June 23, 1936. B. F. RANDEL 2,044,811

MEANS AND METHOD OF REFRIGERATION

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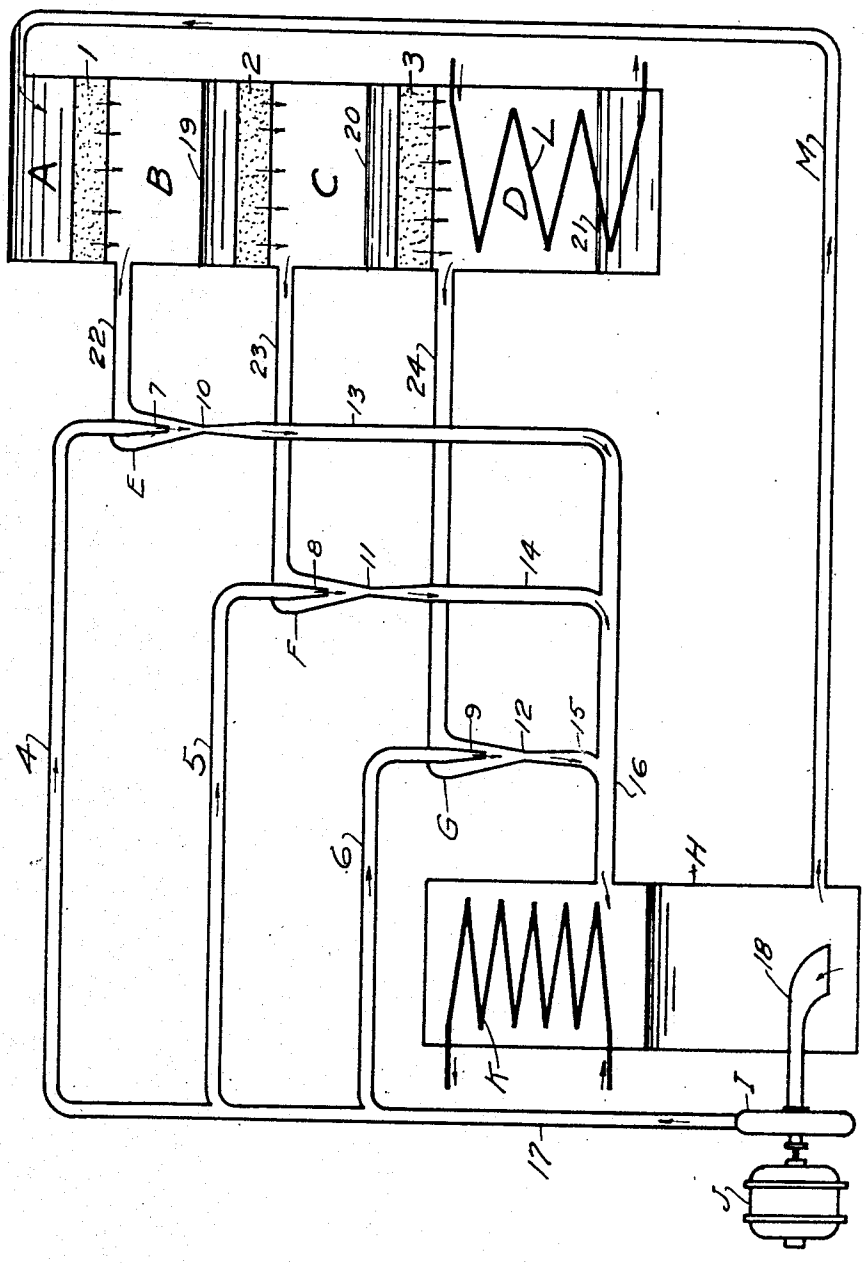


FIG. 1.

