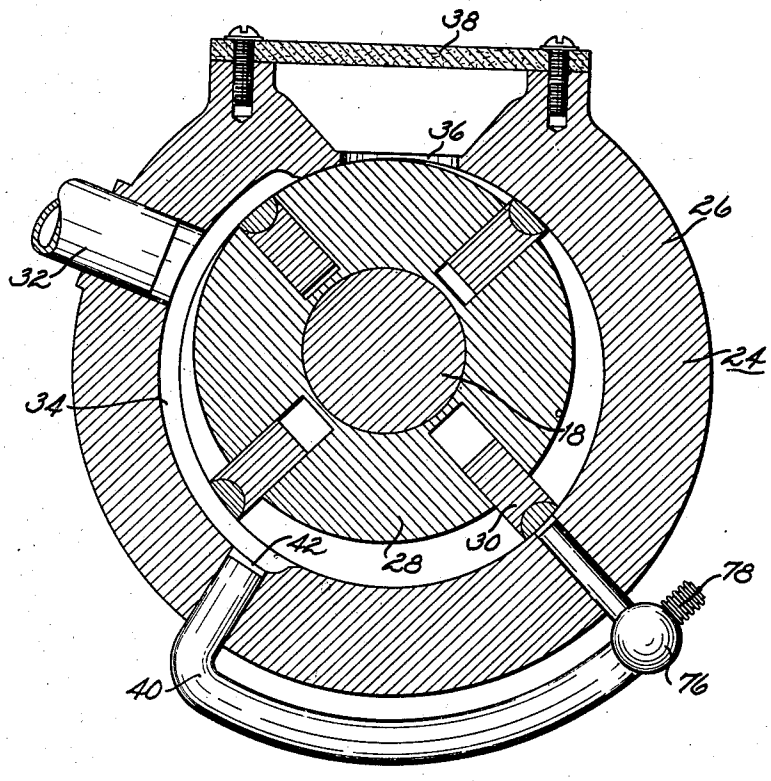

Fig. 4

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UNITED STATES PATENT OFFICE

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REFRIGERATING APPARATUS

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Application February 19, 1942, Serial No. 431,472

2 Claims. (Cl. 62—115)

This invention relates to refrigerating apparatus and more particularly to an improved arrangement for varying the capacity of a refrigerating system.

Another object of this invention is to provide an improved arrangement for varying the capacity of a rotary compressor of the multiple vane type by varying the effective displacement of the compressor.

More particularly it is an object of this invention to provide a simple arrangement for increasing the effective length of the inlet port of a 4-vane rotary compressor.

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 diagrammatically shows a refrigerating system embodying our invention;

Fig. 2 is a horizontal sectional view taken on line 2—2 of Fig. 1;

Fig. 3 is a view somewhat similar to Fig. 1 showing a modified system; and

Fig. 4 shows a modified arrangement for controlling the capacity of a 4-vane rotary compressor.

The refrigerating system shown in Fig. 1 comprises a conventional evaporator 10 over which air to be conditioned is circulated by means of a fan 12. A refrigerant liquefying unit generally designated by the reference numeral 14 supplies liquid refrigerant to the evaporator 10. The refrigerant liquefying unit 14 comprises an outer casing 15 in which is mounted a conventional electric motor 16 having a drive shaft 18 supported in the bearing 20 provided in the main frame 22. The lower end of the shaft 18 drives a 4-vane rotary compressor generally designated by the reference numeral 24. The compressor 24 includes the usual cylinder 26 in which a conventional rotor 28 is adapted to operate in accordance with well known practice. Rotor 28 is secured to the main shaft 18 so as to rotate therewith and is provided with four vanes 30 which function in their usual well known manner. The refrigerant to be compressed enters the compressor through the inlet 32 which communicates with a circumferentially extending port 34 constructed in accordance with the usual well known practice. The compressed refrigerant discharges through the usual form of outlet port 36.

In order to simplify this disclosure, no check valve has been shown at the outlet port 36, whereas it is within the purview of this invention to provide a check valve for the outlet port if desired. A piece of porous sintered metal 38 has been provided adjacent the outlet port 36 so as to assist in separating the lubricant from the compressed refrigerant vapor leaving the outlet port 36. The compressor mechanism described so far is merely conventional compression mechanism.

In the usual form of rotary compressor, no means is provided for varying the effective displacement of the compressor, whereas in the arrangement disclosed, means has been provided for varying the effective displacement of the compressor. This means comprises a by-pass 40 having the one end thereof communicating with the circumferentially extending port 34, as shown at 42 and the other end thereof communicating with an auxiliary port 44. A valve 46 has been provided intermediate the ends of the by-pass 40 so as to control the flow of refrigerant through the by-pass 40. When it is desirable to operate the compressor at full capacity, the valve 46 is held closed whereby no refrigerant is permitted to flow through the by-pass 40. Opening of the valve 46 permits refrigerant to flow through the by-pass 40 whereby the effective circumferential length of the inlet port is increased so that compression does not begin until after the vanes have moved beyond the auxiliary port 44. Thus opening of the valve 46 serves to reduce the capacity of the compressor. The location of the auxiliary port 44 determines the amount of reduction in compressor capacity which results from opening the valve 46. The closer the port 44 is to the port 34, the less will be the reduction in compressor capacity when the valve 46 is opened.

