Nov. 30, 1948. M. T. CAHENZLI, JR 2,455,298

COMBINATION METERING DEVICE AND HEAT EXCHANGER FOR REFRIGERATORS

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Fig. 1

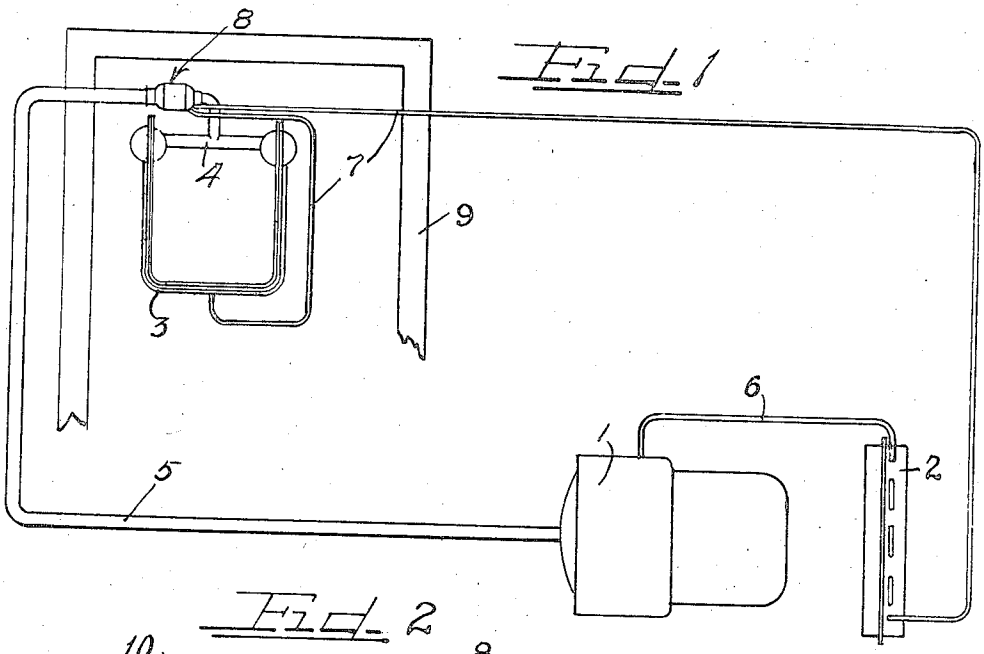


Fig. 2

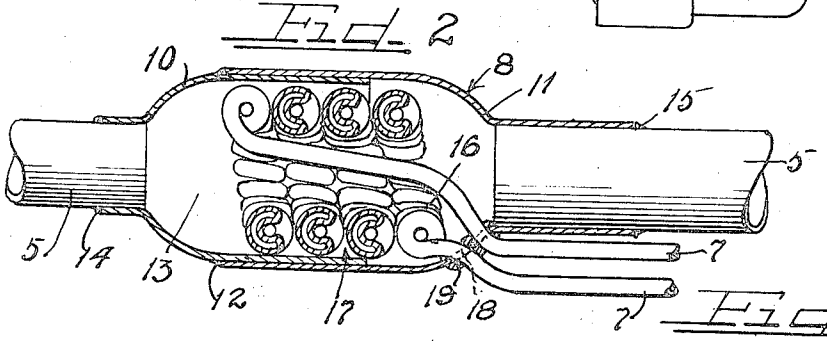


Fig. 4

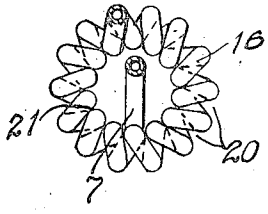


Fig. 3

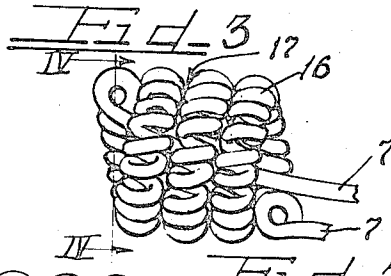
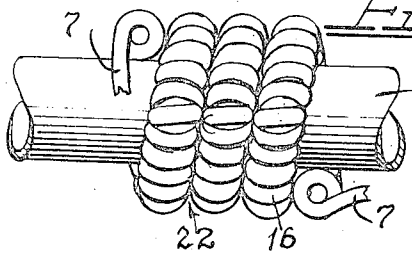