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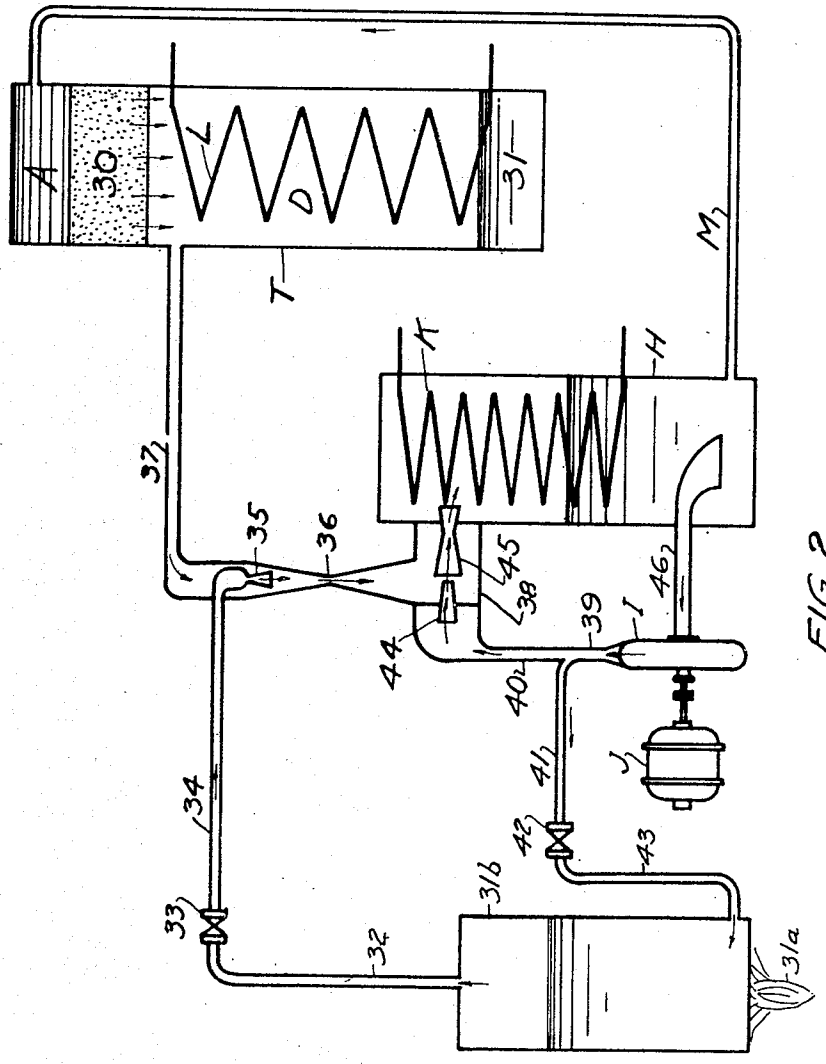


FIG. 2.

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MEANS AND METHOD OF REFRIGERATION

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Application November 14, 1932, Serial No. 642,531

6 Claims. (Cl. 62—115)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

My invention relates to refrigerating apparatus and methods and is an improvement on my apparatus as disclosed in my co-pending application Sr. No. 477,038, filed August 22, 1930.

In my co-pending application 477,038 I employ a refrigerant liquid in motion to exhaust a refrigerating space to vaporize another portion of liquid refrigerant; then compress the vapors to condense same and return to the refrigerating space. The exhausting and compressing is performed by the aid of a liquid jet passing across a suction space and accumulating the vapors in a compression tank.

In the present application I employ a similar means to exhaust a refrigerating space, vaporize a refrigerant and then compress and condense the resultant vapor. However, I introduce a number of jets, either in parallel or in series to perform the exhausting and I arrange for steps of exhausting from a higher pressure to a very low pressure.

Fig. 1 illustrates in diagrammatic form the principle of my invention. The illustration is entirely diagrammatic and no attempts have been made to show in detail. The different parts are conventional and very well known and may be constructed in many different ways, and I include any construction in my combination.

The main part of my apparatus is a vessel T, which I call evaporating tower. This vessel is divided into several sections, which may be multiplied in any amount desired. I illustrate four such sections, A, B, C, and D, but include other divisions, single or multiple. Each such section is separated from the others by porous walls or plugs 1, 2, and 3. These plugs will allow a liquid to trickle through, especially if the pressure below the plug is less than above the plug, about similar to filtering apparatus, where a liquid is filtered through a porous wall by reducing the pressure on one side of this wall. If therefore pressure in D is less than in C, and in C less than in B, and in B less than in A, a liquid at A will pass downwards through these plugs and spaces to finally reach D.

Besides this tower T I have a multistage arrangement of exhausting, one exhauster for each section B, C and D, and of course if these sections were multiplied, I would also multiply the exhausters. These exhausters are identified by E, F and G.

The exhausters are supplied with liquid refrigerant or any other liquid motive medium by pump I, driven by motor J, through main 17 and laterals 4, 5 and 6. The liquid is discharged at high velocity through nozzles 7, 8 and 9 enclosed in the suction chamber and the jet is then delivered through tubes 10, 11 and 12 laterals 13, 14 and 15 and return main 16 to compression tank H, which also serves as a condenser cooled by coil K or in any other suitable manner. The pump is supplied with liquid through pipe 18. The tower is supplied with liquid refrigerant through pipe M, such liquid being delivered into section A.

