Dec. 1, 1936. A. HENNIG 2,062,651

REFRIGERATOR

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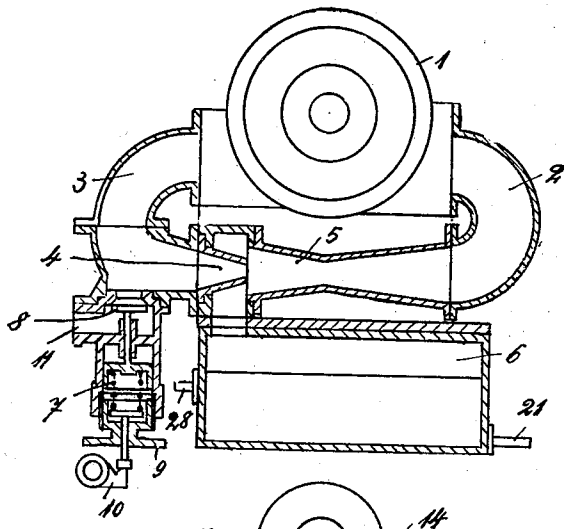


Fig. 1

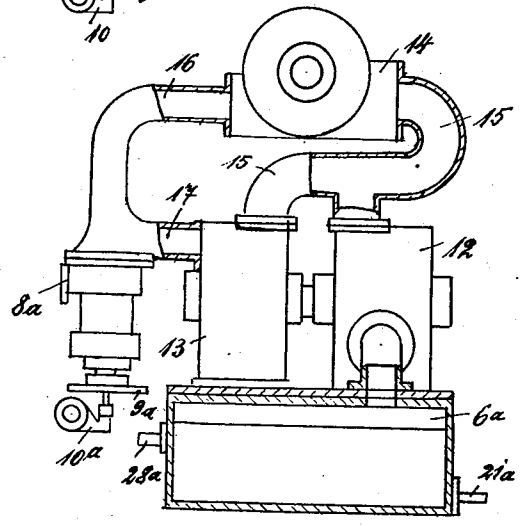


Fig. 2

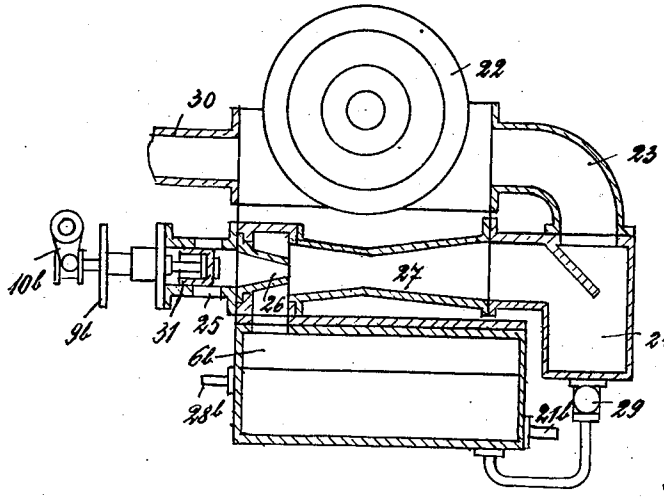


Fig. 3

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REFRIGERATOR

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4 Claims. (Cl. 62—115)

I have filed an application in Germany, January 3, 1933.

Refrigerators are known which employ water as cooling medium. In these machines water is evaporated in an evaporator under very high vacuum and at low temperature, the water absorbing heat from its surroundings, which is usually the brine in the evaporator.

Two types of water vapor refrigerating machines are known.

1. The high vacuum is produced by a pump driven by means of a power engine and drawing off the water-vapor which is produced, this water-vapor being then compressed in one or more stages, cooled in a condenser and condensed. The water-vapor must be so strongly compressed, that the resultant temperature produced is considerably higher than that of the cooling water employed in the condenser. If this is not the case, the vapor cannot possibly be condensed.

This arrangement is open to the objection, that the suction pump, which draws the vapor out of the evaporator, must in practice have inadmissibly large dimensions because vapor at the necesarily very high vacuum has a large specific volume.

2. In order to overcome the objection of the large size mechanically actuated suction pump, steam ejector pumps have been successfully employed. In this instance the steam (live or waste) flows to the steam ejector pump, produces a high vacuum in the evaporator and carries off the resultant vapor into the water-cooled condenser where it is immediately condensed and thus produces a relatively high vacuum.

