Sept. 19, 1939. F. J. SIBLEY 2,173,666

FINNED TUBE CONSTRUCTION

Filed April 20, 1936 3 Sheets-Sheet 1

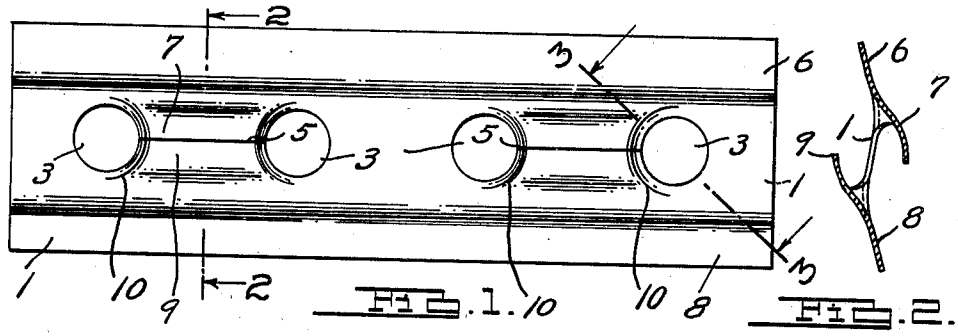


Fig. 1. Fig. 2.

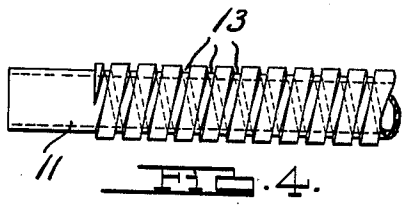


Fig. 4.

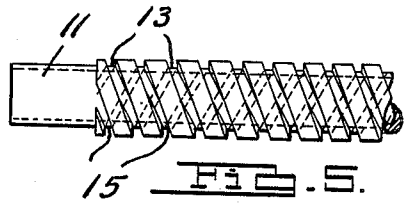


Fig. 5.

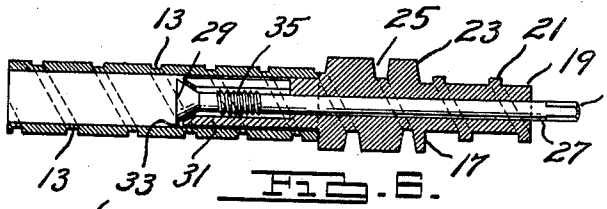


Fig. 6.

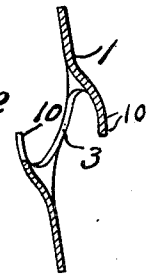


Fig. 3.

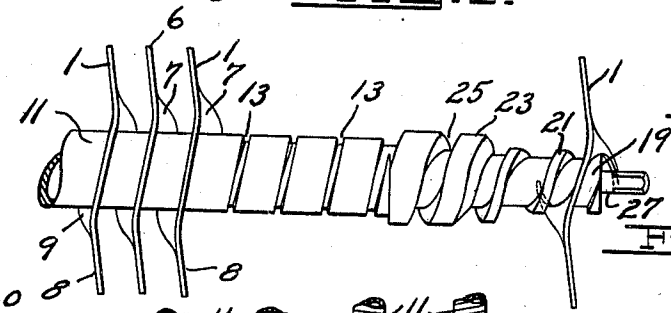


Fig. 7.

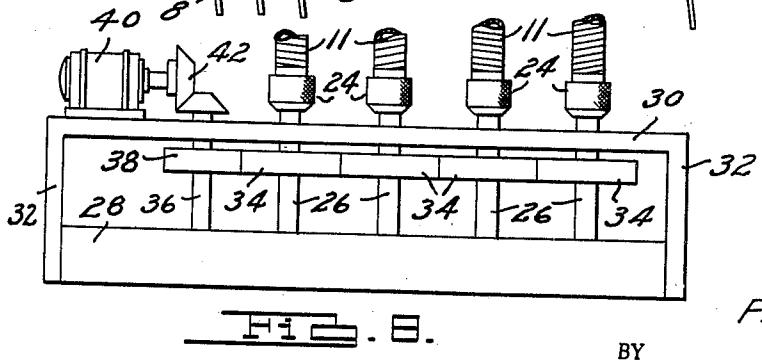


Fig. 8.

