Nov. 28, 1939. H. F. SMITH 2,181,213

REFRIGERATING APPARATUS

Filed Oct. 31, 1934 3 Sheets-Sheet 1

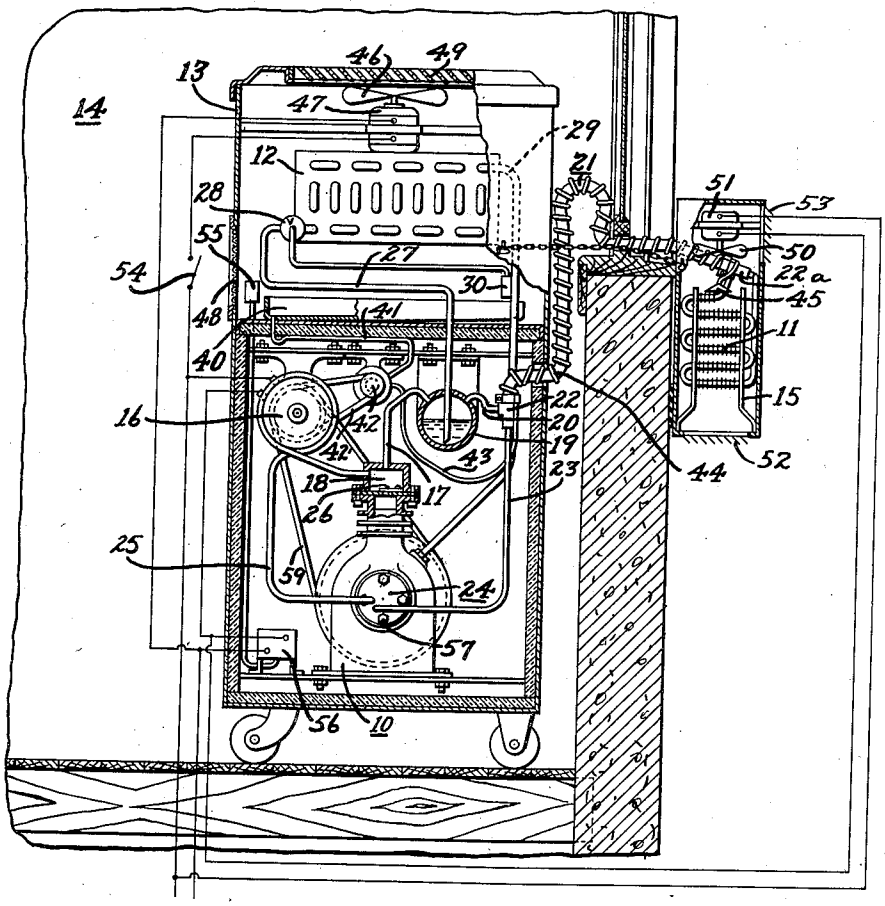


Fig. 1

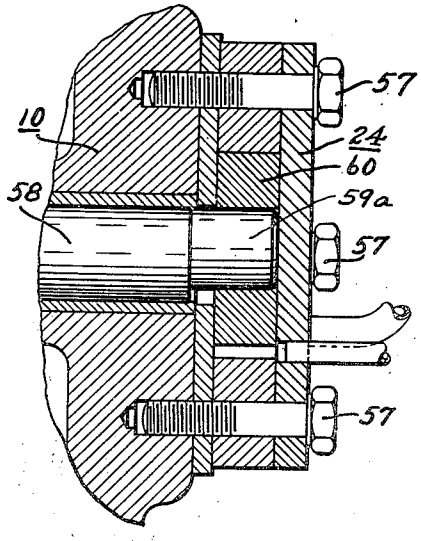


Fig. 2

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REFRIGERATING APPARATUS

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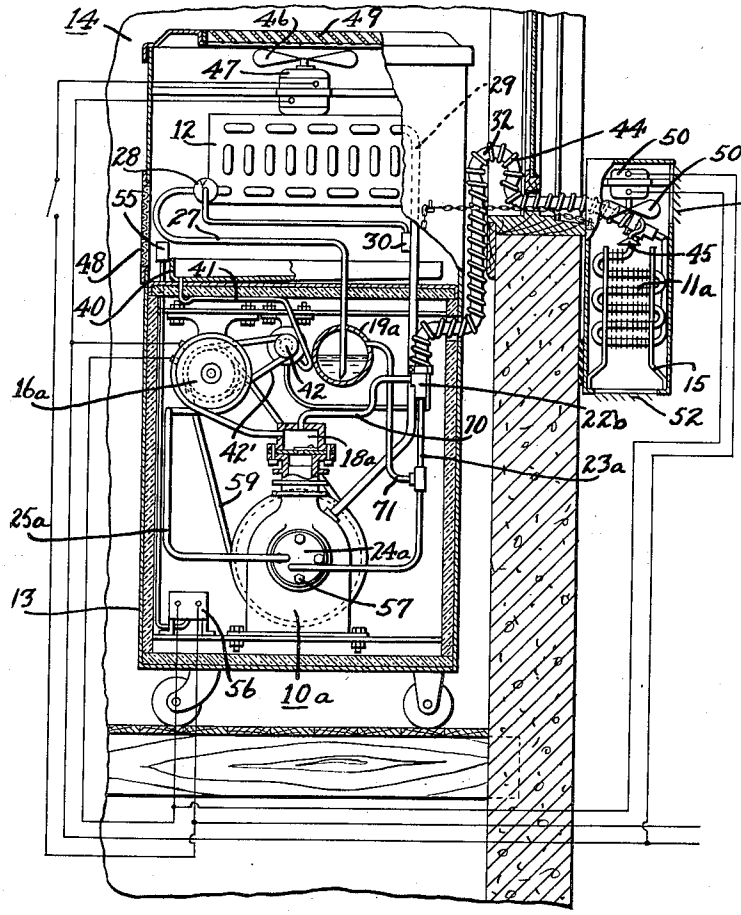


