Dec. 5, 1939. E. L. KASTLER 2,181,898

REFRIGERATING APPARATUS

Filed June 17, 1935 3 Sheets-Sheet 1

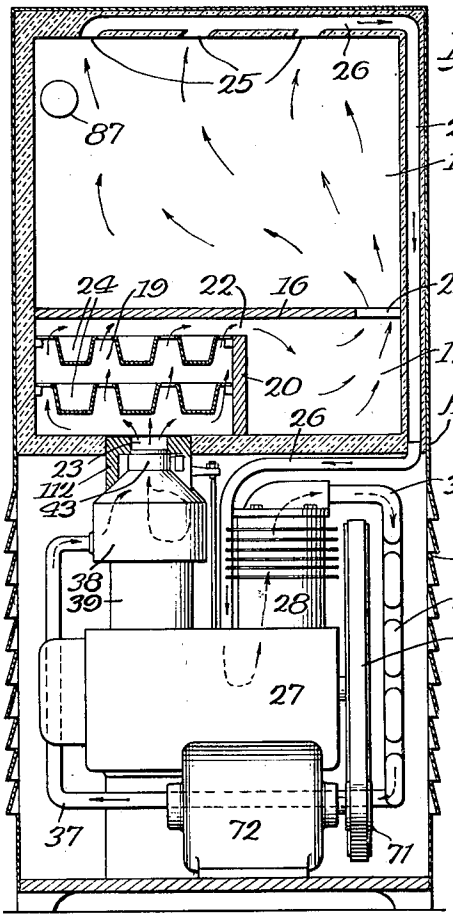


Fig. 1

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Fig. 2

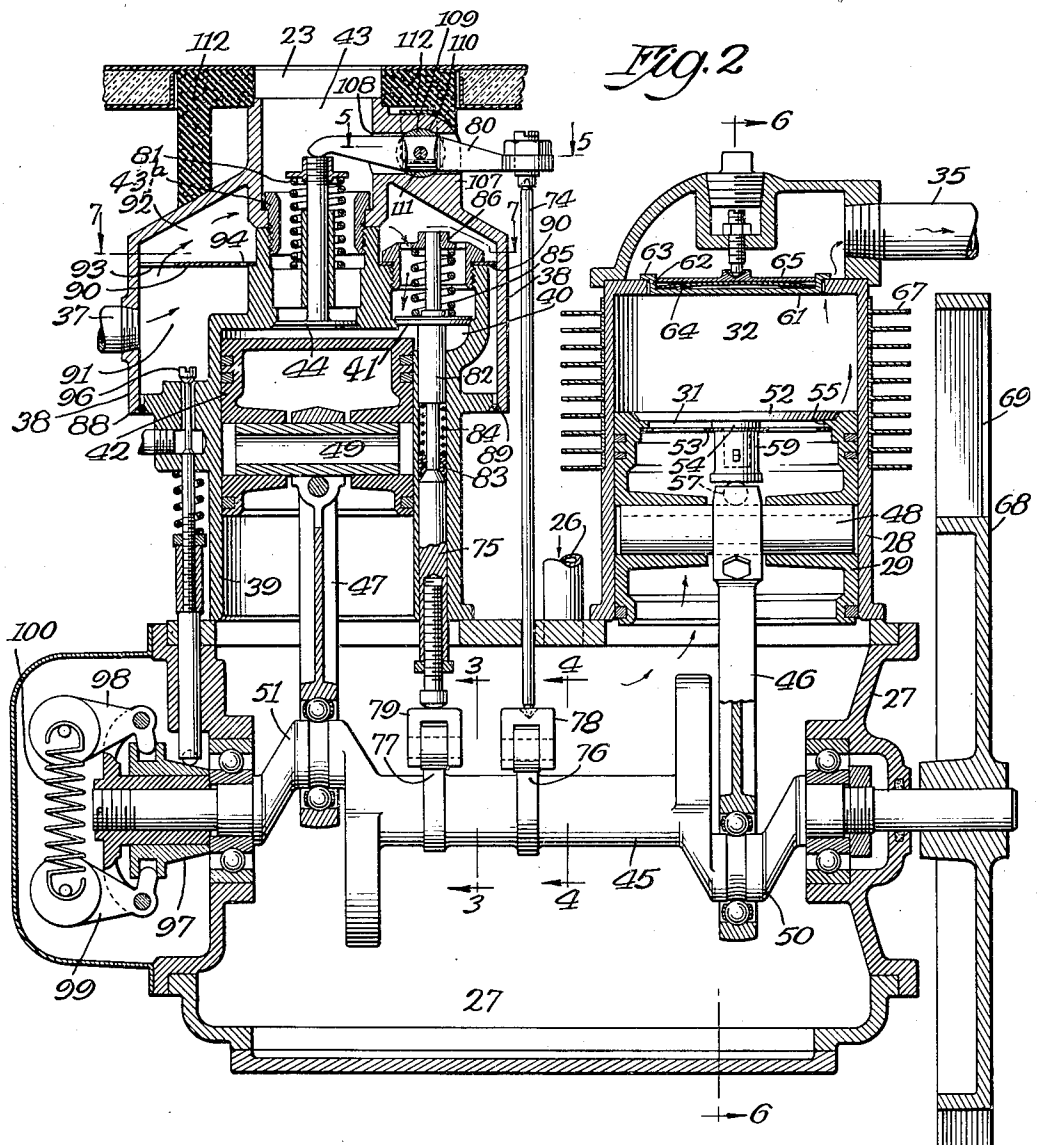


Fig. 3

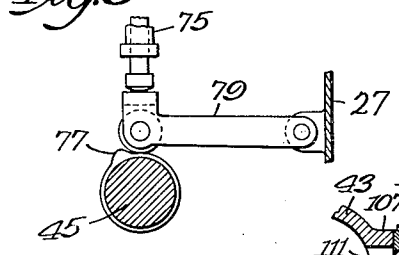


Fig. 4

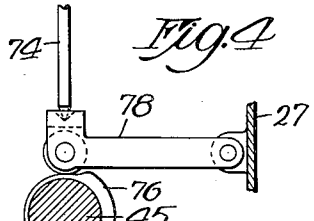
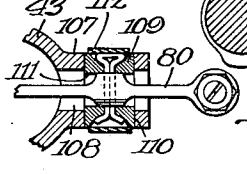


