

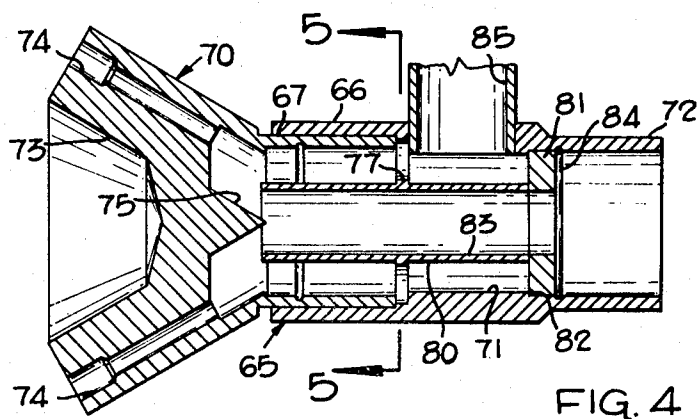
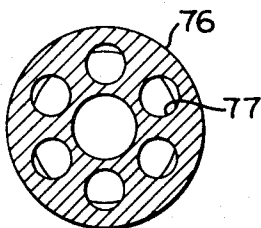
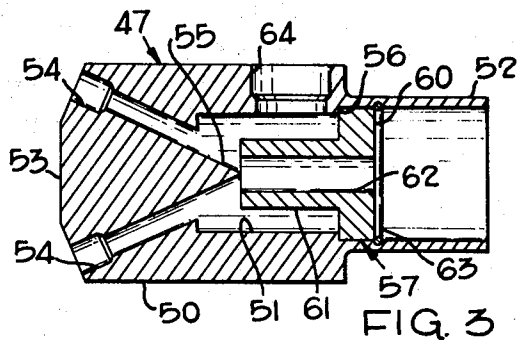
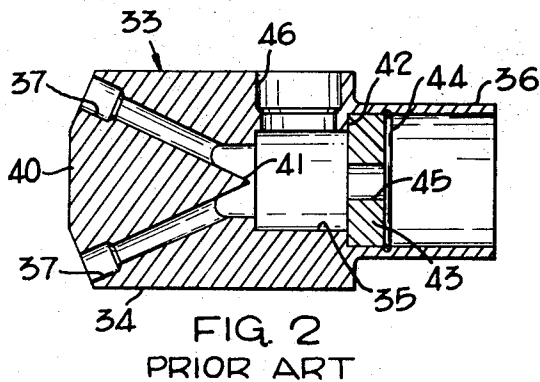
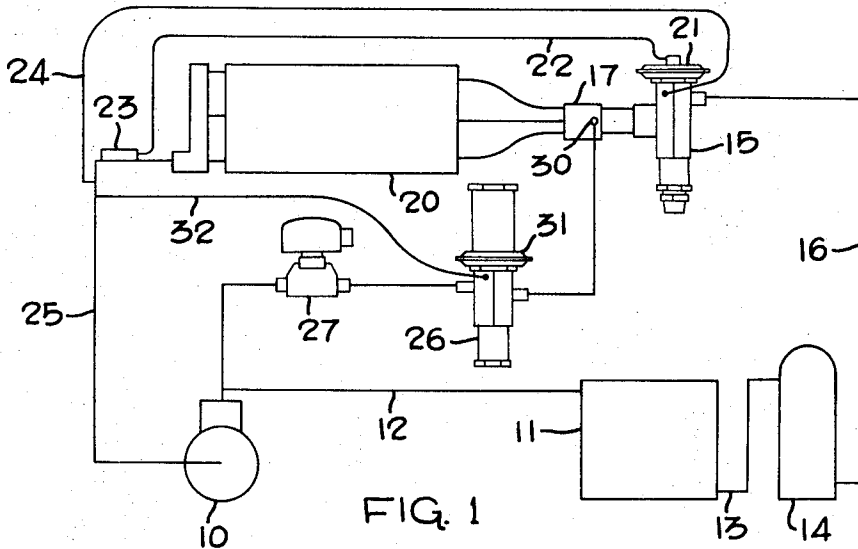
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REFRIGERANT DISTRIBUTOR

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REFRIGERANT DISTRIBUTOR

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10 Claims

ABSTRACT OF THE DISCLOSURE

A refrigerant distributor for delivering refrigerant from an expansion valve to a multi-circuit evaporator, the distributor having a nozzle in a body chamber through which the liquid/gas mixture leaving the expansion valve is fed from a first inlet in one body end to a plurality of divergent feed passages in the opposite body end. The nozzle includes a tube that extends forwardly in the chamber to a point of distribution in the chamber. A second inlet in the body side communicates with the chamber in front of the nozzle partition yet rearwardly of the tube end so that hot refrigerant gas is mixed in the chamber around the tube and then fed into the feed passages at the distribution point.