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Sept. 19, 1939. F. J. SIBLEY 2,173,666

FINNED TUBE CONSTRUCTION

Filed April 20, 1936 3 Sheets-Sheet 2

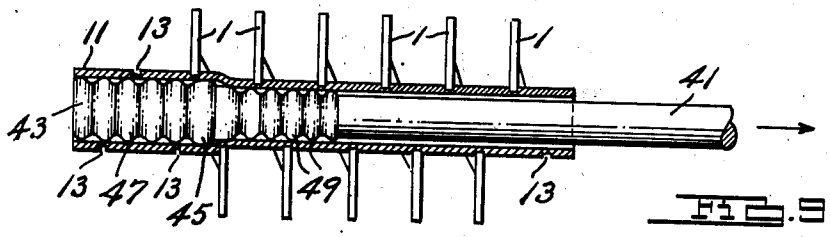


Fig. 9.

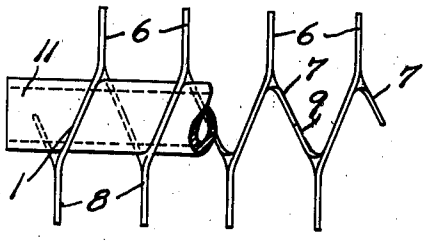


Fig. 10.

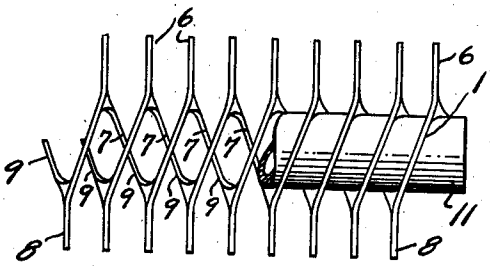


Fig. 11.

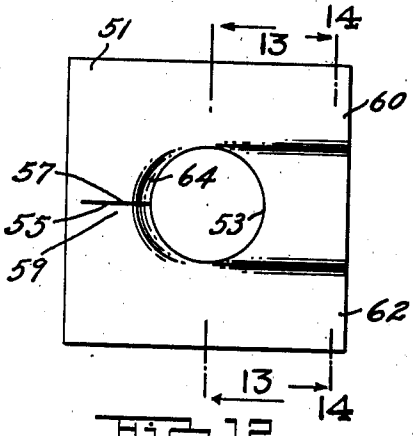


Fig. 12.

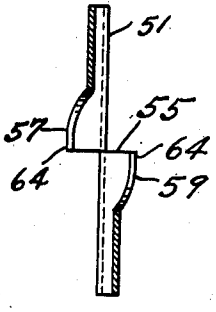


Fig. 13.

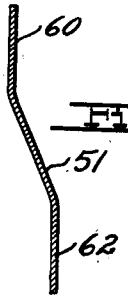


Fig. 14.

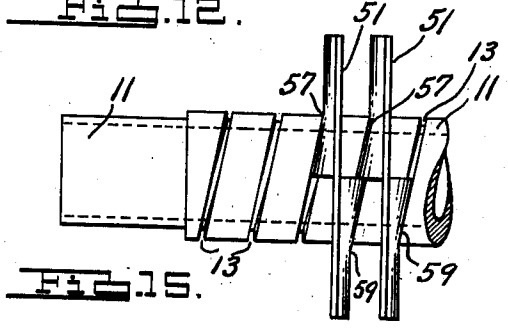


Fig. 15.