Fig. 3

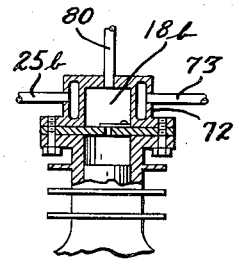


Fig. 6

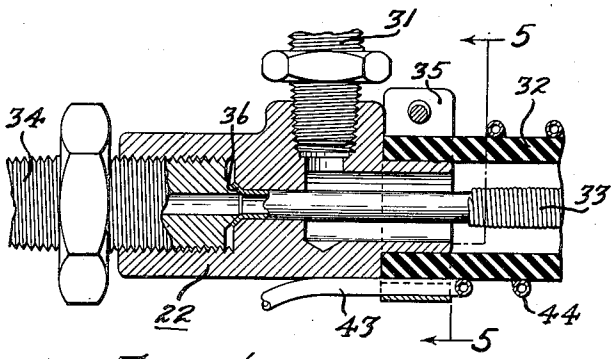


Fig. 4

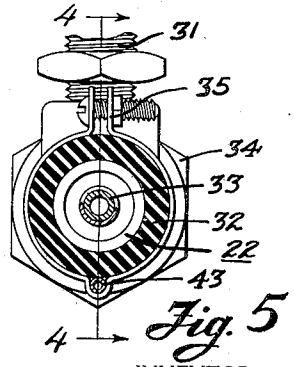


Fig. 5

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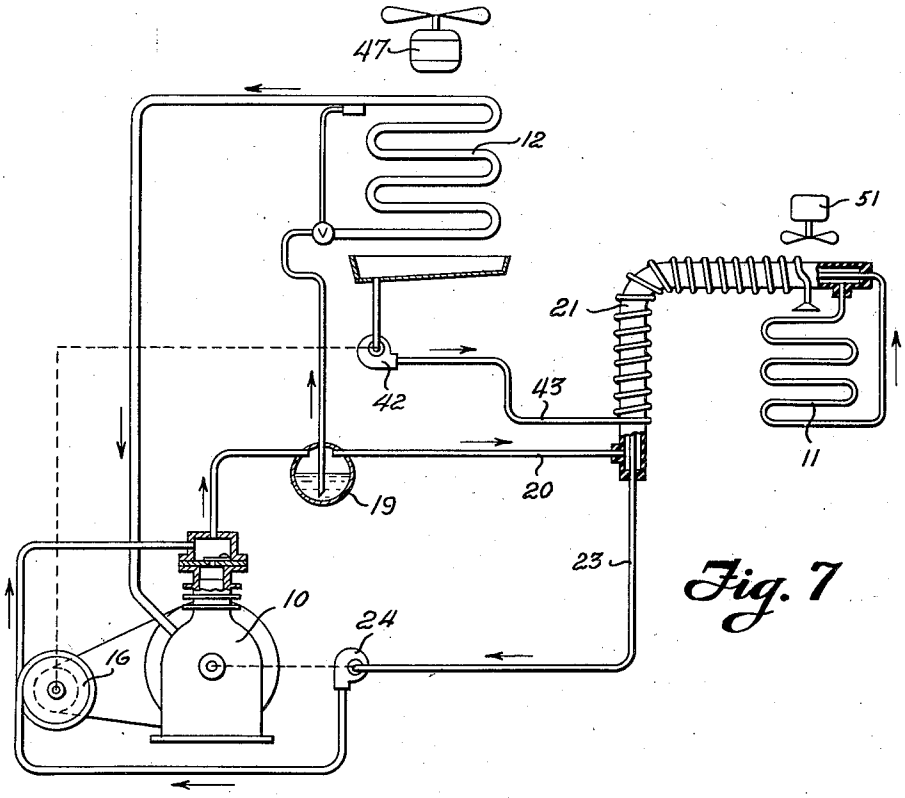


Fig. 7

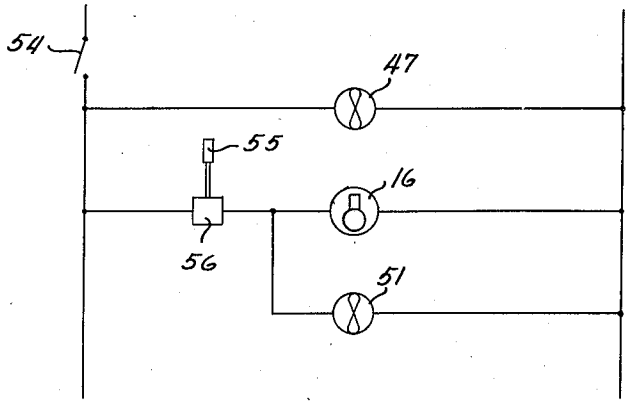


Fig. 8

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UNITED STATES PATENT OFFICE

2,181,213

REFRIGERATING APPARATUS

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Application October 31, 1934, Serial No. 750,842

9 Claims. (Cl. 62—129)

This invention relates to refrigeration.

An object of this invention is to provide a novel refrigerating system which is useful for many purposes and particularly for use in connection with the cooling of rooms or the like.

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

In the drawings:

Fig. 1 is a vertical cross-sectional view, somewhat diagrammatic, of an apparatus embodying features of my invention

Fig. 2 is a vertical cross-sectional view of the liquid refrigerant pump at the end of the drive shaft of the compressor shown in Figs. 1 and 3;

Fig. 3 is a view somewhat similar to Fig. 1, but showing a slightly modified form;

Fig. 4 is a detailed cross-sectional view of a portion of the flexible connections shown in Figs. 1 and 3 and taken along the line 4—4 of Fig. 5;

Fig. 5 is a cross-sectional view taken along the line 5—5 of Fig. 4; and

Fig. 6 is a cross-sectional view of a portion of a slightly modified compressor which may be used in lieu of the form shown in Figs. 1 and 3.

Fig. 7 is a diagrammatic showing of the fluid flow circuits of the apparatus shown in Fig. 1;

Fig. 8 is a diagrammatic showing of the electric circuits of said apparatus.

