

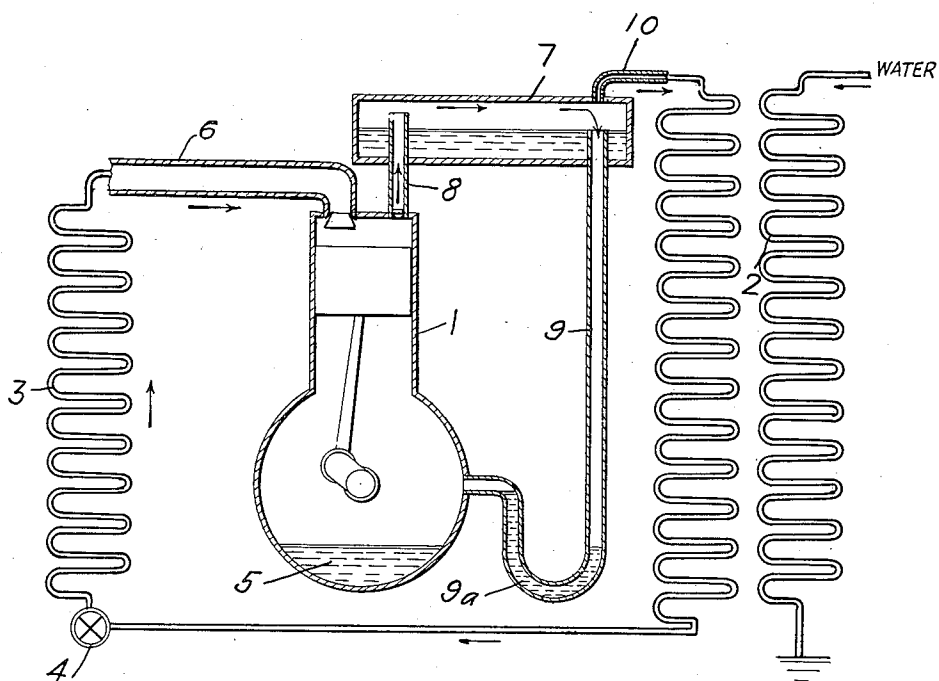
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PROCESS OF AND APPARATUS FOR PRODUCING REFRIGERATION

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PROCESS OF AND APPARATUS FOR PRODUCING REFRIGERATION.

Application filed February 15, 1926. Serial No. 88,164.

This invention relates to processes of and apparatus for transforming heat and more particularly to processes and apparatus relating to refrigeration.

5 One object of the invention is to devise a process of and apparatus for utilizing mixtures or solutions as refrigerants. Another object is to prevent or greatly to retard the accumulation in the zone of refrigeration of
10 any undue proportion of the relatively non-volatile components of a liquid mixture or solution used as a working substance. Other objects will be apparent from the detailed description which follows:

15 In the conventional refrigerating system there is a tendency for the oil or grease used for lubrication to work into the system and form a mixture or solution with the refrigerant. Since the lubricant is relatively of
20 low volatility as compared with the refrigerant, the lubricant which enters the system is carried to and accumulates in the evaporator. In time this results in a marked impairment of the efficiency of the apparatus,
25 particularly when the substance used for lubricating is non-miscible with the refrigerant since it tends to form an insulating coating upon walls of the evaporator, to interfere with the absorption of heat by the
30 vaporizing refrigerant, and to clog the connections. In a similar manner the refrigerant tends to work into the lubricating system of the pumping apparatus and to produce an undesirable dilution of the lubricant. The mingling of liquid refrigerants
35 with the lubricant in systems where the same are intended to be kept separate is highly undesirable since rapid wear of working parts develops from inadequate lubrication
40 resulting in impairment of service and frequent repairs and replacements. I have discovered that a working substance may contain a certain proportion of lubricant without unduly affecting the efficiency of the system
45 provided that the lubricant is miscible with or soluble in the working substance and such lubricating refrigerants are disclosed and claimed in my copending application, Serial No. 60,311 filed October 3, 1925.

50 The invention may be considered as based upon the principle of operation which involves the fractional distillation of a suitable fluid mixture or solution at the high temperature of compression and the utilization of the
55 concentrates for lubrication, accompanied by

the condensing of the vapor of the volatile components and the utilization of the condensate for refrigeration, and the repetition of the steps in a continuous closed cycle. The invention further includes suitable apparatus for practicing the aforesaid process.

