July 1, 1930. R. W. DAVENPORT 1,769,113

REFRIGERATING PROCESS AND APPARATUS

Filed Aug. 3, 1926

Fig. 1

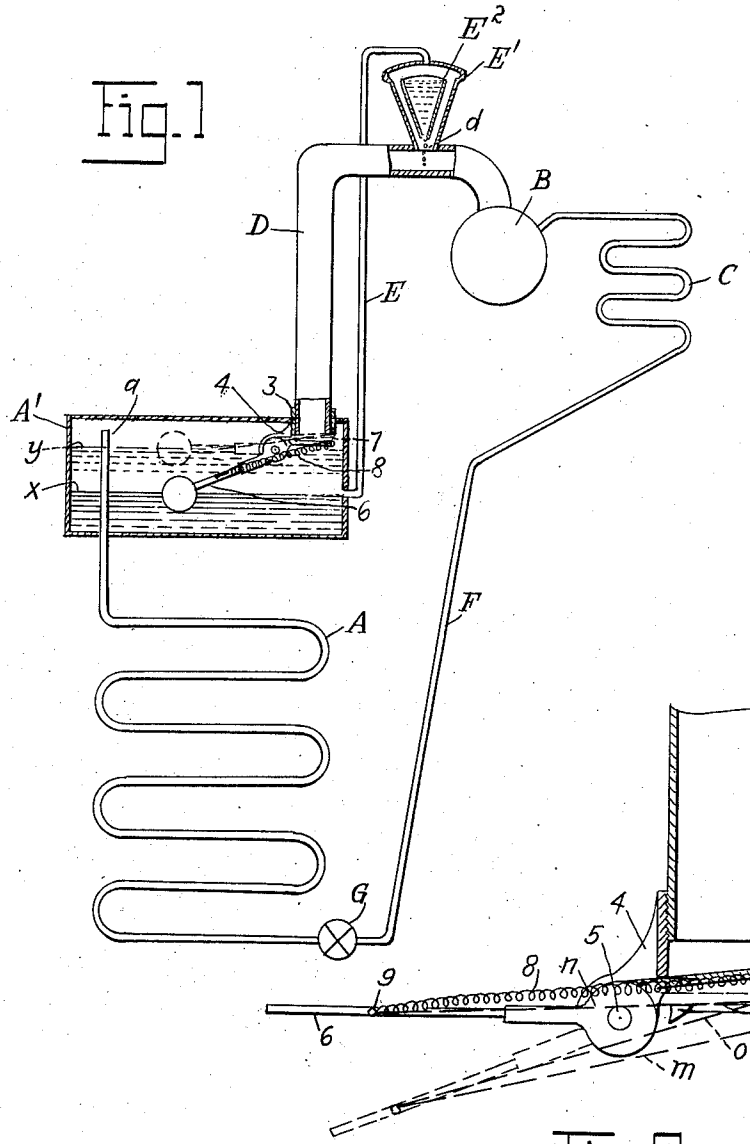


Fig. 2

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Patented July 1, 1930 1,769,113

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REFRIGERATING PROCESS AND APPARATUS

Application filed August 3, 1926. Serial No. 126,782.

This invention relates to processes and apparatus for producing heat transforming effects with particular reference to closed cycle systems utilizing lubricating working substances of the type disclosed in my copending application Serial No. 60,311 filed October 3, 1925, and distinguishes in certain important respects from my previously disclosed methods and means for producing refrigeration with a lubricating refrigerant whose physical constitution resembles a solution of viscous and volatile liquids, as set forth in my copending applications, Serial No. 85,580 filed February 2nd, 1926; Serial No. 88,164 filed February 15th, 1926; Serial No. 95,531 filed March 18, 1926; Serial No. 106,825 filed May 5th, 1926; and Serial No. 106,826 filed May 5, 1926. These previous disclosures all involve the concentrating or "thickening" of the working substance for lubricating purposes and the feeding of the "thickened" liquid to the pump. Such feeding of the lubricating concentrate, however, is substantially continuous and is effected largely by gravity so that the pump necessarily must be on a lower level or beneath the evaporator containing the working substance.

One object of the invention is to devise processes and apparatus for utilizing lubricating refrigerants without restriction as to the position of the pump relative to other parts of the apparatus. Another object is to permit the periodic return of the concentrated solution to or towards the pump. Other objects will be apparent from the detailed description of the invention which follows.

