

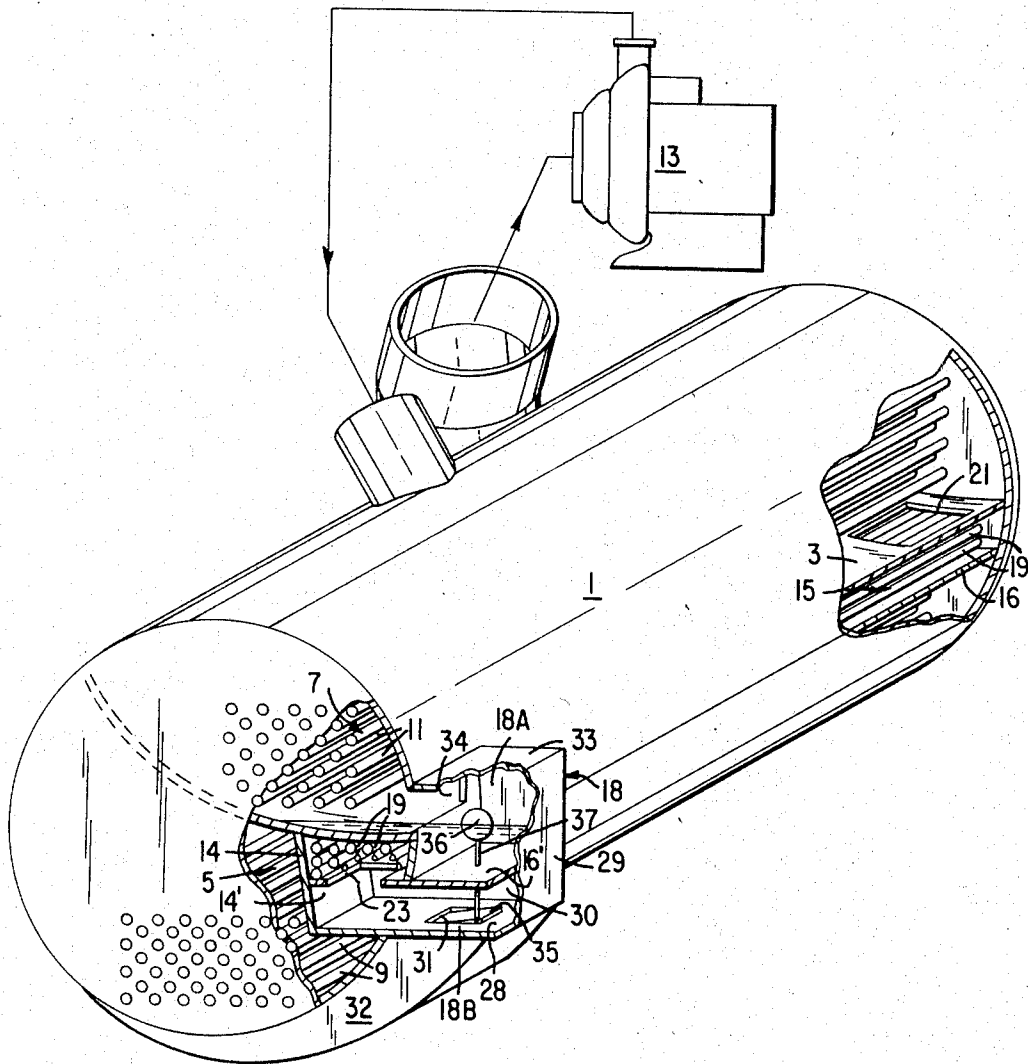
Jan. 30, 1968

W. E. CLARK ET AL

3,365,900

REFRIGERATION MACHINE AND METHOD OF OPERATION

Filed Aug. 1, 1966



INVENTORS.
WILLIAM E. CLARK.
JAMES W. ENDRESS.
BY *Raymond C. Lustin*
ATTORNEY.

1

3,365,900

REFRIGERATION MACHINE AND METHOD OF OPERATION

William E. Clark and James W. Endress, Syracuse, N.Y.,
assignors to Carrier Corporation, Syracuse, N.Y., a corporation of Delaware

Filed Aug. 1, 1966, Ser. No. 569,376

5 Claims. (Cl. 62-115)

ABSTRACT OF THE DISCLOSURE

A refrigeration machine having a subcooler for lowering the temperature of the condensed refrigerant wherein refrigerant flow to the evaporator is regulated by a valve between the subcooler and the evaporator which is controlled in response to the refrigerant level upstream of the subcooler to maintain high liquid refrigerant level therein while permitting forced feed of refrigerant therethrough for maximum subcooler efficiency.

