Oct. 15, 1963 C. S. SIMPELAAR 3,106,958

HEAT EXCHANGER

Filed June 6, 1961

FIG. 1

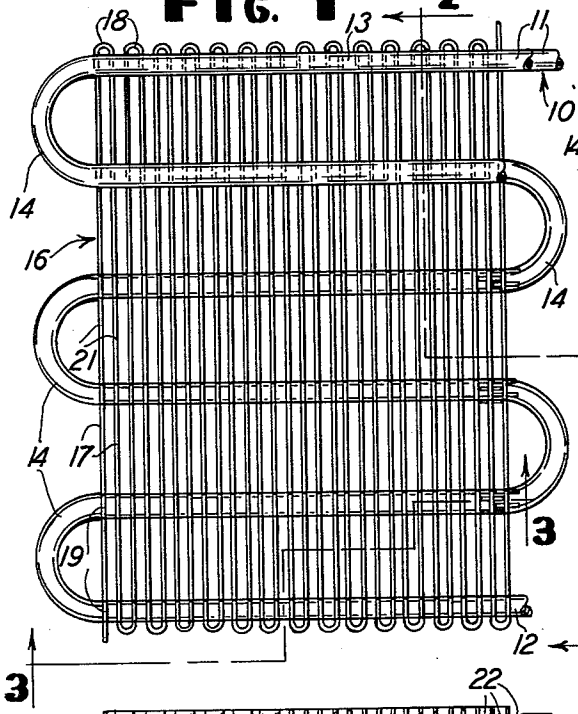
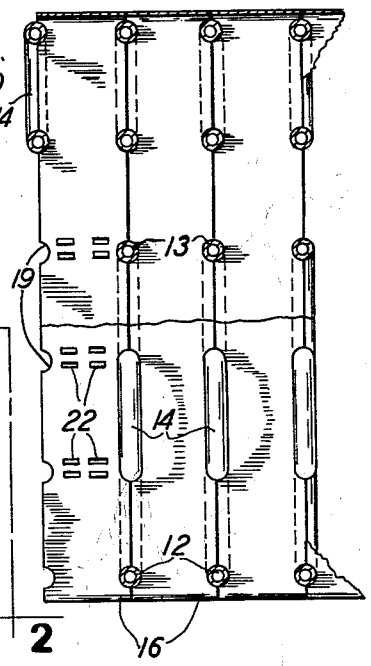


FIG. 2



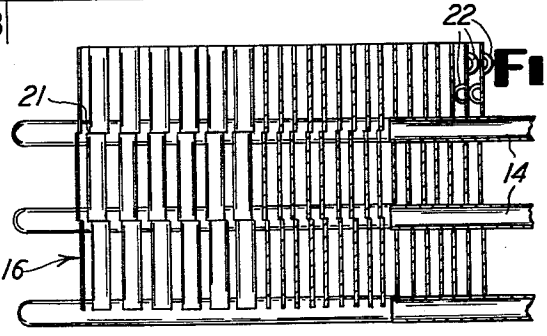
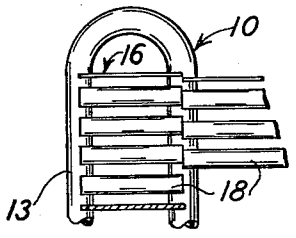


FIG. 3

FIG. 5



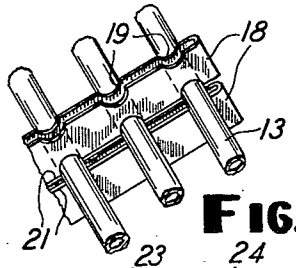
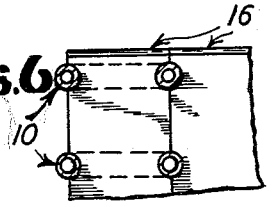


FIG. 4

FIG. 6



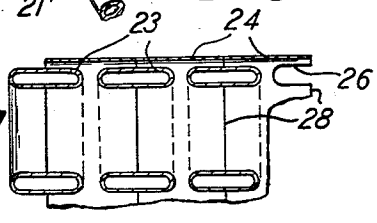


FIG. 7

INVENTOR:
CLYDE SIMPELAAR

BY: Arthur J. Hansmann
ATTORNEY

United States Patent Office 3,106,958 Patented Oct. 15, 1963

3,106,958

HEAT EXCHANGER

Clyde S. Simpelaar, Racine, Wis., assignor to Modine Manufacturing Company, Racine, Wis., a corporation of Wisconsin

Filed June 6, 1961, Ser. No. 115,234
5 Claims. (Cl. 165—181)

This invention relates to a heat exchanger, and more particularly it relates to a fin and tube type of exchanger which is especially useful as an evaporator in an air conditioning system or the like.

