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COOLING APPARATUS

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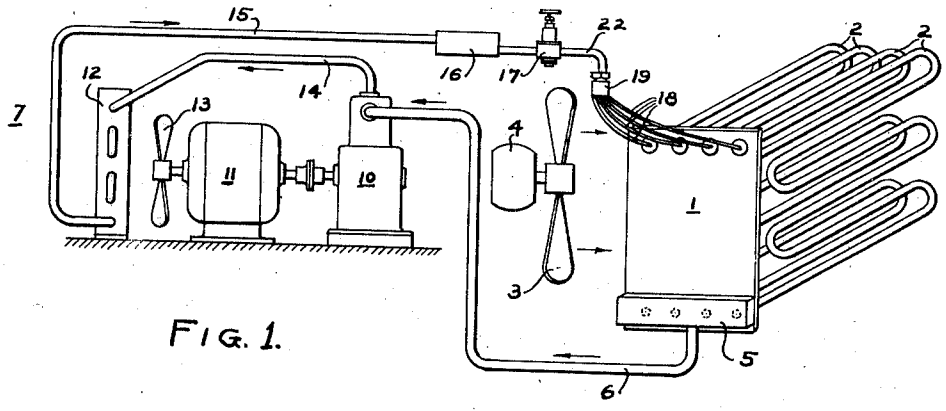
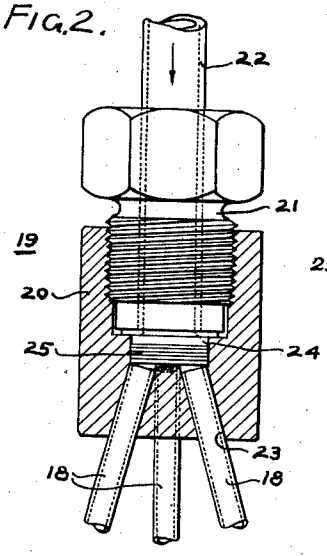


FIG. 1.

FIG. 2.



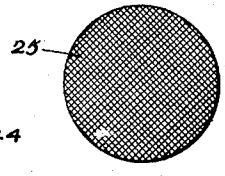
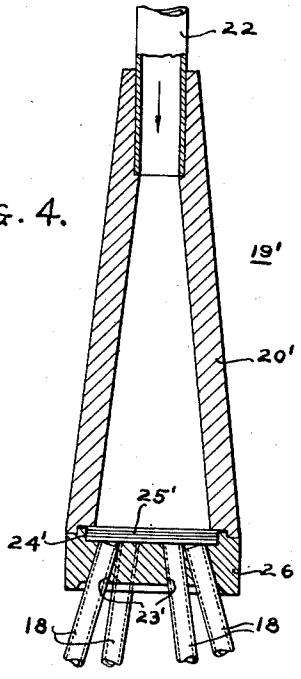


FIG. 6.

FIG. 4.



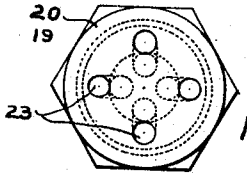
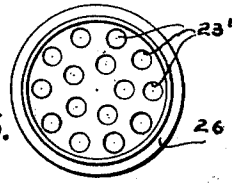


FIG. 3.

FIG. 5.



WITNESSES

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COOLING APPARATUS

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16 Claims. (Cl. 62—127)

Our invention relates to cooling or refrigerating apparatus, more particularly to the refrigerant supply passages for evaporators having a plurality of refrigerant passages operating in parallel, and it has for an object to provide improved distribution of refrigerant to the evaporator passages.

The invention relates, still more particularly, to refrigerating apparatus including an evaporator having a plurality of refrigerant passages, an expansion valve or other means for at least partially expanding or reducing the pressure of the refrigerant, and flow-resistance passages, such as the tubes known in the art as capillary tubes, for distributing refrigerant in parallel from the expansion valve to the evaporator passages. It has been found that the partial evaporation of the refrigerant as its pressure is reduced at the expansion valve results in relatively large bubbles of gas and slugs of liquid, which, at the inlets to the capillary tubes, cause some of the tubes to receive greater portions of liquid and other tubes greater portions of gas. Thus, the several evaporator passages do not receive refrigerant in the proper proportions, that is, in proportion to the respective flow capacities of the several capillary tubes, and the refrigerating capacity of the evaporator is reduced.

It is an object of our invention to provide flow of refrigerant through the several capillary tubes in accordance with their respective flow capacities.

