Dec. 27, 1949 E. W. ZEARFOSS, JR 2,492,611

REFRIGERATING APPARATUS

Filed Nov. 30, 1944 2 Sheets-Sheet 1

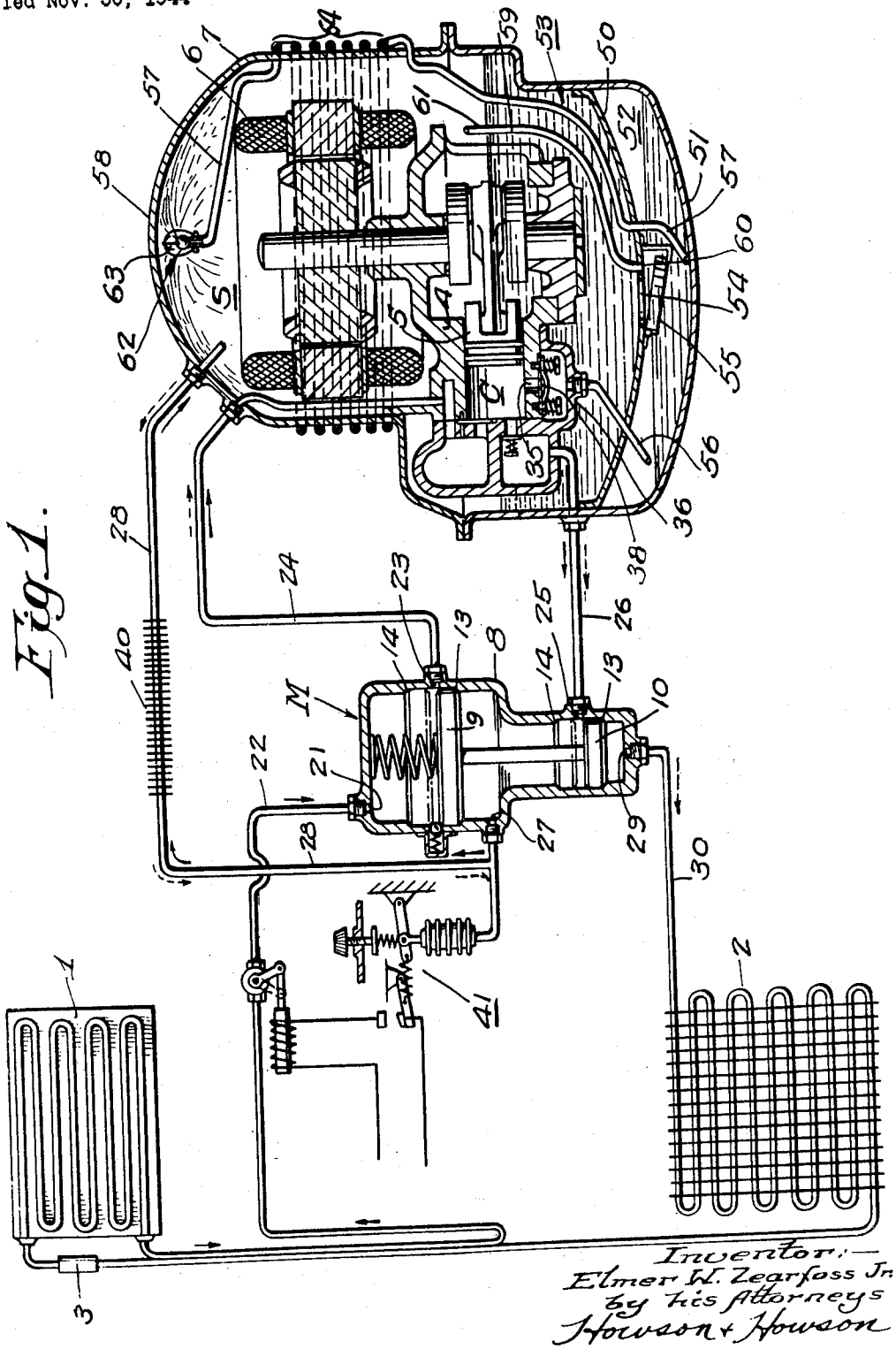


Fig. 1.