Fig. 5



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Fig. 7

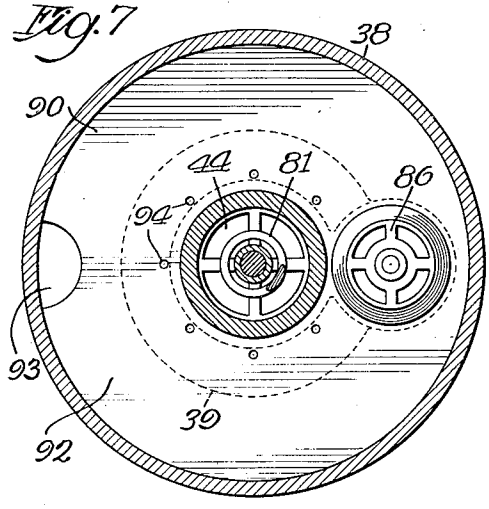


Fig. 6

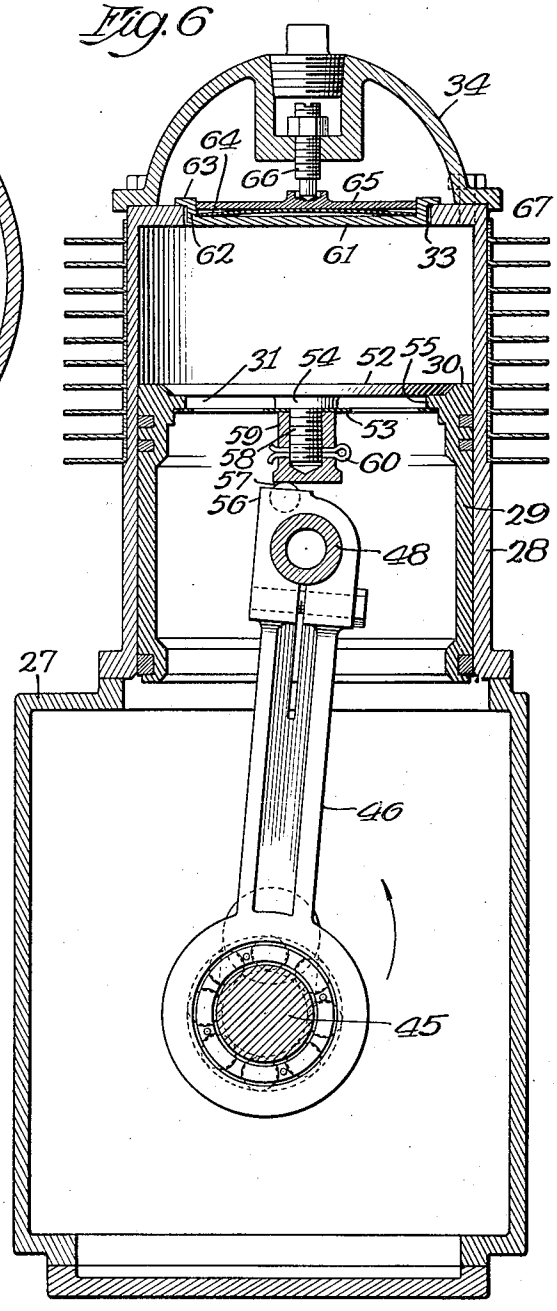
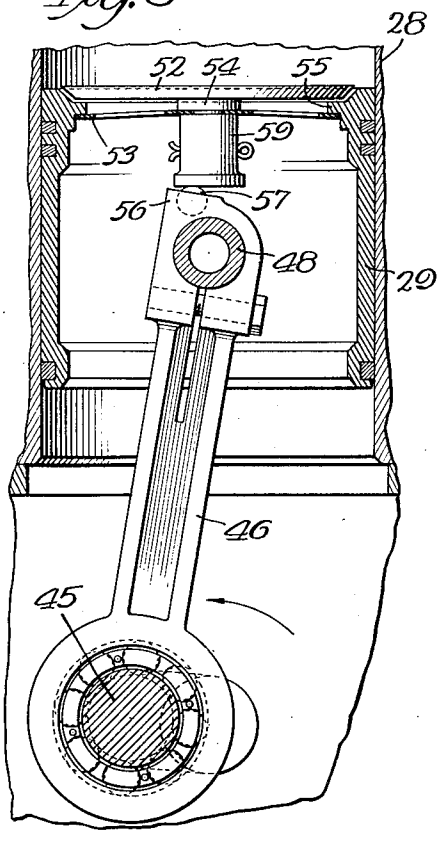


Fig. 8



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Patented Dec. 5, 1939

2,181,898

UNITED STATES PATENT OFFICE

2,181,898

REFRIGERATING APPARATUS

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Application June 17, 1935, Serial No. 27,001

6 Claims. (Cl. 62—98)

The invention relates to that type of refrigerators in which air is used as the refrigerant by circulating it through a refrigerating cabinet, its temperature being lowered in the circuit by mechanical means; and more particularly, to such refrigerators intended for domestic use. In domestic refrigerators of this type it is essential that the mechanism be as nearly noiseless as possible; that the refrigerant be circulated through the refrigerating compartment by power-driven mechanism for causing its compression; for reducing its temperature while maintaining its pressure; effecting its dehydration; and causing its expansion for the purpose of substantially lowering its temperature.

The invention provides for the accomplishment of these several steps, and by means of mechanism which can be operated at low cost and practically without noise.

In the accompanying drawings—

Fig. 1 is a vertical section of the device, the compressing, cooling, dehydrating and expanding mechanism being shown in elevation;

Fig. 2 is a vertical, central section through the power mechanism;

Figs. 3 and 4 are sectional details of the valve lifters associated with the expansion cylinder;

Fig. 5 is a detail section on the line 5—5 of Fig. 2;

Fig. 6 is a vertical section through the compressor cylinder, its crank case and drive shaft;

Fig. 7 is a sectional view on the line 7—7 of Fig. 2; and

Fig. 8 is a detail section similar to Fig. 6, showing the parts in different position.

The refrigerator is housed within a casing A. The refrigerating cabinet is enclosed within the upper portion of the casing and is divided, by a horizontal partition 16, into an upper storage compartment 15, for provisions for immediate use, and a lower compartment 17 for articles which may be held for future use; a congealing compartment 19 being separated from the compartment 17 by a vertical partition 20. The partitions 16 and 20 are apertured, as shown at 21, 22, for the passage of air, which enters the compartment 19 at 23. Congealing pans 24 may be located in the compartment 19.