A still more particular object is to provide a uniform mixture of gaseous and liquid refrigerant so that the refrigerant will flow through the capillary tubes in accordance with their respective flow capacities.

In accordance with our invention, we break up the relatively large bubbles of gas and slugs of liquid into a more uniform and intimate mixture of smaller particles of gas and liquid. This is preferably effected by one or more fine mesh screens interposed between the refrigerant supply means and the capillary tubes, preferably adjacent the latter. The substantially uniform mixture thus produced divides evenly or in accordance with the respective flow capacities of the several capillary tubes.

The above and other objects are effected by our invention as will be apparent from the following description and claims taken in connection with the accompanying drawing, forming a part of this application, in which:

Fig. 1 is a diagrammatic view of refrigerating apparatus in which our invention is embodied;

Fig. 2 is an enlarged detail view, partly in section, of a fitting to which the inlet ends of the capillary tubes are connected and having screens for breaking up the large bubbles of gas and slugs of liquid;

Fig. 3 is a bottom plan view of the fitting shown in Fig. 2, without the capillary tubes;

Fig. 4 is a view similar to Fig. 2 showing a modified form;

Fig. 5 is a bottom plan view of the fitting shown in Fig. 4, without the capillary tubes; and

Fig. 6 shows one of the screens used in the fittings.

Referring to the drawing in detail, we show, in Fig. 1, an evaporator 1 of the forced-flow or so-called "dry expansion" type comprising a plurality of coils 2. A fan 3, driven by a motor 4, circulates air to be cooled over the several coils. The coils receive refrigerant in parallel and, in the present embodiment, are shown in series with respect to flow of air. The outlet ends of the coils are connected to a suction header 5 which is connected by a suction conduit 6 to a refrigerating unit 7.

The refrigerating unit 7 comprises a compressor 10 whose inlet is connected to the suction conduit 6, a motor 11 for driving the compressor, a condenser 12, and a fan 13, driven by the motor 11, for circulating air through the condenser 12. A conduit 14 conveys the compressed refrigerant from the compressor 10 to the condenser 12, and a conduit 15 conveys the condensed refrigerant to a liquid receiver 16. From the latter, the refrigerant is conveyed to an expansion valve 17, in which the refrigerant is either partially or wholly expanded, that is, its pressure is reduced. This device may be of any suitable type known in the art.

In order to distribute the low-pressure refrigerant to the evaporator coils 2, we provide a plurality of tubes 18, one for each coil, of the type commonly referred to in the art as capillary tubes. These are tubes having passages of small diameter providing resistance to the flow of fluid therethrough. The provision of these tubes between the refrigerant supply conduit 15 and the coils 2 provides for the distribution of refrigerant in desired proportion to the respective coils, the flow through each coil being proportional to the flow capacity or inversely proportional to the flow resistance of the tube. The relative lengths of the several tubes 18 are such as to divide the refrigerant among the several coils in the desired proportions.

As the liquid refrigerant leaves the expansion

valve 17, its pressure is reduced, so that partial evaporization of the liquid refrigerant takes place. We have found that this partial evaporization results in relatively large bubbles of gas and slugs of liquid, and that, when this mixture is conveyed to the inlets of the capillary tubes, uneven or improper distribution of refrigerant among the tubes takes place, due to the fact that some of the tubes receive greater portions of liquid and other tubes receive greater portions of gas.

In our construction, we provide a fitting 19 which includes a member 20, which is more or less cup-shaped, and a plug 21 screw-threaded therein. A conduit 22, connecting the fitting 19 with the expansion valve 17, extends through the plug 21 and its end is clamped in place by the plug 21. Th inlet ends of the capillary tubes 18 are inserted through openings 23 in the lower end of the member 20, extending to a countersunk recess 24 below the end of the conduit 22 and communicating therewith. In the recess 24, there are disposed a plurality or stack of fine mesh screens 25.

The operation of the above-described apparatus is as follows:

Vaporized refrigerant is withdrawn from the evaporator 1 by the compressor 10 through the conduit 6. It is compressed and conveyed through the conduit 14 to the condenser 12, in which it is condensed. It is then conveyed through the conduit 15 to the liquid receiver 16, and thence to the expansion valve 17. As the refrigerant leaves the expansion valve 17, the reduction in pressure causes partial evaporation of the refrigerant. The mixture of gaseous and liquid refrigerant then flows through the conduit 22 to the fitting 19, in which it passes through the fine mesh screens 25. In passing through the screens 25, the volumes of gas and liquid are divided into smaller particles of gas and liquid which readily mix and form a substantially uniform mixture of gas and liquid, which is admitted to the capillary tubes 18. Inasmuch as the fluid flowing through the several capillary tubes is uniform, the proportions of fluid flowing through the several capillary tubes will be in accordance with the flow capacities of the several tubes, so that refrigerant will be distributed to the several coils in the desired proportions.

