Aug. 10, 1965 R. W. KRITZER 3,199,581

FIN-TYPE HEAT EXCHANGE UNIT WITH NON-REGISTERING FIN EDGES FOR FROST-INHIBITING PURPOSES

Filed Jan. 11, 1961 2 Sheets-Sheet 1

Fig. 2

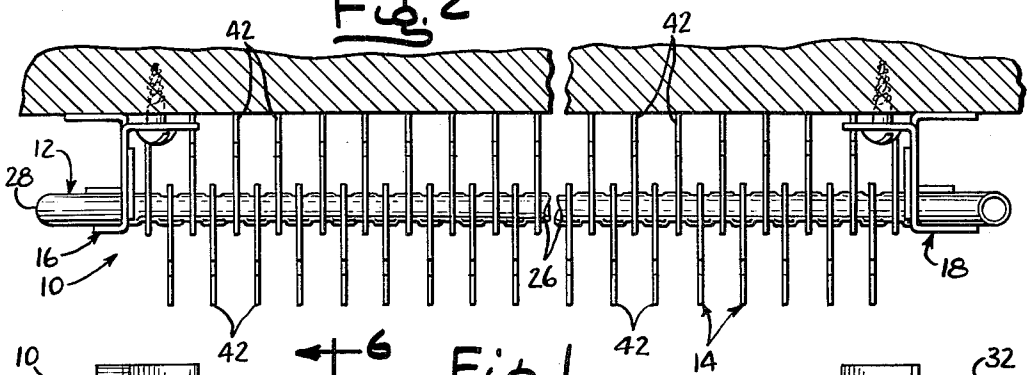


Fig. 1

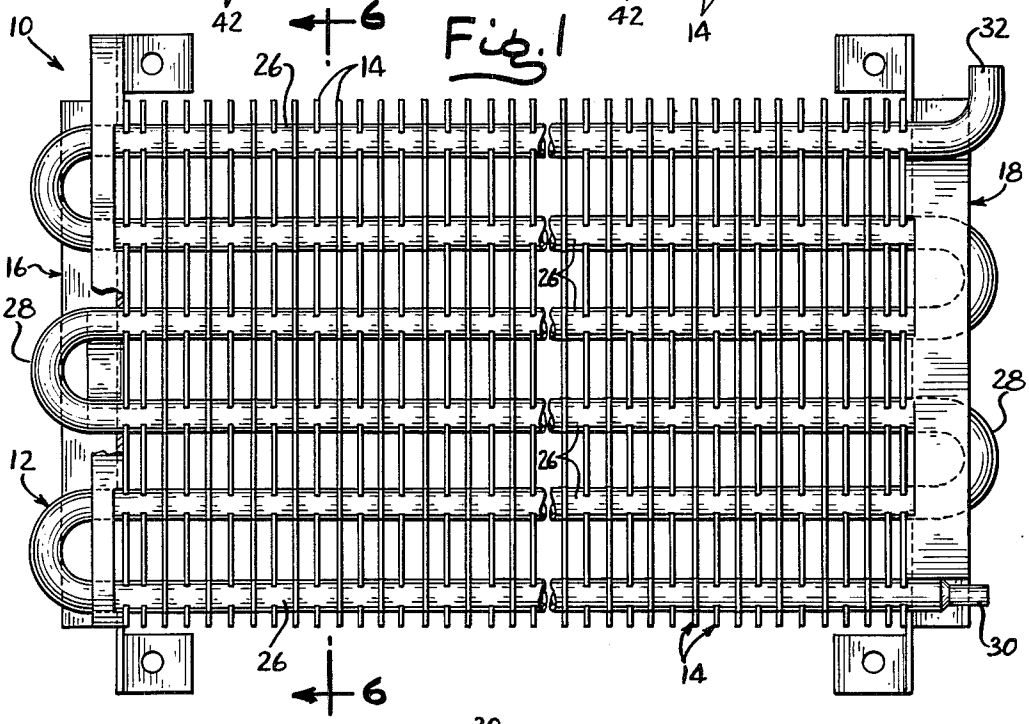
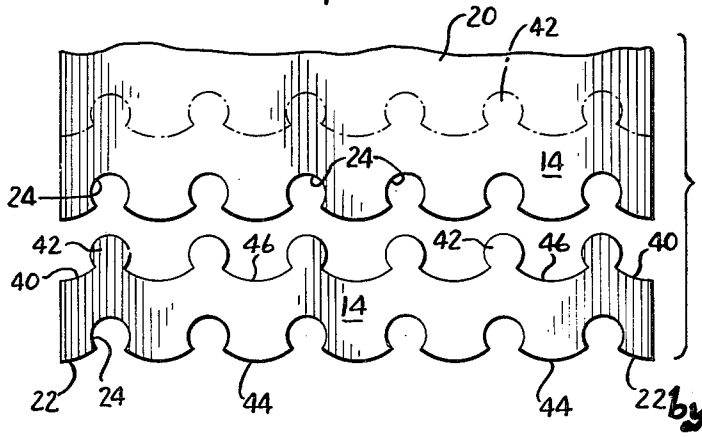


