

Sept. 27, 1966

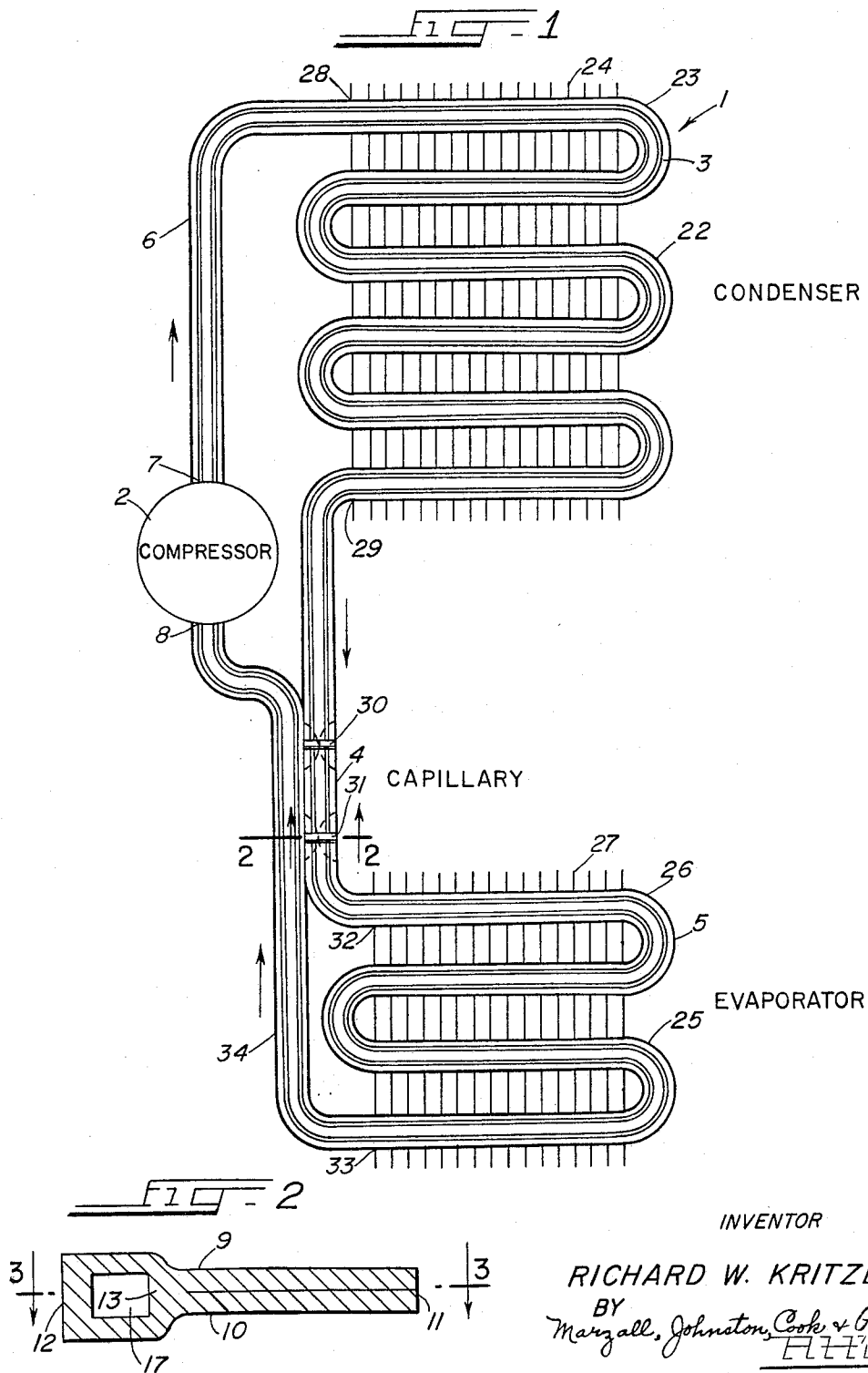
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HEAT EXCHANGER INCLUDING A CAPILLARY TUBE SECTION