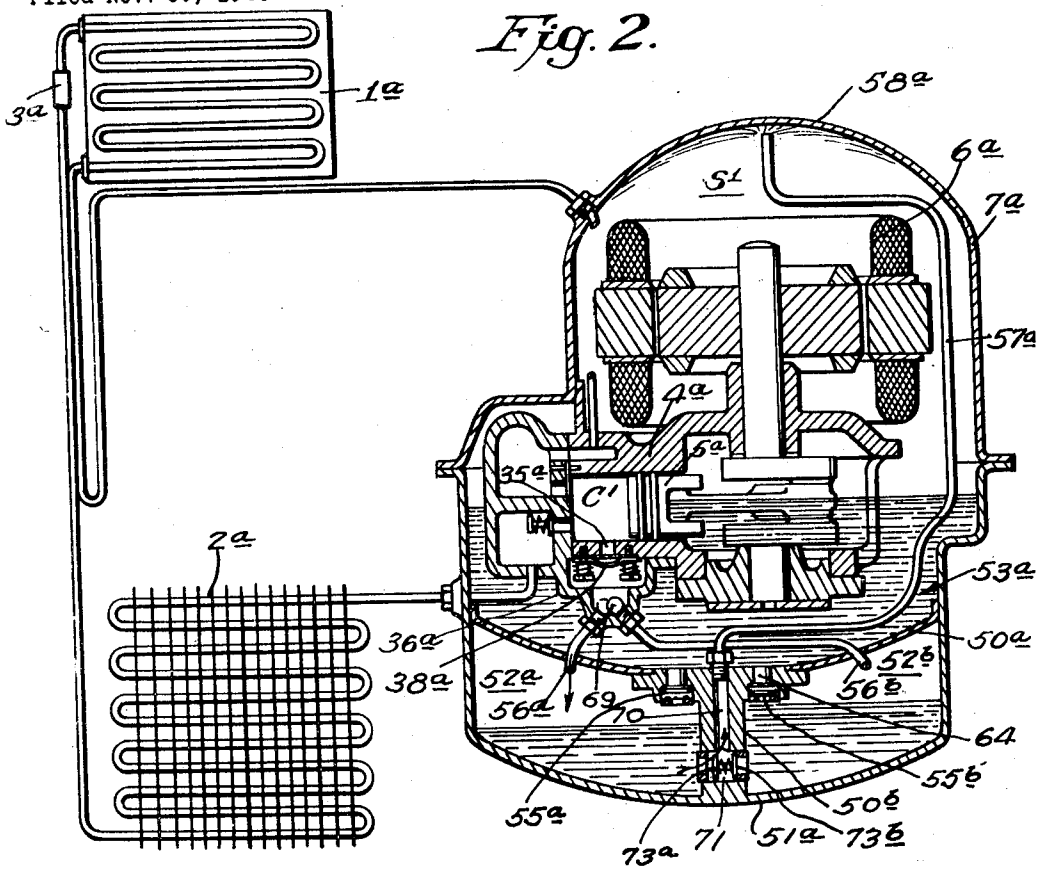
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REFRIGERATING APPARATUS

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Fig. 2.



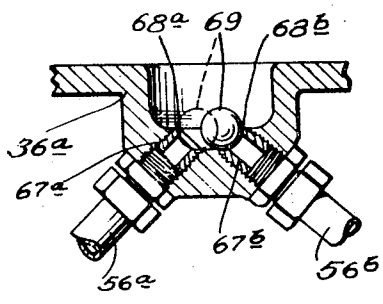


Fig. 4.