In carrying out the present invention the step common to my previous disclosures which involves the returning of the concentrate to the pump is also performed, but in a different manner and by means of different apparatus, so that the usual machine unit which contains the pump may be placed above the evaporator if desired. My improved process contemplates periodically interrupting the withdrawal of the vaporized working substance from the concentrating chamber in order to draw concentrate therefrom for lubricating purposes. The change in the fluid being withdrawn is effected in alternation and entirely automatically. The automatic regulation may be controlled by the variations of the liquid level in the concentrating chamber and the change is preferably instantaneous. The concentrated lubricating liquid which is withdrawn may be passed directly to the pump or other pressure reducing device if the latter is adapted to handle surges of liquid, or it may be stored and fed in small amounts. The invention further comprises suitable apparatus for practicing the improved process.

In order to illustrate the invention and the manner of its use one form and arrangement of apparatus is shown in the accompanying drawings in which:

Fig. 1 is a view largely diagrammatical in character of a refrigerating system; and

Fig. 2 is a view on an enlarged scale partly in section and partly in side elevation of the automatic control apparatus.

The apparatus diagrammatically indicated in Fig. 1 for practicing my improved process consists essentially of an evaporator A disposed in the zone from which heat is to be extracted as in the storage compartment of a refrigerator, a pump or compressor B and a condenser C, these parts being connected together to form a closed cycle system. The parts with the possible exception of the evaporator A may be of any suitable or desired type, a prime mover of some kind (not shown) being necessary to drive pump B.

Evaporator A terminates in a concentrating vessel A′, the outlet *a* of the evaporator proper being disposed adjacent the top of concentrator A′ so as to permit a body of the working substance to gather and remain therein. From the concentrator extends a large conduit D for vapor and a small conduit E for liquid, the openings of both said conduits being spaced from the bottom of concentrator A′ and the opening of conduit D being at a higher level than the opening for conduit E. Both conduits lead to pump B. While conduit E may be entirely distinct from conduit D it is shown as connect-

ing with conduit D at point *d* adjacent pump B. Condenser C connects with evaporator A through a conduit F controlled by a valve or expansion device G of any suitable or desired type.

The system is arranged to operate with a lubricating working substance consisting of a mixture of a volatile liquid and a lubricant, such as disclosed in my aforementioned copending application, Serial No. 60,311 filed October 3, 1925. A typical working substance is methylene chloride having grease in solution in the proportions of 85% methylene chloride and 15% grease. A body of this liquid mixture is placed in evaporator A and in the concentrator chamber A′. On starting pump B, it will be evident that the gaseous contents of the evaporator AA′ including the vapor of the working substance will be withdrawn through both conduits D and E if the same are open and if the body of liquid is at or about the level indicated at *x*. With the proper amount of working substances in the system, the concentrated lubricant will gradually accumulate in concentrator A′ raising the level of the liquid therein above the opening to conduit E whereupon the vapor of the working substance will continue to be drawn off through conduit D.

With the liquid level standing above the opening to conduit E, it will be evident that if the opening to conduit D is closed the entire suction effect of pump B will operate through conduit E to draw liquid from concentrator A′ and discharge it into pump B. The means for restricting or closing the vapor line while the concentrate is being "sucked" up are preferably automatic in operation. Such means may comprise a float controlled by the level of the liquid in concentrator A′ operating a "snap" valve disc on to and off the vapor pipe inlet when the liquor is respectively high and low in level. The variation in the level may be great so that the liquid is drawn away only at rare intervals, or small, in which event the liquid will be drawn away more frequently.

In the form shown conduit D carries adjacent its extremity a collar 3 having projections or ears 4 (Fig. 2) in which is mounted a shaft or pivot 5. A float member 6 is mounted upon pivot 5, also a closure plate 7 for the open end of conduit D. Float member 6 is arranged to operate closure 7 with a "snap" action by means of a coiled spring 8 secured at one end to member 6 at a point 9 spaced from pivot 5 and at its other end to closure 7 adjacent the outer extremity of the latter. By suitable disposing members 6 and 7 relative to each other and by connecting the spring 8 thereto at suitable spaced points member 6 will throw valve 7 in response to predetermined variations in the level of the liquid in concentrator A′. With the arrangement shown closure valve 7 will open when the liquid level is at *x* and close when the liquid is at *y*. With the float in its lower position and valve 7 open, the pull or "lie" of the spring 8 is indicated by the full line indication of the spring in Fig. 1 and by the broken line *m* in Fig. 2. With the rise of the liquid to the *y* level the position of the float is indicated in broken outline in Fig. 1 and in full lines in Fig. 2, the pull of spring 8 upon the open valve then being indicated by broken line *n* (Fig. 2). This causes the valve to move to its closed or full line position shown in Fig. 2. With the fall of the liquid level to *x* the inclination of the float is indicated in full lines in Fig. 1 and in broken lines in Fig. 2. The pull of spring 8 upon the closed valve indicated by broken line *o* (Fig. 2) is such as to cause the valve 7 to move to open position. A stop 11 may be provided to fix the extent of opening of valve 7. With the parts so far described it will be apparent that when the system is in operation the gaseous and the liquid contents of concentrating chamber A′ are withdrawn by pump B in alternation. The periods during which conduit D is open for the withdrawal of vapor are preferably longer than the periods during which conduit E is receiving the total suction effect of the pump to withdraw liquid, a proper arrangement and adjustment of the float control mechanism being effective to establish the duration of such periods and the quantity of liquid withdrawn at any one time.