Fig. 5



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COMBINATION METERING DEVICE AND HEAT EXCHANGER FOR REFRIGERATORS

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7 Claims. (Cl. 62—127)

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This invention relates to improvements in a combination metering device and heat exchanger for refrigerators, and more particularly to an apparatus readily installed in a refrigerating system for metering the supply of liquid refrigerant to an evaporator and for maintaining that liquid refrigerant as cold as possible when it is delivered to the evaporator, although the invention may have other uses and purposes as will be apparent to one skilled in the art.

Many manufacturers of electrical or mechanical refrigerators and refrigerating systems have adopted the use of a metering tube for controlling the flow of liquid refrigerant from the condenser to the evaporator, a tube frequently referred to as a capillary tube. The use of such a tube eliminates the need of expansion valves, float valves, other types of valves, restrictive orifices, jets, or similar structures likely to become out of order and difficult to repair or replace.

In all present installations of which I am aware where a metering tube is utilized to control the flow of liquid refrigerant, and a heat exchange is desired, that metering tube is soldered or otherwise metallically bonded to the suction line, and this is especially true of that portion of both the tube and suction line leading from the top of the cabinet near the evaporator down to the compressor. While the tube and suction line may be embedded to some extent in the installation of the cabinet, if so desired, in most instances a goodly portion of the tube and suction line is exposed to the temperature of the ambient air. The heat exchange resulting, that is the cooling of the liquid refrigerant in the metering tube from the cold gaseous refrigerant in the suction line, while desirable is nevertheless a relatively small amount, and not nearly as great as is desired. Further, the bonding of the metering tube to the suction line is a hand operation, and consequently very expensive. With apparatus of the type now used, there is a much greater length of metering tube than can be bonded to the suction line, but which length is necessary in order to properly control the flow of liquid refrigerant to the evaporator, and this excess portion of the metering tube is sometimes made into a flat pancake coil of relatively large diameter and disposed at the back of the cabinet near the evaporator or in some other feasible location. Such arrangement is not only messy, difficult and expensive to install, but cumbersome, occupies an objectionable amount of space, and is both difficult and expensive to repair.

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With installations of the character above mentioned as heretofore made, it is obvious that when the compressor is operating some heat exchange occurs, but when the compressor is not operating, very little if any heat exchange occurs. The advantages of having a heat exchanging arrangement is lessening of time of operation of the refrigerating mechanism, especially when the ambient air temperature is above 70° F. The object, of course, is to have the liquid refrigerant introduced into the evaporator as close as possible to the temperature inside the refrigerator cabinet, preferably very close to the temperature inside the evaporator itself if possible, to thereby increase the efficiency of the refrigerator or the refrigerating system as the case may be. Extreme difficulty has been experienced in the past in locating even a portion of the metering tube in a colder or the coldest portion of the apparatus, and in obtaining heat exchange between the metering tube and the suction line or between the metering tube and any other cold part of the apparatus to anywheres near the desired extent.

With the foregoing in mind, it is an important object of the instant invention to provide a combination metering tube and heat exchanging arrangement which may be easily located in substantially the coldest part of the refrigerating system.

Also an object of the instant invention is the provision of a heat exchanger for refrigerating systems which is located inside the refrigerator cabinet at all times, and which may be so located in an extremely inexpensive manner.

Another object of the instant invention is the provision of a heat exchanging arrangement for refrigerating systems which eliminates any need of hand soldering or other metallic bonding operations between various lines or conduits of the system and which is so simple in construction as to require only one additional connection over a system having no heat exchange arrangement whatever.

It is also a feature of the instant invention to provide a combination metering tube and heat exchanger for refrigeration systems, wherein heat exchange occurs all the time, both when the mechanism of the refrigerating system is in operation, and when that mechanism is not in operation.