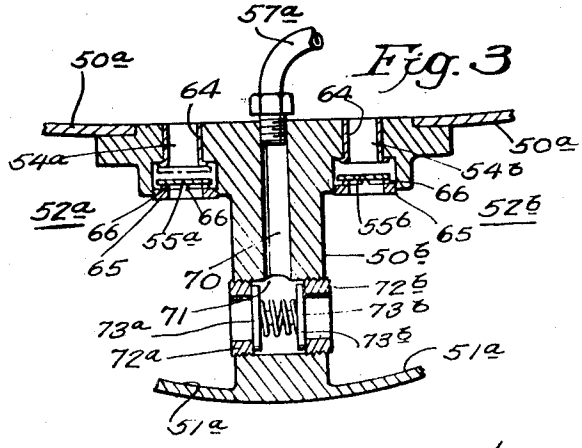


Fig. 3

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2,492,611

REFRIGERATING APPARATUS

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Application November 30, 1944, Serial No. 565,843

11 Claims. (Cl. 62—115)

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The present invention relates to refrigerating apparatus and particularly to motor-compressors for refrigerating systems. More specifically, the invention pertains to improved means for cooling motor-compressor units of the hermetically sealed type.

It is an object of the invention to provide means whereby a motor-compressor unit of the general type above referred to may be effectively cooled by forcibly spraying over the unit a cooling medium, such as oil, from a permanent supply, through operation of the compressor itself thereby eliminating the necessity of additional pumping mechanism for that purpose.

Another object of the invention is to provide an arrangement whereby pressure resulting from operation of the piston of a motor-compressor unit is utilized for the forcible spraying of a cooling medium, such as oil, from a reservoir over the said unit for the purpose of cooling the same.

Still another and more specific object of the invention is to provide a simplified arrangement which may be readily incorporated in a motor-compressor unit of the hermetically sealed type without necessitating material change in the basic structure of said unit, which arrangement employs the normal function of the compressor piston to create a pressure within an oil reservoir inside the motor-compressor housing for displacing the oil from said reservoir for use thereof in cooling the unit.

Other objects and advantages of the invention will appear in the following description which is based upon the accompanying drawings, wherein:

Fig. 1 is a transverse vertical sectional view of a hermetic motor-compressor unit in association with a refrigerating system and illustrating one embodiment of the invention;

Fig. 2 is a view similar to Fig. 1 but illustrating another form of the invention; and

Figs. 3 and 4 are cross-sectional detail views on an enlarged scale of certain port and valve members included in that form of the invention shown in Fig. 2.

In Fig. 1 of the drawings, the invention is shown as applied to the improved multi-stage refrigerant compressing system described and claimed in my copending application, Serial No. 565,842, filed November 30, 1944; whereas in Fig. 2 of the drawings, the invention is shown as applied to the conventional single-stage refrigerant compressing system.

With particular reference to Fig. 1, the aforesaid multi-stage refrigerant compressing system is incorporated in a refrigerant circulating circuit which, conventionally, includes an evaporator 1 and a condenser 2, a suitable refrigerant flow restrictor 3 being interposed between said evaporator and condenser. The compressing system basically comprises a compression chamber C, a hermetically sealed space S and pressure responsive means M, the latter being adapted to control the initiation of the first and second stage operations of said system.

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As shown, the chamber C is defined by a cylinder 4 in which a piston 5 is mounted for reciprocatory motion under operation by a suitable motor 6, and the space S is defined by a housing 7 which hermetically seals the motor-compressor unit. As also shown, the pressure responsive means M is in the form of a multiple valve mechanism comprising a valve body 8 and a pair of spaced, interconnected valve members, 9 and 10 respectively, each adapted to cooperate with valve seats 13 and 14.

It is pointed out that when the valve members 9 and 10 are seated on their respective seats 13, that is, in the position shown in full lines, the system will function for first stage operation. In this position of the valve members, a port 21, which is connected with a conduit 22 leading from the refrigerant evaporator 21, communicates with a port 23 connected with a conduit 24 leading to the compression chamber C; and a port 25 connected with a conduit 26 leading from said chamber C, communicates with a port 27 which is connected with a conduit 28 leading to the hermetically sealed space S. When the valve members 9 and 10 are seated on their respective seats 14, that is, in the position shown in dotted lines, the system will function for second-stage operation. In this position of the valve members, the port 23 communicates with port 27, and port 25 with a port 29 connected with a conduit 30 leading to the refrigerant condenser 2.