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Sept. 19, 1939. F. J. SIBLEY 2,173,666

FINNED TUBE CONSTRUCTION

Filed April 20, 1936 3 Sheets-Sheet 3

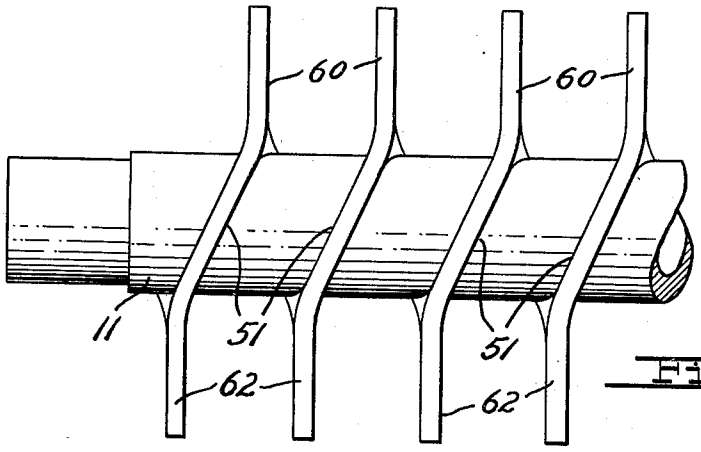


Fig. 16.

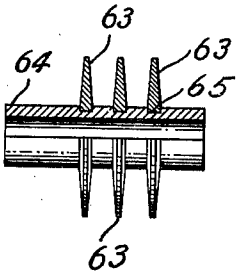


Fig. 17.

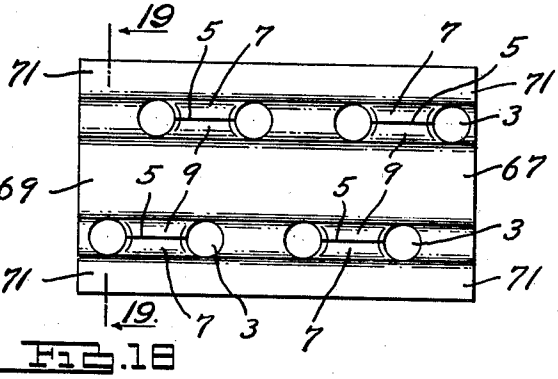


Fig. 18

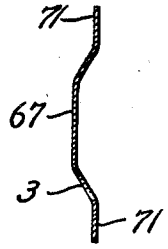
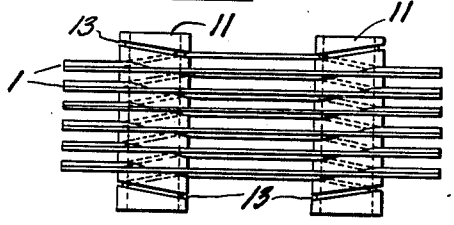


Fig. 19.

Fig. 20.



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Patented Sept. 19, 1939 2,173,666

UNITED STATES PATENT OFFICE

2,173,666

FINNED TUBE CONSTRUCTION

Floyd J. Sibley, Detroit, Mich.

Application April 20, 1936, Serial No. 75,326

3 Claims. (Cl. 257—262)

My invention pertains to an improved finned tube construction and more particularly to heat exchanging devices.

It is an object of my invention to provide an improved finned tube comprising an improved three-sided joint construction for securing the plates in spaced relation upon a tube for heat exchanging and other purposes with greater mechanical strength, and increased thermal efficiency while eliminating the necessity of utilizing auxiliary securing means or material.

Another object of my invention is to provide an improved fin tube construction comprising pairs of thermal conducting tubes each having a groove cut around its outer surface for receiving and securing a set of apertured fin plates, each plate having tabs deformed on opposite sides of the plane of the plate to follow in the groove and abut the tabs on opposite sides.

It is also an object of my invention to provide an improved finned tube assembly for heat exchanging apparatus comprising a tube having a plurality of helical grooves for receiving a plurality of sets of pre-formed fin plates having helical edged apertures in said grooves to provide a plurality of separated sets of plates spaced apart in substantially parallel relation and the plates of each set contacting continuously between the plates and the tube.

