

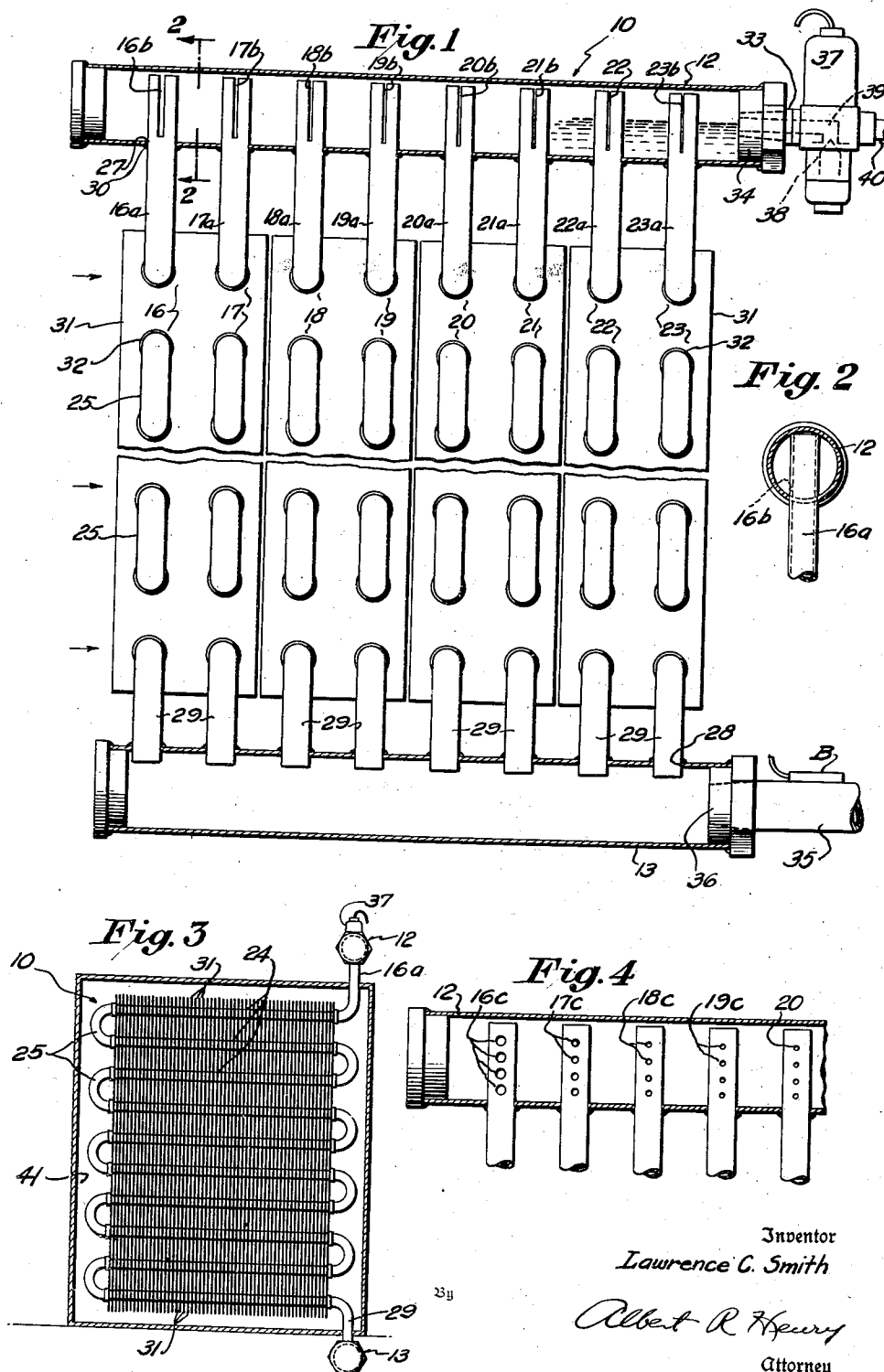
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REFRIGERATION APPARATUS

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REFRIGERATION APPARATUS

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This invention relates to improvements in refrigeration systems.