This invention relates to a refrigeration machine. More particularly, this invention relates to a refrigeration machine having means therein to subcool condensed refrigerant. Still more particularly, this invention relates to a refrigerant flow control particularly adapted to increase the efficiency of the refrigerant subcooler.

In high tonnage refrigeration machines, a compressor is arranged to extract gaseous refrigerant from an evaporator and pump the compressed refrigerant to a condenser where the refrigerant is cooled and condensed. The liquid refrigerant in the condenser is ordinarily passed through a refrigerant metering device to the evaporator. The evaporator contains a multiplicity of tubes, usually referred to as a tube bundle, through which the medium to be cooled is passed in heat transfer relation with the refrigerant in the evaporator, cooling the medium and evaporating the refrigerant.

To increase the efficiency of the machine, it is desirable to cool the condensed refrigerant to a temperature below condensing temperature before it is passed to the evaporator. To accomplish this, a tube bundle is provided in a chamber at the bottom of the condenser or in a separate enclosure wherein condensed refrigerant may flow over the tube bundle in heat exchange relationship with a cooling medium flowing within the tubes.

For maximum subcooling, the refrigerant level in the subcooler must be maintained to completely cover the tube bundle therein and the refrigerant flow rate across the tubes must be maximized. Present subcoolers utilize gravity flow of refrigerant therethrough.

The chief object of this invention is to provide an improved refrigeration machine. It is a further object of this invention to provide a forced flow subcooler for a refrigeration machine. Another object of this invention is to provide a novel refrigerant metering device, particularly suited to accomplish the desired subcooler operation.

A further object is the provision of an improved method of operating a refrigeration machine wherein subcooler performance is greatly enhanced.

The objects of this invention are attained by providing a refrigerant level sensing device on the condenser side of the refrigerant subcooler operably connected to a refrigerant metering device on the evaporator side of the subcooler.

Other objects and features of this invention will be apparent upon a consideration of the ensuing specification and drawing in which the figure is a schematic view of a refrigeration machine showing the heat transfer por-

2

tion thereof in perspective with parts broken away for clarity.

Referring more particularly to the drawing, there is shown a shell 1 having a partition 3 therein dividing the shell into an evaporator section 5 and a condenser section 7.

Evaporator section 5 has a tube bundle 9 therein for passage of the medium being cooled by the refrigeration machine. Condenser section 7 has a tube bundle 11 therein for passage therethrough of cooling water from a suitable source, such as a cooling tower (not shown). A refrigerant motor-compressor 13 is provided for compressing the low pressure refrigerant gas from evaporator section 5 to provide high pressure refrigerant gas to the condenser section 7. A subcooler chamber 15 is provided, defined on the top by a portion of partition 3, on one side by shell 1, on the other side by an upstanding wall 14 and on the bottom by plate 16. An opening 21 in partition 3 provides a passageway between condenser section 7 and subcooler chamber 15 near one end thereof. An opening 23 in bottom plate 16 is provided near the other end of subcooler chamber 15 to provide a passageway for flow of refrigerant from subcooler chamber 15 into refrigerant metering box 18 to be hereinafter described. A tube bundle 19 is provided in subcooler chamber 15 for circulating cooling water therethrough to subcool the condensed refrigerant that drains into chamber 15 from condenser section 7 through opening 21. This cooling water may be passed through the subcooler tube bundle and then through the condenser tube bundle or the subcooler and condenser tube bundles may be supplied with cooling water from separate circuits. Due to the large number of tubes in the tube bundle 19 and the distance between opening 21 and opening 23, there is a sizeable pressure drop across the subcooler. A principal feature of this invention involves employing this pressure drop to create a forced feed, as opposed to a gravity feed, of refrigerant through the subcooler increasing the efficiency thereof in a manner to be later described. Refrigerant metering box 18 is provided for regulating the flow of refrigerant from condenser section 7 through subcooler chamber 15 to evaporator section 5. Refrigerant metering box 18 is comprised of two chambers 18A and 18B. The bottom chamber 18B is defined on the bottom by a plate 28 on one side by an extension of a portion 14' of upstanding wall 14 of the subcooler chamber, on the other side by an upstanding wall 29, on the back by upstanding wall 30 and on the top by the bottom side of a portion of plate 16 and an extension 16' thereof. An opening 31 in the bottom plate 28 provides a communication between chamber 18B and refrigerant passageway 32 for flow of refrigerant from chamber 18B to the evaporator. The top chamber 18A is defined on the top by a plate 33, on the back by the aforementioned wall 30, on the bottom by the top of the aforementioned extension 16', on one side by the aforementioned wall 29, and on the other side by a portion of the shell 1. It should be noted that a portion of the shell 1 extending from the back wall 30 to the front wall (not shown) and from the juncture of the partition 3 with shell 1 to the juncture of shell 1 with the top plate 33 is cut out, thereby providing a large opening 34 between upper chamber 18A and condenser section 7 for flow of refrigerant from the condenser into chamber 18A. Refrigerant expansion means comprising a suitable valve member 35 in opening 31, connected to a valve actuating mechanism (float ball) 36 disposed in upper chamber 18A by rod 37, regulates the flow of refrigerant from the condenser, through the subcooler, to the evaporator.