If pump B is not adapted to handle surges of liquid such as will result when conduit D is closed, or if the lubrication of the pump will be better accomplished by a gradual feeding of the concentrate, suitable means may be provided for storing the liquid withdrawn from chamber A′ and permitting it to pass in limited amount to the pump. One manner of effecting this result is shown in Fig. 1 wherein conduit E is enlarged at E′ to form a chamber in which is positioned beneath the open end of the conduit a receptacle E^2 for the liquid concentrate. This receptacle may be of any desired size so as to hold the entire charge or only a part thereof and the bottom of the receptacle is formed with a small opening as indicated to permit a dribble of liquid into the conduit which leads directly to pump B.

The vapor and such of the concentrate as is not used directly for lubrication, are discharged at higher temperature and pressure by pump B into the condenser C where heat is extracted causing the vapor to condense. The condensate dilutes the concentrate and this diluted liquid is fed back to evaporator A through expansion device G and eventually reaches concentrating chamber A′ where the volatile component of

the liquid passes off as vapor leaving the concentrated lubricant to be periodically removed through pipe E. While the invention is applicable to conventional refrigerating systems, in which the working substance is vaporized by straight pumping, it has particular application to closed cycle systems operating on the vapor-gas principle as disclosed in my copending application, Serial No. 15,172, filed March 19, 1925. Fig. 1 illustrates either system since the character of the feeding device G determines the operating characteristics of the system. If device G is arranged to pass liquid only, the system operates in the conventional manner by straight pumping. If device G is arranged to pass a stream of gas, vapor and liquid the system operates on the vapor-gas principle. The vapor-gas arrangement effects a greater concentration of the lubricant since the contents of the evaporator chamber E under this system are drawn off at approximately the highest temperature obtaining in the chamber in which evaporator A is mounted rather than at the relatively low uniform temperature of the working substance as in conventional systems.

With the arrangement herein disclosed the vapor conduit is normally wide open and no loss of efficiency through wire drawing is occasioned. Yet the machine unit which includes the pump may be at any reasonable height above the evaporator since the full pressure difference of the two sides of the system is available to lift the concentrate.

While the process and apparatus aspects of the invention have been described in what is now considered to be their preferred forms, it is to be understood that the invention 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. The process of refrigeration with a working substance consisting of a volatile liquid and a lubricant in solution which comprises disposing a body of the working substance in the zone from which heat is to be extracted, reducing the pressure on said body to produce vaporization of the volatile liquid so as to cause a heat absorbing effect and to concentrate the lubricant, periodically stopping the removal of vapor to withdraw concentrate for lubricating purposes, returning the withdrawn fluids to said body after condensing the vapor and diluting the concentrated lubricant with the condensate, and controlling the periods of vapor and liquid withdrawal automatically in response to the operating characteristics of the system.

2. The process of refrigeration with a working substance consisting of a volatile liquid and a lubricant in solution which comprises disposing a body of the working substance in the zone from which heat is to be extracted, reducing the pressure on said body to produce vaporization of the volatile liquid so as to cause a heat absorbing effect and to concentrate the lubricant, periodically stopping the removal of vapor to withdraw concentrate for lubricating purposes, returning the withdrawn fluid to said body after condensing the vapor and diluting the concentrated lubricant with the condensate, and controlling the periods of vapor and liquid withdrawal automatically in response to variations in the level of said body.

3. In a closed cycle system utilizing as a working substance a mixture of a volatile liquid and a lubricant, the process of refrigeration which comprises disposing a body of the liquid mixture in the zone of refrigeration, withdrawing in alternation first the vapor of the liquid and then the liquid itself, the former to cause absorption of heat and to effect concentration of the liquid and the latter for lubricating purposes, storing the withdrawn liquid and feeding it constantly in limited amount to the parts requiring lubrication, condensing the vapor, diluting the liquid with the condensate, and returning the liquid so diluted to said body.