This arrangement is open to various objections. In most instances a separate boiler, and for the condensing of the steam an especially large condenser and a large quantity of cooling water are necessary, because not only the steam flowing out of the jet blower, but also the vapor produced from the brine under vacuum must be condensed. Therefore, arrangements of this type are only suitable in such cases, where a steam boiler plant already exists for other purposes or where large quantities of waste steam and water are available at low cost, for example for driving ships.

In order to overcome these objections, a method is proposed, in which the steam for actuating the driving engine of the vacuum pump or the jet blower is not supplied from a steam boiler or as waste steam from a power plant, but in which the energy of the steam discharged from the jet blower is increased by compression to such an extent, that it again carries out the desired effect in the jet blower. Thus, a saving in energy is attained, because the compressor does not produce steam from water, but serves only to increase the energy of already existing steam, that is, it has not to do the portion of work corresponding to the latent heat. The energy of the steam flowing out of the jet blower is therefore not destroyed in a condenser, but further utilized for the working process.

Owing to the internal work of the steam, a considerably smaller condenser and a smaller quantity of cooling water are sufficient, or the condenser or the cooling water may be dispensed with entirely.

Several embodiments of the invention are illustrated by way of example in the accompanying drawing, in which:—

Fig. 1 shows a form of construction of the machine in vertical section.

Fig. 2 is a similar view of a modified form of construction.

Fig. 3 shows a third form of construction.

In Fig. 1 a compressor (secondary stage) 1 produces a vacuum in a compartment 2. The mixture of air and steam drawn off is compressed by the air pump 1 and flows through a pipe 3 to a nozzle 4, in which a high speed is imparted to the same, and then returns through the diffuser 5 into the compartment 2. At the same time a vacuum is produced in known manner in the evaporator 6 and the water vapor produced is carried into the compartment 2, whence it is returned to the air pump 1 through the diffusor 5 and the compartment 2 together with the steam coming from the nozzle 4. The nozzle 4 and the diffusor 5 together form an ejector air pump of known type. The mixture vapor and air drawn in is compressed in the compressor 1. Thus, the energy of the mixture is again increased and becomes capable of again performing work in the steam jet pump 4, 5 (primary stage) and of drawing further water vapor out of the evaporator 6. Owing to the fact that a portion of the evaporator liquid is evaporated this is considerably cooled.

As fresh water vapor is continually drawn from the evaporator 6, the effective quantity of the mixture delivered by the compressor 1 increases continually. Consequently, the pressure in the pipe 3 increases to above the normal pressure necessary for driving the ejector air pump. When the normal pressure in the pipe 3 is exceeded, a valve 8 loaded by a spring 7 opens. As much of the mixture flows then continually through the valve 8, as is necessary for maintaining the normal pressure in the pipe 3. The spring pressure can be adjusted by turning a hand wheel 9. The stronger the spring is compressed, the higher will be the pressure in the pipe 3, and consequently the higher will be the refrigerating effect of the machine. In the case of automatic regulation, the spring may also be compressed at the same time by a lever 10, which is actuated by a temperature regulator of known type, not shown in the drawing.

The water evaporated in the evaporator 6 is replaced either by hand or automatically by means of a known float valve through the pipe 21. In order to assist the evaporation in the evaporator 6 air is continually fed therein through the pipe 28. By regulating this admission of air the moisture content of the mixture can be varied, which is particularly important for the efficiency of the compressor 1. If it is desired to rapidly increase the percentage of steam in the mixture when starting up the machine it is only necessary to inject a quantity of boiling water into the pipe conduit 2, this water immediately evaporating under the vacuum existing in this conduit.

The steam flowing through the valve 8 and the outlet 11 is either conducted into the atmosphere or may be further utilized for power, heating or cooking purposes.

A second form of construction is illustrated in Fig. 2.

In this instance 12 designates a compressor (primary stage), 13 a power engine and 14 a second compressor (secondary stage). The compressor 14 draws a mixture of steam and air from a compartment 15 and compresses same to a sufficient degree. The compressed mixture then flows through the pipe conduits 16 and 17 to the power engine 13 of the compressor 12 (primary stage). The mixture, after having performed the necessary work for the delivery work of the pump 12 in the power engine 13 flows into a pipe conduit 15. Owing to the action of the pump 12 a high vacuum is produced in the evaporator 6*a*, the water vapor thereby produced being forced by the compressor 12 into the pipe conduit 15, the steam discharged by the power engine 13, and the vapor conveyed from the evaporator 6*a* by the compressor 12 is drawn in by the compressor 14, compressed and returned through the pipe conduits 16 and 17 to the power engine 13 of the compressor 12.