The invention is particularly directed to systems in which a plurality of independent cooling coil units are supplied by a common header or reservoir. In prior art structures of this nature the ends or terminals of each coil were simply connected to communicate with the header with little or no attention given to apportioning the liquid refrigerant. As a result, deviations in level, due to inaccuracies in assembly or installation, have caused certain coils to be deprived of their proportionate supply of refrigerant, with accompanying inefficiencies in the entire system. This condition has been particularly aggravated in systems where, due to operating conditions, the coils have required different feed rates, and where an attempt has been made to cope with the problem by abandoning the common header in favor of the more expensive and somewhat impractical individual coil feed by separate thermostatic control valves.

According to the present invention, it is proposed to provide a common header as a supply means for two or more cooling coil units, wherein is incorporated means for insuring under all operating conditions a properly distributed supply of refrigerant to each coil in proportion to its demand.

A typical embodiment of the principles of the invention is illustrated in the accompanying drawing, wherein:

Fig. 1 is a side elevation of an air conditioning cooling unit with the headers thereof shown in section;

Fig. 2 is a section on the line 2—2 of Fig. 1;

Fig. 3 is a diagrammatic cross section through an air duct showing the cooling unit of Fig. 1 positioned therein; and,

Fig. 4 is a partial longitudinal section through the upper header of an installation similar to that of Fig. 1, provided with a different type of metering port.

The principles of the invention are applied to a cooling device 10 which is specifically adapted for use in air conditioning systems in which a moving body of air is forced to flow through a duct in which the coil is located.

In Figs. 1 and 3, the cooling device 10 is formed of horizontally disposed feed and suction headers 12 and 13, which are organized with individual vertically disposed cooling coils or units 16, 17, 18, 19, 20, 21, 22, and 23. Each unit may be a continuous pipe or fabricated of horizontally disposed tubes 24 connected by

loops 25 to provide a continuous refrigerant passage. The upper ends of the coils, thus formed, are connected to elbows or feed terminals 16a, 17a, 18a, 19a, 20a, 21a, 22a, 23a, respectively, whose free extremities extend in a vertical direction for insertion through holes 27 in the upper or feed header 12, and they are secured by brazing as indicated by the numeral 30.

As shown in Fig. 2, the feed terminals preferably extend diametrically through the interior of the header and engage the upper portion of the wall. Inasmuch as the positioning of the terminals relative to the axis of the header may be a significant consideration, as hereinafter set forth, it will be obvious that abutting them against the wall of the header serves as a simple and efficient gaging or locating means.

The lower or suction header 13 is formed with holes 28 for receiving elbows or discharge terminals 29, which are secured to the lower extremity of each coil.

Each pair of adjacent coils are provided with common cross fins 31 having aligned holes 32, through which the tubes 24 extend. This lends a unitary structural characteristic to the assembly which is desirable in a cooling device for an air conditioning system. However, it will be understood that the coils may be remote from each other in other systems to be supplied with individual fin structures.

The cooling device is inserted in a refrigerant circuit, which includes a supply conduit 40 having a terminal fitting 33 entering the head 34 of the feed header 12, and a suction conduit 35 communicating with the suction header 13 through a head 36. The supply conduit is provided with a suitable control such as a thermostatic expansion valve 37, which, as well understood in the art, contains a valve 38 which opens or closes an orifice 39 in response to temperature variations in the suction conduit 35, under control of the bulb B. Liquid refrigerant is thus introduced into the header 12 in controlled quantities dependent upon the orifice area of the valve.

In assembly, the device 10 is positioned transversely in an air duct 41 (Fig. 3) so that the fins 29 are parallel to the direction of air flow therein. The air flows across the fins from left to right in Fig. 1, and it has been practically demonstrated that a preferential heat exchange condition is set up in this type of installation, in which the heat transfer from the coils to the air stream progressively diminishes in succeeding coils as the result of loss of air velocity and

the progressive reduction of temperature differential. For example, the first coil 16 in one installation was found to bear over thirty per cent of the total heat transfer load and the remaining coils progressively less to a factor of seven per cent on the last coil 23.