In Figs. 4 and 5, we show a modified form of fitting designated by the reference numeral 19'. This fitting includes a member 20', connected to the conduit 22 and which is of divergent form, increasing in cross-section from the conduit 22 downwardly. A stack of screens 25' is positioned in a recess 24' formed in a closure member 26 at the lower end of the member 20', and is retained between said closure member and the end of the member 20'. The closure member 26 is formed with a plurality of openings 23' through which capillary tubes 18 are inserted and extended to the screens 25' as in the first embodiment.

The operation of this embodiment is identical with the operation of the first embodiment, except that a portion of the velocity of the refrigerant entering the fitting from the conduit 22 is converted into pressure in passing through the diverging portion within the fitting 20'. The refrigerant flows downwardly from the conduit 22 into the fitting 20', that is, it enters the same longitudinally thereof. By providing a gradual increase in flow area from that of the conduit 22, the refrigerant is kept flowing downwardly in a steady stream. This arrangement avoids any suddenly enlarged spaces as may afford the liquid and vapor an opportunity to separate.

The fittings of both embodiments are preferably arranged for downward flow of refrigerant with the screens at the bottom of the fitting, as shown on the drawing, so that the liquid refrigerant will tend to flow over the screens and distribute itself among the several capillary tubes.

From the above description, it will be seen that we have provided apparatus for providing a substantially uniform mixture of gaseous and liquid refrigerant which may be distributed in desired proportions to the several coils of the evaporator.

While we have shown our invention in several forms, it will be obvious to those skilled in the art that it is not so limited, but is susceptible of various other changes and modifications without departing from the spirit thereof, and we desire, therefore, that only such limitations shall be placed thereupon as are imposed by the prior art or as are specifically set forth in the appended claims.

What we claim is:

1. In refrigerating apparatus, the combination of a plurality of evaporator passages, and means for supplying refrigerant to the several passages in the form of a mixture of gas and liquid and subdividing the refrigerant among the several evaporator passages, said means including a plurality of fine mesh screens to break up the bubbles of gas and slugs of liquid into a finely divided, substantially uniform mixture which may be properly distributed among the several evaporator passages, said screens being disposed in the flow path of the refrigerant adjacent the point of subdivision of the refrigerant among the several evaporator passages.

2. In refrigerating apparatus, the combination of a plurality of flow-resistance passages for distributing refrigerant, means supplying a mixture of vaporous and liquid refrigerant to the flow-resistance passages, and means traversing the flow path of the refrigerant for intimately mixing the vaporous and liquid portions of the refrigerant before it is admitted to the flow-resistance passages in order to provide proper division of refrigerant among the flow-resistance passages.

3. In refrigerating apparatus, the combination of a plurality of capillary tubes for distributing refrigerant, a source of refrigerant, means for partially expanding refrigerant, and means interposed between said means and said capillary tubes for transforming the mixture of gas and liquid into a uniform mixture of liquid and small gas bubbles, which uniform mixture enables proper distribution of refrigerant to the several capillary tubes.

4. In refrigerating apparatus, the combination of a plurality of flow-resistance passages, means for supplying refrigerant to said flow-resistance passages in the form of a mixture of gas and liquid and including a fine mesh screen to break up the bubbles of gas and slugs of liquid into a finely divided, substantially uniform mixture which is properly divided among said flow-resistance passages.

5. In refrigerating apparatus, the combination of an evaporator comprising a plurality of refrigerant passages, means for supplying refrigerant for said evaporator passages in the form of bubbles of gas and slugs of liquid, a plurality of flow-

resistance passages for distributing said refrigerant to the evaporator passages, and means for dividing the bubbles of gas and slugs of liquid into smaller parts to secure more uniform mixture of gas and liquid, thereby providing for proper distribution of refrigerant by the flow-resistance passages.

6. In refrigerating apparatus, the combination of a plurality of evaporator passages, means providing a supply of liquid refrigerant for said evaporator passages, means for at least partially reducing the pressure of the refrigerant from said supply means, a plurality of flow-resistance passages for distributing the reduced pressure refrigerant to the evaporator passages, and means for breaking up the volumes of gaseous and liquid refrigerant formed at the pressure reducing means into smaller parts providing a substantially uniform mixture of gas and liquid which is adapted to be distributed by said flow-resistance passages substantially in accordance with their respective flow capacities.

