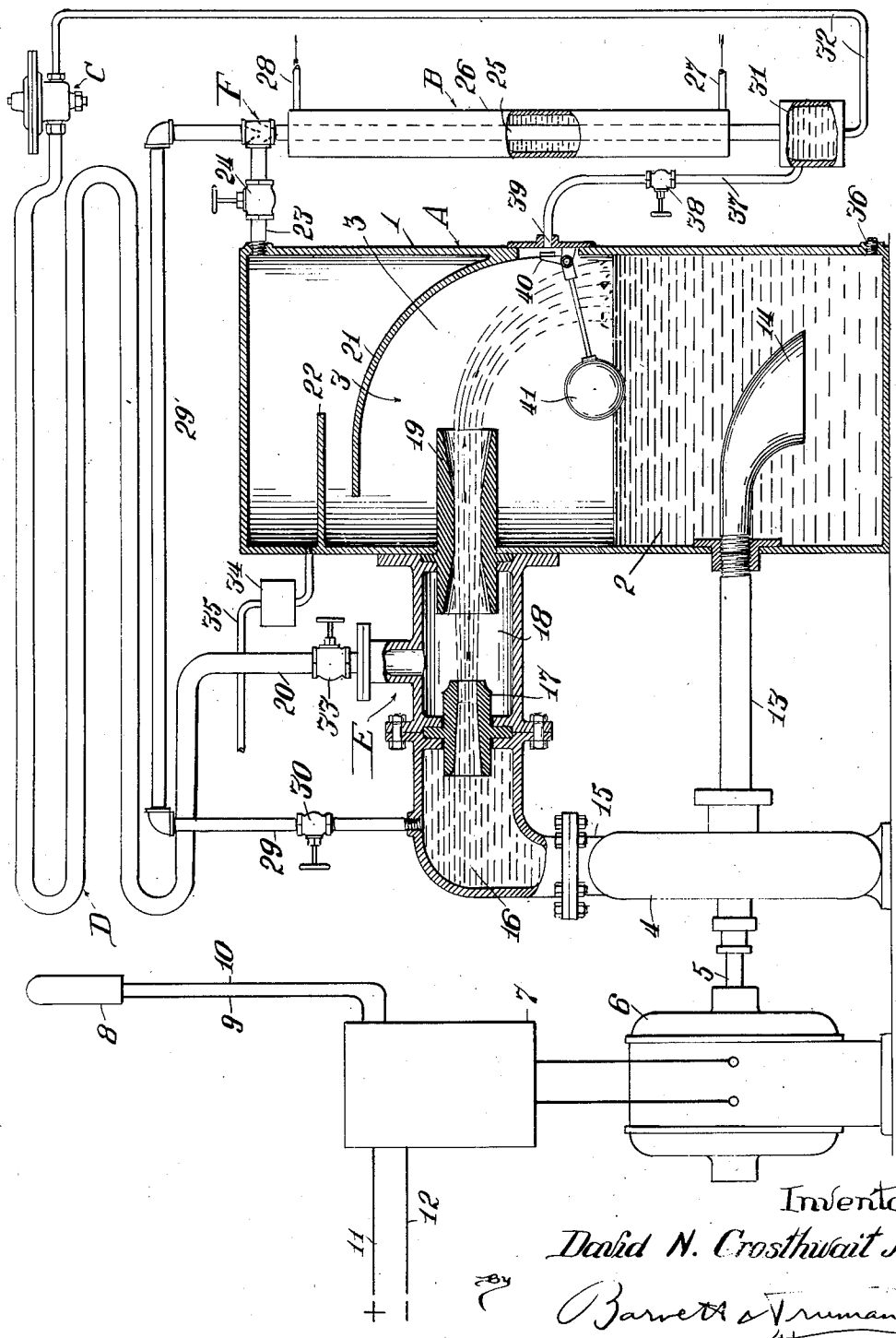
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REFRIGERATING METHOD AND APPARATUS

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REFRIGERATING METHOD AND APPARATUS

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This invention relates to a new and improved refrigerating process and apparatus, and more particularly to a refrigerating system wherein a jet exhauster actuated by a moving stream of the liquid refrigerant is utilized to create a reduced pressure in the evaporating coil and also to compress the vaporized refrigerant and force this refrigerant through the condenser and back to the evaporator.