4. In a closed cycle system utilizing as a working substance a mixture of a volatile liquid and a lubricant, the process of refrigeration which comprises disposing a body of the liquid mixture in the zone of refrigeration, withdrawing in alternation first the vapor of the liquid and then the liquid itself, the former to cause absorption of heat and to effect concentration of the liquid and the latter for lubricating purposes, storing the withdrawn liquid and feeding it constantly in limited amount to the parts requiring lubrication, condensing the vapor, diluting the liquid with the condensate, returning the liquid so diluted to said body, and controlling the periods of vapor and liquid withdrawal automatically in response to variations in the level of said body.

5. In a refrigerating system, in combination, an evaporator for containing a liquid to be evaporated, a pump, a plurality of fixed connections between said pump and said evaporator, means controlling at least one of said connections to cause said pump to withdraw either the gaseous or the liquid contents of said evaporator, and a condenser receiving the discharge from said pump and directing the same to said evaporator.

6. In a refrigerating system, in combination, an evaporator for containing a liquid to be evaporated, a pump, a plurality of fixed connections between said pump and said evaporator, means controlling at least one of said connections so that said pump withdraws the gaseous contents of said evaporator for a given period and then

withdraws liquid only from said evaporator, and means for removing heat from the liquid and vapor discharged from said pump before returning the same to said evaporator.

7. In a refrigerating system, in combination, an evaporator for containing a liquid to be evaporated, a pump, connections from said pump to said evaporator so arranged that one draws liquid and the other gas, means operating with a snap action automatically at intervals to cause said pump to withdraw from said evaporator in alternation either the gaseous or the liquid products thereof, and a condenser in the connection from said pump to said evaporator.

8. In a refrigerating system, in combination, an evaporator for containing a liquid to be evaporated, a pump, connections from said pump to said evaporator so arranged that one draws liquid and the other gas, control means for at least one of said connections operating automatically with a snap action in response to changes in the level of the liquid in said evaporator for causing said pump to withdraw in alternation from said evaporator either the gaseous or the liquid products thereof, and condensing means in the connection from said pump to said evaporator.

9. In a refrigerating system, in combination, an evaporator containing a refrigerant solution, a pump, a connection from said pump to said evaporator for gas, a connection from said pump to said evaporator for liquid, a valve for closing said gas connection, means for effecting a quick action of said valve, and connecting means including a condenser from said pump to said evaporator.

10. In a refrigerating system, in combination, an evaporator containing a refrigerant solution, a pump, a connection from said pump to said evaporator for gas, a connection from said pump to said evaporator for liquid, a valve for closing said gas connection, a float device controlled by the level of said solution, means connecting said device to said valve arranged to be "off-centered" by the movement of said device to throw said valve with a snap action, and a connection from said pump to said evaporator including a condenser.

11. In a heat transforming system the combination with a concentrating evaporator containing a lubricating refrigerating solution, of a pump adapted to evaporate and to be lubricated by said solution, a connection between said pump and said evaporator for vapor, a connection between said pump and said evaporator for liquid, control means for one of said connections within said evaporator and operating automatically with a snap action in response to the operating conditions of the system, and a return connection from said pump to said evaporator including a condenser.

12. In a heat transforming system the combination with a concentrating evaporator containing a lubricating refrigerating solution, of a pump adapted to evaporate and to be lubricated by said solution, a connection between said pump and said evaporator for vapor, a connection between said pump and said evaporator for liquid, means comprising a float controlled by the liquid level in said evaporator acting to close said vapor connection while said liquid level is between predetermined limits, and a condenser forming a part of the return connection from said pump to said evaporator.

13. In a refrigerating system, in combination, a concentrating evaporator containing a lubricating refrigerant solution, a pump adapted to evaporate and to be lubricated by said solution, means whereby said pump withdraws either vapor or liquid from said evaporator, means for feeding the liquid withdrawn by said pump in limited quantity to said pump to lubricate the same, and means including a condenser for returning the discharge of said pump to said evaporator.

14. A refrigeranting system comprising a concentrating evaporator containing a lubricating refrigerating solution, a pump, a connection for vapor from said evaporator to said pump, a connection for liquid from said evaporator to said pump, means operating automatically and periodically to close said vapor connection, means in said liquid connection for storing liquid and feeding it at a predetermined rate to said pump, and a connection from said pump to said evaporator including a condenser.

15. A refrigerating system comprising a concentrating evaporator containing a lubricating refrigerating solution, a pump, a connection for vapor from said evaporator to said pump, a connection for liquid from said evaporator to said pump, means controlled by the level of the solution in said evaporator for automatically and periodically closing said vapor connection, a receptacle in said liquid connection for intercepting and storing liquid withdrawn from said evaporator, said receptacle having a restricted opening for feeding the liquid at a predetermined rate to said pump, and a connection from said pump to said evaporator including a condenser.

Signed by me at Detroit, Wayne County, Michigan, this 30th day of July, 1926.

RANSOM W. DAVENPORT.