In order to illustrate the invention and the manner of its operation reference is to be had to the accompanying drawing. The single view of the drawing, which is largely
65 diagrammatic of a heat transforming or refrigerating system, shows the compressor and associated parts in vertical sections.

The refrigerating system shown is of the closed cycle type, the essential elements of
70 which are the pump or compressor 1, the condenser 2, and the evaporator 3. A suitable feeding device or so called expansion valve 4 controls the feeding of liquid working substance from the condenser 2 to the evaporator 3. Since these essential elements of the system may be of any suitable or desired type, the condenser 2 and evaporator 3 are indicated diagrammatically and a conventional form of reciprocating pump or compressor is illustrated in section. A suitable
80 lubricating system is provided for the pump such as a body of lubricant 5 in the crank case arranged to reach the moving parts of the pump by the splash from the crank shaft
85 and connecting rods.

In the form of system shown pump 1 is arranged to withdraw from the evaporator through the communicating conduit 6 only the vapor of the refrigerant. Hence it is
90 apparent that the lubricant or other relatively non-volatile substance which becomes mixed with the refrigerant tends to accumulate in evaporator 3. This is due to the fact that the components of any mixture of liquids exert partial pressures when they are miscible and the vapor of the mixture is always richer in the more volatile components. When one component has a very much higher vapor
100 tension than the other, as in a mixture or solution of a volatile refrigerant and a lubricant, the vapor of the mixture contains only traces of the less volatile one and the vapor tension of the mixture is nearly as high as that of the pure volatile component. Thus
105 it is clearly apparent that if the mixture of lubricant or other non-volatile substance with the refrigerant is not permitted to reach too high a proportion, satisfactory thermodynamic results can be secured.

In order to entirely prevent an excessive accumulation of non-volatile ingredients, such as lubricant, in evaporator 3, or to nullify natural tendencies in this direction, the invention contemplates the separation from the working substance of such ingredients at some point in the system. In the system shown in the drawing this separation is effected upon the high pressure side of the system at the high temperature of compression, and by fractional distillation. While a part of the compressor itself might be used for this purpose such as the crankcase, it is preferable to provide other means such as a still 7 into which the compressed vapor of the working substance is discharged as through conduit 8. Still 7 is maintained at the desired high temperature to effect fractional distillation of the compressed vapor in any suitable manner, as by covering the still with heat insulating material, or by the application of heat thereto if necessary. The still is of such size and the connections thereto are so proportioned and arranged that the vapors discharged by the compressor 1 are retained in the still 7 a sufficient period to enable the components of the working substance to separate. The lubricant gathers in the lower part of the still 7 below the inlet opening and is drawn off by a pipe 9 which returns the lubricant to the lubricating system of compressor 1, in the present instance to the crank case, pipe 9 being provided at 9^a with a trap to protect the crank case against high side pressure. The vapor of the volatile component of the working substance passes from still 7 by a conduit 10 to the condenser 2 where the vapor is changed to liquid form and fed back through expansion valve 4 to the evaporator 3 to complete the heat transforming cycle.

With reference to the apparatus as herein disclosed and assuming that the evaporator is charged with a pure volatile refrigerant and the lubricating system with pure lubricant, the process set forth in full detail comprises the following steps:

1st—compressing the vapor of the refrigerant and raising its temperature and pressure in compressor 1: 2nd—mixing the highly compressed vapor with concentrated lubricating refrigerant which works by the pistons of the compressor: 3rd—discharging the highly compressed mixture into the still 7 and preventing loss of heat therefrom while the vapor of the refrigerant separates: 4th—returning the hot concentrate to the compressor crank case through pipe 9: 5th—conducting the highly compressed vapor to condenser 2 and liquefying the same: 6th—feeding the condensed liquid to the refrigerating evaporator 3 through feed valve 4: and 7th—evaporating the liquid refrigerant in evaporator 3 to produce refrigeration. During the second step some of the vapor of the

refrigerant will leak past the pistons of the compressor into the crank case and produce dilution of the lubricant.