Jet exhauster E will cause a lowering of the pressure in section B. Liquid trickling downwards through plug 1 to continue through section B to accumulate at 19 will pass a space at lower pressure with the result that part of the vapor will evaporate causing a lowering of the temperature in the liquid at 19. In then passing through plug 2 and section C further evaporation with further lowering of the pressure will occur. This will again occur when the liquid reaches section D. The vapor pressure being a function of the temperature and the liquid being lowered in this temperature as it passes each section, the pressure in each section will be correspondingly reduced thus giving a gradiating pressure from high at A to low at D. This gradient will pull the liquid from section to section through the porous plugs. And the temperature, being the highest at A will be the lowest at D. In this section is introduced a coil L which by some suitable medium will transfer the refrigerating effect to any purpose desired. Of course the entire evaporating tower may serve as a refrigerator, or the lower part only as desired.

The nozzles in the exhauster will be adjusted to suit the different pressures in the sections. The combined vapor and liquid will pass through laterals 13, 14 and 15 and main 16 back to compression tank H, the vapors being condensed by coil K.

In Fig. 2 I illustrate a modification of my apparatus in which I add a vapor ejector to assist in the flow of refrigerant vapor from the evaporator to the compression space. The evaporator is here shown with one stage exhaustion and one section and one porous plug, however, any amount of stages may be added as shown in Fig. 1. Identical letters in Fig. 2 refer to similar parts of Fig. 1.

Briefly described, liquid refrigerant from compression tank H is delivered into space A of evaporating tower T. Porous plug 30 will allow refrigerant to seep through into space D which is

kept under reduced pressure. The plug 30 acts as an expansion valve, and in fact may be replaced by a conventional expansion valve. Refrigerant is evaporated in space D. Some liquid may collect at point 31, which liquid will act as an equalizer and as storage. If water should be the refrigerant and a low temperature is desired, the water at 31 may be a brine solution, thus preventing freezing of same and permitting a lower temperature. This solution will remain in this space as concentrated or diluted depending upon the amount of water passing through unevaporated.

The low pressure in the evaporating space is produced by two means in series, a vapor ejector 35 and 36 and a liquid jet exhauster 44 and 45. The liquid jet exhauster is enclosed in a suction chamber 38 and is composed of jet nozzle 44 and delivery tube 45, discharging into compression tank H. The vapor ejector is supplied by vapor from vapor generator 31b through pipe 32, valve 33 and pipe 34.

Liquid pump I delivers refrigerant liquid to jet exhauster through pipes 39 and 40 and to vapor generator 31 through pipe 41, valve 42 and pipe 43. Generator is provided with heating means 31a. Vapor is condensed in tank H by coil K.

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

I claim:

1. A method of refrigeration comprising, imparting motion to a portion of liquid refrigerant, utilizing the energy in this liquid in motion to compress vaporized refrigerant, condensing said vapor, passing a portion of liquid refrigerant through a pressure resisting element to an evaporating space and another portion to a generating space, generating refrigerant vapor in said generating space by the application of heat and utilizing said vapor in an ejector to lower the pressure in said evaporating space causing liquid refrigerant in said space to vaporize, passing the combined vapors from said ejector to point of compression.

2. A method of refrigeration comprising, imparting motion to a portion of liquid refrigerant and vaporizing another portion of said refrigerant by heat application, utilizing the energy in said liquid in motion and in said vapor to lower the pressure on another portion of said refrigerant so as to evaporate same, the liquid thus evaporated passing from a higher to a lower pressure through a pressure resisting element.

3. A selfcontained refrigerating apparatus consisting of a generator in which a vapor is generated from a liquid refrigerant and heating means in connection with same generator, a vapor ejector in communication with said generator, an evaporator and connection between said evaporator and said vapor ejector, a compression chamber containing liquid refrigerant and vapor of refrigerant and cooling means in said chamber to condense said vapor, pump means to cause liquid refrigerant to circulate from said compression chamber through a liquid ejector and back to said compression chamber, communication means between said vapor ejector and said liquid ejector for vapor to pass from the former to the latter, communication means to pass liquid from said compression chamber to said generator, other communication means to pass liquid from said compression chamber to said evaporator and an element in said communication means to cause a reduction of the pressure on a fluid passing through.

4. A method of refrigeration comprising exhausting an evaporating space evaporating a liquid in said space by the means of a jet of vapor, compressing motive vapor and vapor produced in said evaporating space by the means of a jet of liquid, condensing said vapors, passing part of the condensate to said evaporating space through a pressure reducing element and another part to a vapor generating space, generating vapor in said space by heat application and passing said vapor to point of beginning.

5. A selfcontained refrigerating apparatus containing a boiler, a thermodynamic compressor, a hydraulic compressor, a condenser communicably connected in series in one circuit; and an evaporator, said thermodynamic compressor, said condenser and a flow-controlling element communicably connected in series in a second circuit.

6. A method of refrigeration which consists in reducing the pressure exerted upon a refrigerant sufficiently below normal to cause the evaporation thereof by the joint action of thermodynamic and mechanical forces, and subsequently increasing the pressure exerted upon the vapor of evaporation sufficiently above normal to cause the condensation thereof by the joint action of the same forces.

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