The refrigerant is drawn from the upper chamber 15 of the cabinet through ports 25 in its top wall, and a conduit 26 in such wall and extending downwardly through a side wall and communicating with the crank case 27, which is housed in the lower section of the casing and with which are associated the compressing, cooling, dehydrating and expansion elements.

The cylinder 28 of the compressor is mounted on top of the crank case 27, the lower end of the cylinder being open thereto, the cylinder receiving air therefrom. The piston 29 of the compressor is of the trunk type and is hollow, and has a valve-controlled induction port 31 in its head 30, being open at its lower end. Air enters from the case 27 into the compression chamber 32 of the cylinder, from which it is discharged through a valve-controlled port 33, in the head of the cylinder 28, into the chamber of a dome 34.

A pipe 35 connects the dome 34 with a cooling coil 36, conveniently located adjacent one end of the crank case 27. From this coil there leads a pipe 37, which delivers to the chamber of the dehydrating casing 38. This casing is located upon the upper end of the expansion cylinder 39, with which its chamber communicates through a port 40, controlled by a valve 41.

The piston 42 of the expander is of the trunk type, being open at its lower end and closed at its upper end. The upper end of the cylinder 39 communicates with the port 23 through a central nipple 43, leading from the discharge port in the cylinder head, which is controlled by an inwardly opening valve 44.

The compressor piston 29 and expander piston 42 are connected with a crank shaft 45, journaled horizontally within the case 27 by the rods 46, 47, which are pivotally connected with the pistons by the wrist pins 48, 49, and at their lower ends with approximately oppositely positioned cranks 50, 51, of the shaft.

In the preferred form of construction of the compressor, as shown in Figs, 2, 6 and 8, the port 31 in the upper end of the piston 29 is controlled by a disk valve 52, held to its seat by a ported disk spring 53, carried by the stem 54 of the valve and reacting against an annular shoulder 55, which defines the air port in the piston head. The valve 52 is controlled by the connecting rod 46, a ball or roller 57 being mounted in a suitable socket in its upwardly projecting end 56 of the rod, and engaging the flat lower end of the valve stem 54. To provide for the mounting of the spring disk 53 upon this stem the latter takes the form (Fig. 6) of a screw-threaded stud 58 and a thimble 59, mounted thereon and locked against rotation and accidental loosening by a suitable pin, as 60.

The port 33 in the upper end of the compression cylinder is controlled by a disk valve 61, which fits loosely within the port and has at its

margin an upstanding annular flange 62, from the upper end of which projects an outstanding lip 63, which seats against the outer face of the end of the cylinder and seals the port. This valve is held to its seat by a dome-shaped disk spring 64, seated against its upper face and reacting against a circular plate 65, fitting within the flange 62 and adjustably urged against the center of the spring by a screw rod 66, carried by the dome 34. This valve is opened by the pressure developed within the cylinder, mainly against the air pressure within the dome chamber.

The spring 64 is very light and fits snugly against the outer face of the valve 61 throughout its circumference. The plate 65 fits sufficiently close within the flange 62 of the valve to provide a dashpot action. The valve action is so retarded by the passage of air from and into the chamber provided by the dome shape of the spring, and past the margin of the plate 65, to prevent any appreciable noise.

As the crank shaft 45 rotates the projecting upper end 56 of the connecting rod 46 oscillates across the face of the valve stem 54, raising the valve 52 to admit air from the case 27 to the upper end of the cylinder 28 on the downstroke of the piston and to permit it to close during the upstroke, during which stroke the air is compressed and discharged from the cylinder through the port 33.

As shown, the crank shaft 45 is located a little to one side of the center line of the cylinders 28 and 39, thereby relieving side pressure on cylinder walls to reduce friction and improving the valve timing.

Although the valves 52 and 65 are of the poppet type, they are practically noiseless in operation, both because of their slight range of movement and the manner in which they are controlled. Both valves approach their seats so gradually that the sound is hardly noticeable.

The upper portion of the cylinder 28 may be provided with radiating flanges 67, which carry off some of the heat developed by the compression of the air.