A refrigerating apparatus embodying features of my invention includes in general a compressor or refrigerant translating device 10, a condenser 11 and an evaporator 12 arranged in refrigerant flow relationship. The compressor 10 and evaporator 12 are preferably assembled with a cabinet 13 so that they are adapted to be placed in the room 14 which is to be cooled. The condenser 11 is adapted to be carried on a mounting 15 so that the same may be placed outside of the room 14. The arangement is such that heat is absorbed from the air which is being conditioned for the room 14, the heat being absorbed into the evaporator 12. This heat eventually is discharged into the atmosphere outside of the room through the walls of the condenser 11, the heat being pumped (for instance along with the refrigerant) by the compressor or refrigerant translating device 10 from the evaporator to the condenser.

Means are provided whereby the heat generated by the compressor 10 and by the motor 16, which drives the compressor 10, may also be discharged through the walls of the condenser 11. To this end arrangements are provided whereby refrigerant vapor is discharged from the compressor 10 to the condenser 11 where the refrigerant is liquefied. A portion (or all) of the refrigrant thus liquefied is circulated while under high pressure liquid form in thermal exchange relationship with the compressor and/or the motor in such a manner that the liquid refrigerant absorbs heat therefrom. If any of the liquid refrigerant is vaporized, it may be returned to the condenser 11 where it delivers the heat thus absorbed from the motor and/or compressor and where the refrigerant is reliquefied. Refrigerant flow connections are also provided for delivering liquid refrigerant to the evaporator where it is reduced in pressure and is vaporized and from whence it flows, in vapor form, through the vapor line to the compressor.

The foregoing refrigerant flow is attained in the embodiment shown in Fig. 1 by providing a compressed vapor refrigerant line 17 which connects an outlet valve chamber 18 of the compressor 10 with a liquid refrigerant receiver 19. The refrigerant vapor flows from the receiver 19 through the connection 20 to a flexible fluid-flow structure 21 through which it flows through the wall or window of the room 14 to the condenser 11. Here the refrigerant is liquefied and flows back in liquid form through the fluid-flow flexible connection 21 to the coupling 22 from whence the liquid refrigerant flows through the pipe 23 to the liquid refrigerant pump 24 at the end of the crankshaft of the compressor. It is then circulated by the pump 24 in thermal exchange relationship with the motor 16 by the pipe 25, which conveniently may be wrapped around the motor 16, and from whence it is discharged into the outlet valve chamber 18 above the outlet valve 26 where it removes heat from the compressor and superheat from the compressed refrigerant. The vaporized refrigerant is discharged with the refrigerant being compressed by the compressor into the line 12 and finds its way to the condenser 11 through connection 21 while any unvaporized liquid refrigerant is separated at the receiver 19 by gravity.

Liquid refrigerant flows from the receiver 19 through the line 27 to an automatic expansion valve 28 and from thence into the evaporator 12 where the refrigerant is reduced in pressure and vaporized and from whence it returns through the expanded refrigerant line 29 to the compressor 10. The valve 28 is of the type which automatically introduces liquid refrigerant into the evaporator 12 whenever the pressure therein is

reduced below a predetermined limit. This valve is also provided with a thermostatic bulb control 30 which automatically throttles the valve 28 whenever the refrigerating effect reaches the bulb 30 through the line 29 and thus prevents the flooding of the compressor 10 with unvaporized refrigerant but maintains the evaporator in substantially flooded condition.

A portion of flexible fluid-flow structure 21 is shown more in detail in Figs. 4 and 5. The coupling 22 is provided with a connection 31 which forms the usual flare joint with the pipe 20 and thus permits the introduction of refrigerant in vapor form into the interior of the rubber-like pipe 32 and from thence to the condenser 11. The liquefied high pressure refrigerant flows from the condenser 11 through the flexible metallic pipe 33 through the coupling 22 to the connection 34 into the pipe 23 previously described. The connection 34 may form the usual flare joint with the line 23. The coupling 22 is connected with the pipes 32 and 33, the pipe 32 being secured thereto by the bolt and strap construction 35, while the pipe 33 is connected by means of the flare joint 36 well-known in the art. The pipe 32 may be of any flexible refrigerant resisting material, and where a fluorine hydrocarbon derivative refrigerant is used such as dichloro-tetrafluoroethane, this rubber-like material may be a synthetic rubber now marketed under the trade name "duprene", and known as chloro-2-butadiene-1,3. The other end of the structure 21 may have a coupling 22*a* which is similar to the coupling 22 and which connects with the inlet and outlet of the condenser 11 as is readily apparent.