Fig. 3



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Filed Jan. 11, 1961 2 Sheets-Sheet 2

Fig. 4

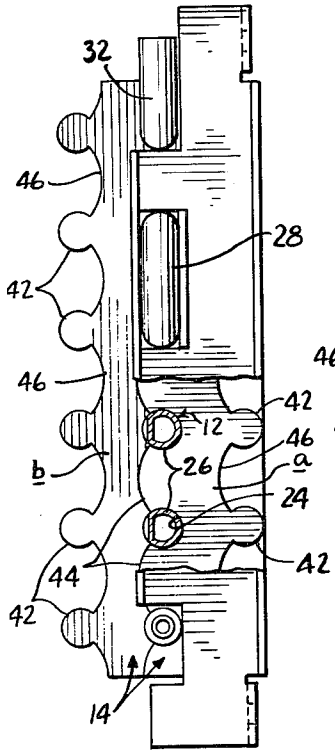


Fig. 5

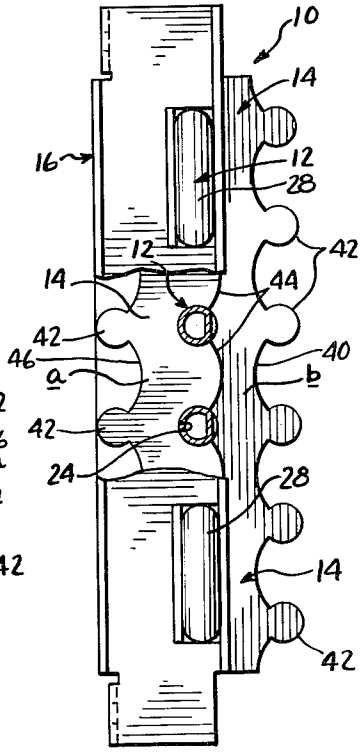


Fig. 6

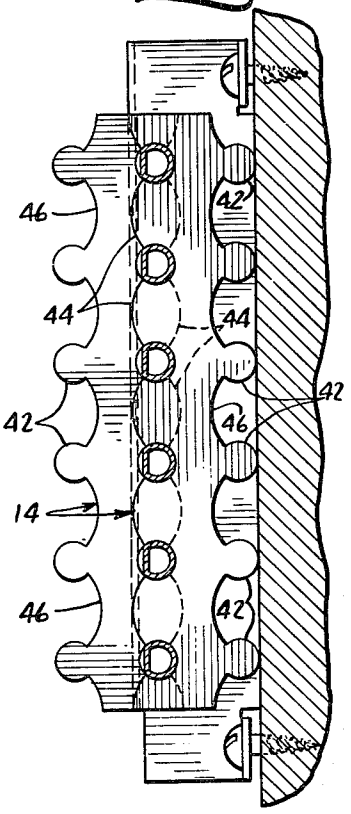


Fig. 7

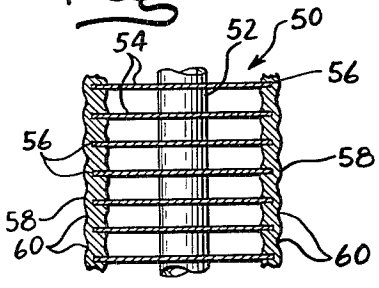
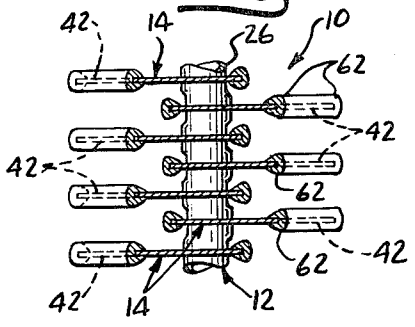


