Sept. 25, 1956 E. L. TULLENERS 2,763,998

COOLING MACHINE WITH JET COMPRESSORS

Filed April 11, 1952

Fig. 1

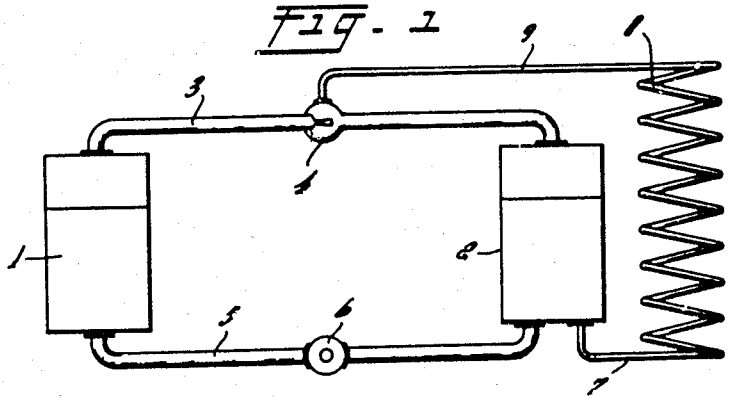


Fig. 2

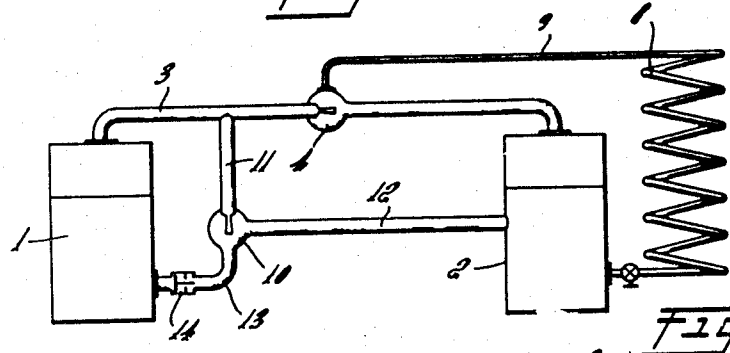


Fig. 3

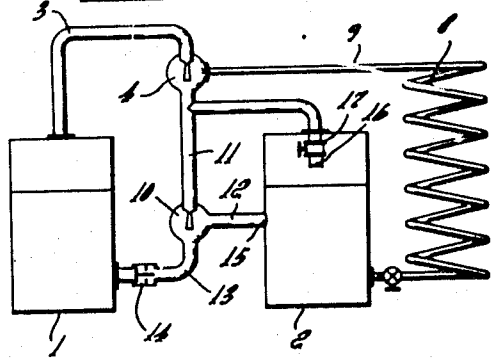
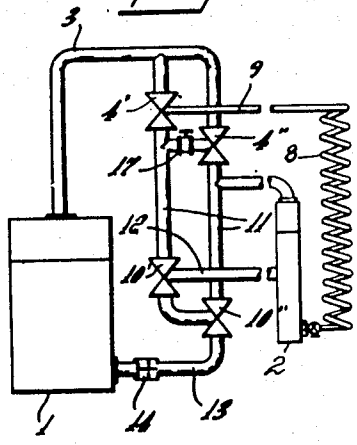


Fig. 4



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COOLING MACHINE WITH JET COMPRESSORS

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Cooling machines are known, in which the vapor of a cooling medium is compressed by means of an ejector, the ejector being fed by vapor of the cooling medium formed in a boiler.

In principle such machines offer great advantages over the many other systems of cooling machines which are in use, but until now they have been used on a relatively small scale. The reason is that it was found difficult to recycle the cooling medium in liquid condition to the boiler in opposition to the pressure prevailing in said boiler. Various methods for refilling the boiler have been proposed, but to all of these the drawback attaches that it is not possible to operate the machine continuously. High heat consumption prevents general use.

It stands to reason that this is a great drawback. In the first place because it is very objectionable if it is not possible to maintain a stable low temperature and furthermore because the parts required for periodically filling the boiler are liable to give rise to breakdowns.

The object of this invention is to provide a cooling machine which while retaining the advantages attached to the system meant above, offers the additional advantage of a continuous operation, while no parts to be put into and out of operation are required.

To that end the cooling machine comprises a boiler adapted to be heated, a condenser for the cooling medium, an evaporator, and an ejector fed by the vapor of the cooling medium for compressing the vapor of the cooling medium in the condenser and for sucking said vapor out of the evaporator respectively, is so designed according to the invention that an injector fed by the vapor of the cooling medium is connected on the one hand with the condenser and on the other hand with the boiler.