The air passing over the evaporator 12 has its temperature reduced often below its dew point. When this occurs, water is condensed therefrom, and it is desirable to discharge this water outside of the room. This may be accomplished by providing a drain pan 40 from which the water drains through the pipe 41 to a pump 42, driven by the motor 16 through the medium of belt 42; and from whence the water is discharged through the pipe 43, which is wrapped around the rubber-like pipe 32 as shown at 44, and eventually the water is discharged at the spray-head 45 over the condenser where the water is evaporated by the heat of the condenser and is discharged, in vapor form, into the air outside the room.

Means are provided for the circulation of air. Thus a fan 46, driven by a motor 47, causes air to flow through the inlet 48 past the evaporator 12 and out the grille 49 into the room 14, the air having been cooled and dehumidified thereby. In order to simplify the disclosure in the drawings no means has been shown for introducing outside air into the evaporator compartment. It is obvious, however, that any conventional means may be used for bringing outside air into the evaporator compartment in the event that it is desired to introduce fresh air into the room being conditioned. Air may also be circulated over the condenser 11. Thus a fan 50, driven by a motor 51, causes air to circulate from outside the room through the inlet 52 and be discharged outside the room through the outlet 53. The circulation of this air cools the condenser 11.

Controls are provided for the motors. Thus the motor 47 may be controlled by the hand switch 54 which causes the motor to turn whenever the switch is closed. The motors 16 and 50 may be automatically controlled in accordance with conditions in the apparatus or conditions created thereby. Thus a thermostatic bulb 55 may be placed where it is responsive to conditions in the apparatus and preferably to temperature conditions in the room 14. This bulb 55 may be responsive either to dry bulb or wet bulb temperatures, or to a combination of both, and may be conveniently placed near the inlet 48 where it is representative of the temperature or relative humidity conditions of the room 14. Thus bulb 55 opens and closes a snap switch 56 which starts and stops the motors 16 and 51, these motors being started when the temperature and/or relative humidity in the room rises above a predetermined limit and being stopped when the temperature and/or relative humidity falls below another and lower predetermined limit. The pump 24 may be hermetically sealed to the compressor 10 by means of the bolts 57 as shown in Fig. 2. The compressor 10 may be provided with a drive shaft or crankshaft 58, which is driven by the motor 16 through the medium of the belt 59 at one end. The other end of the shaft is provided with an eccentric 59*a* which drives the oscillating piston 60 of the pump 24. The pump 24 may be of any well-known type which may be driven from an eccentric 59*a* at the end of crankshaft 58, and since pumps of this type are well-known in the art, further description thereof is not necessary.

The material of which the tube 32 is made, if rubber-like in character, is likely to be damaged by exceedingly high temperatures. The ordinary superheat of compressed refrigerant, as discharged from a compressor, is likely to damage such material, but by introducing liquid refrigerant into thermal contact with the compressed refrigerant before it is discharged into the tube 32, this superheat is removed and damage to the tube 32 is therefore prevented.

In the modification shown in Fig. 3, substantially all of the parts of the apparatus may be exactly as shown in Fig. 1 with the exceptions hereafter noted. Refrigerant is discharged from the outlet valve chamber 18*a*, through the pipe 70, into the coupling 22*b*. Thus refrigerant both in liquid and vapor form flow through a tube similar to the tube 32 to the condenser 11*a*. Here the vaporized refrigerant is condensed and refrigerant in liquid form flows through a pipe similar to the pipe 33 through the coupling 22*b* to the pipe 23*a*. The arrangement is such that a portion only of the liquid refrigerant need be circulated in thermal exchange with the compressor 10*a* and motor 16*a*. This is accomplished by providing a pipe 71 which connects the pipe 23*a* with the receiver 19*a*. Any excess liquid refrigerant which is not pumped by the pump 24*a* flows through the pipe 71 into the receiver 19*a*. The pump 24*a* may be chosen to be of such a capacity that only the necessary amount of liquid refrigerant is circulated through the pipe 25*a* into the chamber 18*a*. The other parts of the apparatus have their counterparts in Fig. 1 and it is believed that they need not be further described.

