June 20, 1939. P. OKEY 2,163,054

REFRIGERATING SYSTEM

Filed Aug. 10, 1937

Fig. 1.

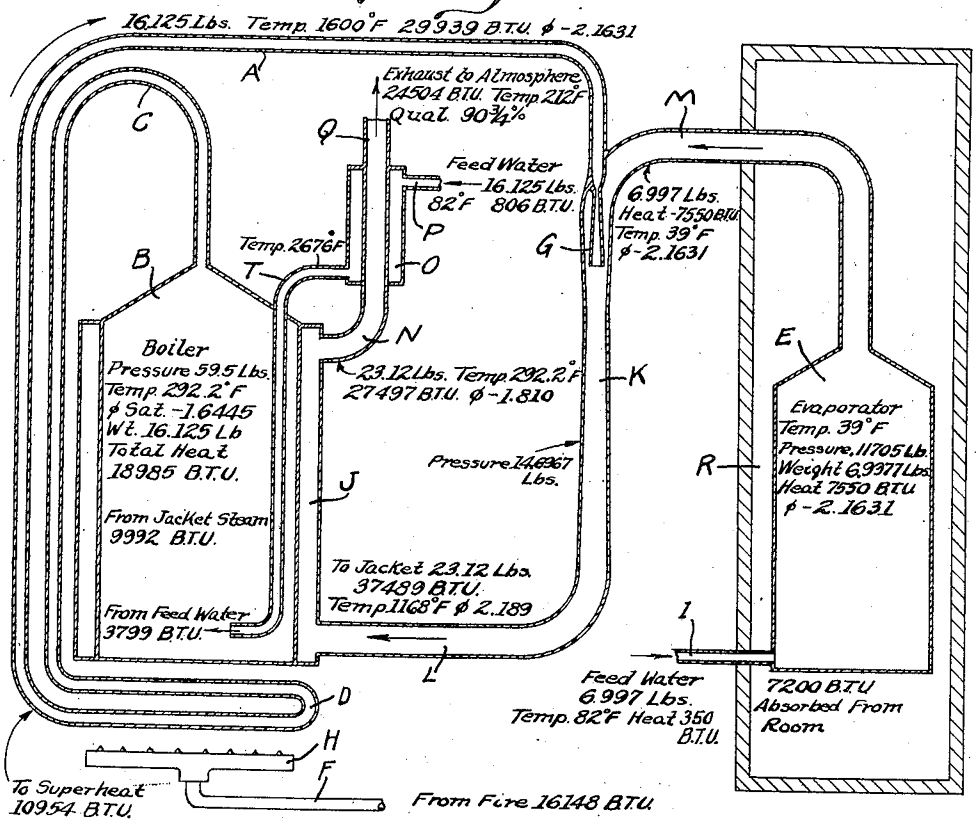

Fig. 2.

HEAT BALANCE

Zeros of Entropy and Total Heat (Enthalpy) Lie on the Saturated Liquid Line at 32°F. Entropy Symbol = ϕ

Heat Supplied to System			Heat Rejected in Exhaust
In 16.12 Lbs Water at 82°F			
To Feed Water Heater		806	
In 6.997 Lbs Water at 82°F			
To Evaporator		350	
To Vaporizer From Cold Room		7200	
		8356	
Total Heat Required to Boiler	18985		
Less Heat From Jacket	9992		
	8993		
Less Heat in Feed Water	3799		
Heat to Boiler From Fire	5194		
Heat to Superheat From Fire	10954		
Total Heat From Fire	16148	16148	
		24504 B.T.U.	24504 B.T.U.

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Patented June 20, 1939

2,163,054

UNITED STATES PATENT OFFICE

2,163,054

REFRIGERATING SYSTEM

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Application August 10, 1937, Serial No. 158,383

4 Claims. (Cl. 62—152)

This invention relates to an improved refrigerating system, an object thereof being to provide a refrigerating system having a novel heat cycle through the use of which economies in the consumption of a motivating heat transfer fluid are obtainable.