In practice, an interstage pressure varying between a predetermined minimum value of, say, 50 pounds per square inch absolute and a predetermined maximum value of, say, 55 pounds per square inch absolute is maintained within the space S, and in operation, if the interstage pressure within the space S is reduced to its minimum value, then the valve members 9 and 10 move to first-stage position, that is, to the position shown in full lines. The flow of refrigerant is then as indicated by the solid arrows in Fig. 1, that is, gaseous refrigerant at suction pressure of, say, 15 pounds per square inch absolute or

substantially atmospheric pressure, is admitted to the compression chamber C through conduit 22, port 21, port 23 and conduit 24, and is discharged at an elevated pressure into the hermetically sealed space S through conduit 26, port 25, port 27 and conduit 28. Continued pumping of the refrigerant causes the pressure in said space to gradually increase until the interstage pressure reaches its predetermined maximum value, say, 55 pounds per square inch absolute, which causes valve members 9 and 10 to move to second stage position, that is, the position shown in dotted lines. The flow of refrigerant is then as indicated by the broken arrows in Fig. 1, that is, gaseous refrigerant at interstage pressure passes into the compression chamber C through conduit 28, port 27, port 23 and conduit 24, and is discharged at higher pressure, say, 180 pounds per square inch absolute, into the condenser through conduit 26, port 25, port 29 and conduit 30. The high pressure gaseous refrigerant gives up its heat in the condenser 2 and condenses therein to return, as liquid, to the evaporator. This second stage operation continues until the interstage pressure within the space S is reduced to its predetermined minimum value, whereupon valve members 9 ad 10 return automatically to their initial positions thereby initiating another first stage operation.

A blow-off port 35 in the side wall of the compressor cylinder 4 and an associated valve 38 are provided for bleeding off a part of the gaseous refrigerant during second stage operation of the system so that the weight of refrigerant handled during both the first and second stages may be substantially balanced and, therefore, the work performed per stroke, and the number of strokes required for each stage, thereby equalized.

An inter-cooler 40 of known structure may be included in the system to remove the heat of first stage compression; and the system may include an overload cutoff arrangement generally indicated at 41 which functions to prevent the imposition of excessive load on the motor, particularly during "pull down" periods, that is, during those periods when the evaporator 1 is working at abnormally high temperatures, such as is the case, for instance, during defrosting cycles.

The system, in so far as described, is the same as that disclosed in my co-pending application aforesaid, and for a more detailed description of the construction and operation of such a system, reference may be had to said co-pending application.

In accordance with the present invention, the aforesaid bleeding of a part of the relatively heavy gaseous refrigerant is utilized for pumping and spraying a cooling medium, such as oil, internally of the motor-compressor housing 7 to cool the motor-compressor unit.

For that purpose, the housing 7 is provided with a partition 50 spaced from the bottom 51 of said housing to define a reservoir 52 in the latter. The partition 50 is shaped to cooperate with the adjoining portions of the housing 7 to form a sump 53 adapted to retain a supply of oil as is customary in motor-compressor units of the general type shown. The partition 50, moreover, has an aperture 54 therein, said aperture establishing communication between the sump 53 and reservoir 52 so that oil may pass from said sump to the reservoir. Suitable valve means, such as disc type valve 55, is associated with the aperture 54

to control the communication between the sump 53 and the reservoir.

A length of tubing 56 extends from the blow-off casing 36 into the reservoir 52 and an oil riser tube 57 extends from said reservoir to a point above the motor 6 in close proximity to the inside surface of the top wall 58 of the motor-compressor housing 7. An equalizer tube 59, having one end 60 opening into the reservoir 52 and the other end 61 extended into the space S to a point above the oil level therein, is preferably provided to establish communication between said space and reservoir when the check valve 55 is opened, it being noted that the end 60 of the equalizer tube 59 is arranged to be sealed off by said valve when the latter is closed.