According to the invention the injector may also have its vapor inlet side connected with the vapor outlet line of the boiler. Furthermore the injector may have its vapor inlet side connected with the vapor outlet side of the ejector.

According to the invention it is also possible to include an adjustable stop valve in the line from the ejector to the condenser.

In another embodiment of the invention the mouth of the line from the ejector to the condenser may be located in the condenser at some distance above the mouth of the line from the injector to the condenser, the level of the liquid in the condenser being located between said two mouths. The cooling machine according to the invention can also be so designed that the ejector is a multi-stage ejector. Finally the injector used according to the invention may be a multi-stage injector.

In order to illustrate the invention an embodiment of the cooling machine will be described with reference to the accompanying drawing.

Fig. 1 diagrammatically shows the principle on which the cooling machine is based and

Fig. 2 diagrammatically shows an embodiment of the machine.

Fig. 3 diagrammatically shows a second embodiment of the machine, the injector being fed by vapor which has already passed the ejector.

Fig. 4 diagrammatically shows another embodiment according to which both the injector, which is likewise fed by vapor coming from the ejector, and the ejector are constructed as a multi-stage apparatus.

With reference to Fig. 1 the principle on which the machine is based, will be explained. The reference numeral 1 denotes a boiler and the numeral 2 denotes a condenser. It is assumed that the boiler 1 and the condenser 2 are each partly filled with a cooling medium, for which preferably a medium of the Freon type is chosen.

The boiler 1 can be heated in a manner not shown, for which purpose any heating method desired can be used. The upper side of the boiler 1 is connected with the upper side of the condenser 2 by means of a line 3 in which an ejector 4 is included. Furthermore the boiler 1 and the condenser 2 are connected by a line 5 at points located below the liquid levels, in which line 5 a pump 6 is included. The condenser 2 is furthermore connected with an evaporator 8 by a line 7, said evaporator being again connected with the suction side of the ejector 4 by a line 9. The operation of the apparatus is as follows.

By heating the boiler 1 the amount of cooling medium contained therein is gradually evaporated and the vapor formed will enter the condenser 2 via the line 3 and the ejector 4. The vapor is compressed in the condenser and is cooled there in a manner not shown. This vapor, therefore, will pass into the liquid phase.

The evaporator 8 likewise contains an amount of cooling medium in liquid condition which has flowed from the condenser 2 to the evaporator via the line 7. This amount of cooling medium is evaporated under the influence of the suction action which is exerted by the ejector 4 via the line 9. The evaporator 8 can be used therefore in the conventional manner for withdrawing heat from its surroundings.

Seeing that the cooling medium in the boiler 1 gradually evaporates, the amount of medium in said boiler must be replenished and this is effected under the influence of the pump 6 which, via the conduit 5, supplies an appropriate amount of liquid from the condenser 2 to the tank 1.

If this pump is operated continuously and if this pump is capable of overcoming the over-pressure prevailing in the boiler 1, the entire machine can operate continuously, provided that by correctly dimensioning the pump 6 and/or by providing correctly adjusted valves or the like care is taken that the liquid level in the condenser 2 is entirely or substantially maintained.

Fig. 2 shows how the basic idea according to the invention can be realised.

In said figure, in which the fundamental scheme according to Figure 1 is retained, the pump 6 is designed as a second fluid entraining device 10, in this case acting as an injector which has its vapor inlet side connected with the line 3 via a line 11, has its suction side connected with the condenser 2 via a line 12 and which has its outlet side connected with the boiler 1 via a line 13. It will be clear that by means of this injector 10 which is fed by vapor directly coming from the boiler 1, cooling medium in liquid condition can be sucked from the condenser 2 or introduced into the boiler 1 respectively.

In addition, the line 13 comprises a non-return valve 14 so that notwithstanding the pressure prevailing in the boiler 1 only a flow towards the boiler 1 is possible through the line 13. The apparatus thus outlined does not comprise any moving parts and only one medium is used. Moving parts subject to wear and tear are not employed so that the cost of maintenance will be exceed-

ingly slight. From a heat-economical point of view it is an advantage that part of the vapor originating from the boiler 1 is re-cycled via the injector 10 to the boiler 1, so that as little as possible heat is lost.

It hardly needs saying that the possibility of operating the machine continuously offers a great advantage, which enables the machine to be used for installations, where a non-continuous operation is found to be very objectionable, such for example, as air-conditioning installations.

It stands to reason that, while retaining the principle of the invention, various modifications are possible. The ejector can, for example, also be constructed as a two-stage or multi-stage ejector 4', 4'' (Fig. 4). In addition the injector may be fed by vapor which has already completely or partly passed the ejector (vide Figure 3 and Figure 4) instead of by vapor coming from the line 3 which is in direct communication with the boiler 1. This may constitute a further heat-economical advantage.