The drive wheel 68, mounted on a projecting end of the shaft 45, is located between the case 27 and the cooling coil 36, and is provided with fan blades 69, for causing a circulation of air between the turns of this coil. The wheel 68 may be faced to carry a belt 70, running over a pulley 71 on the shaft of an electric motor 72, mounted within the cabinet and controlled by a thermostat, conventionally shown at 87, located in the chamber 15. The walls of the casing are preferably composed in part of louvers, as shown at 73, to provide for the circulation of air.

The valves 41 and 44 of the expander cylinder are spring-closed, and are opened by means of rods 74, 75, controlled by cams 76, 77, formed on the shaft 45, smoothness of action being secured by seating the valve rods on arms 78, 79, pivoted to the side wall of the case 27 and resting upon the cams through suitable anti-friction rollers. The valve rod 74 connects at the upper end with a rocker arm 80, which bears downwardly upon the stem of the valve 44 and opens it against the resistance of a spring 81.

The valve rod 75 is sectional, its upper end 82 being attached to the valve 41 and resting upon the lower section. The upper end of the lower section of this valve rod is of reduced diameter and carries a suitable packing 83, which is urged against a conical shoulder and thereby expanded under the pressure of a helical spring 84. The valve 41 is held to its seat by a spring 85, reacting against a ported cap 86, threaded into the upper end of the port 40.

The chambered head or casing 38 fits over the upper end of the cylinder 39, and within it is formed the outlet nipple 43. The head 38 is attached to the cylinder 39 by a bushing 43a, threaded into the nipple section projecting from the discharge port of the cylinder and having a radial shoulder at its outer end bearing upon an instanding shoulder on the section of the nipple 43 which communicates with the cabinet. The head 38 fits upon the cylinder, as shown at 88, 89, and this joint may be suitably sealed, as with solder. The chamber of the head 38 is horizontally divided by a ported diaphragm 90 into lower and upper compartments 91, 92.

The discharge outlet from the expansion cylinder is directly through these two compartments, and consequently the air entering the lower compartment through the pipe 37 is brought directly into contact with metal chilled by the cold air discharged from the cylinder, and a portion of the moisture with which it is charged is condensed. The partially dehydrated air passes on to the upper portion 92 of the chamber through suitable ports, as 93, and again comes in contact with chilled metal surrounding the outlet 43, and the dehydrating action is completed,—the water of condensation escaping through suitable perforations, as 94, in the plate 90. The air passing through the casing 38 insulates the discharge passage from the expansion cylinder from the air of the room, and this insulation is supplemented by the slight accumulation of frost on the outer surface of the walls of this passage.

A discharge port for the water of condensation leads from the chamber 91, and is closed by a spring-controlled valve 96, the stem of which is seated upon a conical sleeve 97, slidably mounted on the outer end of the shaft 45, and controlled by a pair of bell cranks 98, 99, carried by the crank shaft, each having an arm engaged in an annular channel formed in the cone, their outer arms being weighted and drawn toward each other by a spring 100.

When the shaft 45 is at rest the bell cranks 98, 99, drawn together by the spring 100, thrust the cone 97 forwardly under the stem of the valve 96, raising the valve from its seat and permitting the escape of water which has accumulated in the chamber 91. When the shaft 45 is in motion the weighted arms 98, 99, of the bell cranks are urged outwardly by centrifugal force against the resistance of the spring, and the cone 97 is withdrawn to permit the valve 96 to close.

The nipple 43, while projecting but a short distance beyond the body of the head or casing 38, reaches substantially to the bottom of the refrigerating cabinet, and is preferably inclosed within a jacket 112, of nonheat conducting material, such as sponge rubber, which fits within the opening 23 and extends downwardly over the upper portion of the casing, as shown in Fig. 1.

The operation of the device is as follows:— Air withdrawn from the refrigerating compartment 15 will be somewhat below room temperature. When compressed within the cylinder 28 its temperature will be raised. It has been found that when suitable pressure is attained the temperature rises to about 300 degrees. This temperature is reduced by means of the radiating flanges 67, and the cooling coil 36, to approximately room temperature, and the air enters the expansion cylinder 39 at the beginning of the

downstroke of its piston at approximately that temperature, but still under substantially the pressure developed by the cylinder **28**.