Briefly described, a stream of the liquid refrigerant is pumped from a storage and compression tank through a jet exhauster and back into the tank. This jet exhauster is connected up with the evaporating coil or refrigerating element so as to withdraw the vaporized refrigerant therefrom and reduce the pressure therein so that further liquid refrigerant will be vaporized. The vaporized refrigerant is carried back into the compression tank along with the liquid stream of the hurling circuit passing through the jet exhauster, the vaporized refrigerant being compressed in the storage tank and then flowing or being drawn into a condenser where it is cooled and condensed to liquid form before being returned to the refrigerating coil. According to the particular improvements of this invention, a stream of the high pressure liquid refrigerant from the compression tank is forced, by the same means which forces the liquid refrigerant through the jet exhauster, through the condenser where it acts as a means of drawing in the compressed vaporized refrigerant from the compression tank, and flows on together with the condensed refrigerant into the evaporator.

The general object of this invention is to provide a new and improved refrigerating process and apparatus of the type briefly described hereinabove and disclosed more in detail in the specifications which follow.

Another object is to provide a refrigerating process and apparatus in which the energy of a moving body of the refrigerating medium is utilized to lower the pressure in the evaporating coil and increase the pressure in the condenser, and to also act as a conveying medium for causing a proper circulation of the vaporized refrigerant.

Another object is to provide, in a system of the type hereinabove set forth, means for utilizing a stream of liquid refrigerant for causing a flow of compressed vaporized refrigerant into the condenser, and forcing the condensed refrigerant from the condenser into the evaporator.

Another object is to provide a simple, efficient and economical means and method to compress and condense a refrigerating medium and create proper circulation through the refrigerating apparatus.

Other objects and advantages of the invention will be more apparent from the following detailed description of one approved form of apparatus operating according to the principles of this invention.

In the accompanying drawing:

The figure shows a diagrammatic elevation, partially in section, of the assembled refrigerating apparatus.

The principal features of the apparatus comprise a compressor A, a condenser B, an expansion valve C, an evaporating coil or refrigerating element D, and a jet exhauster E which functions to create the necessary pressure differences in the system and cause the refrigerant to circulate.

The compressor A comprises a closed storage and separating tank 1 which normally is partially filled with liquid refrigerant indicated at 2, the space 3 above said liquid refrigerant being filled with compressed vaporized refrigerant as will be hereinafter apparent.

A centrifugal pump 4 is driven through shaft 5 from an electric motor 6 which is controlled through starter 7 by a thermostat 8 positioned so as to be responsive to temperature changes in the refrigerating coil D. The thermostat 8 is connected with starter 7 through wires 9 and 10, and the power supply for the motors is indicated by wires 11 and 12.

The pump 4 withdraws liquid refrigerant from tank 1 through pipe 13 having an enlarged inlet end 14 in order to lessen the velocity of the liquid at this point. This

liquid refrigerant is discharged from pump 4 through pipe 15 into receiving chamber 16 from which a jet of liquid refrigerant is projected from nozzle 17 through the exhausting chamber 18 into delivery tube 19 and thence back into tank 1. A vacuum is thus created in exhausting chamber 18 which causes vaporized refrigerant to be drawn in through pipe 20 from the evaporator D, this vaporized refrigerant being entrained in the jet and forced into the compression and separating tank 1. This tank is preferably equipped in its upper portion with baffle plates 21 and 22 adapted to break the force of the liquid stream and more readily separate the liquid and the vapors which are projected into the tank from delivery tube 19.