Filed May 8, 1964

2 Sheets-Sheet 1



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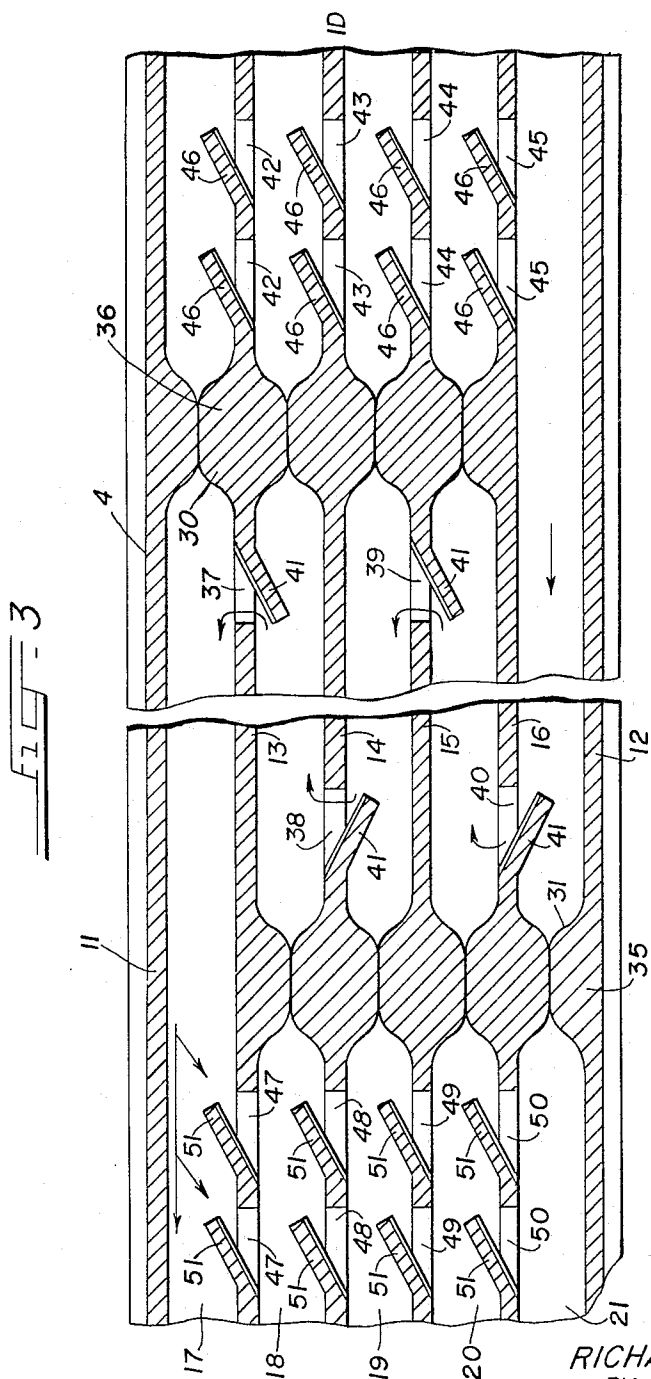
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HEAT EXCHANGER INCLUDING A CAPILLARY TUBE SECTION

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Filed May 8, 1964, Ser. No. 365,905
12 Claims. (Cl. 62-511)

This invention relates to heat exchangers and, more particularly, to heat exchangers which are particularly well adapted for use in refrigerating apparatus of the capillary tube type.

The primary object of the present invention is to enable novel refrigeration, heat exchanger apparatus of the capillary tube type to be afforded.

Heretofore, in the field of capillary tube type of refrigeration systems, it has been common practice to connect a condenser to the outlet of a compressor, connect a capillary tube to the condenser, connect an evaporator to the capillary tube, and connect the evaporator through a suction line to the inlet of the compressor, with joints being afforded at each such connection. When certain materials are used for such conduits, such as, for example, copper, or the like, such joints may be relatively easily made by welding, or the like, although such joints have long been recognized as undesirable because they are a substantial, potential source of leaks. However, such multiple joints are particularly undesirable when the refrigeration system embodies elements constructed of aluminum, the joining of aluminum to aluminum, or aluminum to copper, and the like, requiring pressed-fit or some type of connection other than welding. It is an important object of the present invention to enable many such joints to be eliminated from refrigeration apparatus, and the like, in a novel and expeditious manner.

Another object of the present invention is to enable novel capillary tube type of refrigeration apparatus to be afforded wherein the refrigerant conduit, extending from the outlet to the inlet of the compressor and including the refrigerant conduits, of the condenser, evaporator, and capillary tube portions of the apparatus may all be made as a single unitary structure, without any joints between the ends thereof attached to the aforementioned outlet and inlet of the compressor.