In the operation of the system, when, during first stage compression, gaseous refrigerant at suction pressure, say, 15 pounds per square inch absolute, is drawn into the compression chamber C, the valve 38 remains closed because then the pressure in said chamber is lower than the pressure in the casing 36. However, during first stage compression, compressed gaseous refrigerant is discharged into the space S to increase the pressure therein so that the force of the increasing pressure in said space plus the force of gravity unseats the check valve 55, thus allowing oil to flow into the reservoir 52. The gas being displaced by the oil entering said reservoir, escapes to the space S through the equalizer tube 59.

Since during second stage compression gaseous refrigerant, at interstage pressure, is passing from the space S to the compression chamber C, the pressure in said chamber tends to decrease, but since a part of such gaseous refrigerant is being bled through the blow-off port 35 and valve 38 into the casing 36 and thence through tube 56 into the reservoir 52, the pressure in the latter tends to increase.

The increased pressure in the reservoir 52 causes the disc valve 55 to close, thereby unbalancing the pressures in the space S and reservoir 52. This unbalancing of pressures forces the oil up through the riser tube 57 and forcibly discharges the oil against the inner surface of the motor-compressor housing 7, causing the oil, cooled by contact with the wall of the housing, to drip downwardly and to cool the unit.

A check valve 62, preferably in the form of a ball 63, associated with the discharge end of the riser tube 57, serves as a means to prevent downward flow through said tube and also as a nozzle to effect spraying of the oil when forcibly emitted through said discharge end.

It will be appreciated that by properly proportioning the elements through the medium of which oil pumping is attained, a considerable quantity of oil may be circulated during each second stage compression, or in other words, during approximately 50% of the time.

If desired, the riser tube 57 may be circulated externally of the motor-compressor housing as indicated at 64, thereby enhancing the cooling effect.

Fig. 2 shows an ordinary refrigerating system comprising an evaporator 1*a*, a condenser 2*a*, a flow restrictor 3*a*, and a motor-compressor unit. The motor-compressor unit shown is of the well known hermetic type including a compression chamber C', which takes the form of a cylinder 4*a* provided with a piston 5*a* actuated by a motor 6*a*, said unit being sealed in a housing 7*a*.

The construction and operation of systems of this type are known in the art. The evaporated

or expended refrigerant flows at suction pressure from the evaporator 1*a* into the space S' within the housing 7*a*. During the intake strokes of the piston 52 gaseous refrigerant flows from said space S' into the compression chamber C' and during the compression strokes of said piston, the refrigerant is compressed to discharge pressure and flows from the chamber C' into the condenser 2*a* where the refrigerant gives up its heat and condenses to flow, as liquid, to the evaporator 1*a*.

In accordance with the form of the invention shown in Fig. 2, a blow-off port 35*a*, opening to a casing 36*a*, is provided in the side wall of the compressor cylinder 4*a*, and a valve 38*a* is associated with said port to allow a part of the gaseous refrigerant being compressed in the chamber C' to escape therefrom. The location of the port 35*a* is such that "blow-off" occurs only during a small percentage of the total compression stroke of the piston 5*a*. Also, in this form of the invention a partition 50*a* and a separator member 50*b* are provided in the lower portion of the housing 7*a* and are disposed in relation to the bottom 51*a* of said housing to define a pair of reservoirs 52*a* and 52*b*. The partition 50*a* is shaped to cooperate with the adjoining portions of the housing to form a sump 53*a* adapted to retain a supply of oil. The partition, moreover, has a pair of apertures 54*a* and 54*b*, which respectively establish communication between the sump 53*a* and the reservoir 52*a*, and between said sump and the other reservoir 52*b*. Suitable valve means, such as disc type valve, 55*a* and 55*b* are respectively associated with the apertures 54*a* and 54*b* to control communication between the sump and the respective reservoirs 52*a* and 52*b*. For that purpose and as more clearly shown in Fig. 3, the apertures 54*a* and 54*b* may be provided with seat-forming elements 64 for the disc valves 55*a* and 55*b*, and the valves may be supported by means of retainer rings 65 having spaced raised portions 66 to permit the flow of oil from the sump 53*a* into the respective reservoirs 52*a* and 52*b*.

