

Jan. 15, 1929.

1,698,939

R. W. DAVENPORT
REFRIGERATING APPARATUS

Filed March 18, 1926

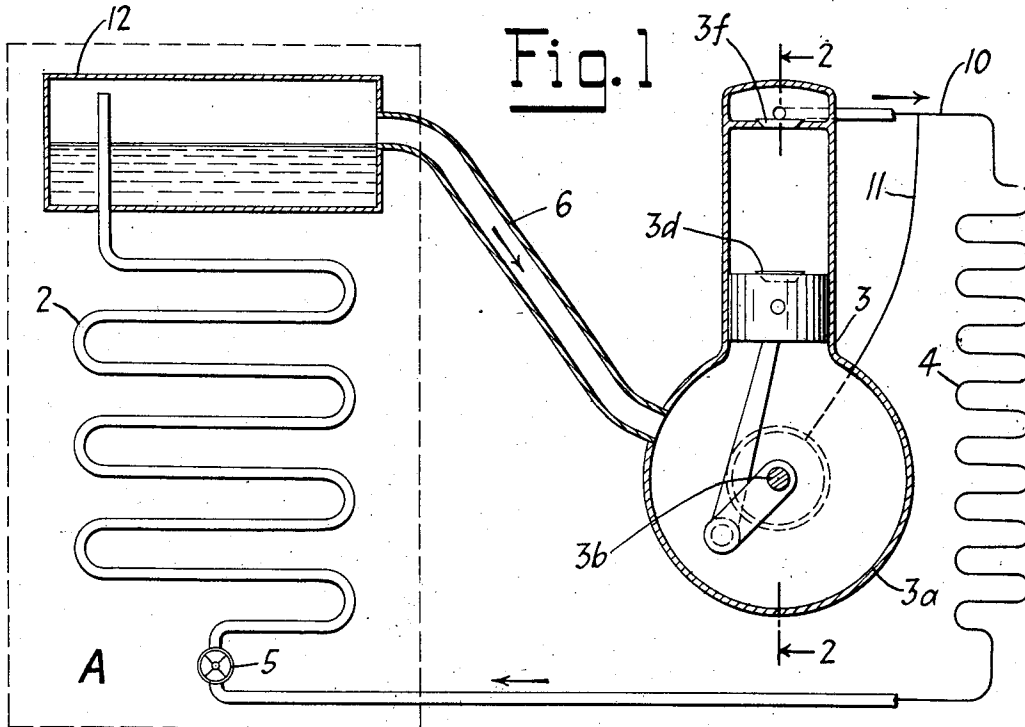
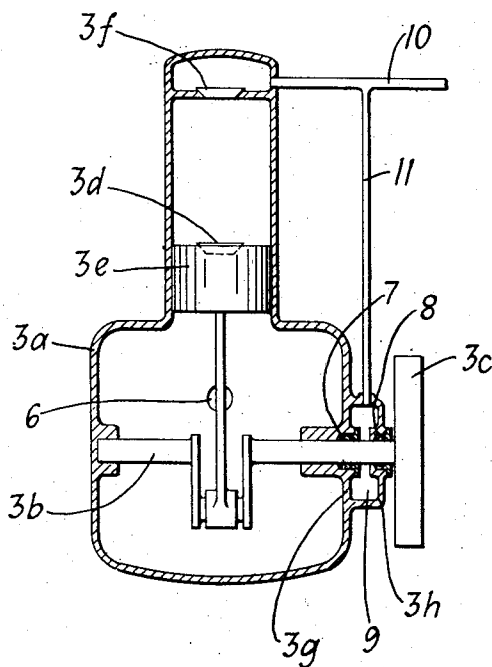


Fig. 2

INVENTOR.
Ransom W. Davenport
BY
Ira L. Nickerson
ATTORNEY.

UNITED STATES PATENT OFFICE.

RANSOM W. DAVENPORT, OF DETROIT, MICHIGAN, ASSIGNOR TO CHICAGO PNEUMATIC TOOL COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW JERSEY.

REFRIGERATING APPARATUS.

Application filed March 18, 1926. Serial No. 95,531.

This invention relates to apparatus for transforming heat. It has special application to refrigerating machines for household use although by no means confined thereto. The apparatus of the present invention is particularly adapted and intended for use with lubricating working substances or refrigerants of the type disclosed and claimed in my copending application Serial No. 60,311 filed October 3, 1925.

One object of the invention is to provide apparatus which will successfully utilize lubricating working substances in the transforming of heat. Another object is to provide such apparatus operating with the crank case of the compressor considerably below atmospheric pressure. Another object is to provide a concentrating evaporator for the lubricating working substance. Still another object is to provide an improved packing arrangement for the shaft of the compressor. Other objects relating generally to improvements in prior apparatus will be apparent from the detailed description which follows:

In order to illustrate the invention one concrete embodiment thereof is indicated somewhat diagrammatically in the accompanying drawings in which:

Fig. 1 discloses a refrigerating system in accordance with the present invention, certain parts of the apparatus being shown in section, other parts in elevation, and the remaining parts diagrammatically indicated.