Yet another object of the present invention is to enable novel heat exchanger apparatus, embodying a capillary tube portion, to be afforded in the form of a multiple-passageway conduit in a novel and expeditious manner.

A further object is to afford a novel heat exchanger, which embodies a condenser portion and an evaporator portion connected to each other through a capillary tube portion, wherein each of the portions embody a conduit having multiple passageways therein, with the passageways interconnected, and constituted and arranged relative to each other in a novel and expeditious manner effective to afford practical and efficient heat exchanger apparatus for a refrigeration unit.

An object ancillary to the foregoing is to enable the multiple passageway conduit portions of such an apparatus to be afforded in the form of a single, unitary metal extrusion.

A further object of the present invention is to enable refrigerant flow in a multiple passageway heat exchanger of the aforementioned type to be such that the effective cross-sectional area of the passageway through the capillary tube portion is of the desired reduced size as compared to the corresponding areas of the condenser and evaporator portions to afford the desired control of refrigerant through the heat exchanger.

Another object is to afford a novel heat exchanger of the aforementioned type which is practical and efficient in

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operation and which may be readily and economically produced commercially.

Other and further objects of the present invention will be apparent from the following description and claims and are illustrated in the accompanying drawings which, by way of illustration, show a preferred embodiment of the present invention and the principles thereof and what I now consider to be the best mode in which I have contemplated applying these principles. Other embodiments of the invention embodying the same or equivalent principles may be used and structural changes may be made as desired by those skilled in the art without departing from the present invention and the purview of the appended claims.

In the drawings:

FIG. 1 is a somewhat diagrammatic view of refrigeration apparatus embodying the principles of the present invention;

FIG. 2 is an enlarged detail sectional view taken substantially along the line 2-2 in FIG. 1; and

FIG. 3 is an enlarged, fragmentary, detail sectional view taken substantially along the line 3-3 in FIG. 2.

A refrigeration apparatus 1, embodying the principles of the present invention, is shown in the drawings to illustrate the presently preferred embodiment of the present invention.

The refrigeration apparatus 1 embodies, in general, a compressor 2 for refrigerant, a condenser 3, a capillary tube portion 4 and an evaporator 5, which, in the preferred embodiment of the present invention, are all operatively connected together by a single unitary conduit 6, which extends from the outlet 7 of the compressor 2 to the inlet 8 thereof.

The conduit 6 is substantially rectangular in transverse cross-sectional shape, and embodies a top wall 9 a bottom wall 10 and two oppositely disposed side walls 11 and 12, FIG. 2. It also embodies four equally spaced partition walls 13, 14, 15, and 16 disposed between the side walls 11 and 12, and extending longitudinally of the conduit 6 to define five passageways 17, 18, 19, 20, and 21 extending longitudinally through the conduit 6 in uniplanar, side-by-side relation to each other between the side walls 11 and 12, FIG. 3. The conduit 6 may be made of any suitable material such as, for example, aluminum, and is preferably constructed in the form of a one-piece extrusion, so that there are no joints therein between the connection thereof to the outlet 7 and the inlet 8 of the compressor 2.

The condenser 3 includes a portion 22 of the conduit 6 looped back and forth upon itself to afford a coil 23, FIG. 1. A series of fins 24 are provided on the coil 23 to afford heat radiation. The fins 24 may be of any suitable type, but are preferably of the type shown in my co-pending application for United States Letters Patent, Serial No. 345,914, filed February 19, 1964, and now Patent No. 3,229,722.

Like the condenser 3, the evaporator 5 includes a portion 25 of the conduit 6 looped back and forth upon itself to afford a coil 26, a series of fins 27, like the fins 24 being provided on the coil 26 for heat radiation.

The inlet end 28 of the coil 23 of the condenser 3 is connected to the outlet 7 of the compressor 2, and the outlet end 29 of the coil 23 is connected to the inlet end 30 of the capillary tube section 4, FIGS. 1 and 3. The outlet end 31 of the capillary tube section 4 is connected to the inlet end 32 of the coil 26 of the evaporator 5, and the outlet end 33 of the coil 26 is connected by a suction line portion 34 of the conduit 6 to the inlet 8 of the compressor 2.