7. In refrigerating apparatus, the combination of a plurality of evaporator passages, means providing a supply of liquid refrigerant for said evaporator passages, means for at least partially reducing the pressure of the refrigerant from said supply means, a plurality of flow-resistance passages for distributing the reduced pressure refrigerant to the evaporator passages, and means comprising a large number of small openings interposed between the pressure-reducing means and the flow-resistance passages for breaking up relatively large volumes of gaseous and liquid refrigerant into a substantially uniform mixture of gas and liquid adapted to be distributed by said flow-resistance passages substantially in accordance with their respective flow capacities.

8. In refrigerating apparatus, the combination of a plurality of evaporator passages, means providing a supply of liquid refrigerant for said evaporator passages, means for at least partially reducing the pressure of the refrigerant from said supply means, a plurality of flow-resistance tubes for distributing the reduced pressure refrigerant to the evaporator passages, a pipe fitting connected to said pressure-reducing means and to the inlet ends of said flow-resistance tubes, and a plurality of fine mesh screens in said fitting adjacent the inlet ends of the flow-resistance passages for dividing the gaseous and liquid refrigerant into smaller parts providing a more uniform mixture adapted to be properly distributed by said flow resistance tubes.

9. In refrigerating apparatus, the combination of a plurality of evaporator passages, means providing a supply of liquid refrigerant for said evaporator passages, means for at least partially reducing the pressure of the refrigerant from said supply means, a plurality of flow-resistance tubes for distributing the reduced pressure refrigerant to the evaporator passages, a pipe fitting having an inlet connected to said pressure-reducing means and outlets connected to the inlet ends of said flow-resistance tubes, and a plurality of fine mesh screens in said fitting adjacent said outlets for dividing the gaseous and liquid refrigerant into smaller parts providing a more uniform mixture adapted to be properly distributed by said flow-resistance tubes, said fitting having a passage diverging from the inlet therein to said screens to provide for velocity-pressure conversion of the refrigerant.

10. An expansion mechanism for refrigeration evaporators, comprising an expansion valve, a distributor head, a plurality of outlets in said head leading to a plurality of evaporators, a plurality of orifices connecting with said outlets and with the output side of said valve, and means for preventing the segregation of unevaporated liquid from the evaporated liquid in its travel between said valve and said orifices.

11. An expansion mechanism for refrigeration evaporators, comprising an expansion valve, a distributor head, a plurality of outlets in said head leading to a plurality of evaporators, a plurality of orifices connecting with said outlets, a channel connecting said orifices with the output side of said valve, and means within said channel for preventing the segregation of the unevaporated liquid from the gas passing therethrough.

12. In a refrigerating apparatus, the combination of a plurality of flow resisting tubes for distributing refrigerant, a source of refrigerant, means for partially expanding refrigerant, and means interposed between said means and said flow-resisting tubes for transforming the mixture of gas and liquid into a uniform mixture of liquid and small gas bubbles, which uniform mixture enables proper distribution of refrigerant to the several flow resisting tubes.

13. In refrigerating apparatus, the combination of a plurality of evaporator elements, an expansion valve, and a distributor fitting having an inlet connected to the output side of said valve, said fitting having a plurality of outlets arranged similarly with respect to said inlet and leading to said evaporator elements, respectively, said fitting further having a divergent passage extending from said inlet to said outlets, the fitting being constructed and arranged so that refrigerant enters said divergent passage longitudinally thereof and the angle of divergence of said passage being such as to convert velocity of the refrigerant into pressure thereof.

14. In refrigerating apparatus, the combination of a plurality of evaporator elements, an expansion valve operating to effect a portion of the expansion of the refrigerant and to discharge a mixture of liquid and vaporous refrigerant, and a distributor, said distributor having an elongated divergent passage and a plurality of outlets arranged in closely spaced relation at the large end of said divergent passage and leading to the respective evaporator elements, the distributor being constructed and arranged so that refrigerant enters said divergent passage longitudinally thereof, and the small end of said divergent passage being connected to the outlet side of said valve and the flow area thereof being substantially equal to that of the inlet through which the refrigerant enters the divergent passage, so that the refrigerant is kept flowing in a steady stream toward said outlets.

15. The combination set forth in claim 14, wherein said outlets are of restricted flow area to provide resistance to flow therethrough.

16. The combination set forth in claim 14 wherein the angle of divergence of said passage is such as to convert velocity of the refrigerant into pressure thereof.

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