One of the problems frequently encountered in the installation and operation of certain refrigerating systems lies in the difficulty and/or expense of obtaining sufficient water into which the waste heat of the system may be rejected. Thus in many localities where high temperatures prevail, there often exists a high scarcity of water and concomitant high water expense.

It is one of the primary purposes of this invention to provide a cycle which uses but a minimum quantity of water, or other corresponding operating fluid. In a certain sense, the cycle employed by the present invention may not be considered thermodynamically efficient, as heat is rejected at a relatively high temperature but this is offset by the structural simplicity of the system and its economical use of water.

For a further understanding of the invention, reference is to be had to the accompanying drawing, wherein:

Fig. 1 is a diagrammatic sectional view of the apparatus employed in my improved refrigerating system;

Fig. 2 is a chart showing the heat balance of the system.

Referring more particularly to the drawing, there is illustrated in Figure 1 the structural elements of the system to which legends and data have been applied disclosing the quantities of water delivered to the system, the quantity of heat supplied by the fire, the quantity of heat removed from the refrigerated area or cold room, various heat transfers, the expansion and compression of the steam, changes in entropy and total heats at each change of pressure and other mathematical and operative functions comprising the heat cycle.

The various parts comprising the system have been designated by reference letters, wherein B is a suitable type of boiler shown, in this instance, as being surrounded by a jacket J. A pipe C leads from the steam space of the boiler to a superheater D, and from the superheater a pipe A carries the steam to a typical steam jet compressor G. The pipe M leads from the steam jet compressor to the evaporator E located in the cold room R, or other enclosed area to be refrigerated. A pipe I is provided to supply feed water to the evaporator E.

A customary part of a steam jet compressor is the diffuser, shown at K, which is connected with a pipe L, the latter serving to carry a mixture of steam from the steam jet system into the jacket J surrounding the boiler.

Steam from this jacket is led through a pipe N to the feed water heater O, from whence the steam is finally discharged to the atmosphere through the pipe or outlet Q. A pipe P serves for delivering water to the feed water heater, and then pipe T leads from the heater into the boiler.

For convenience of illustration, a gas burner H is shown as the source of heat for both the boiler and superheater, and F indicates a pipe to supply gas to the burner.

Having briefly described the various elements of construction employed by my improved system, the cycle of operation may now be discussed.

The fundamental difference between this apparatus and the customary types of steam jet systems lies in the use of a very high temperature of superheat in the operating steam. By the use of this high initial temperature, the temperature and total heat in the system, after passage through the jet compressor, are such that a very substantial portion of its heat is available to generate high pressure steam in the boiler, this being done by passing the steam through the jacket surrounding the boiler.

It will be noted by reference to Fig. 1 of the drawing that the total heat in the steam passing through the pipe L, and after passage through the jet system, is the sum of the heat in the steam from the boiler and from the evaporator, and that, by adiabatic compression by the steam jet, the steam from the evaporator has been raised in temperature from 32° F. to 1168° F., this steam being also available to generate steam in the boiler.

A heat balance chart, disclosed in Fig. 2, shows that 16,148 B. t. u. are supplied by the fire or heat developed by the operation of the burner H and 9,992 B. t. u. are supplied to the boiler from the jacket. This heat as returned to the boiler from the jacket is in excess of 61% of the heat supplied by the burner, thus effecting a satisfactory overall efficiency even though the final rejection of heat occurs at a temperature of 212° F. through outlet Q.

In operation, 16.12 pounds of saturated steam is generated in the boiler B in one hour, at an absolute pressure of 59.5 pounds per square inch. The steam is then superheated in the element D to 1600° F. and subjected to adiabatic expansion in the jet nozzle to the pressure of .11705 pound per square inch existing in the evaporator E. After leaving the mouth of the nozzle, the 16.12 pounds of boiler steam carries with it 6.997 pounds of 39° F. steam from the evaporator, and the mixture of 23.12 pounds is then forced into the diffuser K, wherein the velocity is reduced, the pressure increased adiabatically to that of the atmosphere, 14.696 pounds per square inch, and the temperature raised to 1168° F.