Fig. 8



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3,199,581

FIN-TYPE HEAT EXCHANGE UNIT WITH NON-REGISTERING FIN EDGES FOR FROST-INHIBITING PURPOSES

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2 Claims. (Cl. 165—67)

The present invention relates to heat exchange units and has particular reference to units of the type wherein serpentime lengths of tube stock having straight reach sections are pressed into substantially circular notches in certain edge regions of a plurality of laterally spaced strips of flat fin stock. In my co-pending United States patent application Serial No. 241,906, filed on December 3, 1962 and entitled "Heat Exchange Units" (such application being a continuation of now abandoned application Serial No. 6,782, filed on November 2, 1960), there is disclosed a heat exchange unit of the same general type as that with which the present invention is concerned. The heat exchange unit of the present invention is designed as an improvement upon the heat exchange unit of said co-pending application in that it presents functional advantages which are not present in the earlier unit.

A heat exchange unit of the type to which the present invention relates consists of a length of serpentine tube stock having spaced apart, straight reach sections and curved or arcuate end sections at ends of the straight reach sections. Closely spaced, elongated, parallel strips of flat fin stock are secured to and extend transversely of the straight reach sections. In fabricating a heat exchange unit of the type under consideration, the straight reach sections which are originally of circular cross section are laterally compressed or flattened so as to make them of oval cross section. This operation is performed before the serpentine tube stock and the fin stock strips are brought into assembled relation. After the compressing or flattening operation the strips of fin stock are arranged in series form and proper position and the serpentine tube stock in manipulated so as to effect insertion of the laterally compressed or flattened straight reach sections into the substantially circular notches in the edge regions of the strips. Thereafter the straight reach sections of the tube stock are subjected to pressure in the direction of oval elongation so as to expand them back to circular cross section to the end that they will engage frictionally the notch defining portions of the strips and thus become interlocked with the strips of fin stock. In order to conserve fin stock and prevent waste, the individual strips of fin stock are severed from a large sheet of flat metal stock by progressive shearing operations wherein identical fin-forming strips are created or formed. The successive shearing operations are performed by a single pair of shearing dies which effect one shearing stroke for each strip of fin stock severed. The shearing dies are so designed that the metal which is severed from the confines of the various substantially circular notches along one longitudinal edge of each strip of fin stock remains attached in the form of tabs or ears to the non-corresponding opposite longitudinal edge of the strip of fin stock next-to-be-severed from the large sheet at the next stroke of the shearing dies. Each resultant elongated strip of fin stock emerges from the shearing process or operation somewhat in the form of a conventional jig-saw puzzle piece having plural spaced, substantially circular tabs or ears along one edge thereof and plural spaced, substantially circular notches along the other or opposite edge thereof. In this manner, there is no loss of metal whatsoever involved in the process of forming the strips of fin stock, while, in the finished heat

exchange unit, the attached ears on each strip of fin stock may be put to numerous advantageous uses wherein they serve as bracing, rigidifying strengthening or reinforcing members, as desired, or as attachment means for the unit as a whole, while at the same time the tabs serve materially to increase the heat-radiating capacity of the unit as compared to a conventional heat exchange unit the fin-forming strips of which are formed from the same quantity by weight of sheet metal stock. When the thus severed identical strips of fin stock are assembled in closely spaced relationship upon the straight reach sections of the serpentine tubing in the manner previously described, the individual strips are identically oriented in the unit so that the edges of adjacent strips around the entire perimeters thereof are in close proximity to each other. This proximity of corresponding edges has a deleterious effect upon the overall heat-exchange efficiency of the unit for reasons that will now be fully set forth.