I propose to effect a proportionate feed in a multiple coil system from a common header by providing ports in the portions of the coil feed terminals within the feed header 12. These ports may be formed as axial slits or saw cuts. For example, as shown in Fig. 1, the terminals 16a to 23a inclusive are supplied with slits 16b, 17b, 18b, 19b, 20b, 21b, 22b, and 23b, all of which vary in width in decreasing ratio from the widest slit 16b, and in direct ratio to the previously discussed load factor.

Where a large reserve supply of refrigerant is desired in the header 12, the total area of the slits 16b to 23b, inclusive, is advantageously made substantially equal to the orifice area of the thermostatic valve orifice 39 under full throttle. With this value as a basis, the relative size of the slits may be easily computed; for example, the slit area of the first terminal 16a would be thirty per cent of the area of the valve orifice, as reflected by its load factor, while the slot width of the last terminal would be seven per cent of the orifice area.

It will be obvious, therefore, that under a full throttle valve condition, the header 12 would fill rapidly until the liquid level would approximately reach the top of the terminals, whereupon the level would remain constant as the result of equalization of orifice and slit areas until the valve setting changed. Similarly, under normal supply conditions, where the valve orifice is partially closed, the refrigerant would fill the header to approximately a half way mark, as shown in Fig. 1. In any event, the level varies with the orifice opening, and the slits at any level always feed the correct amount of refrigerant to their respective coils.

Other formations may be substituted for the slits to obtain approximately the same results. For example, the terminals may each be formed with a row of holes 16c, 17c, 18c, 19c, etc., with the total area of each row of holes corresponding to the load factors of their respective coils. It is recommended that holes in the adjacent terminals be positioned in the same plane to prevent irregular relative feed conditions.

As a practical consideration, it is extremely difficult to obtain an absolutely co-planar relation between the bottom of the slits, since slight discrepancies in assembly of units up to ten feet in depth are apt to occur. In installing the unit, slight errors in levelling the feed header may also be made. These errors have caused considerable trouble in prior art structures, as previously discussed, and, while in the present invention similar errors may also occur, it will be observed that the great height of the slits in proportion to their width renders slight errors inconsequential, particularly when the header has a relatively high liquid level.

From the foregoing description, it will be understood that I propose to apply the invention to any multi-coil unit refrigerant system, and therefore the invention is not to be limited to the precise means described, but rather is to be construed in the light of the following claims.

I claim:

1. A refrigerant coil adapted to be disposed in an air duct to effect the cooling of air moving

through said duct, said refrigerant coil comprising an upper header disposed in a substantially horizontal plane, a plurality of rows of pipes depending from said header and having the upper ends thereof disposed within said header in vertical position, said rows being spaced and being adapted to be disposed along said duct in successive cross-sectional planes thereof, said header being formed with means for admitting refrigerant thereto, said pipe ends within said header being formed with apertures, the area of the aperture in one end row of pipe being greater than the area of the aperture in succeeding rows of pipes, the areas of the apertures gradually diminishing from one end of said header to the other.

2. In combination with a refrigerant control valve having a predetermined orifice area under full throttle, a refrigerant coil connected to said valve, said coil comprising a horizontal header disposed at a high point of said coil and a plurality of rows of tubes depending from said coil, the upper end of each row of tubes extending into said header in a vertical direction to a point adjacent the top of said header, each of said ends being formed with an aperture, the total areas of said apertures substantially equalling the area of said orifice, the areas of each aperture being different and being a maximum at one end of the coil and a minimum at the opposite end, the intermediate apertures being progressively proportioned between said maximum and minimum, whereby refrigerant admitted to said header may discharge in progressively varying quantities into all of said tubes in proportion to the area of the aperture therein and said rows may thereby be proportioned to differential load demands.