Lengths of tubings 56*a* and 56*b* extend from the blow-off casing 36*a* into the reservoirs 52*a* and 52*b* respectively. As more clearly shown in Fig. 4, the ends of the tubings 56*a* and 56*b* are preferably connected with the blow-off casing 36*a* by means of bushings 67*a* and 67*b*, each of which has a valve seat, 68*a* and 68*b* respectively, disposed in angular relationship so that a single valve element, such as a ball 69, may seat itself upon either valve seat 68*a* or 68*b*, as illustrated in Fig. 6. Referring again to Fig. 2, a riser tube 57*a* having one end disposed for communication with the reservoirs 52*a* or 52*b*, extends to a point above the motor 6*a* in close proximity to the inside surface of the top wall 58*a* of the motor compressor housing 7*a*. This riser tube may be circuited externally of the housing in the same manner as shown in Fig. 1. As more clearly shown in Fig. 3, the riser tube 57*a* may communicate with the reservoirs 52*a* and 52*b* by means of a bore 70 formed in the separator member 50*b* and terminating in a cross bore 71 extending transversely through said member. Spaced retainer rings 72*a* and 72*b* may be mounted in said cross bore to provide seats for oppositely facing spring urged valve elements 73*a* and 73*b*.

The operation of the system shown in Fig. 2, is as follows:

During off cycles, that is, when the motor-compressor is idle, the pressure in the space S' and in each of the reservoirs 52*a* and 52*b* is equalized because of the communication between said reservoirs and space. Under these conditions the disc valves 55*a* and 55*b* uncover the apertures 54*a* and 54*b* allowing oil to fill the reservoirs 52*a* and 52*b*.

At the initiation of an on cycle, assuming that the ball valve 69 covers the tubing 56*b*, then compressed gaseous refrigerant will escape through the tubing 56*a* into the reservoir 52*b*, thus keeping the latter at a pressure above the suction pressure of the system, such suction pressure being the pressure against which oil must be pumped. In other words, the gaseous refrigerant escaping into the casing 36*a* tends to expand and flow through the tubing 56*a* into the reservoir 52*a*, thus increasing the pressure tending to force the oil up the riser tube 57*a* and against the inner surface of the motor-compressor housing.

During this pumping action, the valve disc 55*a* is held in closed position sealing the aperture 54*a* due to the pressure force in the reservoir 52*a*. Since the gaseous refrigerant emitted in the reservoir 52*a* must displace the oil by forcing it through the riser tube 57*a*, the flow rate is restricted until the oil level in said reservoir 52*a* falls below the valve controlled opening to the riser tube. The gas flow then is virtually unimpeded as it passes up the riser tube. This increased gas flow or increased velocity of gas passing the ball 69 exerts a force on said ball in a direction to move the same from its position on the seat 67*b* to the seat 67*a*, thereby uncovering tubing 56*a* and covering tubing 56*b*. Accordingly, an oil pumping cycle as above described occurs in the reservoir 52*b*.

Meanwhile, the disc valve 55*a*, associated with the aperture 54*a* between the sump 53*a* and the reservoir 52*a*, opens because of the force effect of the oil above said valve, so that oil then flows into the said reservoir 52*a*. The gaseous refrigerant displaced by the oil as it accumulates in the reservoir, escapes through the aperture 54*a*, or through an equalizer tube similar to the tube 59 in Fig. 1, which tube may be included, if desired, in the structure shown in Fig. 2.

When the oil pumping cycle on reservoir 52*b* is completed, the gas velocities acting on the ball 69 are again increased and operate in the manner hereinbefore described to return said ball into a position to close tube 56*b* and open tube 56*a*.

From the foregoing, it will be apparent that the force effects of gas velocity on ball 69 will increase and move the ball when an oil pumping cycle is completed in either reservoir 52*a* or 52*b*. In the meantime, the other reservoir has been filling so that it is ready to deliver oil upon conclusion of an oil pumping cycle in the first reservoir.