The compressed vaporized refrigerant which accumulates in the space 3 in the upper portion of tank 1 will be forced out through pipe 23 provided with flow-control valve 24 into the condenser B. This condenser comprises a central tube or group of tubes 25 through which the refrigerant flows, and a surrounding water jacket 26 through which cooling water passes, the water being forced in through pipe 27 and out through upper pipe 28. Another pipe connection 29 leads from the receiving chamber 16 which supplies the liquid stream to the jet exhauster 17, this pipe 29 being provided with a control valve 30 and connecting with the upper end of tube 25 through which refrigerant passes into and through the condenser B. By means of this pipe 29, a constant stream of liquid refrigerant is forced by pump 4 from storage tank 1 into and through the condenser B, this liquid stream serving to help draw in the compressed vaporized refrigerant from space 3 in tank 1 and carry same through the condenser B. If desired a jet exhauster as indicated in dotted lines at F may be used to increase the action of the liquid stream from pipe 29 in drawing vapor through pipe 23 from tank 1. As this vaporized refrigerant is condensed, it unites with the liquid stream from pipe 29 and all of this compressed and liquefied refrigerant passes into receiving chamber 31 and thence through pipe 32 to the expansion valve C which feeds the refrigerant in limited quantities into the evaporating coil D wherein a low pressure or partial vacuum is maintained by the suction created by jet exhauster E. A valve 33 in pipe 20 serves to regulate the suction exerted by exhauster E, and hence the vacuum in coil D.

As the relatively high pressure liquid refrigerant is permitted to expand into the low pressure existing in coil D, it will vaporize thus absorbing considerable quantities of heat from the space or substance adjacent coil D which are to be refrigerated. The low pressure vaporized refrigerant from the coil D is forced by the jet exhauster E into the compressor A where the gas is compressed and then forced, along with the liquid stream through pipe 29, through condenser B, where the heat acquired in the evaporator D during the vaporizing process is dissipated into the water flowing through the condenser, as the refrigerant is again liquefied. The compressed vaporized refrigerant, when thus relieved of this heat, condenses and the cycle is completed and this high pressure liquid refrigerant is again ready to be fed into the evaporator D.

A pressure relief valve 34 is located in an outlet pipe 35 leading from tank 1, this valve being set to open when a predetermined maximum is exceeded. Normally this valve will remain closed. Tank 1 should also be provided with a draw-off or drain plug as indicated at 36.

A pipe connection 37 leads back from liquid receiver 31 to the central portion of tank A, this pipe being provided with a cut-off valve 38. The outlet 39 at the upper end of this tube will be closed by a valve 40 operated by float 41 when the liquid level in tank A is at or above a certain height. If the liquid level in tank A falls below that height, the valve 40 will open and surplus liquid from the circulating system can be forced back through pipe 37 into the storage tank A.

It will be noted that the high velocity jet of liquid refrigerant circulated through the jet exhauster E not only serves to provide the partial vacuum in the evaporator D but also serves to compress the vaporized refrigerant in the tank A. The stream of liquid refrigerant forced through pipe 29 aids the pressure created by the jet exhauster in carrying the compressed vaporized refrigerant into and through the condenser B.

It will be noted that the liquid refrigerant withdrawn from storage tank 1 by centrifugal pump 4 is divided into two streams, one of which is returned through the jet exhauster to the tank 1, and the other of which passes through the condenser and thence through the refrigerating cycle before being returned to tank 1. It is preferable, therefore, that the refrigerant be some material which exists in both the liquid and vapor form within the range of pressures that may be easily maintained by the jet exhauster E. Examples of suitable refrigerants are dichloroethylene, and carbon tetrachloride. Numerous other mediums suitable for use as refrigerants in this system will be apparent to those skilled in this art.

While one suitable form of jet exhauster has been illustrated, it will be apparent that numerous other forms of exhausters operating on the ejector principle could be substituted. Also other forms of vacuum pumps wherein the vacuum is produced by means of a moving body of liquid, whether this liquid is rotating and operating centrifugally or

projected longitudinally as a jet, would be suitable for use in this combination.

I claim:

1. The method of refrigeration consisting in circulating refrigerant from a closed compression and storage space through a refrigerating space wherein it is vaporized, mechanically imparting motion to a portion of the liquid refrigerant and utilizing the energy of this moving liquid to lower the pressure in the refrigerating space, a stream of liquid refrigerant from the compression space also being forced together with compressed vaporized refrigerant into a condensing space and thence into the refrigerating space.

2. The method of refrigeration consisting in circulating refrigerant from a closed compression and storage space through a refrigerating space wherein it is vaporized, mechanically imparting motion to a portion of the moving liquid to lower the pressure in the refrigerating space and to withdraw and compress the vapors formed therein, the remainder of the moving liquid being forced through a condensing space along with the compressed vapors and thence into the refrigerating space.