An adaptor body portion that is compatible with a conventional distributor can be inserted between the expansion valve and such distributor. The nozzle of the conventional distributor is removed and inserted in the body adaptor portion to cooperate with a nozzle tube in the adaptor body portion, whereby the refrigerant from the expansion valve is delivered directly to the feed passages at the distribution point in the discharge portion of the conventional distributor. A web, carried by the adaptor body portion, supports the tube. The hot gas inlet in the adaptor body portion is located between the insertable nozzle and the web, the web being provided with openings that permit flow along the tube to the feed passages at the distribution point.

BACKGROUND OF THE INVENTION

This invention relates generally to improvements in refrigerant distributors, and more particularly to means for introducing hot gas to the evaporator inlet of a refrigeration system for capacity reduction when a refrigerant distributor is used.

The practice of introducing hot discharge gas into the low side of a refrigeration system for capacity reduction is well known. This is a method of capacity control to prevent the suction pressure from dropping below a desired minimum.

When the hot gas is introduced into the low side downstream of the evaporator, several problems occur. One problem is that the hot gas must be desuperheated, usually by introducing liquid refrigerant from an auxiliary expansion valve prior to the time it enters the compressor. Another problem is that the reduced load in the evaporator allows the refrigerant gas velocity to become low and the oil return from the evaporator does not occur properly. For these reasons, it is advantageous to introduce the hot gas to the inlet side of the evaporator so that the main expansion valve can accomplish the desuperheating, and the hot gas travel through the evaporator keeps the velocity in the evaporator high so that oil return is accomplished.

When the evaporator is a multi-circuit evaporator, a refrigerant distributor must be used. The introduction of hot gas to the evaporator inlet presents a special problem. The most common type of refrigerant distributor employs a nozzle and is commonly referred to as the pressure drop type. The purpose of this nozzle is to receive the refrigerant liquid/gas mixture leaving the expansion

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valve and remix it so that equal portions of gas and liquid enter each circuit leaving the refrigerant distributor. When such a nozzle handles the normal refrigerant flow from the expansion valve, the pressure drop on a refrigerant 22 system normally runs about 35 p.s.i. If an attempt is made to introduce hot gas between the expansion valve and such a refrigerant distributor, the pressure drop in the refrigerant distributor nozzle becomes excessive and will not allow sufficient hot gas or liquid from the expansion valve to enter the evaporator.

A conventional refrigerant distributor utilized in the industry to overcome this problem is shown in FIG. 2. This heretofore conventional refrigerant distributor is one in which the nozzle has been displaced from the converging feed passages of the refrigerant distributor to provide an internal chamber. Hot gas is then introduced into this chamber between the nozzle and the feed passages so that the hot gas can be admitted to the evaporator inlet downstream of the refrigerant distributor nozzle, thereby preventing excessive pressure drop.

The problem that occurs when this type of refrigerant distributor is used is that the velocity of the hot gas entering the side of the distributor tends to divert the flow of liquid refrigerant coming through the nozzle and to force it over to one side of the chamber so that the majority of the liquid enters the feed passages opposite the hot gas inlet, while the hot gas enters the feed passages adjacent to the hot gas inlet. This unequal distribution of refrigerant to the evaporator causes variation in air temperature leaving the evaporator and becomes especially troublesome on multi-zone units where the top half of the evaporator might be feeding one zone while the bottom half feeds another zone.

Another problem exists in refrigeration systems installed in the field or on evaporators fitted with standard refrigerant distributors prior to the time that it is decided that a hot gas bypass will be required. Because it is quite a job to change a refrigerant distributor of the standard variety in which there is no facility for hot gas bypass to the type described above, some means is desired for utilizing the standard refrigerant distributor and introducing hot gas between the expansion valve and such a standard distributor.