It is a general object of this invention to provide a fin and tube type of heat exchanger which is an improvement over those heretofore known, and which retains the desirable features of those heretofore known while utilizing tubes in continuous serpentine form but without joints along the tubes or connectors thereon.

Another object of this invention is to provide an exchanger of the type mentioned for use in evaporators where condensate is formed on the fins, and the purpose is to provide for easy drainage of the condensate off the fins by providing a capillary path for the drainage of the condensate. In accomplishing this particular object, the exchanger construction is such that collars are not employed on the fins around the tubes, and therefore the attending resistance to heat flow and drainage is not present as it is in the prior art constructions, and the fins are offset to each other.

Still another object of this invention is to provide a tube and fin type heat exchanger which can be both readily and inexpensively manufactured and assembled, but with a maximum of efficiency in the exchanger operation. In accomplishing this particular object, the structure permits tight fitting of fins to tubes by the employment of only simple clamping means for the bonding process, and it does not require separate expanding of the tubes, nor does it require elaborate insertion of tubes into pierced or punched fins and thus does not have the attending galling effect on the tubes in the assembly process, and still further, it does not require the close tolerances for the parts, as required by the prior exchangers.

Another object of this invention is to provide a fin and tube type exchanger wherein the fins and tubes can be easily and readily assembled and mated for providing a tight joint therebetween, but with the requirement of only an inexpensive fin and tube and the application of a simple assembly and clamping process and fixture.

Still another important object of this invention is to provide a fin and tube type heat exchanger which utilizes only a minimum number of parts, so the exchanger of course is inexpensive and has a maximum efficiency. In accomplishing this object and in constructing the exchanger, only five or seven parts are required for the entire exchanger core consisting of several serpentine lengths of tube and all of the intervening and flanking fins, and this number of parts is considerably less than the number required in most of the prior art exchangers wherein sometimes one hundred or even two hundred individual pieces are required in the capacity of an exchanger referred to herein.

Still another object of this invention is to provide a heat exchanger which can be made in any desired capacity by simply selecting the shape and length of the tube and the corresponding shape and length of the fin and no elaborate design of the exchanger is required for the selected capacity. Thus the same tooling can easily provide a wide variety of structures with varying capacity, and simplicity of assembly also lends the structure to automation in the manufacturing thereof.

Other objects and advantages will become apparent

upon reading the following description in light of the accompanying drawings wherein:

FIG. 1 is a front elevational view of a heat exchanger core made according to a preferred construction of this invention and having parts thereof fragmentarily shown.

FIG. 2 is a sectional view taken on the line 2—2 of FIG. 1.

FIG. 3 is a sectional view taken on the line 3—3 of FIG. 1.

FIG. 4 is a perspective view of a fragment of the fin and tube construction shown.

FIG. 5 is a front elevational view of another embodiment of the invention shown in FIG. 1 and of course showing only a front segment of the core thereof, slightly enlarged.

FIG. 6 is an end elevational view of the embodiment shown in FIG. 5.

FIG. 7 is a sectional view similar to FIG. 2 but showing still another embodiment of the invention.

The drawings show a plurality of serpentine-shaped tubes generally designated 10 and FIG. 1 shows the tubes to be formed of a desired cross-sectional shape and to extend from one end 11 to the opposite end 12 through six passes of straight and parallel sections 13 which are interconnected by return or curved bends designated 14. It will thus here be noted that several straight passes 13 are formed in the continuous length of the tubes 10, and FIGS. 2 and 3 along with FIG. 1 show that a plurality of such formed tubes 10 can be utilized and stacked according to the capacity of exchanger desired. It will of course further be noted that the tubes 10 are continuous and are not provided with elbows or separately pieced joints at the bends 14, but instead these sections or bends 14 are of course of the continuous part of the tubes 10. Further, the tubes 10, in this particular instance, are shown to be circular in cross section, and it will of course be understood that they could be of the extruded type which is provided with interior fins for the purposes understood in the art.

It will of course also be understood that the usual connectors or header are provided for the tube ends 11 and 12 in the well-known manner of introducing and exhausting the liquid through the liquid tube lines 10, but in this instance, the headers are not shown since they form no particular part of this invention and it is believed that the drawing and explanation is more succinct with the showing of the exchanger core which does not include the headers in this instance.