Under certain conditions it may furthermore be of advantage to construct the injector as a multi-stage injector 10', 10'', either or not in combination with the above mentioned possibility of constructing the ejector as a multi-stage ejector (vide Figure 4).

In all these cases the result is obtained that it is possible to operate continuously with a closed system, while the installation is practically noiseless, is not subject to wear and tear and does not need supervision.

This is also a result of the fact that the line 12, which forms the connection between the injector 10 and the condenser 2, discharges into said condenser 2 at 15, at a level lower than the mouth 16 of the line connecting the ejector 4 and the condenser 2. This construction has the following effect.

Liquid can only be sucked through the line 12 as long as the liquid level in the condenser 2 is above the mouth 15 of the line 12. If proportionally too large an amount of liquid would be sucked from the condenser 2 by the injector 10 the liquid level will fall to below the mouth 15 of the line 12. Thereupon no liquid can be sucked by the injector 10 any longer. The condenser 2 is then only replenished by the line coming from the ejector 4, so that the liquid level will rise again.

If on the other hand the amount of liquid that is fed to the condenser 2 is temporarily greater than the amount of liquid removed therefrom, the liquid level in the condenser 2 will rise until the mouth 16 is sealed. This means that the counter pressure in the line from the ejector 4, towards the condenser 2 increases, so that a greater amount of vapor will be fed to the injector 10. Consequently more liquid will be sucked through the line 12 by the injector 10, as a result of which the liquid level in the condenser 2 will fall.

Accordingly the liquid level in the condenser 2 will be constant within definite limits, so that the liquid level in the boiler 1 will likewise vary between definite limits only, which may still be promoted by providing an adjustable stop valve 17 in the line from the ejector to the condenser. In this very simple manner the automatic operation of the machine is realized.

I claim:

1. In a heat transfer machine, a boiler, a condenser and an evaporator, conduit means connecting the vapor space of said boiler with the vapor space of said condenser, said conduit means including an ejector, means connecting the inlet of the ejector to the boiler vapor space, conduit means inter-connecting the liquid spaces of said boiler and condenser, said last mentioned conduit means including an injector, conduit means connecting the ejector outlet with the vapor space of said condenser and conduit means connecting the ejector outlet with the injector inlet.

2. In a heat transfer machine, a boiler, a condenser and an evaporator, conduit means connecting the vapor space of the boiler with the vapor space of the evaporator, said conduit means including an ejector, conduit means connected with the liquid space of said condenser and including an injector, conduit means connecting the outlet from said ejector with the inlet to said injector, conduit means connecting the outlet from said injector with the liquid space of said boiler and including a valve permitting the injector to pass liquid from said condenser to the boiler, conduit means connecting said ejector with said evaporator, said evaporator being connected with the liquid space of said condenser, and conduit means connecting the outlet from said ejector with the vapor space of said condenser.

3. In a heat transfer machine comprising a boiler and a condenser and conduit means inter-connecting said boiler and condenser, said conduit means including an ejector connected with the vapor spaces of said boiler and condenser and an injector connected with the liquid spaces of said boiler and condenser, the provision of conduit means interconnecting said ejector with said injector and said ejector with said condenser such that most of the vapor leaving the ejector is utilised as motive vapor for the injector and only a small portion of said vapor is effective upon the liquid level in said condenser.

4. The invention as claimed in claim 3, said ejector being located above said injector and said conduit means connecting the ejector outlet with the vapor space of the condenser being in the form of a branch pipe extending from the conduit means which connects the outlet from said ejector with the injector inlet.

5. In a heat transfer system, a boiler, a condenser, and an evaporator, a pair of jet pumps disposed in series with connecting conduit means to utilize the exhaust from the first jet pump to motivate the second jet pump, conduit means connecting the vapor space of said boiler with the inlet side of said first jet pump, a conduit connection between the vacuum side of said first jet pump and one side of said evaporator, a conduit connection between the discharge side of said second jet pump and the liquid space of said boiler, a conduit connection between the liquid space of said condenser and the other side of said evaporator, a conduit connection between the liquid space of said condenser and the vacuum side of said second jet pump, and conduit means for directing a portion of the discharge of said first jet pump against the liquid level of said condenser.

References Cited in the file of this patent

UNITED STATES PATENTS

258,227	Gergens	May 23, 1882
902,208	Caverly	Oct. 27, 1908
1,874,912	Crosthwait	Aug. 30, 1932
2,044,811	Randel	June 30, 1936
2,513,361	Rausch	July 4, 1950
2,658,356	Neumann et al.	Nov. 10, 1953