The invention itself, however, both as to its construction and as to the method of and apparatus for assembling the same, together with additional objects and advantages thereof, will best be understood from the following description of specific embodiments, when read in conjunction with the accompanying drawings, where like reference characters are applied to similar parts throughout and in which:

Fig. 1 is a side elevational view of a fin plate pierced and cut to provide helical edged apertures for receiving four tubular conduits therethrough;

Figs. 2 and 3 are sectional views on lines 2—2 and 3—3 thereof;

Fig. 4 is a side elevational view of a tube having a helical groove for receiving and securing a set of fin plates thereon;

Fig. 5 is a similar view showing a tube provided with a plurality of spaced helical grooves for securing a plurality of separated sets of mutually engaging fin plates;

Fig. 6 is a longitudinal sectional view showing a grooved tube provided with a leader clamped in the end preparatory to assembling the fin plates thereon;

Fig. 7 is elevation view showing how the fin plates are guided onto the grooved tube;

Fig. 8 is a side elevational view showing a device for rotating a plurality of grooved tubes simultaneously for receiving the fin plates thereon;

Fig. 9 is a longitudinal sectional view showing how the grooved tube is expanded for firmly gripping the assembly fin plates;

Fig. 10 is an elevation view showing the assembly of a set of continuously contacting fin plates clamped upon an expanded tube, a portion of which is broken away to show the contacting plate tabs;

Fig. 11 is a similar view showing a tube provided with a plurality of helical grooves supporting a plurality of continuously contacting sets of fin plates in spaced relation;

Fig. 12 is a side elevational view of a different embodiment of a fin plate comprising a helical edged aperture;

Figs. 13 and 14 are sectional views on lines 13—13 and 14—14 thereof;

Fig. 15 is a side elevational view showing such fin plates assembled on a grooved tube before expanding the same;

Fig. 16 is a rear view thereof enlarged;

Fig. 17 is a sectioned elevational view of an embodiment of the invention comprising a tube having annular grooves deformed by expansion and shrinkage to firmly grip and secure plates disposed thereon for constructing multiple disc cutters, electrical condensers and the like.

Fig. 18 is a side elevational view of another embodiment of fin plate;

Fig. 19 is an end elevational view thereof, and

Fig. 20 is a plan view showing a finned tube assembly made in accordance with the invention.

Referring more particularly to Figs. 1, 2 and 3 of the drawings, the fin plates 1, in accordance with one embodiment of my invention, comprises a substantially rectangular piece of sheet metal which is provided with four circular apertures 3 for mounting on tubular members when the structure is assembled. The fin plate 1 is cut through by slits 5 extending between each of the pairs of apertures 3 adjacent the opposite ends of the fin plate to provide flexible tabs or wings 7 and 9 between the adjacent pairs of apertures. The adjacent pairs of tabs 7 and 9 are bent outwardly from the surface plane of the plate 1 in opposite directions, one of the tabs 7 of each pair projecting to the right and the other tab 9 of each pair projecting to the left, as viewed in Fig. 2, thereby distorting the edges of the apertures 3 into a substantially helical or spiral curvature.

The opposite sides of the plate 1 are also distorted or off-set into displaced substantially parallel planes 6 and 8 to further distort the edges of the apertures 3 and the intermediate portion of the plate to provide a helically edged aperture which will be a full circle in projection on a plane perpendicular to the axis of the tube to fit freely into and contact fully around a helical groove on a tube. This off-set arrangement is more clearly shown in Fig. 2, but is also indicated by the shaded portions in Fig. 1. The apertures

thus formed are alternately right and left handed and any desired number may be conveniently provided.

The distorted edges of the apertures 3 are also preferably provided with an annular margin 10, as shown in Fig. 3, which is straightened substantially parallel to the displaced edges of the plate 1. Since the annular margin 10 encircling the apertures will be substantially at right angles to the axis of the tube, on which it will be mounted, it will enter the groove in the tube very readily. Because of the helical or spiral slope of the edges of the apertures thus provided in the fin plates, the plates may be secured upon a helical grooved tube and the maximum contact area with the tube is obtained.