It is accordingly apparent that the present invention is adapted to prevent the undue accumulation of non-volatile substances such as lubricant in the evaporator of a heat engine regardless of whether the non-volatile substances are original components of the working substances of the kind disclosed in my aforesaid copending application Serial No. 60,331 or whether they become mixed with the working substance through leakage from the lubricating system in the compressor. It is further apparent that the above described process also works against excessive dilution of the lubricant in the compressor lubricating system through leakage of the vapor of the working substances from the compression chamber. Thus the present invention avoids or minimizes both undue accumulation of non-volatile substances in the evaporator and undue dilution of the lubricant but also through fractional distillation of the vapor of the working substance utilizes the volatile components for heat transforming and the non-volatile concentrates for lubrication. When proper mixtures are used and the process is carried out as disclosed it is a long time before the refrigerating effect in evaporator 3 is reduced to any serious degree by the concentration of lubricant therein or before the lubricating value of the contents of the lubricating system of the compressor is seriously affected.

I am aware that the problem arising from the intermingling of the working substance and the lubricant is well known in conventional systems and that many attempts at its solution have been made. All previous processes and apparatus, however, so far as known, make use of mechanical steps and means, such as gravity or impact separators and strainers. My process and apparatus differ radically and basically from such previous attempts in that the separation is effected by thermal steps and means.

While the invention has been herein disclosed in what is now considered to be its preferred form, 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. A heat engine utilizing a working substance containing lubricant comprising a compressor, a condenser, and an evaporator connected together to form a closed thermodynamic cycle, a still in spaced relation to said compressor and in the connection between said compressor and said condenser and maintained against loss of heat to either for separating the lubricant from said working substance, and means for conducting the

separated lubricant into the lubricating system of said compressor.

2. A heat engine utilizing a working substance containing lubricant comprising a compressor, a condenser, and an evaporator connected together to form a closed thermodynamic cycle, means intermediate said compressor and said condenser and maintained against loss of heat to either for continuously effecting fractional distillation of said working substance comprising an elongate member forming a still and having an inlet connection from said compressor and two outlets, one above and one below the opening of said inlet connection, said higher outlet being arranged to carry away the volatile components of the working substance to said condenser and said lower outlet to conduct the separated lubricant to the lubricating system of said compressor.

3. In a heat engine having a compressor, a condenser, an evaporator and connections to form a closed cycle through which a working substance is circulated, a lubricating system for said compressor containing lubricant and means operating substantially adiabatically at the heat of compression and maintained against loss of heat to surroundings for separating lubricant from the working substance by fractional distillation and returning it to said lubricating system.

4. In a refrigerating machine adapted to employ as a working fluid a refrigerant which increasingly dissolves the lubricant at temperatures below that of the compressor discharge, the combination with the compressor, of means for maintaining working fluid from said compressor discharge out of heat exchanging relationship with the compressor while said refrigerant separates from said lubricant, and means for conveying the separated lubricant to the working parts of said compressor.

5. A heat engine having a compressor, a condenser, and an evaporator arranged in

a closed cycle for employing as a working substance a refrigerant which increasingly dissolves lubricant for the compressor at temperatures below that of the compressor discharge, means in said cycle between said compressor and said condenser for maintaining the discharge of the compressor at the heat of compression and against loss of heat to the compressor or the condenser thereby providing for the separation of the lubricant from the vapor of the refrigerant by fractional distillation, and means for conducting the separated lubricant to the compressor.

6. A refrigerating system utilizing a working substance having components of differing degrees of volatility but mutually soluble, said system comprising a compressor, a condenser, and an evaporator connected together to form a closed cycle, and means in spaced relation to said compressor, maintained against loss of heat to the latter and operating substantially adiabatically at the heat of compression for continuously separating out from said working substance its less volatile components.

7. A refrigerating system utilizing a volatile refrigerant comprising a compressor, a condenser, and an evaporator connected together to form a closed cycle, a lubricating system for said compressor containing lubricant soluble in the refrigerant, thermally operated means receiving the discharge of said compressor and interposed between the latter and said condenser but maintained against heat loss to either, said means operating at the temperature of compression or higher for separating out from the discharge of the compressor by fractional distillation the lubricant, and means for conducting the separated lubricant to said lubricating system.

Signed by me at Detroit, Wayne County, Michigan, this third day of February, 1926.
RANSOM W. DAVENPORT.