A further feature of the invention resides in the provision of a combination metering tube and heat exchanger for refrigerators which produces a greater degree of heat exchange than heat exchanging arrangements heretofore known, and

which is both economical to manufacture and install.

Still another object of the instant invention resides in the provision of a combination metering tube and heat exchanger which may be installed in a refrigerating system very near the evaporator, and if so desired may be connected directly to the evaporator.

Another object of the instant invention resides in the provision of a combination metering tube and heat exchanger in which substantially all the surface of the metering portion of the tube is exposed at all times to a lower temperature, that is substantially all of the surface of a metering portion of the tube is in heat exchange relationship at all times.

It is also an object of the invention to provide a combination metering tube and heat exchanger which may be constructed in a unitary form, which occupies very little space, and which may be installed easily and quickly in a refrigerating system.

Still a further object of the instant invention resides in the provision of a metering tube for refrigerating systems, which tube embodies a novel shape to expose substantially all the surface of the tube and yet occupy only an extremely small space, thus making the tube highly desirable for use in heat exchange relationship with some other portion of the system.

While some of the more salient features, characteristics and advantages of the instant invention have been above pointed out, others will become apparent from the following disclosures, taken in conjunction with the accompanying drawing, in which

Figure 1 is a fragmentary diagrammatic showing of a refrigerating system including a combination metering tube and heat exchanger embodying principles of the instant invention;

Figure 2 is a fragmentary enlargement of a portion of the showing in Figure 1, illustrating the combined metering tube and heat exchanger partly in section and partly in elevation;

Figure 3 is a fragmentary side elevational view of a portion of the metering tube itself;

Figure 4 is a fragmentary vertical sectional view taken substantially as indicated by the line IV—IV of Figure 3, looking in the direction of the arrows; and

Figure 5 is a fragmentary elevational view of the metering tube showing a different arrangement for purposes of heat exchange.

As shown on the drawings:

In Figure 1 there is shown quite diagrammatically a refrigerating system, and it is to be understood that the various conduits or lines of this system are exaggerated in many cases as to length, and arranged in many cases in a somewhat impractical manner, for purposes of clarity, the object of this showing being merely to illustrate the salient parts of a refrigerating system and the necessary connections.

With reference particularly to Figure 1, it will be seen that the system includes a compressor 1 which may be driven by an electric motor or other mechanical prime mover, a condenser 2 and an evaporator 3. A header 4, or some other salient part of the evaporator structure is connected to the compressor by way of a suction line 5. The compressor is in turn connected to the condenser by a line or conduit 6. The condenser is connected to the evaporator by a metering tube 7, frequently referred to as a "capillary" tube. One end of the metering tube 7 is connected to the condenser, and the other end to the evaporator, preferably in a low portion of the evaporator. An intermediate portion of the metering tube 7 is disposed within a housing forming a heat exchanger and generally indicated by numeral 8 in Figure 1. This housing is disposed as an integral part of the suction line 5, and is located close to the evaporator 3 so as to be in an extremely cold portion of the system. The refrigerator cabinet is diagrammatically illustrated and indicated by numeral 9, to show that the heat exchanger 8 is disposed within the interior of the cabinet. It will be appreciated that the heat exchanger 8 may have one end thereof connected directly to the exaporator 3, if so desired.

If so desired, that part of the metering tube 7 leading from the condenser to the heat exchanger 8 may be soldered or otherwise metallically bonded to the suction line 5, but the showing in Figure 1 has been arranged to indicate clearly that with the instant invention no such soldering or metallic bonding operation is necessary. With the instant invention, both portions of the metering tube outside of the heat exchanger 8, that is that portion leading to the evaporator, and that portion leading to the condenser, may be considered merely necessary connections, and may be as short as is feasible in order to establish those connections. Those portions of the metering tube need not be depended upon for any metering function.