At the outlet end 31 of the capillary tube section 4, the passageways 18-21 are closed by suitable means such

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as, for example, compressing the top wall 9 and the bottom wall 10 of the conduit 6 together to thereby afford a dam 35 extending between the partition wall 13 and the side wall 12 and thereby close the passageways 18-21 at this point, FIGS. 2 and 3. At the inlet end 30 of the capillary tube section 4 the passageways 17-20 are similarly closed by a dam 36 extending between the partition wall 16 and the side wall 11, FIG. 3.

With this construction, at the inlet end 32 of the capillary tube section 4 the condenser 3 is connected to the capillary tube section 4 only through the passageway 21; and at the outlet end 31 of the capillary tube section 4 the evaporator 5 is connected to the capillary tube section 4 only through the passageway 17, FIG. 3.

A series of openings 37, 38, 39, and 40 are formed in the partition walls 13-16, respectively, in the capillary tube section 4 to enable refrigerant to flow from the passageway 21 to the passageway 17 within the capillary tube section 4. The openings 37-40 are alternately disposed at opposite ends of the capillary tube section 4 so that the flow of refrigerant from the passageway 21 to the passageways 17 within the capillary tube section 4 is alternatively one direction and then the other, longitudinally of the capillary tube section 4 in adjacent ones of the tubes 17-21, as shown by arrows in FIG. 3.

Each of the partition walls 13-16 is preferably provided with a baffle plate or scoop-like member 41, which is punched or otherwise formed out of the respective walls 13-16 adjacent the respective opening 37-40 therein. As shown in FIG. 3, each partition wall 13-16 has one of these baffle plates 41 formed as an integral part thereof and cut or gouged therefrom to afford the opening 37-40, respectively, therein. These baffle plates 41 are so directed as to extend into the path of flow of the refrigerant in the passageways 18-21 in a direction to divert or direct the refrigerant from one passageway to the other in its flow from the passageway 21 to the passageway 17 in the capillary tube section 4.

It will be remembered that only the passageway 21 is unobstructed from the condenser 3 to the interior of the capillary tube section 4. Passageways 42, 43, 44, and 45 are formed in the partition walls 13-16, respectively, adjacent to, and on the opposite side of the dam 36 from the capillary tube section 4 to thereby enable the refrigerant flowing through all of the passageways 17-20 from the condenser 3 toward the capillary tube section 4 to flow into the passageway 21 adjacent to the dam 36 for entry into the capillary tube section 4. Preferably, each of the partition walls 13-16 has a plurality of such openings 42-45, respectively, spaced from each other from the dam 36 toward the condenser 3. Also, baffle plates or scoop-like members 46, which are similar to the baffle plates 41, are similarly afforded adjacent each of the openings 42-45, with the baffle plates 46 being so directed as to extend into the path of flow of refrigerant therein toward the passageway 21 adjacent the dam 36.

Similarly, at the outlet end 31 of the capillary tube section 4, passageways 47, 48, 49, and 50 are formed in the partition walls 13-16, respectively, adjacent to the dam 35 on the side thereof remote from the capillary tube section 4, to enable refrigerant flowing from the capillary tube section 4 through the passageway 17 to flow into all of the other passageways 18-21 during its passage from the capillary tube section 4 to the evaporator 5. As at the other end of the capillary tube section 4, each of the partition walls 13-16 preferably has a plurality of such openings 47-50, respectively, spaced from each other longitudinally thereof, and baffle plates or scoop-like members 51, are formed similarly to the baffle plates 41 and 46, the baffle plates 51 being so directed so as to extend into the path of flow of the refrigerant through the passageways 17-20, so as to distribute the refrigerant through all of the passageways 17-21 upon its discharge from the capillary tube section 4 through the passageway 17.