The fin plates 1 may be pre-formed by hand tools and may be made of various shapes and with apertures to accommodate various numbers and arrangements of the tubes as desired. For mass production, the plates may be pre-formed by automatic sheet metal working machinery, in any suitable manner, as by a punch press provided with a suitable die, as will be readily understood. In the first station the holes are preferably pierced, slightly smaller than the finished hole, and in the second station the cuts may be made between the holes and the plate tabs may be distorted and the holes shaved to the final size. Suitable automatic sheet metal working machinery is well known in the art and does not constitute any part of the applicant's invention.

Because it is only necessary to bend the fin plates 1 but slightly in accordance with my invention, it is possible to make them of a very hard sheet metal of high density and thermal conductivity as it comes from the rolling mills. These plates may be assembled with high pressure engagement to provide good thermal contact.

After the pre-formed fin plates 1 have been provided with apertures 3, the edges of which are of substantially helical conformation, they may be conveniently and efficiently assembled upon a tube 11 which, as shown in Fig. 4, has a groove 13 formed, cut, or sawed in any convenient manner around its outer peripheral surface. The groove 13 is preferably of substantially helical conformation either right or left handed. Such a tube may be made of any material which has a suitable modulus of elasticity to take sufficient permanent distortion to be expanded diametrically and shrunk axially, in accordance with my invention, for drawing the side walls of the grooves together to grip and hold the fin plates, in a manner to be subsequently set forth. The grooved tube 11 may be made of any suitable length for supporting the desired number of plates for various applications and installations. For heat exchanging purposes the grooved tube 11 is made of a metal of good heat conductivity having high ductility. For example, half hard copper, aluminum, or soft steel are suitable for this purpose.

A portion of the outer surface of the tube adjacent each end thereof may be turned down to provide a smooth surface of smaller diameter whereon the ends of the tube may be conveniently connected, in any suitable manner, with the source of heating or cooling or other medium which is to be utilized therein. When it is desired to support a plurality of separate sets of mutually engaging fin plates in spaced relation, the grooved tube 11 must be provided with a plurality of helical grooves, such as, 13 and 15 spaced thereon, as shown in Fig. 5 for example. It will be understood that more than two grooves may be thus provided in spaced relation on the tube.

For the purpose of assembling the apertured fin plates 1 upon a grooved tube 11, I provide a leader 17 which, as shown in Fig. 6, is secured in the end of the tube. For this purpose the leader comprises a guide neck 19 having a shallow helical thread 21 on its outer surface for guiding the fin plates toward a leader head 23. The guide neck 19 and its external thread 21 are of a diameter smaller than the diameter of the apertures 3 provided in the fin plates whereby the plates may be readily dropped onto it. The leader head 23 is of substantially larger diameter than the neck and it is provided with a deep helical groove 25 for receiving the fin plates from the guide neck 19. The inner diameter of the helical groove 25 on the leader head is substantially larger than the neck 19 and is suitable for continuously guiding the fin plates in adjacent relation into the helical groove 13 on the adjacent end of the grooved tube 11.

In order to secure the leader 17 upon the end of a tube 11, a shaft 27 extends freely through the leader and carries a tapered wedge 29 thereon for spreading a set of split fingers 31 which extend from and are integral with the head 23. For this purpose, two fingers 31 of semi-circular cross-section are sufficient and these are provided at the inner ends with a substantially tapered cam surface 33 for receiving the wedge-like head 29 on the end of the shaft. The shaft 27 is provided with external threads 35 which cooperate with internal threads between the friction fingers 31 adjacent the leader head for drawing the wedge 29 toward the leader head 23. This spreads the friction fingers 31 apart in snug frictional engagement with the inner surface of the tube 11, as shown in Fig. 6.

The outer end of the leader shaft is provided with a square shank 22 for receiving a suitable wrench or hand-wheel thereon. It will be understood that any number of frictional fingers 31 may be provided for this purpose to provide snug engagement with the internal surfaces of tubes of different diameter, and the outer surfaces thereof may be smooth or roughened to provide suitable gripping engagement with the tubes.