With reference now to Figure 2, it will be seen that the heat exchanger 8 includes a housing, preferably comprising two parts 10 and 11 telescoped together and sealed as indicated at 12. The housing sections 10 and 11 are expanded to provide an interior compartment 13 and reduced end portions of the housing sections may be secured to ends of the suction line as indicated at 14 and 15, respectively. As stated above, if so desired, the connection at 15 may be made directly to a part of the evaporator 3 and the short suction line section illustrated therebetween may be eliminated.

With reference more particularly to Figures 2, 3 and 4, it will be seen that an intermediate portion of the metering tube 7 has been wound into the form of an elongated single layer coil 16, such coil being initially preferably tightly wound. So winding a metering tube, especially into a coil having a relatively small inside diameter, greatly enhances the restricting power of the tube so that a considerably less length of tubing is required to properly control the flow of liquid refrigerant than would be the case in the event the tube was not coiled, or just flatly coiled in a multiple loop of relatively large inside diameter. The nature of such a coil is more fully set forth, described, and claimed, in my co-pending application for United States Letters Patent entitled "Metering tube for refrigerators," filed December 24, 1943, Serial No. 515,546, now abandoned. As pointed out more particularly in that co-pending application, a metering tube wound into an elongated coil having an inside diameter of $\frac{3}{32}$-inch need only have a total length of six feet to restrict the flow of liquid refrigerant therethrough to substantially the same extent as an unwound tube of the same size with a length in excess of 27 feet. Now, insofar as the restricting properties of the metering tube are concerned, it makes no difference whether or not adjacent loops of the coil are in contact with each other or whether the coil is stretched, as long as the

inside diameter of the coil itself remains constant.

The elongated coil 16 is then taken and bodily wound into another coil generally indicated by numeral 17. In short, a section of the metering tube has been wound into a coil, and the resultant coil has then been coiled. Thus, the coiled portion of the metering tube is made to occupy a very small space and may be easily disposed within a heat exchanging housing of relatively small size. One end of the metering tube is brought backward through the center of the resultant coil 17, as clearly shown in Figures 2 and 3, so that both ends of the tube may exit through a single opening 18 in the housing, thus facilitating economical manufacture. A suitable sealing means 19, such as solder or the equivalent, may be employed to seal the opening 18 around the extruding ends of the metering tube so as to render the housing gas-tight.

With reference more particularly to Figure 4 it will be noted that when the coil 16 is wound into the resultatnt coil 17, the individual loops of the coil 16 are caused to be spaced apart as indicated at 20, so that substantially the only contact between adjacent loops of the first coil 16 will be line contacts indicated at 21 in the inside of the resultant coil 17. Thus, substantially all the coiled surface of the metering tube is exposed and exposed freely for contact by the gaseous refrigerant passing through the suction line 5. Preferably the coiled portion of the metering tube is all that is relied upon to control the flow of liquid refrigerant to the evaporator, so that the portion of the tube outside the housing of the heat exchanging arrangement may be as straight as desired, and may be as short as permissible.

In operation, liquid refrigerant passes through the tube 7 from the condenser tube, passes through the coiled portion of that tube inside the heat exchanger 8, and enters the evaporator at the bottom thereof. The refrigerant expands and evaporates within the evaporator, so that gaseous refrigerant leaves the top of the evaporator through the suction line 5. This gaseous refrigerant entirely fills the interior of the housing containing the coiled portion 17 of the metering tube, and the gaseous refrigerant obviously will be very cold as it exists from the evaporator. With substantially the entire surface of the coiled portion of the metering tube exposed to this gas, as above explained, the refrigerant within the metering tube is maintained cold and there is a heat exchange action between this refrigerant and the gaseous refrigerant of a very high degree. It should be especially noted that when the mechanical parts of the refrigerating system are not in operation, and liquid refrigerant remains within the coiled portion of the metering tube, that refrigerant is still located in approximately the coldest position in the system, and heat exchange occurs all of the time, whether the moving parts are in operation or not. Consequently, the efficiency of the refrigerating system is greatly increased.

