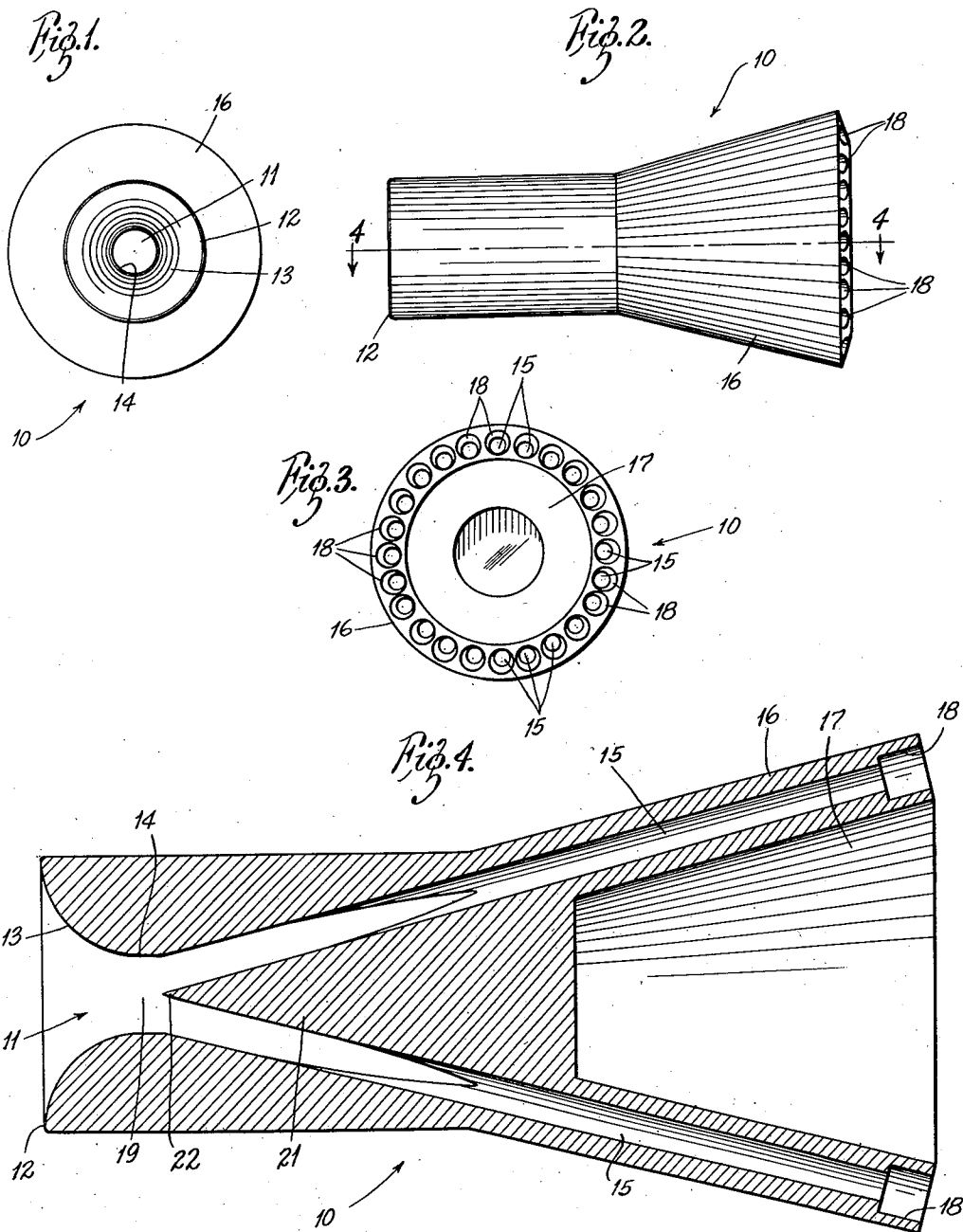


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REFRIGERANT DISTRIBUTOR

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REFRIGERANT DISTRIBUTOR

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The present invention relates to a distribution means, particularly adapted for delivering a refrigerant from a single pipe to multiple pipes. These distributors are used for delivering even quantities of refrigerant from an expansion valve to a plurality of evaporators.