The drawings further show the fins 16 which are also shown to be formed into a serpentine shape from a continuous and flat sheet to be disposed in straight and parallel lengths 17 with return bends 18 provided therein so that one continuous piece of thin material of the desired thin gauge can be formed into the serpentine shape shown in FIG. 1 and placed over the tubes 10 as shown. It will also be noted that the fins 16 have notches 19 formed therein for snug or nesting relation with the tube sections 13 as shown. Of course the notches 19 are spaced along the fin lengths 17 and they are shown to be semicircular in the embodiment disclosed so that they nest with the tubes 10, and the notch shape and dimension can be the same as the shape and semicircular dimension of the tubes 10. Also, it will be readily understood that the notches 19 could be of either a slightly larger or slightly smaller semi-circular dimension than that of the tubes 10 and in either instance, the snug relation between the notched fins and the tubes would be accomplished. That is, if the radii of the notches 19 are slightly larger than that of the tubes 10, then in the bonding process, the bonding material would simply flow in the spaces therebetween and fill the spaces as the edges of the notches provide for the capillary action on the bonding material

to fill the spaces between the edges of the notches and the tube circumference as mentioned. Also, if the radii of the notches be less than that of the tubes **10**, then simple compresion of the fins against the tubes will result in a substantially snug fit and again the capillary action can be utilized for filling the space at the base of the notches and extending to the circumference of the tubes.

It will thus be understood that by the provision of only the two standard pieces, namely the serpentine tube **10** and the serpentine fins **16**, the entire exchanger can be built up by selecting the quantity of each of the two parts mentioned. Further, the assembly can be readily achieved as the fins are disposed between the tubes **10**, and the notches **19** automatically align the fins and tubes as desired. No additional means is required to hold the fins in transverse position on the tubes since the serpentine-shaped fin is self-supporting.

Still further, as shown in FIG. 3, the fins **16** can be placed in a random or arbitrary placing on the tubes **10** so that the upper extent of the fins as shown in FIG. 3 is in one lateral position while the fins **16** therebelow are in a position slightly to the left of the upper one and this provides for the desired guidance of condensate drainage. It will thus be understood that condensate forming on the fins **16** will flow therealong down any of the edges of the fins and if the condensate be flowing in a downward direction with respect to the position shown in FIG. 3, it can readily accumulate on the staggered fin edges designated **21** and this of course permits for a greater drainage when the condensate accumulates to the largest quantity available.

It will further be noted that projections or dimples **22** are provided in the fins **16** and are approximately aligned with the notches **19**, but are shown to be slightly offset therefrom so that, upon mating with the adjacent extent **17** of the fins, the projections **22** serve as spacers between the fin section **17** to hold them apart as desired. Thus it will be seen that the projections **22** are staggered on opposite sides of the fins so that they will be related as shown between FIGS. 1, 2, and 3 for the desired purpose of fully spacing the fins apart in the areas of the tubes **10**. Also, the spacing of the fin portions **17** is less than the diameter of the tubes **10** so the ratio is such that a plurality of fin portions **17** exist in the length of the diameter along the tubes to give a close and efficient fin spacing.

FIG. 5 shows a modification of the construction and here it will be noted that the tubes **10** are disposed in one plane with the sections **13** and the fins **16** are disposed in a plane different from that shown in the first embodiment, however the fins **16** of course have the notches **19** as described and are of the serpentine shape shown and also have the projections or spacers **22** as described.

In both embodiments, the fins and tubes are related such that the planular or intermediate lengths of each are disposed perpendicular to each other such that the notches **19** in the fins **16** readily align with and receive the tube sections **13**. Also, in both embodiments, the fins **16** are of a random or arbitrary spacing so that their edges **21** do not necessarily align and therefore the condensate can drain along the edges **21** and particularly in the locations of the returns **18**, the condensate cannot collect since the adjacent returns are offset from each other and the condensate can therefore pass between the returns **18** at the edges **21**.

Still another embodiment is shown in FIG. 7, and here the tubes **23** are of an oval cross-sectional shape and the fins **24** have notches or recesses **26** to conform to that shape on each half of the tubes **23**. It will be obvious to one skilled in the art that the tubes **23** are otherwise serpentined and disposed like tubes **10** in FIGS. 1 and 2, and FIG. 7 is a section like FIG. 2 on FIG. 1. Of course still different shapes of tubes and notches could be employed, and it is preferred that the fin notches be of a depth so that the fin free edges **21** and **27** extend slightly short of the median plane of the tubes so that the fin nests with the tube and will not abut the opposite fin to prevent the desired snug nesting. Thus, the longest dimension of the fin notch is slightly less than one-half the longest dimension of the cross-section of the tube.

While specific embodiments of this invention have been shown and described, it will be understood that certain changes could be made therein, and the invention therefore should be limited only by the scope of the appended claims.