SUMMARY OF THE INVENTION

The present refrigerant distributor includes a nozzle having a tube extending forwardly in the chamber from the nozzle partition to substantially the point of distribution at the conical deflector provided between the divergent feed passages for directing flow from the nozzle to the feed passages. A hot gas connection communicates with the chamber in front of the nozzle partition yet rearwardly of the tube end. This extended nozzle tube allows the liquid refrigerant from the expansion valve to travel to the point of distribution without being influenced by the velocity of the hot gas entering the side connection. The hot gas enters the side connection and flows into the chamber in the annular area around the nozzle tube, the hot gas mixing with the refrigerant from the nozzle tube at the point of distribution and is delivered directly to the feed passages. This improved refrigerant distributor allows equal distribution of the refrigerant to all circuits when hot gas is being bypassed to the evaporator and in no way interferes with the normal function of the refrigerant distributor during periods of high load, then there is no hot gas being bypassed.

In another embodiment, a hot gas bypass adaptor body is inserted between the refrigerant valve and the standard refrigerant distributor, the adaptor portion allowing the introduction of hot gas at this point without excessive pressure drop. To utilize this improved embodiment, the nozzle is removed from the standard distributor and

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placed upstream of the bypass connection in the hot gas adaptor portion. Then, the expansion valve is connected to the inlet of this hot gas adaptor portion. The flow of liquid refrigerant from the expansion valve is then channeled through the nozzle partition and nozzle tube to the point of divergence of the feed passages in the discharge portion of the distributor. The hot gas enters the side connection is the adaptor portion and then flows in the annular area of the chamber about the nozzle tube. The hot gas then passes through the openings in the web that supports the nozzle tube in the adaptor portion and passes through the annular area of the chamber around the nozzle tube. This hot gas joins the flow of refrigerant from the nozzle tube at the point of divergence of the feed passages and thereby combines equally with the refrigerant from the expansion valve. The adaptor portion enables the use of the standard refrigerant distributor.

While the above mentioned embodiments are utilized to introduce hot gas for capacity control, it will be understood that the same devices can be utilized in reverse cycle refrigeration systems to improve distributor performance whenever the system is operated in the conventional manner and to allow reverse flow of liquid refrigerant out of the evaporator when it is being used as a condenser.

It will also be understood that the present refrigerant distributors may be utilized in refrigeration systems employing hot gas defrost in which it is desirable to drain liquid out of the evaporator during the defrost cycle through the refrigerant distributor. The present embodiments would allow this function to be accomplished with a standard refrigerant distributor when the adaptor portion is used or it could be accomplished with the use of the present distributor in which the advantage would be better refrigerant distribution because the refrigerant from the expansion valve is conveyed closer to the point of divergence before expansion takes place.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a diagrammatic view of the system in which the refrigerant distributor is used;

FIG. 2 is a longitudinal cross section of the heretofore conventional refrigerant distributor designated as prior art;

FIG. 3 is a longitudinal cross section of one embodiment;

FIG. 4 is a longitudinal cross section of another embodiment, and

FIG. 5 is a cross section taken on line 5—5 of FIG. 4.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The refrigeration system in which the refrigerant distributor is used is illustrated diagrammatically in FIG. 1. In this system, a compressor 10 is connected to a condenser 11 by line 12, the outlet of the condenser 11 being connected by line 13 to a receiver 14. A thermostatic expansion valve 15 is connected to the receiver 14 by line 16, the outlet of the expansion valve 15 being connected to a refrigerant distributor 17 that feeds refrigerant to a multi-circuit evaporator 20. The top of the diaphragm constituting the motor element 21 of the expansion valve 15 is connected by tubing 22 to a sensing bulb 23 located at the outlet of evaporator 20. An external tube 24 connects the expansion valve 15 to the evaporator downstream of the sensing bulb 23 to subject the underside of the motor element 21 to the system pressure at that zone. The outlet of evaporator 20 is connected to the compressor 10 by suction line 25.

In this system, a hot gas bypass is provided for feeding hot gas directly to the refrigerant distributor 17 from the compressor 10. This hot gas bypass includes a discharge bypass valve 26 having its inlet connected to a hot gas solenoid valve 27 to the compressor 10, and having its outlet connected to a side connection 30 of the re-

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frigerant distributor. The underside of the diaphragm constituting the motor element 31 of the discharge bypass valve 26 is subjected to pressure existing in the suction line 25 through the external tube 32.

FIG. 2 illustrates a prior art refrigerant distributor 33, the structure and function of which will be described in order to clearly understand the structural differences and functional advantages of the improved refrigerant distributors constituting this invention. This prior art distributor 33 includes a body 34 having an internal chamber 35. An inlet 36 in one end of the body 34 communicates with the chamber 35. The body 34 is provided with a plurality of feed passages 37 extending divergently outward through the opposite body end 40 and communicating with the chamber 35. The formation of the divergent feed passages 37 form a substantially conical deflector 41 between the feed passages for directing flow into the feed passages 37.