The problems of the distributors are both functional and mechanical. Functionally, the distributor must produce a low total pressure drop through itself in order to minimize the energy loss. The present distributor has a very low pressure drop produced by a smooth expansion from the inlet to the several outlets. Also, since the distributor ordinarily must handle a mixed vapor and liquid, there must be good distribution, as distinguished from settling out of the liquid, due to the extreme low pressures in the center of the throat of the distributor. The present invention, as the following description will show, accomplishes both of these objectives.

Mechanically, the problems of making the distributor include the fact that to get even flow paths into the throat of the distributor and from the throat into the several outlet passages, smooth walls are required for these parts. However, multiple outlets must be capable of being made by a drill press if the distributor is commercially practicable. Consequently, the construction must be one that lends itself to rapid manufacture. The present invention accomplishes the foregoing, as the description will show.

The distributor of the present invention accomplishes its objects by having its flow passages formed like a Venturi, wherein there is a central cone on the outlet side, with its apex facing upstream. In the flow passages there is no significant abrupt edge or wall surface. The outlet passages are straight, and are made by drilling, so as to fan out from the throat of the Venturi. As a result, there is smooth expansion of the refrigerant, minimum turbulence, and even distribution of both liquid and gas phases into the several outlets.

Other objects and advantages will appear from the description to follow.

Referring to the drawings:

Figure 1 is an end elevation from the inlet side of the device;

Figure 2 is a side elevation of the distributor;

Figure 3 is an end elevation from the outlet end of the device; and

Figure 4 is a diametrical section taken on the line 4—4 of Figure 2.

The multi-outlet distributor here generally indicated at 10 is typically adapted to be interposed into a refrigerant line subsequent to the expansion valve and ahead of the several evaporators, or a split evaporator.

As illustrated, the distributor 10 may be made of a single piece of metal. It has an inlet 11 that is formed by a smooth curve 12, such as on the development of an arc, extending from a planar ring surface 13 to a throat 14. This throat may be cylindrical. From the throat, a plurality of drilled passageways 15 leads at an angle so that they occupy the conical extension 16 of the device. Preferably, the interior 17 of the cone is hollowed out,

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as illustrated. The ends of the several passages 15 are enlarged at 18, so that the pipes leading to the evaporators may be inserted therein and provide a smooth joint for the free and uninterrupted flow of refrigerant from the passages 15 to the interiors of the several evaporator tubes. The passages 15 open into an angularly arranged surface, so formed as to present surfaces around each passage that are substantially perpendicular thereto. This facilitates fastening of the tubing to the distributor.

The inner cone 21 extends leftwardly in Figure 4 toward the throat 14. Theoretically, its apex 22 extends to the downstream end of the throat, although, from a practical viewpoint, it ordinarily is somewhat shortened because of the impossibility of guiding long drills with complete accuracy. In any case, it constitutes a generally conical element that acts to evenly distribute the refrigerant flowing against its apex.

The curved surface 13 blends into the transverse face 12 of the inlet end of the device, so as to give an index surface. The surface 13 also blends smoothly into the cylindrical throat 14. This cylindrical throat part is provided because of the previously mentioned impossibility of holding the drills making the openings 15 precisely to line, and because it is desirable to have no abrupt turn or change in the direction of flow of the refrigerant at the throat. If the throat 14 were not present, and the passages 15 were designed to intersect the arc of the surface 13 at the point where that arc becomes parallel to the axis, then any displacement of a passage 15 toward the inlet would cause the passage to intersect the surface 13 with some degree of lack of smoothness. Therefore, the cylindrical throat 14 gives a certain amount of leeway for the drills making the holes 15. It may be also noticed that there is no undercut of the throat 14 and, therefore, it can be conveniently made by a single form tool introduced from the inlet end.

In the shorter distributors with a relatively small number of outlets, the throat section may be eliminated. In this group of smaller sizes, any abrupt change of direction is not as critical, and shortness is important. Typical of these smaller sizes are those wherein the throat diameter is in the order of .155 inch.

Typical dimensions may be given for one of these distributors. If it be desired to supply eighteen evaporators of one-half ton capacity each, the distributor would have eighteen outlets of three-sixteenths inch diameter. Tests have demonstrated that with such outlets, the throat diameter should be about .281 inch. It is desirable to have as big a throat as possible to minimize pressure drop through the distributor, and it is found that the present design permits substantially larger throat diameters. With the Venturi type of distribution, there is a minimum of expansion prior to distribution, but a high velocity is maintained throughout the distributor.