Fig. 2 is a sectional view through the compressor, substantially on the line 2—2 of Fig. 1.

The heat transforming or refrigerating system disclosed in Fig. 1, comprises an evaporator 2 which is disposed in the chamber from which heat is extracted such as a refrigerator chamber A indicated by broken lines, a compressor 3 connected to evaporator 2, and a condenser 4 into which compressor 3 discharges to condense the vapor of the refrigerant and to return it to the evaporator through expansion device 5. The elements are suitably connected together, as indicated to form a closed cycle system especially adapted to utilize a lubricating refrigerant of the type disclosed in my copending application above identified.

The compressor 3 is of the reciprocating piston type having a crank case 3^a in which rotates a crank shaft 3^b, arranged to be

driven by a prime mover, such as an electrical motor, (not shown) through a suitable driving connection such as a belt over a pulley 3^c. A connection 6 from evaporator 2 to compressor 3 opens directly into crank case 3^a so that the latter forms a part of the low pressure side of the system. The inlet valve 3^d of the compressor is mounted in piston 3^e and the discharge valve 3^f is in the cylinder head. Suitable means are provided for sealing the projecting end of shaft 3^b against loss of the working substance through leakage. To this end the crank case 3^a is provided with spaced walls 3^g and 3^h, through which the crank shaft extends and in which suitable bearings are provided. Spaced packing glands 7 and 8 for shaft 3^b are provided in walls 3^g and 3^h and a restricted chamber 9 is formed sealed off from the crank case 3^a on the one hand and from the atmosphere in the other in a substantially fluid-tight manner. The discharge duct 10 leading from the cylinder head of compressor 3 to condenser 4 has a branch connection 11 to chamber 9, so that the latter is under high side pressure. Thus low side and high side pressure obtains on opposite sides of the inner packing 7 and since the high side pressure in the system disclosed is approximately that of atmosphere, leakage along crank shaft 3^b tends to be from chamber 9 to the crank case, i. e., within the refrigerating system, so that loss of the working substance is avoided. Moreover the high side pressure in chamber 9 assists in maintaining a fluid-tight seal for the crank shaft.

Since the inlet connection from the evaporator to the compressor is directly to the crank case of the latter there is a natural tendency to dilution of the crank case lubricant by the vaporized working substance. Moreover, the splashing of this somewhat diluted lubricant results in some of it being carried past the piston up into the discharge line 10. Therefore, in order to maintain the required quantity as well as quality of lubricant in the crank case, it is necessary continually to feed concentrated lubricant thereto. This is accomplished by providing a concentrating evaporator, or a concentrator in relation to the evaporator, so arranged that a body of the lubricating refrigerant is subjected to the vaporizing effects of the system for a sufficient period to drive off the

volatile component thereof and leave the highly concentrated lubricant to be fed to the crank case 3^a. To this end the evaporator 2 includes or is provided with a hollow member 12 providing a chamber of substantial size which member is disposed adjacent the top or warmest part of the refrigerating chamber A. The connection 6 to the compressor 3 extends from member 12, being connected thereto intermediate the top and bottom of the same. By preference the connection 6 is downwardly inclined so that any liquid having access thereto will find its way by gravity to crank case 3^a. The evaporator coil 2 opens into the chamber of concentrator 12 above the opening of connection 6 so that agitated liquid in the evaporator overflows into the concentrating chamber forming a body of liquid up to the opening of connection 6. The body of liquid in concentrator 12 remains in the warmest part of the refrigerating chamber for a considerable period subjected to the vaporizing effect produced by the operation of pump 3, thus giving ample opportunity for the volatile ingredients thereof to pass off as vapor leaving lubricant in highly concentrated form to pass by gravity through connection 6 to the crank case.

The operation of the apparatus may be described as follows: To place the apparatus in condition for operation pure refrigerant (such for example as methylene chloride) is placed in evaporator 2 and a pure lubricant which is miscible with or soluble in the refrigerant (such for example as a blend of castor oil) is placed in the crank case 3^a. The remainder of the system may be filled with air or any other gas substantially inert to and insoluble in both the refrigerant and the lubricant so that the system will operate in its heat transforming effects after the manner disclosed in my copending application, Serial No. 15,172, filed March 12, 1925 now Patent No. 1,619,196. When the compressor is started the passing of vapor of the refrigerant into the crank case 3^a will cause dilution of the lubricant, and the lubricant carried over into the high side of the system will find its way eventually through expansion device 5 into evaporator 2 and become mingled with the refrigerant. The extent of dilution of the lubricant will depend upon the temperature and pressure in the crank case, the lower the pressure and the higher the temperature the less the dilution. The liquid refrigerant in evaporator 2 tends to decrease by the amount remaining in solution in the crank case. When the dilution or mingling of the liquid ingredients has become constant and the system is in stable operation the concentrator 12 is filled to the overflowing point with the castor oil blend and refrigerant mixture so that a limited amount of the mixture