It will be appreciated that by utilizing the system of the present invention it is possible to obtain cooling of a motor-compressor unit by spraying a cooling medium, such as oil, internally of the motor-compressor housing, the spraying being accomplished by the function of the compressor itself so that no additional pumping mechanism is required for the purpose.

It is to be understood that the invention is not limited to the particular structural embodiments herein shown and described, and that such embodiments may be modified within the scope of the appended claims.

I claim:

1. In a refrigerating apparatus, a housing, a compressor unit enclosed in said housing and

including a compression chamber for increasing the pressure of expanded refrigerant, an oil reservoir, means in communication with said chamber and reservoir for diverting a part of the compressed refrigerant under pressure to the reservoir for displacing oil from said reservoir into contact first with wall-portions of said housing to cool such oil and then with said unit to cool the latter, a condenser, and means in communication with said chamber and condenser for discharging another part of the compressed refrigerant under pressure into the condenser.

2. In a refrigerating apparatus, a housing, a compressor unit enclosed in said housing and including a compression chamber for increasing the pressure of expanded refrigerant, an oil sump in the lower section of the housing, a reservoir arranged to receive oil from said sump, and means in communication with said chamber for diverting part of the compressed refrigerant under pressure for displacing oil from said reservoir into contact first with wall-portions in the upper section of the housing to cool such oil and then with the said unit to cool the latter.

3. In a refrigerating apparatus, a housing, a compressor unit enclosed in said housing and including a compression chamber for increasing the pressure of expanded refrigerant, an oil sump in the lower section of the housing, means providing a reservoir arranged to receive oil from said sump, a valve controlled duct between the chamber and reservoir for diversion of a part of the compressed refrigerant under pressure from said chamber to the said reservoir for displacing oil from the latter, and a duct leading from said reservoir for discharging the displaced oil into contact first with wall-portions of said housing to cool such oil and then with said unit to cool the latter.

4. In a refrigerating apparatus, a motor-compressor including a compression chamber for increasing the pressure of expanded refrigerant, a housing enclosing the motor-compressor, partition means in one portion of said housing providing an oil sump and a reservoir adapted to receive oil from said sump, valve controlled port means between said chamber and reservoir for diversion of a part of the compressed refrigerant under pressure from the chamber to the reservoir for displacing oil from the latter, and means extending from said reservoir to another part of the housing for discharging the displaced oil interiorly of the latter into contact first with wall-portions thereof to cool such oil and then with the motor-compressor to cool the same.

5. In a refrigerating apparatus comprising an evaporator and a condenser, a motor-compressor, a housing enclosing the motor-compressor and adapted to receive expanded refrigerant at suction pressure from said evaporator, said motor-compressor having a compression chamber for increasing the pressure of the expanded refrigerant and for discharging the compressed refrigerant to said condenser, partition means in the lower portion of said housing providing an oil sump and a reservoir adapted to receive oil from said sump, valve controlled port means communicating with the reservoir for admitting compressed refrigerant at a pressure above suction pressure into said reservoir to displace oil from the latter, and means leading from said reservoir to a point in the upper portion of the housing for discharging the displaced oil interiorly of said housing into contact first with wall portions thereof to cool such oil and then with the motor-compressor to cool the same.

6. In a refrigerating apparatus, a housing, a compressor unit enclosed in said housing and including a compression chamber for increasing the pressure of expanded refrigerant, an oil supply, a pair of reservoirs adapted to receive oil from said supply, and means in communication with said chamber and operable to direct a part of the compressed refrigerant under pressure to said reservoirs in alternation for displacing oil successively from the reservoirs into contact first with wall-portions of the housing for cooling such oil and then with said unit for cooling the latter.