It is a well established principle of thermodynamics that the heat-radiating ability of a given shape of flat fin stock depends largely upon the linear extent of any exposed edge or edges associated with such shape. Generally speaking, the greater the linear extent of a given edge associated with such shape, the greater will be the heat-radiating capacity of the shape. Conversely the greater the linear extent of the edge, the greater will be the heat-assimilating capacity when the heat exchange unit with which the fin stock is associated is employed for cooling purposes. In the heat exchange unit of my copending application, as well as in connection with a wide variety of other heat exchange units employing tubing and fin stock where a saving in the quantity of fin stock employed for its manufacture is not a consideration, the close proximity of the edges of adjacent strips of the fin stock is conductive toward frosting in the regions of such proximity. It has been found that in such instances frost will collect on these closely positioned edges and will progressively build up thereon to a point where the deposits on adjacent edges will touch or meet each other and establish an ice bridge across the edges. Thereafter the build-up is rapid and ultimately results in a substantial clogging of the air passages between adjacent strips of fin stock so that a complete defrosting of the unit must be resorted to before the thermal efficiency of the same can be restored. This condition is particularly prevalent in connection with a heat exchange unit such as has been shown in my afore-mentioned copending application due to the very materially increased edge areas offered by the adjacent or oppositely disposed tabs.

The present invention is designed to overcome the above-noted limitations that are attendant upon the construction and use of conventional heat exchange units utilizing tube and fin stock and, toward this end, it contemplates the provision of a heat exchange unit including a length of serpentine tube stock having closely spaced, parallel strips of fin stock applied thereto and wherein the fin stock strips are so disposed along the tubing and are so shaped that the marginal edges of adjacent strips of fin stock remain widely separated or offset from each other to the end that the heat-absorption properties or characteristics of these edges are individually isolated as well as physically separated. By such an arrangement there is little opportunity for frost or ice deposits to build up to such an extent that they will form ice bridges across adjacent strips of fin stock as previously described.

Another object of the invention is to provide a heat exchange unit of the aforementioned type or character and wherein the strips of fin stock, despite the fact that they are identical in size and configuration, are so mounted on the tube stock that wide separation of the

edges of adjacent strips of the fin stock obtains at substantially all points around the perimeters of the adjacent strips.

With these and other objects in view, which will become more readily apparent as the nature of the invention is better understood, the invention consists in the novel construction, combination and arrangement of parts that are shown in the accompanying two sheets of drawings forming a part of this specification.

In these drawings:

FIG. 1 is a rear elevational view of a heat exchange unit constructed in accordance with the principles of the present invention;

FIG. 2 is a top plan view of the unit of FIG. 1;

FIG. 3 is a plan view, schematic in its representation, illustrating the manner in which the various identical strips of fin stock are severed from a large flat metal sheet;

FIG. 4 is an end view of the heat exchange unit of FIGS. 1 and 2;

FIG. 5 is an opposite end view of the unit shown in FIG. 4;

FIG. 6 is a sectional view on the line 6—6 of FIG. 1;

FIG. 7 is a fragmentary detail sectional view of a portion of a conventional heat exchange unit having cooling fins the edges of which are in close proximity to one another and illustrating schematically the manner in which frost deposits create an ice barrier to the flow of air between adjacent strips of fin stock; and

FIG. 8 is a fragmentary sectional view similar to FIG. 7 but showing a portion of the present improved heat exchange unit and illustrating schematically how wide edge separation among the strips or cooling fins will prevent the creation of an ice barrier.

Referring now to the drawings in detail, and in particular to FIGS. 1, 2, and 4 to 6 inclusive, one form of heat exchange unit embodying the principles of the present invention has been shown in these views and designated in its entirety at **10**. Briefly, the unit consists of a single length of tubing **12** which has been bent to serpentine form and to which there has been applied a series of closely spaced parallel elongated strips **14** of preformed fin stock. Such strips establish a series of cooling fins which extend across and bridge the straight reach sections of the serpentine tube stock. The assembled tube and fin structure constitutes a basic heat exchange assembly which may be operatively installed or mounted in a wide variety of installations by means of suitable supporting framework, as for example, by specially shaped mounting brackets **16** and **18** which fit over the reverse bends or arcuate end sections at the ends of the straight reach sections of the serpentine tubing **12**. The mounting brackets **16** and **18**, in combination with the various formed strips **14** of fin stock, serve to rigidify the serpentine tubing and the latter similarly lends rigidity to the strips of fin stock so that a compact and fairly rigid heat exchange unit or assembly results.