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In the operation of the refrigeration apparatus 1, refrigerant flows from the outlet 7 of the compressor 2 through all of the passageways 17-21 of the conduit 6 through the condenser 3 to the inlet end 30 of the capillary tube section 4. At the inlet end 30 of the capillary tube section 4, all of the refrigerant flow thereinto from the passageways 17-21 is through the passageway 21. Within the capillary tube section 4, the refrigerant flows from the passageway 21 back and forth through the adjacent passageways 20, 19, and 18 to the passageway 17, through which it is discharged from the capillary tube section 4. Substantially immediately upon discharge from the capillary tube section 4, the refrigerant is again distributed throughout all of the passageways 17-21 and flows through the evaporator 5 and the suction line portion 35 back to the inlet 8 of the compressor 2. Thus, the capillary tube section 4 affords an effective restriction to the flow of refrigerant through the refrigeration apparatus 1, the cross-sectional area of the effective passageway through the capillary tube section 4 being substantially less than that of the remainder of the conduit 6.

The capillary tube section 4 is parallel to, and disposed in tight abutting engagement with the suction line portion 34 of the conduit 6 to thereby afford good heat exchange relationship therebetween. This renders the refrigerant in the capillary tube section 4 responsive to the temperature in the suction line portion 34 through which the refrigerant flows from the evaporator 5 to the compressor 2, to thereby vary the rate of the flow of refrigerant to the evaporator responsively to the temperature of the refrigerant in the suction line portion 34.

It will be appreciated by those skilled in the art that, although five passageways 17-21 are shown herein, this is merely by way of illustration and not by way of limitation, and a greater or lesser number of such multiple passageways may be provided without departing from the purview of the present invention.

From the foregoing, it will be seen that the present invention affords novel refrigeration apparatus.

Also, it will be seen that the present invention affords novel refrigeration apparatus wherein no joints in the refrigerant line are necessary, other than the joints attaching the line to the outlet and inlet of the compressor.

In addition, it will be seen that the present invention affords novel refrigeration apparatus wherein the refrigerant conduit for the various portions thereof, including the capillary tube section thereof, may be afforded by a multiple passageway conduit in a novel and expeditious manner.

Also, it will be seen that the present invention affords a novel refrigeration apparatus which is practical and efficient in operation and which may be readily and economically produced commercially.

Thus, while I have illustrated and described the preferred embodiment of my invention, it is to be understood that this is capable of variation and modification, and I therefore do not wish to be limited to the precise details set forth, but desire to avail myself of such changes and alterations as fall within the purview of the following claims.

I claim:

1. A heat exchanger element comprising
 - (a) a condenser section means,
 - (b) an evaporator section means, and
 - (c) a capillary tube section means,
 - (d) said first two mentioned means each including an elongated conduit having a plurality of adjacent passageways extending lengthwise thereof for simultaneously feeding refrigerant in the same direction through all of said passageways,
 - (e) said capillary tube section means being in fluid communication with said two first mentioned means and including an elongated conduit having a plurality of adjacent passageways extending lengthwise thereof and operatively connected to each other in

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- position to feed said refrigerant alternately in said one direction and in the opposite direction through adjacent ones of said last-mentioned passageways.
2. A heat exchanger element comprising
 - (a) a condenser section,
 - (b) an evaporator section, and
 - (c) a capillary tube section,
 - (d) said first two mentioned sections each including an elongated conduit having a plurality of adjacent passageways extending lengthwise thereof for simultaneously feeding refrigerant in the same direction through all of said passageways,
 - (e) all of said passageways except one in each of said conduit being closed at one end of said conduit,
 - (f) all of said passageways in each of said conduits being interconnected adjacent one end thereof for feeding said refrigerant therebetween,
 - (g) said capillary tube section including an elongated conduit having a plurality of adjacent passageways extending lengthwise thereof and operatively connected to each other in position to feed said refrigerant alternately in said one direction and in the opposite direction through adjacent ones of said last-mentioned passageways,
 - (h) all of said last-mentioned passageways except the one at one side of the plurality of last-mentioned passageways being closed at one end of said last-mentioned conduit,
 - (i) all of said last-mentioned passageways except the one at the side of said last-mentioned plurality of passageways remote from said first-mentioned one of said last-mentioned passageways being closed at the other end of said last-mentioned conduit,
 - (j) said ends of said last-mentioned conduit being operatively connected to respective ones of said one end of said first-mentioned two conduits with said one and other passageways of said capillary tube conduit being operatively connected to respective ones of said one passageways in said first-mentioned two conduits.
 3. A heat exchanger comprising
 - (a) an elongated conduit,
 - (b) partition means in said conduit extending lengthwise thereof and defining a plurality of laterally adjacent passageways therethrough for the flow of refrigerant,
 - (c) respective portions of said conduit being included in
 - (1) a condenser section,
 - (2) an evaporator section, and
 - (3) a capillary tube section, respectively,
 - (d) one end of said capillary tube section being operatively connected to said condenser section,
 - (e) all of said passageways except the one disposed at one side of said conduit being closed at the interconnection of said condenser section and said capillary tube section,
 - (f) the other end of said capillary tube section being operatively connected to said evaporator section,
 - (g) all of said passageways except the one disposed at the side of said conduit remote from said one side thereof being closed at the interconnection of said evaporator section and said capillary tube section,
 - (h) said partition means having openings therethrough in said capillary tube section for feeding said refrigerant from said first-mentioned one passageway therein to said second-mentioned one passageway therein, and
 - (i) said partition means having openings therethrough in the portions thereof on the side of said closed portions of said passageways remote from said capillary tube section for feeding said refrigerant from said condenser into said first-mentioned one passageway adjacent said first-mentioned interconnection, and for feeding said refrigerant from said capillary tube section into all of said passageways in said evaporator, respectively.