This 23.12 pounds of high temperature steam is now passed through the jacket J surrounding the boiler B, giving up during such passage 9992 B. t. u. to the fluid in the boiler. The temperature of the steam leaving the jacket through the pipe N is 292.2° F., the pressure that of the atmosphere and the heat content 27,497 B. t. u. In passing through the feed water heater O, 2993 B. t. u. are given up to 16.12 pounds of feed water, the latter being raised in temperature from 82° F. to 267.6° F. and delivered to the boiler at that last-named temperature.

The exhaust steam is now delivered to the atmosphere at 212° F. with a quality of 90¾% and a heat content of 24,504 B. t. u., this final rejection completing the cycle.

It will be understood that the depiction of a jacket around the boiler is used in the drawing for the sake of simplicity, since it is not my desire to limit the construction of apparatus to such a design, as more effective means may be provided by a series of tubes, the walls of which separate the two mediums. Neither do I wish the design of the boiler or evaporator to be confined to the type shown in the drawing, nor need the temperatures or pressures used in practice be those indicated on the drawing. The values herein shown were selected because the entropy of both the superheated steam from the boiler and the saturated steam from the evaporator are identical, i. e., 2.1631, thus facilitating the verification of the heat balance set forth.

To further simplify a study of the system, the boiler efficiency is assumed to be 100%, but the efficiency of the steam jet system is assumed to be 80%. The result of this assumption causes the mixture of steam leaving the jet system to have an entropy of 2.189 instead of 2.1631 which would have obtained if efficiency had been taken at unity. Likewise more heat is returned to the boiler, with the lowered jet efficiency, but the overall efficiency is lowered and more heat is required from the burner to produce a given amount of refrigeration.

What is claimed is:

1. A refrigerating system comprising a boiler for generating and a heater for superheating high pressure steam, an evaporator having a vapor outlet, a nozzle to which high pressure steam from said boiler and heater is delivered, said nozzle being disposed in the outlet of said evaporator, the expansion of the high pressure steam by said nozzle serving to compress vapor discharged from said evaporator through said outlet, and means for transferring heat from the combined vapors to the boiler to vaporize the liquid in the boiler.

2. A refrigerating system comprising a boiler for generating high pressure steam, means for superheating the steam generated in said boiler, a steam jet compressor to which steam obtained from said superheater is delivered for expansion, a water evaporator having a vapor outlet leading to said jet compressor, a heat exchanger disposed adjacent to said boiler, and means for passing vapors discharged from said jet compressor through said heat exchanger to utilize a portion of the heat contained therein for vaporizing fluids within said boiler.

3. A refrigerating system comprising a boiler for generating high pressure steam, means for superheating the steam generated in said boiler, a steam jet compressor to which steam obtained from said superheater is delivered for expansion, a water evaporator having a vapor outlet leading to said jet compressor, a heat exchanger disposed adjacent to said boiler, means for passing vapors discharged from said jet compressor through said heat exchanger to utilize a portion of the heat contained therein for vaporizing fluids within said boiler, means for supplying feed water to said boiler, and means for utilizing heat remaining in the vapors released from said heat exchanger to preheat the water passing to the boiler through said supply means.

4. A refrigerating system comprising a boiler for generating high pressure steam, means for superheating the steam generated in said boiler, a steam jet compressor to which steam obtained from said superheater is delivered for expansion, a water evaporator having a vapor outlet leading to said jet compressor, a heat exchanger disposed adjacent to said boiler, means for passing vapors discharged from said jet compressor through said heat exchanger to utilize a portion of the heat contained therein for vaporizing fluid within said boiler, means for supplying feed water to said boiler, means for utilizing heat remaining in the vapors released from said heat exchanger to preheat the water passing to the boiler through said supply means, and means to reject the remaining vapors to the atmosphere after passage through said feed water heating means.

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