The method of forming the strips **14** of the fin stock and attaching them to the serpentine length of tubing **12** is similar to the method which is shown and described in United States Patent No. 2,913,806, granted on November 24, 1959, and entitled "Fabrication of Heat Transfer Units," and reference may be had to such patent for a detailed description of the method. It is deemed sufficient for purposes of disclosure herein to state that each strip **14** is severed, as shown in FIG. 3, from a large sheet or web **20** of flat sheet metal, preferably aluminum, and is so shaped as to provide one longitudinal or front edge **22** which is interrupted at spaced regions therealong by arcuate notches **24**. The latter constitute major circle sectors which are slightly greater in extent than 180°. The length of tubing **12** includes, as hereinbefore indicated, a series of straight reach sections **26** (see FIG. 2) and reverse bends or arcuate sections **28** at the ends of the straight reach sections. The free ends **30** and **32** of the

tubing **12** terminate at the same end of the unit **10**, the end **30** being coaxial with one of the straight reach sections **26** and the end **32** being turned laterally. Obviously, where the serpentine tubing possesses an even number of straight reach sections **26**, the ends thereof will terminate at the same end region of the unit **10**, and where an odd number of such reach sections are provided, the ends **30** and **32** will terminate at opposite end regions of the unit.

As described in aforementioned Patent No. 2,913,806, prior to their association with the strips of fin stock, the straight reach sections **26** of the tubing **12** are oval or elliptical in cross section and the major axes of the ellipses are slightly less than the entrance openings of each notch **24**. The various strips of preformed fin stock are confined between adjacent spacer strips in slightly spaced parallel relationship with the various notches **24** arranged in straight rows. The straight reach sections **26** are caused to enter the notches of the various rows and thereafter, by means of a suitable pressing platen, the straight reach sections of oval cross section are forced against the bottom of the notches and are caused to expand into intimate contact with the edges of the notches **24** so as to fill the same as shown in FIGS. 4, 5 and 6. In this manner the strips **14** of fin stock are frictionally bonded to the reach sections of the tubing **12** in intimate heat-exchange relationship.

As clearly shown in FIG. 3 of the drawings, each strip **14** of fin stock, in addition to its notched front edge **22**, has an opposite rear longitudinal edge **40** which is interrupted at spaced regions by the provision of a series of tabs or ears **42** which conform in size and configuration to the various notches **24**. The ears **42** are thus also in the form of major circle sectors and each ear is aligned transversely of the strip **14** with one of the notches **24**. In between each adjacent pair of notches **24**, the edge **22** is formed with an outwardly bowed curved edge section **44** while in between each adjacent pair of ears **42**, the edge **40** is formed with an inwardly bowed curved edge section **46**. The curvature of the edge sections **44** and **46** is identical so that the two longitudinal edges **22** and **40**, considered in their entirety, are identical in line contour while the oppositely facing edge regions defined thereby are complementary and thus capable of being created by successive severing operations of the same shearing die.

Whereas in my copending application, above referred to, the successively severed strips are installed on the straight reach sections of the serpentine tubing with the notches of each strip facing in the same direction and with the tabs or ears of each strip facing in the opposite direction, in the present heat exchange unit alternate strips **14** form one series of fins, are similarly oriented and have their notches encompassing the straight reach sections **26** of the tubing **12** while the other fin-forming strips form another series, are reversed in direction relatively to the first series and also have their notches encompassing the straight reach sections. This alternate arrangement of the strips **14** and the deviation of the intervening portions **44** and **46** of the edges **22** and **40** from straight line edges result in the provision of a heat exchange unit which is less likely to support the building up of frost in any region thereof and which, therefore, is less susceptible to clogging. These two features, namely fin strip orientation and fin strip contour, constitute the principal features of the present invention.