3. The combination with an air duct having closed sides and open ends and means for moving air through said duct from one of said ends to the other, of a refrigerant coil disposed in said duct, said coil comprising a substantially horizontal header disposed at a high point in said duct, means for admitting refrigerant to said header, and a plurality of separate coil members connected to said header, each of said separate coil members constituting a length of pipe disposed in a cross-sectional plane of said duct, said planes being spaced along said duct whereby air travelling therethrough successively contacts said separate coil members, said separate coil members being bent back and forth to occupy a substantial portion of their respective cross-sectional planes from the top of said duct to the bottom thereof, the ends of said coil members extending into said header to adjacent the top thereof, said ends being formed with apertures to admit refrigerant in said header to said coils, the areas of the apertures in the successive coil ends being progressively less from the coil adjacent the inlet end of the duct to the coil adjacent the outlet end of the duct, whereby the several coils will receive amounts of refrigerant proportioned to the change in the temperature differential between the air and refrigerant as the air moves past said coils.

4. An evaporator for cooling a stream of gas passing therethrough; said evaporator comprising an elongated inlet header and a series of heat exchange devices arranged one behind another with respect to the direction of flow of said gas; each of said devices having an inlet member extending vertically into said header and having an aperture with a predetermined area below the

normal liquid level in said header, said areas progressively decreasing in size in a direction determined by the direction of said flow and being graduated to distribute to the respective devices amounts of refrigerant determined by the relative positions of such devices with respect to each other and to the direction of flow of the gas.

5 5. An evaporator for cooling a stream of gas passing therethrough; said evaporator comprising an elongated inlet header and a series of coils arranged one behind another with respect to the direction of flow of said gas; each of said coils having an inlet member extending vertically into said header and having an aperture with a predetermined area below the normal liquid level in said header, said areas progressively decreasing in size in a direction determined by the direction of said flow and being graduated to distribute to the respective coils amounts of refrigerant determined by the relative positions of such coils with respect to each other and to the direction of flow of the gas.

6. An evaporator for cooling a stream of gas passing therethrough; said evaporator comprising an inlet header and a series of heat exchange devices arranged one behind another with respect to the direction of flow of said gas; each of said devices having an inlet member extending into said header to a point above the normal liquid level therein and having aperture means with a predetermined area below the normal liquid level in said header, said areas varying in size and being graduated to distribute to the respective devices amounts of refrigerant determined by the relative positions of such devices with respect to each other and to the direction of flow of the gas.

7. An evaporator for cooling a stream of gas passing therethrough, said evaporator comprising an inlet header and a series of heat exchange devices adapted to be contacted by said stream of gas, each of said devices having an inlet member extending into said header, each of said inlet members having formed therein an aperture below the normal liquid level in said header, the areas of said apertures of the different inlet members varying in size and being graduated to

distribute to the respective devices amounts of refrigerant determined by the heat loads on said respective devices.

8. An evaporator for cooling a stream of gas passing therethrough, said evaporator comprising an inlet header and a series of coils adapted to be contacted by said stream of gas, each of said coils having an inlet member extending into said header, each of said inlet members having formed therein below the normal liquid level in said header aperture means with a predetermined area, said areas of the different inlet members varying in size in accordance with the heat loads on the respective coils served thereby.

9. An evaporator for cooling a stream of gas, said evaporator comprising an inlet header and a series of heat exchange devices adapted to be contacted by said stream of gas, each of said devices having an inlet member extending into said header, each of said inlet members having formed therein an aperture below the normal liquid level in said header, the areas of said apertures of the different inlet members varying in size and being graduated to distribute to the respective devices amounts of refrigerant determined by the heat loads on said respective devices, each of said inlet members having means for providing communication between the interior thereof and the interior of said header above the normal liquid level in said header.

10. An evaporator for cooling a stream of gas, said evaporator comprising an inlet header and a series of heat exchange devices adapted to be contacted by said stream of gas, each of said heat exchange devices having an inlet member extending into said header, each of said inlet members having formed therein below the normal liquid level in said header aperture means with a predetermined area, said areas of the different inlet members being determined in accordance with the heat loads on the respective heat exchange devices served thereby, each of said inlet members having means for providing communication between the interior thereof and the interior of said header above the normal liquid level in said header.

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