When the leader is applied to the end of a tube, it is firmly secured therein by turning the shaft 27 to expand the fingers 31 for engaging the tube. The leader is so applied that the end of the large groove 25 in the leader head suitably connects with the end of the fine helical groove 13 in the tube wherein the fin plates are guided onto the tube. Leaders are provided with right or left handed threads to fit the right and left handed grooved tubes.

After the leaders have been properly installed on the ends of a suitable number of the tubes 11, which are arranged alternately with right and left handed grooves, the fin plates 1 are dropped on over the guide necks 19. By turning the tubes 11 simultaneously in alternate reverse directions, the leaders are rotated relative to the fin plates 1 which are thereby guided forward and enter the deep helical grooves 25 in the leader heads in adjacent relation. By continuing the rotation, the fin plates 1 are started into the helical grooves 13 of the tubes. The fin plates 1, as shown in Fig. 1, are thus simultaneously guided upon four grooved tubes 11 which extend through

the four apertures 3 of the plates. The leaders 17 are then removed from the tubes by turning the shafts 27 in the reverse direction.

For convenience in rotating the tubes 11 simultaneously, I provide the assembling device shown in Fig. 8, which comprises chucks 24 of a suitable size for receiving and gripping the lower ends of the grooved tubes 11. The chucks 24 are rotatably supported on the upper ends of individual shafts 26 which are vertically journalled in a base plate 28. The base plate 28 also supports a bearing bracket 30 which has depending end legs 32 secured to the ends of the base plate 28 in any suitable manner. The shafts 26 rise vertically through the bracket 30 which comprises bearing means therefore.

The shafts 26 carry gears 34 which mesh together for rotating the shafts simultaneously in alternate reverse directions. For driving the shafts 26, a drive shaft 36 is similarly journalled in the base 28 and the bracket 30 and carries a suitable gear 38 intermeshing with the adjacent one of the series gears 34. The drive shaft 36 may be turned manually, or by any suitable motive means such as the electric motor 40 connected thereto through gears 42 or other suitable speed changing means.

The order in which these steps are performed is immaterial as the tubes 11 may be first mounted vertically in the assembling device chucks 24 and the guides 17 thereafter installed in the upper ends of the tubes and the apertured fin plates dropped thereon.

After the set of helically apertured fin plates is assembled on the tubes, the guides are removed from the upper ends of the tubes 11 by turning their shafts 27 in the reverse direction. On the lower ends of the tubes, the chucks 24 are released and the fin tube assembly is removed. In this manner any desired number of plates may be simultaneously assembled upon any number of grooved tubes.

For gripping and securing the fin plates 1 upon the grooved tubes, I collapse the grooves to pinch the plates therein after the plates have been assembled on the tubes. For this purpose, I provide an expander which, as shown in Fig. 9, comprises an elongated stem 41 for extension through the tube 11 which is to be expanded. An enlarged expander head 43 is provided on the end of the stem and it carries a substantially sharp shoulder 45 extending in annular conformation around the leading edge of the peripheral surface of the head. A series of friction reducing guide rings 47, comprising ridges extending circumferentially around the outer surface, are spaced axially along the expander head. Also the portion of the stem 41 joining the expander head is provided with a plurality of axially spaced annular guide rings 49.

To expand the tube 11, the expander stem 41 passes freely therethrough, as shown in Fig. 9. The expander head 43 is then drawn through the grooved tube for which purpose force may be applied in any suitable manner as by mechanical, pneumatic or hydraulic means as will be readily understood. As the expander passes through the tube, the annular guide rings 47 and 49 on the stem and the expander head serve to reduce the frictional losses which would be obtained if flat contacting surfaces were provided. The shoulder 45, which is rather sharp, on the leading edge of the expander head 43 packs or collapses the tube 11 in the weakest portions under the grooves 13 thereby shrinking the grooves axially. The diametrical expansion of the tube also requires additional metal for increasing the diameter some of which is taken from the length of the tube which is thus shrunk or shortened axially. As this takes place the side walls of the grooves move together. This effect also augments the groove collapsing effect caused by expanding the tube with my expander.