passes through pipe 6 into the crank case 3^a along with the cool vaporized refrigerant. The concentrated lubricant mixture is splashed about in the crank case and some of it is carried over into the discharge pipe 10. Part of the carried over lubricant passes on to the condenser and part goes into branch 11 and into the high side chamber 9. The proportion of the lubricant going to the condenser 4 and to chamber 9 may be varied as desired by suitable separating means (not shown). In the condenser the concentrated lubricant mixture is diluted by the condensate of the refrigerant so that the mixture leaving the condenser is very dilute and in this condition passes through the expansion device 5 into evaporator 2. In evaporator 2 the mixture again begins to concentrate as the vapor of the volatile ingredient is carried away by the compressor 3 and this concentration is greatly increased in concentrator 12 since the liquid trapped therein cannot flow back into the evaporator 2 and the liquid body remains at the top of the refrigerator for a considerable period, during which period it is subjected to the vaporizing action of compressor 3.

That portion of the concentrated lubricant mixture which passes into branch 11 and thence into the stuffing box chamber 9 serves to lubricate and seal the packing glands 7 and 8 and gradually works back into the crank case by reason of the lower pressure obtaining in the crank case as compared with that in chamber 9.

By reason of the presence of the inert gas in the stream of fluid circulated through the system, which gas expands through member 5 into and through the liquid in evaporator 2 carrying or blowing some of the liquid into member 12, a free boiling effect is produced resulting in energetic vaporizing of the volatile parts of the liquid, thus producing a marked heat absorbing effect and at progressively higher temperatures as the top of the evaporator is approached. As disclosed in my aforementioned process application, Serial No. 15,172, the high side pressure of the system does not greatly exceed atmospheric pressure so that the sealing arrangement for the crank shaft including the high side pressure chamber 9 intermediate crank case 3^a and atmosphere overcomes any tendencies toward leakage outside of the system.

From the above it will be apparent that the herein described apparatus provides for the efficient utilization of refrigerants having atmospheric boiling points, that such refrigerants may be successively used with compressors whose crank cases are operated below atmosphere, that any leakage which may occur to or from such crank cases tends to be internal as to the system, and that the use of a concentrating evaporator insures

adequate lubrication of the compressor. Processes for transforming heat with lubricating refrigerants are disclosed and claimed in my copending applications Serial No. 85,580, filed February 2, 1926 and Serial No. 88,164, filed February 15, 1926.

While the invention has been herein described in what is now considered to be its preferred form, it is to be understood that it is not limited to the specific details thereof but covers all changes, modifications and adaptations within the scope of the appended claims.

I claim as my invention:

1. In a heat transforming system of the closed cycle type having compressing and condensing means in which a lubricant is diluted with a solvent working fluid while ejecting heat, means for absorbing heat comprising a series of vessels arranged and connected to form a fractional still, means for feeding dilute fluid from said condensing means into the first of said series, and means for feeding concentrated liquid by gravity from the last of the series into said compressing means, while vapor is being taken from all said vessels into said compressing means.

2. In a heat transforming system of the closed cycle type a compressor, a condenser in which a lubricant is diluted with a solvent working fluid while ejecting heat, means for absorbing heat comprising a series of vessels arranged and connected to form a fractional still, means for feeding dilute fluid from said condenser to the first of said vessels, a connection from the last vessel of said evaporator series to the crank case of the compressor for vapor of the solvent working fluid and arranged to move concentrated lubricant by gravity to said crank case, and a connection from said compressor to said condenser.

3. A refrigerating system utilizing a lubricating refrigerant, an evaporator comprising a series of vessels connected to form a fractional still and including a concentrating chamber, a compressor having a crank case, a connection from said chamber to said crank case arranged to pass vapor from said evaporator together with a limited amount of concentrated lubricant by gravity to said crank case, a condenser into which said compressor discharges, and a connection from said condenser to said evaporator thereby to form a closed cycle system.

4. In a heat transforming system of the closed cycle type utilizing a lubricating working substance and having a high side pressure which is substantially atmospheric, in combination, a condenser, an evaporator, a compressor having a crank case, a crank shaft in said crank case, a packing for one end of said shaft, a connection from said evaporator to said crank case, and means

subjecting the exterior of said packing to the pressure of the discharge line of said compressor.