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4. A heat exchanger as defined in claim 3, and in which
 - (a) said openings in said partition means in said capillary tube section are disposed in such position as to cause said refrigerant to flow in one direction and then the other in passing between said first-mentioned and second-mentioned one passageways in said capillary tube section.
5. A heat exchanger as defined in claim 4, and which includes
 - (a) baffle plates in said passageways in said capillary tube section for diverting refrigerant from one passageway to the other through said openings in said capillary tube section.
6. A heat exchanger as defined in claim 3, and which includes
 - (a) baffle plates on said partition means
 - (1) disposed in position on the side of said closed passageway portions closest to said condenser to divert refrigerant to said first-mentioned one passageway, and
 - (2) disposed in position on the side of said closed passageway portions closest to said evaporator to divert refrigerant away from said second-mentioned one passageway.
7. A heat exchanger as defined in claim 6, and in which
 - (a) said openings in said partition means outside of said capillary tube sections include a plurality of openings in each of said partition means spaced from each other in a direction away from said capillary tube section.
8. In a refrigeration unit embodying a compressor for refrigerant having an inlet and an outlet
 - (a) an elongated conduit,
 - (b) a condenser comprising a portion of said conduit having one end operatively connected to said outlet,
 - (c) a capillary tube section comprising a second portion of said conduit having one end operatively connected to the other end of said first-mentioned portion remote from said outlet,
 - (d) an evaporator comprising a third portion of said conduit having one end operatively connected to the other end of said second portion on the side of said second portion remote from said condenser,
 - (e) a suction line comprising a fourth portion of said conduit having one end operatively connected to the other end of said third portion remote from said capillary tube section and having another end remote from said evaporator operatively connected to said inlet,
 - (f) said conduit having a plurality of passageways extending longitudinally therethrough in side-by-side relation to each other for feeding refrigerant from said outlet to said inlet,
 - (g) certain of said passageways in said capillary tube section being closed at the ends thereof,
 - (h) two other passageways in said capillary tube section being closed at alternate ends and open at alternate ends, with said open ends operatively connected to the ends of corresponding passageways in said condenser and evaporator, respectively,
 - (i) said passageways in said capillary tube section being operatively connected to each other for feeding refrigerant therethrough from the one of said other passageways operatively connected to said corresponding passageway of said condenser to the second of said other passageways operatively connected to said corresponding passageway of said evaporator,
 - (j) said passageways exteriorly of said capillary tube section being operatively interconnected adjacent to said closed ends
 - (1) for feeding refrigerant from passageways in said condenser into said first-mentioned corresponding passageway, and

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- (2) for feeding refrigerant from said second-mentioned corresponding passageway into other passageways in said evaporator.
9. The combination defined in claim 8, and in which (a) said capillary tube section is disposed in heat exchange engagement with said suction line. 5
10. The combination defined in claim 8, and in which (a) said conduit is a single, unitary metal extrusion.
11. The combination defined in claim 8, and in which (a) said conduit is substantially rectangular in transverse cross-section, and 10
- (b) said passageways therein are disposed in substantially uniplanar relation to each other.
12. The combination defined in claim 11, and in which

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- (a) said two other passageways are disposed at respective opposite sides of said conduit.

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MEYER PERLIN, *Primary Examiner*.