The body 34 is provided with an annular shoulder 42 between the inlet 36 and chamber 35. A nozzle 43, constituting a partition, seats against the annular shoulder 42 and is retained in place by a lock ring 44. The nozzle partition 43 is provided with a port 45 aligned axially with the conical deflector 41, the port 45 constituting a part of the inlet to chamber 35. Another inlet 46 is provided in the side of distributor body 34 and communicates with the chamber 35 between the nozzle partition 43 and the conical deflector 41.

In using this prior art distributor 33, the refrigerant liquid/gas mixture leaving the expansion valve 15 flows through the inlet 36 and the nozzle port 45 into the chamber 35. The hot gas from the hot gas bypass is introduced into chamber 35 through the side inlet 46 between the nozzle partition 43 and the feed passages 37. With this type of refrigerant distributor, the velocity of the hot gas entering the side inlet 46 tends to divert the flow of liquid refrigerant leaving the nozzle port 45 and tends to force it over to one side of the chamber 35 so that the majority of the refrigerant liquid enters the feed passages 37 opposite the hot gas inlet 46, while hot gas enters the feed passages 37 adjacent to the hot gas inlet 46. This unequal distribution of refrigerant to the evaporator 20 causes variations in air temperature leaving the evaporator 20 and becomes especially troublesome on multi-zone units where the top half of the evaporator 20 might be feeding one zone and the bottom half feeding another zone.

An improved refrigerant distributor which overcomes the problems of the prior art distributor of FIG. 2, is shown in FIG. 3. In this distributor 47, the distributor body 50 is provided with an internal chamber 51. One end of body 50 is provided with an inlet 52 that communicates with chamber 51. The opposite end 53 of body 50 is provided with a plurality of divergently extending feed passages 54, the feed passages 54 extending outwardly from substantially a point of distribution in chamber 51. A substantially conical deflector 55 is provided between the divergent feed passages 54 for directing flow into the feed passages 54.

An annular shoulder 56 is provided by the body between the inlet 52 and chamber 51. Seated on the annular shoulder 56 is a nozzle generally indicated by 57, the nozzle 57 including a nozzle partition 60 extending across the chamber 51 at the inlet 52 and a nozzle tube 61 extending forwardly from the nozzle partition 60 in the chamber 51 to the distribution point defined by conical deflector 55. The nozzle 57 is provided with a port 62 axially aligned with the conical deflector 55 and adapted to deliver refrigerant from the inlet 52 directly to the feed passages 54 around the conical deflector 55. The nozzle 57 is retained by lock ring 63.

Formed in the side of distributor body 50 is a hot gas inlet 64 that communicates with the chamber 51 forwardly of the nozzle partition 60 yet rearwardly of the front end of nozzle tube 61. With this arrangement, the hot gas

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from inlet 64 flows into the chamber 51 around the exterior of nozzle tube 61 and flows forwardly so as to mix with the refrigerant delivered by the nozzle tube 61 at the distribution point. The hot gas and the refrigerant liquid/gas mixture delivered by the nozzle tube 61 is mixed completely and fed equally by the conical deflector 52 directly into the feed passages 54.

In operation, when the suction pressure reaches a predetermined minimum, the discharge bypass valve 26 will deliver hot gas from the compressor 10 directly to the refrigerant distributor 47 through the hot gas inlet 64. The refrigerant liquid/gas mixture leaving the expansion valve 15 is fed into the inlet 52 and moves through the nozzle port 62, the nozzle tube 61 feeding the liquid/gas mixture directly to the distribution point at the conical deflector 55 where the feed passages 54 diverge. This extended nozzle tube allows the liquid refrigerant from the expansion valve 15 to travel to the point of distribution without being influenced by the velocity of the hot gas entering the inlet 64. The hot gas entering the inlet 64 flows around the nozzle tube 61 and forwardly to the tube end where the hot gas joins with refrigerant from the nozzle 57 at the point of distribution. The conical deflector 55 feeds the co-mingled refrigerant from the nozzle tube 61 and the hot gas from the inlet 64 directly and equally to the feed passages 54.