Thus as the expander is drawn through the tube, the tube is expanded diametrically and shrunk axially and the side walls of the helical grooves are drawn together to pinch or squeeze the edges of the helical apertures of the fin plates mounted thereon, while the bottoms of the helical grooves are expanded diametrically into snug abutting engagement.

After the tubes 11 have been expanded, the assembly of a set of continuously contacting fin plates 1 is clamped together thereon, as shown more clearly in elevation in Fig. 10, where a portion of the tube 11 is broken away to show the mutually engaging relation provided between the plates. The oppositely disposed plate tabs 7 and 9 abut the tabs 9 and 7 respectively projecting from the plates on opposite sides and provide a continuous air flow engaging surface between the parallel offset portions 6 and 8 of the plates with sufficient irregularity to provide eddies for efficient heat transfer. Such a completed assembly of fin plates on oppositely grooved tubes is also shown in plan view in Fig. 20. The helical edged apertures provide continuous thermal coupling between the plates and the tube and provide a rigid support around the helical groove from one end of the tube to the other. The fifth plates 1 are supported in axially spaced and substantially parallel relation on the tube.

When a plurality of separated sets of spaced fin plates are to be supported each in continuous contacting relation, I provide a tube 11 such as that shown in Fig. 5 which has a plurality of helical grooves 13 and 15 or more thereon. The preformed fin plates 1 are then assembled simultaneously in the separate grooves on the tube by means of a leader which is provided with a plurality of spaced helical grooves, in a manner similar to the operation of guiding plates upon a grooved tube as previously described. After the plates have been assembled in adjacent contacting relation along the helical grooves, the tubes are expanded and the side walls of the grooves are collapsed for snugly gripping the inner edges of the apertures of the plates in a snug three-sided joint, as previously set forth, to provide an efficient thermal coupling and mechanical support.

It is also possible by a simplified arrangement to obtain a single helical edged aperture in a fin plate, as shown in Figs. 12, 13 and 14. In accordance with this embodiment of my invention, a fin plate 51 is provided with a single circular aperture 53 and a slit 55 is cut diametrically from one edge of the aperture about one radius distance toward one edge of the plate. The adjacent flexible points 57 and 59 thus provided are bent in opposite directions from the plane of the plate, as shown in Fig. 13. The portion of the fin plate 51 on the side of the aperture opposite from the slit 57 is deformed into two spaced and substantially parallel planes 60 and 62, as shown more clearly in Fig. 14. The edges of the aperture 53 are thus distorted to substantially helical or spiral conformation. Along the edges of the aperture 53 on opposite sides of the slit 57, annular portions 64 are flattened or deformed

back to positions substantially parallel to the main plane of the plate 51 whereby they are perpendicular to a supporting tube and freely enter its grooves. Although only a single aperture 53 is shown in the square plate 51, the latter may be of elongated rectangular or other conformation to provide a plurality of such helically edged apertures to receive as many grooved tubes as desired.

Fin plates of this conformation are guided upon and into the helical grooves of tubes 11 similarly to the fin plates previously described. Such an assembly of plates on an unexpanded tube is shown in the enlarged Fig. 15, and a rear view thereof is shown in Fig. 16. After the plates 51 have been assembled on the grooves, the side walls of the grooves are collapsed together to grip the edges of the plate apertures. This is accomplished by expanding the tube diametrically and shrinking it axially in the manner previously described whereby the side walls of the groove 13 grip the sides of the edges of the apertures 53, and the plates 51 are firmly secured thereon in efficient thermal coupled relation.

In accordance with another embodiment, the principle of my invention may be utilized for supporting a plurality of plates 63 such as disk cutters, condenser plates or the like in parallel spaced relation upon a tubular supporting member 64, as shown in Fig. 17. For this purpose, I provide annular grooves 65 around the tube 64 and spaced axially along the outer surface thereof. The plates 63 have circular apertures of such a size that they fit loosely over the outer diameter of the tube 64. The plates are slipped on over the tube until they rest in their respective grooves 63 after which the tube is expanded to bring the bottoms of the grooves into snug abutting engagement with the inner edges of the disk apertures. When the tube 64 is then expanded, as previously described, the side walls of the grooves 65 are drawn together sufficiently to grip the plates or disks 63 quite firmly on the sides of their apertures.