Considering the operation of the refrigeration machine at start-up, refrigerant vapor condensed on tube bundle 11 will collect on the top side of partition 3. Chamber 18A

3

being empty of refrigerant, float ball 36 will hold valve 35 closed. Refrigerant on partition 3 will flow through opening 21 into subcooler chamber 15 and through opening 34 into chamber 18A. Eventually, refrigerant flowing through opening 21 will fill up chamber 18B, subcooler chamber 15 and chamber 18A up to the bottom of opening 34. Further condensation of refrigerant will cause refrigerant to puddle on partition 3 and raise the refrigerant level in chamber 18A high enough to cause float ball 36 to rise and partially open valve 35.

From this point on, the float controlled valve will maintain the proper flow of refrigerant to the evaporator to keep the subcooler tube bundle submerged at all times.

It should be noted that by placing the refrigerant valve on the evaporator side of the subcooler and the level sensor (float or equivalent) on the condenser side as shown in the drawing, liquid refrigerant is forced through the subcooler. This forced flow of refrigerant causes a greater scrubbing action by the refrigerant on the subcooler tube bundle greatly increasing the heat transfer efficiency therebetween as compared to subcoolers utilizing gravity flow of refrigerant therethrough.

While we have described a preferred embodiment of our invention, it is to be understood that our invention is not limited thereto, but may be otherwise embodied within the scope of the following claims.

We claim:

1. A refrigeration machine comprising a refrigerant compressor; a condenser; and an evaporator connected to form a closed circuit for the flow of refrigerant, means defining a subcooler chamber for reducing the temperature of condensate formed in the condenser; refrigerant expansion means interposed between the subcooler chamber and the evaporator, said expansion means including a valve member regulating flow of refrigerant from the subcooler chamber to the evaporator, valve actuating mechanism operably associated with the valve member, said subcooler chamber having communication with the condenser and with the evaporator so that condensate formed in the condenser may flow through the subcooler chamber to the evaporator, said valve actuating mechanism being responsive to the level of liquid refrigerant upstream of the subcooler chamber whereby the flow of refrigerant to the evaporator is regulated to continuously establish a prede-

4

termined quantity flow of refrigerant in the subcooler chamber.

2. A refrigeration machine as described in claim 1 wherein said valve actuating mechanism responds to the level of liquid refrigerant in the condenser.

3. A refrigeration machine as described in claim 1 including a refrigerant metering box communicating with the subcooler chamber, said box containing said valve member.

4. A refrigeration machine according to claim 1 wherein said means defining a subcooler chamber includes a first passageway at one end thereof for receiving condensed refrigerant from said condenser and a second passageway at the other end thereof for discharge of refrigerant from the subcooler chamber so as to assure passage of condensed refrigerant the full length of the chamber for maximum subcooling thereof.

5. The method of operating a refrigeration machine including a compressor, a condenser, a liquid refrigerant subcooler having means therein for passage of a cooling medium therethrough, a refrigerant expansion device, and an evaporator connected to form a closed circuit for the flow of refrigerant which consists in the steps of:

collecting liquid refrigerant in the high pressure side of the machine,

passing the liquid refrigerant through the subcooler in heat exchange relationship with the cooling medium flowing therethrough, and

controlling passage of refrigerant from the subcooler through the refrigerant expansion device to the evaporator in response to a predetermined level of collected liquid refrigerant to create a pressure drop across said subcooler to provide a forced flow of liquid refrigerant therethrough.

References Cited

UNITED STATES PATENTS

2,791,105	5/1957	Aronson	62—509
2,921,446	1/1960	Zulinke	62—117
3,067,590	12/1962	Wood	62—335
3,315,485	4/1967	Clark et al.	62—504

LLOYD L. KING, *Primary Examiner.*