As the quantity of active steam continually increases owing to the continual withdrawing of fresh vapor from the evaporator 6*a*, a portion of the mixture must always be discharged, which, as explained in detail in connection with the construction shown in Fig. 1, may be effected by a spring-loaded valve, the spring pressure of which may be regulated by a hand wheel 9*a* or at the same time by a lever 10*a*. The steam escaping from the discharge aperture 8*a* generally escapes into the atmosphere but may also be utilized for other purposes.

During the beginning of the operation of the machine the mixture will consist chiefly of air. In the course of time the air will be gradually forced out through the valve 8, and as chiefly only steam is drawn off from the evaporator, it may happen that the mixture, after the machine has been running for a long time, will consist almost exclusively of vapor. As the boiling point of the brine will be raised by the lack of air a small quantity of fresh air is continually fed into the evaporator 6*a* through the pipe 28*a*. The water which is evaporated and carried off is replaced through the pipe 21*a*.

A third form of construction of the machine is illustrated by way of example in Fig. 3.

The air pump 22 (secondary stage) produces a vacuum in the compartments 23 and 24. Thus, atmospheric air of normal atmospheric temperature flows through the slots 25 into the nozzle 26 and the diffusor 27 at a high speed. A vacuum is thus produced in the evaporator 6*b*, the resultant steam is carried off and supplied to the compartment 24 which is constructed as a water separator. The temperature of the atmospheric air flowing in through the slots 25 is lowered by the expansion in the jet blower 26 and 27 so that the steam carried out of the evaporator 6*b* condenses. The water from condensation is then either returned to the evaporator through the regulating valve 29 or is discharged into the open by a pump, not shown in the drawing. The highly heated air delivered from the compressor 22 is either allowed to escape into the atmosphere through the pipe conduit 30 or can be utilized for heating and cooking purposes. The quantity of air flowing through the slots can be adjusted by a slide 31. The adjustment may be effected by hand by means of the hand wheel 9*b* or automatically by the lever 10*b* which is actuated by a temperature regulator.

Instead of employing a jet air pump, a compressor driven by a power engine as illustrated in Fig. 2, may be used.

As in the construction illustrated in Fig. 2 fresh air is supplied into the evaporator 6*b* through the pipe 28*b* and the evaporated water is renewed through the pipe 21*b*.

The arrangement illustrated in Fig. 3 presents the following advantage:—

In the arrangements shown in Figs. 1 and 2 the driving medium coming from the jet blower and the vapor carried off from the evaporator must be conveyed by the compressors 1 or 14 respectively. In the arrangement according to Fig. 3, however, the vapor coming from the evaporator condenses before entering the secondary stage and is then immediately discharged. The compressor 22 (Fig. 3) therefore need only to suck in the driving air for jet blower. Thus, the working volume and the power required by the compressor 22 are reduced, this representing an important advantage.

I claim:—

1. A refrigerator, comprising in combination a compressor operated from any suitable source of power, a compartment on the intake side of said compressor, a pipe leading from the delivery side of said compressor, an evaporator partly filled with liquid and a suction pump at the end of said delivery pipe actuated by the mixture of steam and air compressed by said compressor and connected with said compartment on the intake side and with said evaporator above the level of the liquid therein, said pump adapted to produce a vacuum in said evaporator to evaporate the liquid therein and feed the vaporized liquid and air through said compartment to said compressor.

2. In a refrigerator as specified in claim 1 the suction pump comprising a nozzle on the end of the delivery pipe and a diffusor leading to said compartment.

3. In a refrigerator as specified in claim 1 the pump, comprising a motor connected to the delivery pipe driven by the medium circulated by the compressor, and a compressor connected with the evaporator and the compartment.

4. In a refrigerator as specified in claim 1 means for maintaining at constant pressure the medium circulated by the compressor, comprising a spring loaded valve in the delivery pipe adapted to allow a portion of the medium in circulation to escape when the pressure in this pipe exceeds 1 atmosphere, and means for maintaining constant the liquid level in the evaporator.

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