Because the hot gas is admitted to the evaporator inlet downstream of the refrigerant distributor nozzle 57, excessive pressure drop is prevented. Moreover, the hot gas being introduced into the evaporator 20 downstream from the expansion valve 15 keeps the velocity in the evaporator 20 sufficiently high so that oil return is accomplished. The particular nozzle construction and its arrangement with respect to the hot gas inlet 64 and the conical deflector 55 enables equal distribution of refrigerant to all circuits of the evaporator 20 when hot gas is being bypassed to the evaporator 20, and does not interfere with the normal function of the refrigerant distributor during periods of high loads when there is no hot gas being bypassed.

FIGS. 4 and 5 disclose a refrigerant distributor that incorporates the parts of a standard refrigerant distributor and yet enables the use of a hot gas bypass. Some systems are installed in the field and are fitted with standard refrigerant distributors prior to the time that it is decided that a hot gas bypass will be required. The distributor disclosed in FIGS. 4 and 5 enables the utilization of the standard refrigerant and yet permits the introduction of hot gas.

In this embodiment, the distributor body referred to at 65 includes an adaptor body portion 66, one end of which receives the inlet portion 67 of the conventional distributor 70. When so connected, the body 65 is provided with an internal chamber 71. The adaptor body portion 66 is provided with an inlet 72 that communicates with the chamber 71. The opposite end of body 65, as provided by the discharge portion 73 of the conventional distributor 70, is provided with a plurality of outwardly diverging feed passages 74 converging to a distribution point in chamber 71. A conical deflector 75 is provided on the discharge portion 73 between the divergent feed passages 74.

Formed integrally with and carried by the adaptor body 66, is a web 76 extending across the chamber 71. The web 76 is provided with a plurality of openings 77 located circumferentially in regularly spaced relation. A nozzle tube 80 is carried by and formed integrally with the web 76, the nozzle tube 80 being aligned axially with the conical deflector 75. A nozzle partition 81 seats on an annular shoulder 82 formed between the adaptor body portion and the inlet 72, the nozzle partition engaging one end of nozzle tube 80. The nozzle partition 81 and the nozzle tube 80 are provided with a port 83. A lock ring 84 secures the nozzle partition 81 in place across the chamber 71.

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A hot gas inlet 85 is provided in the side of adaptor body portion 66 and communicates with the chamber 71 forwardly of the nozzle partition 81, yet rearwardly of the front end of nozzle tube 80. Specifically, the hot gas inlet 85 is located rearwardly of the web 76. The hot gas from inlet 85 flows around the exterior of nozzle tube 80 and flows forwardly through the web openings 77 to the distribution point around the front end of tube 80, at which point the hot gas is fed directly into the feed passages 74. The refrigerant flow through the nozzle tube 80 is directed to the distribution point and flows around the conical deflector 75 and is directed into the feed passages 74.

It will be understood that the discharge portion 70 and the nozzle partition 81 constitute parts of the conventional distributor. When it is decided that the hot gas bypass is needed in the system, the discharge portion 70 of the conventional distributor is interfitted with the adaptor body 66 and the nozzle partition 81 is removed from this conventional distributor and placed in the adaptor body 66 in the manner shown in FIG. 4. The inlet 72 of the adaptor body portion 66 is connected to the expansion valve 15, and the feed passages 74 are connected to the multi-circuit evaporator 20, while the hot gas inlet 85 is connected to the discharge bypass valve 26.

The operation and functional advantages of the distributor shown in FIGS. 4, 5 are essentially identical to those previously described with respect to the distributor disclosed in FIG. 3. Basically, the refrigerant liquid/gas mixture from the expansion valve 15 is fed through the nozzle port 83 and is delivered by the nozzle tube 80 directly to the distribution point defined by the conical deflector 75. This refrigerant from the nozzle tube 80 flows around the conical deflector 75 and is directed into the feed passages 74. The hot gas introduced through the hot gas inlet 85 flows into the chamber 71 and around the exterior of nozzle tube 80. The hot gas flows axially along the nozzle tube 80 through the web openings 77 and is delivered to the distribution point around the front end of nozzle tube 80, at which point the hot gas is mixed with the refrigerant flow from the nozzle tube 80 and is delivered in equal proportion to the feed passages 74.