5. In a heat transforming system of the closed cycle type utilizing a lubricating working substance and having a high side pressure which is substantially atmospheric in combination, a condenser, an evaporator, a compressor having a crank case, a crank shaft in said crank case, spaced packings for one end of said shaft providing therebetween a chamber, a connection from said evaporator to said crank case, and a connection from the discharge line of said compressor to said chamber.

6. In a refrigerating system utilizing a lubricating refrigerant and operating with a high side pressure which is substantially atmospheric and with a low side pressure much below atmospheric, an evaporator comprising a series of vessels connected together to form a fractional still and including a concentrating chamber, a compressor having a crank case, a crank shaft in said case, a connection from said chamber to said crank case arranged to pass vapor from said evaporator along with a limited amount of concentrated lubricant to said crank case, a condenser into which said compressor discharges, a connection from said condenser to said evaporator thereby to form a closed cycle system, spaced packings for said crank shaft providing therebetween a chamber, and a connection from the discharge line of said compressor to said chamber, thereby to improve the sealing of said shaft and to confine leakage along said shaft to the system itself.

7. In apparatus of the class described including an evaporator, a compressor connected thereto and having a crank case, a crank shaft rotatably mounted therein, spaced packings for said shaft providing therebetween a chamber, and means subjecting said crank case and said chamber to differential pressures so that leakage along said shaft is interpal.

8. In a closed cycle system, in combination, an evaporator, a compressor connected thereto and having a crank case, a crank shaft rotatably mounted therein, spaced packings for said shaft providing therebetween a chamber, and means subjecting said chamber to approximately atmospheric pressure and said case to a lower pressure, both said pressures being supplied by the system whereby leakage along said shaft is into said case and internal of the system.

9. In combination in a closed cycle refrigerating system of the compressor-condenser-evaporator type having a low side pressure much below atmospheric and a high side pressure substantially atmospheric, an evaporator, a compressor connected thereto and having a crank case,

a crank shaft rotatable therein, packing means for the end of the shaft issuing from said case comprising spaced packings providing therebetween a chamber, and means connecting said crank case to the low side of said system and said chamber to the high side thereof so as to seal said shaft opening and direct any leakage that may develop into said crank case.

10 10. In combination in a closed cycle refrigerating system of the compressor-condenser-evaporator type utilizing a lubricating refrigerant, said system having a substantially atmospheric high side pressure and a low side pressure much below atmospheric, an evaporator, a compressor connected thereto and having a crank case, a crank shaft rotatable therein, sealing means for an end of the shaft issuing from said case comprising spaced packings providing therebetween a chamber, a connection from the low side of said system to said crank case arranged to feed concentrated lubricant thereto, and a connection from the high side of said system to said chamber.

11. In combination in a closed cycle refrigerating system of the compressor-condenser-evaporator type utilizing a lubricating refrigerant, said system having a substantially atmospheric high side pressure and a low side pressure much below atmospheric, an evaporator, a compressor connected thereto and having a crank case, a crank shaft rotatable therein, sealing means for an end of the shaft issuing from said case comprising spaced packings providing therebetween a chamber, a connection from the low side of said system to said crank case, and a connection from the high side of said system to said chamber arranged to feed lubricant thereto to assist said packings in sealing said shaft.

12. In combination in a closed cycle refrigerating system of the compressor-condenser-evaporator type utilizing a lubricating refrigerant, said system having a substantially atmospheric high side pressure and

a low side pressure much below atmospheric, an evaporator, a compressor connected thereto and having a crank case, a crank shaft rotatable therein, sealing means for an end of the shaft issuing from said case comprising spaced packings providing therebetween a chamber, a connection from the low side of said system to said crank case arranged to feed concentrated lubricant thereto, and a connection from the high side of said system to said chamber arranged to feed lubricant thereto to assist said packings in sealing said shaft.

13. A concentrating evaporator for heat transforming systems having a elongate passage terminating in a chamber, said chamber having a single outlet for the contents thereof, said outlet being intermediate the top and bottom of the chamber to enable a predetermined quantity of liquid to remain in said chamber, the terminal of said passage being above the liquid level determined by said outlet.

14. The combination with the evaporator of a heat transforming system, of a concentrating chamber disposed above the evaporator, said chamber having a single outlet for the contents thereof, said outlet being intermediate the top and bottom of said chamber to enable a body of liquid to gather in the same, and an overflow inlet from the evaporator opening into said chamber above the level of such liquid body.

15. A concentrator for use with an evaporator in heat transforming systems comprising a hollow member providing a chamber arranged to be placed above the evaporator, a single outlet connection for the contents of said chamber above the bottom of the same to enable a body of evaporating liquid to gather therein, and an inlet arranged for connection to the evaporator and terminating above said outlet.

Signed by me at Detroit, Wayne County, Michigan, this 15th day of March, 1926.

RANSOM W. DAVENPORT.