In FIG. 7 of the drawings hereof there has been illustrated a fragmentary section of a conventional heat exchange unit **50** having a length of tubing **52** and a series of fins **54** mounted thereon. The fins **54** have edges **56** which are disposed in close proximity to one another. It has previously been stated herein that the edge regions of any given strip of fin stock are appreciably more thermally effective than is the flat medial region thereof both as regards its heat radiating and heat collecting functions. It follows, therefore, that when two edges, such as the

edges 56, are disposed in close proximity to each other, a localized cold region is established in the immediate vicinity of these edges which is subject to increased moisture condensation and consequent ice formation. Additionally, because of their close proximity, there is likelihood that a sufficient amount of ice may collect on the fins in the vicinity of these edges to establish an ice bridge between the two edges. An example of a progressive build-up of ice deposits has been schematically illustrated at 58 in FIG. 7, and the establishing of an ice bridge has been shown at 60. Such a bridge prevents the free flow of air through the interstices between fins and greatly reduces the efficiency of the heat exchange unit as a whole.

In FIG. 8 of the drawings a short section of the heat exchange unit 10 of the present invention has been shown and it is to be observed that because of the fact that the edge regions of adjacent strips of fin stock are widely spaced from each other at substantially all regions along the longitudinal edges thereof, small ice deposits such as have been shown at 62 have little effect on the flow of air between the fin stock strips. This wide edge spacing may best be visualized by reference to FIGS. 4, 5 and 6. In FIG. 4, for example, it may be seen that the strip 14 labelled *a* presents no edge region along its longitudinal edge 40 which is close to an edge region on the longitudinal edge 22 of the adjacent strip labelled *b*, nor does the strip labelled *b* have an edge region along its longitudinal edge 40 adjacent an edge region along the longitudinal edge 22 of the strip labelled *a*. This condition of widely spaced edge regions between adjacent strips 14 obtains throughout the entire heat exchange unit 10.

It should be finally observed that due to the alternate disposition of the various strips 14 of fin stock insofar as their orientation is concerned, the straight reach sections 26 of the serpentine length of tubing 12 may be substantially centrally located within the fin structure where they are most effective as heat-collecting elements.

The invention is not to be limited to the exact arrangement of parts shown in the accompanying drawings or described in this specification as various changes in the details of construction may be resorted to without departing from the spirit of the invention. Therefore, only insofar as the invention has been particularly pointed out in the accompanying claims is the same to be limited.

Having thus described the invention what I claim as new and desire to secure by Letters Patent is:

1. A heat exchange unit comprising in combination a length of tube stock of serpentine configuration and presenting straight parallel reach sections lying in a common plane and connected together at their ends by reverse bends, and a series of closely spaced elongated parallel strips of fin stock secured to and extending transversely between said reach sections at a right angle to said common plane, each strip presenting oppositely facing inside and outside edges respectively, said strips being of identical size and configuration, the inside edges of the strips being formed with circular notches in the form of major circle sectors and within which the reach sections are pressed with a tight fit, the outside edges of the strips being formed with outwardly projecting ears which correspond in size and shape to the size and shape respectively of said circular notches, said notches and ears being in paired transverse alignment across the strips, the inside edges of the strips terminating in the vicinity of said common plane, one set of alternate strips in the series being reversely positioned with respect to the other set of alternate strips whereby the outside eared edges of the two sets lie on opposite sides of said common plane and terminate in respective planes which are parallel to and equally spaced from said common plane, and whereby adjacent eared edges of each set are disposed on strips which are once removed from each other and which are consequently devoid of intervening fin stock material.

2. A heat exchange unit as set forth in claim 1 and wherein the intervening edge regions between adjacent notches of each strip of fin stock are of curved outwardly bowed configuration and wherein the intervening edge regions between adjacent ears of each strip of fin stock are of curved inwardly bowed configuration.

References Cited by the Examiner

UNITED STATES PATENTS

2,038,912	4/36	Summers	165—150
2,092,170	9/37	Kritzer et al.	29—157.3
2,225,760	12/40	Wynn	165—82
2,271,538	2/42	Brace	165—150
2,512,540	6/50	Friedman	165—151

FOREIGN PATENTS

325,485	1/03	France.
633,229	10/27	France.
987,535	4/51	France.

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