7. In a refrigerating apparatus, a housing, a compressor unit enclosed in said housing and including a compression chamber for increasing the pressure of expanded refrigerant, an oil supply, a pair of reservoirs adapted to receive oil from said supply, means in communication with said chamber and operable to direct a part of the compressed refrigerant under pressure to said reservoirs in alternation for displacing oil from the reservoirs successively into contact first with wall-portions of the housing to cool such oil and then with said unit to cool the latter, and means for refilling each of said reservoirs while oil is being displaced from the other reservoir.

8. In a refrigerating apparatus, a motor-compressor including a compression chamber for increasing the pressure of expanded refrigerant, a housing enclosing the motor-compressor, partition means in the lower portion of said housing providing an oil sump and a pair of reservoirs each adapted to receive oil from said sump, valve controlled port means connecting said chamber and reservoirs and operable to divert a part of the compressed refrigerant under pressure to said reservoirs for displacing oil from the reservoirs alternately, and conduit means extending from the reservoirs to the upper portion of the housing for discharging the displaced oil interiorly of the latter into contact first with wall-portions thereof to cool such oil and then with the motor-compressor to cool the same.

9. In a refrigerating apparatus, a motor-compressor including a compression chamber for increasing the pressure of expanded refrigerant, a housing enclosing the motor-compressor, partition means in the lower portion of said housing providing an oil sump and a pair of reservoirs each adapted to receive oil from said sump, valve controlled port means connecting said chamber and reservoirs and operable to divert a part of the compressed refrigerant under pressure to said reservoirs in alternation for displacing oil from the reservoirs successively, conduit means extending from the reservoirs to the upper portion of the housing for discharging the displaced oil interiorly of the latter into contact first with wall portions thereof to cool such oil and then with the motor-compressor to cool the same, and means for refilling each of the reservoirs while oil is being displaced from the other reservoir.

10. In a refrigerating apparatus comprising an evaporator and a condenser, a motor-compressor including a compression chamber, a hermetically sealed housing enclosing the motor-compressor, conduit means interconnecting said evaporator, condenser, compression chamber and housing for the circulation of refrigerant therethrough, a device interposed in said conduit means and operable to initiate first and second stage com-

pression operations in said chamber, said device including valve means movable into two alternative positions in response to pressure variations in said housing, said valve means in one of said positions establishing communication between the evaporator and compression chamber and between said chamber and the housing, thereby initiating first stage compression, and in the other of said positions establishing communication between said housing and chamber and between said chamber and condenser, thereby initiating second stage compression, means in the lower portion of said housing providing an oil sump and a reservoir adapted to receive oil from said sump during first stage compression, means in communication with said chamber operable to bleed a part of the refrigerant out of said chamber and into said reservoir during second stage operation thereby to displace oil out of the reservoir during second stage compression, and conduit means extending from the reservoir to a point in the upper portion of the housing for discharging the displaced oil interiorly of the latter into contact first with wall-portions thereof to cool such oil and for subsequent diversion of the oil from said wall into contact with the motor-compressor to cool the latter.

11. In a refrigerating apparatus having an evaporator and a condenser, a motor-compressor including a compression chamber, a hermetically sealed housing enclosing the motor-compressor, conduit means interconnecting said evaporator, condenser, compression chamber and housing for the circulation of refrigerant therethrough, a device interposed in said conduit means and operable to initiate first and second stage compression operations in said chamber, said device including valve means movable selectively into two positions in response to pressure variations in said housing, said valve means being operative

in one position to establish communication between the evaporator and compression chamber and between said chamber and the housing, thereby initiating first stage compression, and being operative in the other position to establish communication between said housing and chamber and between said chamber and condenser, thereby initiating second stage compression, means in the lower portion of said housing providing an oil sump and a reservoir adapted to receive oil from said sump during first stage compression, means in communication with said chamber for bleeding a part of the refrigerant out of said chamber during second stage operation and into the reservoir so as to displace oil out of the reservoir during second stage compression, and a conduit extending from said reservoir to the upper part of the housing for discharging the displaced oil into the housing to cool the motor-compressor, said conduit having a section passing exteriorly of the housing to cool such oil prior to its discharge into said housing.

ELMER W. ZEARFOSS, JR.

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