For installations requiring a large fin area and a great many tubes, fin plates 67 are advantageously made, as shown in Figs. 18 and 19, with the tube receiving apertures 3 arranged in adjacent parallel rows. To provide a rigid and thermally efficient relation, the apertures 3 in each row are preferably staggered relative to the apertures in the adjacent rows for receiving tubes which are disposed in similar staggered relations.

Slits 5 are cut between adjacent pairs of apertures 3, as in the first embodiment of fin plate, shown in Fig. 1. To make helically edged apertures, the adjacent pairs of plate tabs 7 and 9 thus provided are bent outwardly in opposite directions and the plate is distorted to provide parallel offset portions on opposite sides of the row of apertures. As shown, the offset portion of the fin plate between the rows of apertures 3 provides a continuous aligned surface 69. The portions 71 of the plate above and below the rows of apertures are parallel to but offset from the intermediate portion, and they are in alignment with each other, as shown in Fig. 19. The plate tabs 7 of each row, which are directed toward each other, are distorted to the left and the tabs 9 which are directed away from each other are bent to the left of the plate as shown in Fig. 19.

It will be seen that I have provided a simple and rugged fin tube construction, and method and apparatus for conveniently assembling the same, whereby the fin plates may be supported upon a grooved tube in spaced relation in a simple convenient manner which provides improved mechanical strength and increased thermal efficiency while eliminating the necessity for auxiliary fastening accessories and operations.

Aside from the specific embodiment of the invention herein shown and described, it will be understood that various details of the construction may be altered or omitted without departing from the spirit and scope of the invention as disclosed and claimed, and that I do not desire to limit the invention to the exact constructions herein set forth.

I claim:

1. A finned tube construction comprising, a pair of thermal conductive tubes, a right-handed groove in the peripheral surface of one of said tubes, a left-handed groove in the peripheral surface of the other one of said tubes, a fin plate having a pair of spaced tube receiving apertures for passing said tubes in spaced relation therethrough, a slit in said plate between said pair of apertures to provide a pair of deformable tabs, and the tabs on opposite sides of the slit being deformed in opposite directions from the plane of the plate to distort the edges of the apertures to follow in the respective right and left-handed grooves in said tubes.

2. A finned tube construction comprising, a pair of thermal conductive tubes, a helical right-handed groove in the peripheral surface of one of said tubes, a helical left-handed groove in the peripheral surface of the other one of said tubes, a fin plate having a pair of spaced tube receiving apertures of a diameter greater than the tubes for passing said tubes in spaced relation therethrough, a slit in said plate between said pair of apertures to provide a pair of deformable tabs, the tabs on opposite sides of said slit being deformed in opposite directions from the plane of the plate to distort the edges of the apertures to follow in the respective right and left handed helical grooves in the tubes, and the intermediate portion of said fin plate being deformed for distorting the plate to fill a complete circle projected on a plane perpendicular to the axis of the tube and to provide the maximum length of thermal contact in said helical grooves.

3. A finned tube construction comprising, two thermal conductive tubes, a right-handed helical groove in the peripheral surface of one of said tubes, a left-handed helical groove in the peripheral surface of the other one of said tubes, a fin plate, a pair of tube receiving apertures spaced in said fin plate for passing said tubes in spaced relation therethrough, a slit cut in said plate between said apertures to provide a pair of deformable tabs, said tabs on opposite sides of said slit being deformed in opposite directions from the plane of said fin plate to distort the edges of said apertures to follow in the respective right and left-handed grooves in said tubes, said grooves having side walls firmly gripping the side surfaces of the edges of the tube receiving apertures and said grooves having bottom walls firmly abutting the inner surfaces of the edges of said tube receiving apertures.

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