I claim as my invention:

1. A refrigerant distributor, comprising:

- (a) a body having an internal chamber,
- (b) the body being provided with a first inlet in one body end adapted to receive refrigerant from an expansion valve and communicating with the chamber,
- (c) the body being provided with a plurality of feed passages extending through the opposite body end and communicating with the chamber,
- (d) a nozzle fixed in the body and including a partition and a tube having a port receiving flow from the first inlet, the tube extending forwardly in the chamber from the partition to deliver flow to the feed passages, the chamber providing an annular space around the tube rearwardly of the discharge end of the tube, and
- (e) the body being provided with a second inlet in its side adapted to receive hot refrigerant gas or to allow discharge of liquid refrigerant, the second inlet being located in front of the nozzle partition yet rearwardly of the discharge end nozzle tube, and communicating directly with the annular space around the tube.

2. A refrigerant distributor as defined in claim 1, in which:

- (f) the feed passages extend outwardly from substantially a point of distribution in the chamber,
- (g) the nozzle tube extends forwardly to substantially the point of distribution, and
- (h) the second inlet is located rearwardly of the distribution point.

3. A refrigerant distributor as defined in claim 1, in which:

(f) a substantially conical deflector is provided between the feed passages for directing flow into the feed passages, and

(g) the discharge end of the nozzle tube extends forwardly substantially to the conical deflector to deliver flow from the nozzle against the deflector.

4. A refrigerant distributor as defined in claim 1, in which:

(f) the annular space around the tube extends at least from the second inlet forwardly to the feed passages.

5. A refrigerant distributor as defined in claim 3, in which:

(h) the nozzle tube has its longitudinal axis substantially aligned with the axis of the conical deflector and communicates directly with the feed passages around the conical deflector, and

(i) the annular space around the tube communicates directly with the feed passages around the discharge end of the nozzle tube.

6. A refrigerant distributor as defined in claim 1, in which:

(f) a substantially conical deflector is provided between the feed passages for directing flow into the feed passages,

(g) the discharge end of the nozzle tube extends forwardly substantially to the conical deflector to deliver flow from the nozzle against the deflector,

(h) the annular space around the tube extends at least from the second inlet forwardly to the feed passages,

(i) the nozzle tube has its longitudinal axis substantially aligned with the axis of the conical deflector,

(j) the discharge end of the nozzle tube communicates directly with the feed passages around the conical deflector, and

(k) the annular space around the tube communicates directly with the feed passages around the discharge end of the nozzle tube.

7. A refrigerant distributor, comprising:

(a) a body having an internal chamber,

(b) the body being provided with a first inlet in one body end adapted to receive refrigerant from an expansion valve and communicating with the chamber,

(c) the body being provided with a plurality of feed passages extending through the opposite body end and communicating with the chamber,

(d) a nozzle including a partition and a tube having a port receiving flow from the first inlet, the tube extending forwardly in the chamber from the partition to deliver flow to the feed passages,

(e) the body being provided with a second inlet in its side adapted to receive hot refrigerant gas or to allow

discharge of liquid refrigerant, the second inlet communicating with the chamber in front of the nozzle partition yet rearwardly of the nozzle tube,

(f) the body including an adaptor portion in which the first inlet is provided at one end, and including a discharge portion in which the feed passages are provided, the discharge portion being selectively interfitted in the other end of the adaptor portion, and

(g) the nozzle tube extending forwardly in the chamber longitudinally of the adaptor portion and into the discharge portion.

8. A refrigerant distributor as defined in claim 7, in which:

(h) a web is carried by the adaptor portion and supports the nozzle tube in the chamber with one tube end located adjacent the nozzle partition, and

(i) the second inlet is located in the adaptor portion between the nozzle partition and the web, the web being provided with openings for flow from the second inlet to the feed passages.

9. A refrigerant distributor as defined in claim 8, in which:

(j) a substantially conical deflector is provided between the divergent feed passages for directing flow into the feed passages,

(k) the web supports the nozzle tube intermediate the tube ends, and

(l) the other tube end is located adjacent to the conical deflector to deliver flow from the tube against the deflector.

10. A refrigerant distributor as defined in claim 9, in which:

(m) the chamber extends completely around the periphery of the nozzle tube and extends at least from the second inlet forwardly to the feed passages,

(n) the nozzle tube has its longitudinal axis substantially aligned with the axis of the conical deflector,

(o) the nozzle tube communicates directly with the feed passages around the conical deflector, and

(p) the chamber communicates directly with the feed passages around the nozzle tube.

References Cited

UNITED STATES PATENTS

3,110,162	11/1963	Gerteis	62—196
3,120,743	2/1964	Wilson	62—525

MEYER PERLIN, Primary Examiner

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