But a small quantity of air is admitted to the expansion cylinder, the valve **41** being closed early in the downward stroke of the piston. The excess pressure of the air admitted to the cylinder urges the piston downwardly, contributing to the upward movement of the compressor piston. By reason of the expansion of the air within the cylinder **39** its pressure is reduced to approximately three or four pounds per square inch above atmosphere, and its temperature is lowered approximately 100° below room temperature.

The valve **44** is open during the upstroke of the piston of the expander, and the air is forced into the congealing chamber **19** without change in either pressure or temperature. As it passes through the congealing chamber its temperature will be somewhat raised, and it will take up more heat as it passes through the chamber **17**, entering the chamber **15** at temperature suitable for preserving the food stored therein.

The compressor and expander and their valves are, of course, proportioned and timed in their action to secure the variations in pressure and temperature desired.

The condensing and expanding mechanism are operated with but slight friction, the shaft **45** being journaled on ball bearings, as are also the connecting rods **46**, **47**. The power required to operate the compressor is considerably reduced by the expansive action of the air within the cylinder **39**, the expansion stroke of the piston **42** being coincident with the compression stroke of the piston **29**; and the work thus performed contributes to the lowering of the temperature of the expanding air. Furthermore, the apparatus is substantially noiseless in its operation. While the valves of the compressor are of the poppet type, they are of such form that they open and close without the metallic click or wire drawing sound usually incident to the operation of such valves.

The rocker arm **80** is pivotally mounted within a boss **107**, formed externally on the casing **38** and its nipple **43**. The aperture **108** in the boss, through which the arm extends, opens into the chamber of the nipple, and is of sufficient diameter to allow for the movement of the arm incident to the opening of the valve **44**. In order to prevent the escape of chilled air through this aperture, and to provide for the convenient assembly, the rocker arm is fitted snugly within an aperture **111**, diametrically through a pivot shaft **109**, seated in an aperture **110** extending transversely through the boss, a pin, such as a cotter, extending through an axial aperture in the pivot and an alined transverse aperture in the rocker arm, as shown.

In assembling these parts the pivot shaft is first entered within its bearing **110**, the arm **80** is then inserted in the apertures **108** and **111**, and the cotter pin is now inserted through the shaft and arm. The pivot shaft may be held against longitudinal displacement by means of a spring clamp **112**, set down over the boss **107** and engaging the ends of the shaft. This form of construction is sufficiently tight, as the air pressure within and external of the nipple **43** is substantially the same.

I claim as my invention—

1. A refrigerator apparatus comprising a storage chamber, a congealing compartment within the lower portion of said chamber and communicating therewith, said chamber having an air inlet through the bottom wall of said compartment, an air outlet in the upper portion of said chamber, and mechanism communicating with said outlet for withdrawing air from said chamber, reducing the temperature thereof below the freezing point of water and discharging the same directly into said compartment for maintaining the temperature therein at or below the freezing point of water.

2. In a refrigerator, in combination, a cabinet having an air outlet, a cooling chamber and a congealing compartment communicating with the cooling chamber, means for chilling air by expansion, a nipple connecting the expanding means with the interior of the cabinet and delivering into the congealing compartment, and a dehydrating chamber surrounding and in contact with the nipple discharging air from the expander.

3. In a device for chilling air in combination a compressor, cooling means and an expander arranged in series, and a dehydrator receiving from the cooling means and delivering to the expander and comprising a chambered casing enclosing the outlet from the expander.

4. In a device for chilling air in combination a compressor, cooling means and an expander arranged in series, and a dehydrator receiving from the cooling means and delivering to the expander and comprising a chambered casing enclosing the outlet from the expander, such chamber having a normally open drain valve, and means for automatically closing the valve when the expander is in operation.

5. In a device for chilling air, in combination, a compressor, a cooling device receiving from the compressor, an expander having a dehydrating compartment surrounding the outlet thereof and receiving from the cooling device and communicating with the expander through a valve controlled port, the named compartment having a normally open valve controlled drainage port, and means for automatically closing the valve.

6. In a device for chilling air, in combination, a compressor, a cooling device receiving from the compressor, an expander having a dehydrating compartment surrounding the outlet thereof and receiving from the cooling device and communicating with the expander through a valve controlled port, the named compartment having a valve controlled drainage port, power means for actuating the compressor and expander and for closing the valve of the drainage port, such valve being normally open.

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