The inlet diameter for the foregoing distributor should be about one and one eighth inches. In terms of area this means that the inlet area is about fifteen times the throat area. An appropriate arc for the surface 13 is three-eighths inch, and the throat length is about three-sixteenths inch, although the length varies according to the accuracy of the drilling. The angle of the core is controlled by the desire for maximum smooth flow, on the one hand, and mechanical convenience of attaching the outlet tubes, on the other. Here an appropriate angle is about 30°. The length of the outlets is sufficient to insure a separation of all of them into individual openings. Reference to Figure 4 shows that the intersection of adjacent passages is quite long. Also, the passages are long enough to provide enough outlet head space to attach the outlet tubing. The foregoing dimensions are illustrative and not limiting.

Multi-outlet distributors have heretofore had abrupt

changes in the passage walls, and usually have had a fairly sharp-edged orifice instead of the throat opening into an enlarged distribution cavity. It was thought that maximum turbulence gives most homogeneous distribution of liquid and gas phases in the refrigerant, and, hence, most uniform composition of refrigerant into the several outlets.

The present distributor operates on the opposing principle of smooth flow, which provides a minimum pressure drop through the device. However, smooth flow distributors ordinarily lead to less even distribution, because (it is thought) the liquid tends to settle by gravity toward the bottom of the flow passage. So the lower outlets have a relatively larger percent of liquid phase refrigerant and the upper outlets have a relatively large percent of gas or vapor phase. This gives uneven refrigeration by the affected evaporators.

However, with the present Venturi type flow passage, the distribution has better quality than previous distributors, despite the lack of turbulence. It is believed that the explanation lies in the fact that the throat diameter at 14 is small enough to produce a relatively large pressure difference between the center of the column of refrigerant flowing through the throat, and the outer parts of the column that are adjacent the surface of the throat 14. The pressure pattern of flow across the throat of a Venturi is known. The pressure at the axis is minimum, while that at the surface is maximum.

Apparently, the pressure at the axis is sufficiently below that at the surface to produce evaporation at the axis and equivalent condensation at the surfaces. It is assumed that there is no change in heat content. Consequently, the liquid phase is disposed in a ring around the surface instead of being largely located by gravity at the bottom of the fluid passage. This means that each outlet receives the same amount of liquid phase and vapor phase of the refrigerant. The expansion downstream of the throat 14, and prior to separation of the several passages 15, is insufficient to cause the foregoing distribution to be upset.

By the foregoing, it is considered that the smooth flow of a Venturi type, with minimum pressure losses and expansion in the distributor, leads to most even composition and distribution into the several outlets.

What is claimed is:

1. A method of delivering a refrigerant under pressure

in liquid and vapor phases from a single inlet into a plurality of outlets, comprising: constricting a main stream of the refrigerant so as to increase its velocity, thereby reducing pressure in the refrigerant in an even pattern around the stream section; dividing the stream after constricting it, into a plurality of smaller streams that are separated from the main stream around the axis thereof; relieving at least part of the constriction of the stream in the smaller streams; and maintaining a smooth, continuous flow of the refrigerant while constricting it and while dividing it and relieving the constriction.

2. The method of claim 1, wherein the constricting is to a cross-sectional stream area of only about one-fifteenth of the area of the inlet.

3. A multioutlet distributor for refrigerants, comprising: a body having a refrigerant inlet, the walls of which converge smoothly and continuously in the direction of flow to form a constricted throat, through which the refrigerant may be forced at greatly increased velocity over that at the inlet; and a plurality of outlet passages emanating from and diverging from the throat, the walls of the passages merging smoothly and continuously into the walls of the throat.

4. The distributor of claim 3, wherein the cross-sections of the inlet, the throat and the outlet passages are all circular.

5. The distributor of claim 4, wherein the passages comprise straight, circular holes in the body, sloping outwardly from the throat, and providing a cone-shaped, axially disposed, central part with its apex facing the throat.

6. The combination of claim 5, wherein the throat is cylindrical, and the outlet passage walls all intersect the cylindrical throat wall.

7. The combination of claim 3, wherein the throat cross-sectional area is only about one-fifteenth the area of the inlet.

References Cited in the file of this patent

UNITED STATES PATENTS

1,524,280	Brancel	Jan. 27, 1925
2,074,690	Gerdts	Mar. 23, 1937
2,082,403	Larkin	June 1, 1937