The valve 46 is preferably a solenoid valve which is adapted to be operated by a thermostat 48. The thermostat 48 is preferably arranged so as to respond to the temperature within the space to be cooled. However, it is obvious that this thermostat may be arranged to respond to the temperature of the outside air, the temperature of the condenser cooling medium or to the temperature of the air leaving the evaporator 10.

For purposes of illustration, we have shown a conventional fixed restrictor 50 for controlling the flow of refrigerant from the refrigerant liquefying unit 14 to the evaporator 10. However, the flow of refrigerant from the refrigerant liq-

uefying unit 14 to the evaporator 10 may be controlled by any other suitable means such as a conventional thermostatic expansion valve.

The compressed refrigerant leaving the compressor 24 discharges directly into the main motor compressor housing 15. The lower portion of the housing serves as a lubricant sump in accordance with well known practice. The main frame 22 is provided with one or more apertures 54 through which the compressed refrigerant may pass upwardly into the upper portion of the main housing 15. A water coil 52 is arranged within the housing 15, as shown in Fig. 1. Cold water from any suitable source, such as the city water main, is supplied to the water coil 52 through the supply line 56 and leaves the water coil 52 through the discharge line 58. The flow of water through the water coil 52 is controlled by means of a conventional pressure responsive valve 60 which responds to changes in the condenser pressure whereby a greater amount of water is supplied to the coil 52 at high condenser pressures than at low condenser pressures. A pipe 62 provides communication between the pressure operated valve 60 and the interior of the casing 15. The compressed gas condenses upon being cooled by the water flowing through the coil 52 and serves to collect in the space between the outer shell 15 and the main frame 22.

By virtue of the above described arrangement, the compressor capacity may be varied so as to compensate for changes in the refrigerant requirements. The arrangement for reducing the compressor capacity is such that a corresponding reduction in the power requirements takes place when the compressor capacity is reduced. Another desirable feature of the mechanism for varying the compressor capacity is that it may be added to any conventional 4-vane rotary compressor.

Referring now to Fig. 3 in which we have shown a slightly modified arrangement suitable for use in an air cooled refrigeration system, all of the elements shown therein are similar in construction and function to the corresponding elements shown in Fig. 1 except the control for the compressor capacity varying valve and the control for the condenser cooling water. In a modification shown in Fig. 3, the water for cooling the condenser is used over and over again. Thus, the water leaving the refrigerant liquefying unit through the line 58 is circulated through the water cooling coil 70 by means of a pump 72. A fan 74 is provided for circulating outside air in thermal exchange with the water flowing through the coil 70 so as to remove the heat picked up by the water while flowing through the refrigerant liquefying unit. While we have shown a closed water circuit, it is apparent that an open spray tower, for example, could be substituted for the closed coil 70.

Since the amount of water circulated in a system of this general type remains substantially constant, it is apparent that the pressure within the condenser portion of the volatile refrigerant system will vary substantially in accordance with changes in the condition of the air flowing in thermal exchange with the condenser cooling water. This being the case, it is apparent that the pressure within the casing 15 of the refrigerant liquefying unit may be used to indicate the need for a change in the compressor capacity. Thus, in Figs. 3 and 4, we have disclosed a pressure operated by-pass valve 76 for controlling the flow of refrigerant through the compressor modulating by-pass 40. The valve 76 is a conventional pressure operated valve having a bellows portion 78 which expands and contracts in response to changes in pressure of the compressed refrigerant within the refrigerant liquefying unit. Thus, as the pressure within the unit increases, the bellows 78 causes the valve 76 to close the by-pass 40 so as to cause the compressor to operate at full capacity. As the pressure within the refrigerant liquefying unit decreases to a point where full compressor capacity is no longer required, the valve 76 automatically opens so as to reduce the effective capacity of the compressor. Except for the type of valve used for controlling the by-pass 40, the compressor mechanism, disclosed in the modification shown in Figs. 3 and 4, is identical in construction to the compressor shown in Figs. 1 and 2.

By virtue of the arrangement shown in Figs. 3 and 4, the need for any external electrical connections leading to the by-pass valve has been eliminated. It is also apparent that the simple arrangement disclosed in this modification may be added to any conventional 4-vane rotary compressor without materially altering any of the compressor construction.

While the form of embodiment of the invention an 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 a refrigerating system, an evaporator, a fixed restrictor, a condenser, a multiple vane rotary compressor having inlet and outlet ports, refrigerant flow means between said evaporator, restrictor, compressor and said condenser including a casing within which said compressor is mounted and into which said compressor discharges, means for varying the capacity of said compressor including means for increasing the effective size of said inlet port, and means wholly within said casing responsive to the refrigerant pressure therein for operating said capacity varying means.

2. In combination; an evaporator; a multiple vane rotary compressor having inlet and outlet ports; a condenser; refrigerant flow connections between said evaporator, compressor and condenser; and means for varying the effective capacity of said compressor comprising an auxiliary port intermediate the said inlet and outlet ports, said auxiliary port being narrower than any one of said vanes whereby said inlet port is closed each time a vane passes thereover, and means for controlling the supply of refrigerant to said auxiliary port in response to changes in compressor capacity requirements.

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