It will also be noted that the coiled portion of the metering tube occupies a very little space, the housing is simple in construction, and need not be very large, so that the housing together with the metering tube may be manufactured and sold as a unit for installation in a refrigerating system. Only one additional connection is necessary over a refrigerating system having no heat exchange arrangement whatever. Without a heat exchange arrangement, the suction line 5 would be connected directly to the header 4 of the evaporator. With the illustrated heat exchanging arrangement embodied, one end of the suction line may be connected to one end of the housing, and the other end of the housing may be connected directly to the header of the evaporator, this being the extra connection. Consequently, the device may be very economically made, installed and used. It is a simple expedient to remove the heat exchanger together with the metering tube and replace it if ever such becomes necessary.

In Figure 5 I have shown a slightly different heat exchanging arrangement. In this arrangement, the metering tube 7 has been wound into the first elongated coil 16, and then the coil 16 has been coiled directly around the external surface of the suction line 5. This operation may be accomplished by hand during the installation of the metering tube. That is, one end of the metering tube may be connected to the condenser, and then the intermediate coiled portion of the tube may be wound directly around the suction line, preferably as close to the evaporator as possible, and then the other end of the metering tube connected to the evaporator. While this arrangement does not give as high a percentage of heat exchange as the arrangement shown in Figures 1 to 4, inclusive, it nevertheless does provide a higher percentage of heat exchange than any arrangement of which I am aware heretofore used.

From the foregoing, it is apparent that I have provided a highly simplified form of combination metering tube and heat exchanger, which is extremely economical to manufacture, install, and use, which occupies a minimum space, and which may be placed in substantially the coldest part of the refrigerating system. It will further be noted that the arrangement is such as to provide a heat exchange of an extremely high value, and that heat exchange occurs at all times, both when the movable parts of the system are in operation and when they are not.

It will, of course, be understood that various details of construction may be varied through a wide range without departing from the principles of this invention and it is, therefore, not the purpose to limit the patent granted hereon otherwise than necessitated by the scope of the appended claims.

I claim as my invention:

1. A combined metering tube and heat exchanger for a refrigerating system, including a metering tube in the form of a main coil each convention of which is made up of a series of convolutions of the metering tube, and a housing containing said coil and arranged for connection in the suction line of a refrigerating system, said housing having an opening therein through which both ends of said tube extend.

2. A combined metering tube and heat exchanger for a refrigerating system, including a housing arranged for connection as a part of a conduit for cold fluid, and a metering tube for liquid refrigerant wound into a coil with each turn contacting adjacent turns, which coil in turn is wound into a main coil in a manner to separate the turns of the first coil throughout the major portion thereof and fit within said housing.

3. A heat exchange arrangement for a refrigerating system having an evaporator with a suction line leading therefrom, said arrangement includ-

ing a delivery tube for refrigerant arranged for connection to the evaporator and having a part thereof wound into a coil which coil is wound helically about the suction line.

4. A heat exchange arrangement for a refrigerating system having an evaporator with a suction line leading therefrom, said arrangement including a delivery tube for refrigerant arranged for connection to the evaporator and having a part thereof wound into a coil which coil is wound helically about the suction line, said delivery tube being in the form of a metering tube to control the flow of refrigerant therethrough.

5. A metering tube for liquid refrigerant, comprising an elongated tube wound into a tight single layer elongated coil with each turn in contact with adjacent turns which coil in turn is wound into a coil of sufficiently small diameter to cause separation of the turns of the first coil.

6. A combined metering tube and heat exchanger for a refrigerating system, including a housing arranged for connection as a part of a conduit for cold fluid, and metering tube having a part thereof wound into a coil which coil in turn coiled to fit within said housing, said housing being apertured at the colder end thereof for both ends of said tube.

7. A combined metering tube and heat exchanger for a refrigerating system, including a metering tube in the form of a single layer coil with each turn in contact with adjacent turns, said coil being in turn wound into a main coil of such small diameter that the turns of the first said coil are separated except for the parts thereof nearest the center of the main coil, and a housing containing said main coil and arranged for connection in the suction line of refrigerating system.

MARTIN T. CAHENZLI, JR.

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