What is claimed is:

1. An evaporator core for an air conditioner comprising a plurality of serpentine-shaped tubes for containment of fluid and with each one of said tubes including spaced-apart and parallel lengths and a cross-section of a predetermined shape and with all of said tubes disposed in separate and parallel planes, a plurality of serpentine-shaped fins including parallel planular portion with the latter said portions of each respective one of said fins extending across and on opposite sides of all of said parallel lengths of each respective one of said tubes and including oppositely disposed edges, said fins having notches disposed in only said edges and in only the planes in which said planular portions are disposed and said notches being of a shape to conform to one-half of said predetermined shape and being in abutment with said lengths, said fins being on planes disposed perpendicular to the axes of said parallel lengths, said fins being offset with respect to each other on said opposite sides of said parallel lengths and with respect to the planes of said planular portions to be non-aligned between said opposite sides for condensate drainage and fluid turbulence, and said fins having projections integrally existing in said fins for presenting spacers on said fins and extending therebetween for limiting the transverse poistion of said planular portions of said fins relative to each other.

2. A heat exchanger core comprising a plurality of tubes each being of a serpentine-shape and of one continuous length and devoid of connectors and having parallel and spaced-apart lengths and with said tubes being disposed in separate and parallel planes, and a plurality of fins each being of a serpentine shape and of one continuous length disposed between each two said parallel planes of said tubes and each one of said fins having planular portions extending across and perpendicular to all of said lengths of each respective one of said tubes and extending between each two adjacent said tubes in a free edge substantially on the medium plane of one of said lengths to a free edge substantially on the median plane of an adjacent one of said lengths, said fins having notches thereon existing in only said free edges and in only the planes in which said planular portions are disposed and with each of said notches nesting with one-half the cross-sectional shape of said lengths, said tubes and said fins being thermally bonded together at said notches.

3. A heat exchanger core of only tubes and fins for easy assembly, comprising a plurality of serpentine-shaped tubes disposed in spaced-apart separate and parallel planes for containment of fluid and including spaced-apart and parallel lengths, and a continuous length of a serpentine-shaped fin disposed intermediate each two of said tube planes and each one of said fins including parallel planular portions respectively extending across all said parallel lengths of each respective one of said tubes, said parallel planular portions having edges in abutment with said lengths and being on planes disposed perpendicular to the axes of said parallel lengths, each one of said fins having notches in only said edges and in only the planes in which said planular portions are disposed for nesting with said tubes, said planular portions having dimples spaced from said edges integral and extending from said planular portions a distance less than the cross-sectional dimension of said tubes and with said planular portions being spaced apart said distance, said tubes and fins being thermally bonded together

4. A heat exchanger core comprising a plurality of serpentine-shaped tubes for containment of fluid and including spaced-apart and parallel lengths and a cross-section of a predetermined shape, a plurality of serpentine-shaped fins with each one thereof including parallel planular portions respectively extending across all said parallel lengths of each respective one of said tubes and with said fins having notches in only the planes in which said planular portions are disposed and with said notches having a shape to conform to one-half of said predetermined shape and being in abutment with said parallel lengths of said tubes and with said planular portions of said fins being on planes disposed perpendicular to the axes of said parallel lengths, said fins being offset with respect to each other on opposite sides of said parallel lengths and with respect to the planes of said planular portions to be non-aligned between opposite sides of said parallel lengths, and said fins having projections integrally existing in said fins for presenting spacers on said fins and extending therebetween for limiting the transverse position of said planular portions of said fins relative to each other, said tubes and said fins comprising the complete exchanger core and being bonded together at said notches.

5. A heat exchanger core comprising a plurality of serpentine-shaped tubes for containment of fluid and including spaced-apart and parallel lengths and a cross-

section of a predetermined shape, a plurality of serpentine-shaped fins with each one thereof including planular portions respectively extending across all said parallel lengths of each respective one of said tubes and with said fins having notches in only the planes in which said planular portions are disposed and with said notches having a shape to conform to one-half of said predetermined shape and being in abutment with said parallel lengths of said tubes and with said planular portions of said fins being on planes disposed perpendicular to the axes of said parallel lengths, said fins being offset with respect to each other on opposite sides of said parallel lengths and with respect to the planes of said planular portions to be non-aligned between opposite sides of said parallel lengths, said tubes and said fins comprising the complete exchanger core and being bonded together at said notches.

References Cited in the file of this patent

UNITED STATES PATENTS

1,943,557	Ruthenburg et al.	Jan. 16, 1934
2,119,761	Wentworth	June 7, 1938
2,400,157	Merry	May 14, 1946
2,428,145	Cook	Sept. 30, 1947
3,045,979	Huggins et al.	July 24, 1962