It may sometimes be desirable not to discharge the refrigerant from the pipes 25 and 25*a* directly into the chambers 18 or 18*a*, but only in thermal exchange therewith. Under such conditions, the pipe 25*b* which may be representative of either pipes 25 or 25*a*, discharge the liquid refrigerant in thermal exchange with the wall 72 of the outlet valve chamber 18*b*. The refrigerant then continues to flow through the pipe 73 into the receiver 19 in the case of Fig. 1, or into the pipe 70 in the case of Fig. 3. The compressed refrig-

erant flows through the pipe 80 either to the receiver 19 in the case of Fig. 1 or directly to the condenser 11a in the case of Fig. 3.

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 a refrigerating apparatus, a compressor, a condenser and an evaporator in refrigerant flow relationship forming a closed refrigerant flow system, said compressor having a compressed refrigerant outlet valve and an outlet valve chamber, and means to introduce liquid refrigerant from said condenser into said chamber to commingle with compressed gases passing through said valve.

2. A refrigerating apparatus comprising a compressor, condenser, evaporator and refrigerant liquid receiver, a refrigerant vapor discharge connection between said compressor and receiver, means for conveying refrigerant vapor from said receiver to said condenser and refrigerant liquid from said condenser to said receiver, and a pump for circulating liquid refrigerant in thermal exchange with said compressor.

3. A refrigerating apparatus comprising a compressor, condenser, evaporator and refrigerant liquid receiver, a refrigerant vapor discharge connection between said compressor and receiver, means for conveying refrigerant vapor from said receiver to said condenser and refrigerant liquid from said condenser to said receiver, a motor drivingly connected to said compressor, and a pump for circulating liquid refrigerant in thermal exchange with said motor.

4. A refrigerating apparatus comprising a compressor, condenser and evaporator in refrigerant flow relationship and forming a closed refrigerant flow circuit, said compressor including a drive shaft, a pump hermetically sealed to said compressor and driven by said shaft and refrigerant flow connections whereby said pump circulates liquid refrigerant from said refrigerant flow circuit in thermal exchange with said compressor.

5. A refrigerating apparatus comprising a compressor, condenser and evaporator in refrigerant flow relationship and forming a closed refrigerant flow circuit, said compressor including a drive shaft, a motor connected to said drive shaft, a pump hermetically sealed to said compressor and driven by said shaft and refrigerant flow connections whereby said pump circulates liquid refrigerant from said refrigerant flow circuit in thermal exchange with said motor.

6. In a refrigerating apparatus, a compressor, a condenser and an evaporator, said compressor including a discharge valve and discharge valve chamber, a refrigerant vapor line connecting said chamber and condenser, a refrigerant liquid line connecting said condenser and evaporator, a refrigerant vapor line connecting said evaporator and compressor, and connections for introducing refrigerant liquefied in said condenser into said chamber.

7. In a refrigerating apparatus, a compressor, a condenser and an evaporator, said compressor including a discharge valve and discharge valve chamber, a refrigerant vapor line connecting said chamber and condenser, a refrigerant liquid line connecting said condenser and evaporator, a refrigerant vapor line connecting said evaporator and compressor, and connections for introducing liquid refrigerant from said condenser into said chamber above said valve.

8. A refrigerant apparatus comprising a refrigerant translating device, a condenser and evaporator, refrigerant flow connections between said device, condenser and evaporator, said connections including a flexible refrigerant vapor line and a flexible refrigerant liquid line, one of said lines surrounding the other, and a water line surrounding both of said lines.

9. In a refrigerating apparatus, a compressor, a condenser and an evaporator in refrigerant flow relationship and forming a closed refrigerant flow system, said compressor having a compressed refrigerant outlet valve and an outlet valve passage, and a pump operated in unison with said compressor having means for withdrawing liquid refrigerant from said condenser and injecting the same into said passage to commingle with compressed gases discharged through said valve.

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