3. The method of refrigeration consisting in imparting motion to a stream of liquid refrigerant drawn from a closed compression and storage space, directing a portion of this stream into a refrigerating space wherein it is vaporized, and diverting the remainder of the stream back into the compression space and utilizing the energy of this latter stream to lower the pressure in the refrigerating space.

4. The method of refrigeration consisting in imparting motion to a stream of liquid refrigerant drawn from a closed compression and storage space, directing a portion of this stream into a refrigerating space wherein it is vaporized, and diverting the remainder of the stream back into the compression space and utilizing the energy of this latter stream to compress the vapor returned from the refrigerating space.

5. The method of refrigeration consisting in imparting motion to a stream of liquid refrigerant drawn from a closed compression and storage space, directing a portion of this stream into a refrigerating space wherein it is vaporized, and diverting the remainder of the stream back into the compression space and utilizing the energy of this latter stream to lower the pressure in the refrigerating space and to compress the vapor returned from the refrigerating space.

6. The method of refrigeration consisting in imparting motion to a stream of liquid refrigerant drawn from a closed compression and storage space, directing a portion of this stream through a condensing space and thence into a refrigerating space wherein it is vaporized, and diverting the remainder of the moving stream back into the compression space and utilizing the energy of this latter stream to lower the pressure in the refrigerating space and compress the vapor returned into the compression space from the refrigerating space, the first mentioned portion of the liquid stream serving to propel the compressed vapors from the compression space through the condensing space.

7. In a refrigerating apparatus comprising a compression and storage tank, a condenser in open communication with the upper portion of the tank, and an evaporator, means for injecting vaporized refrigerant from the evaporator into the upper portion of the tank and thereby compressing same, and means for withdrawing liquid refrigerant from the lower portion of the tank and forcing same through the condenser.

8. In a refrigerating apparatus comprising a compression and storage tank, a condenser in open communication with the upper portion of the tank, and an evaporator, means for circulating liquid refrigerant from the lower portion of the tank back into the upper part of the tank and thereby injecting vaporized refrigerant from the evaporator into the tank, and means for forcing liquid refrigerant from the tank through the condenser.

9. In a refrigerating apparatus comprising a compression and storage tank, a condenser in open communication with the upper portion of the tank, and an evaporator, a pumping mechanism for withdrawing liquid refrigerant from the lower portion of the tank and returning part of this refrigerant into the upper portion of the tank and thereby injecting vaporized refrigerant from the evaporator into the tank, said pumping mechanism also serving to force a stream of liquid refrigerant through the condenser and thence into the evaporator.

10. A refrigerating apparatus comprising a compression and storage tank, a condenser in communication with the storage tank, an expansion valve, an evaporator, a jet exhauster, a pump, connections whereby the pump forces liquid refrigerant from the tank through the jet exhauster and back into the tank whereby to withdraw vaporized refrigerant from the evaporator and lower the pressure therein, and connections through which the pump forces liquid refrigerant from the tank through the condenser and expansion valve into the evaporator.

11. A refrigerating apparatus comprising a compression and storage tank, a condenser in communication with the storage tank, an expansion valve, an evaporator, a jet exhauster, and means for forcing two independent streams of liquid refrigerant from the tank, one stream flowing through the jet exhauster and back into the tank together with vaporized refrigerant withdrawn from the

evaporator, and the other stream flowing through the condenser and expansion valve into the evaporator.

12. A refrigerating apparatus comprising a compression and storage tank, a condenser, a pipe connection whereby gases may be forced from the upper portion of the storage tank into the condenser, a pump connected to withdraw liquid refrigerant from the lower portion of the tank, a jet exhauster through which a portion of the liquid is forced by the pump, a pipe connection through which the remainder of the withdrawn liquid is forced by the pump into and through the condenser, a refrigerating coil in which the refrigerant is evaporated, a connection for conducting liquid refrigerant from the condenser to the refrigerating coil, an expansion valve in this connection, and a pipe connection leading from the evaporator to the jet exhauster through which vaporized refrigerant is withdrawn.

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