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W. D. FRANCE ET AL

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BIMETAL TUBING WITH FERRULED ENDS

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Fig. 1.

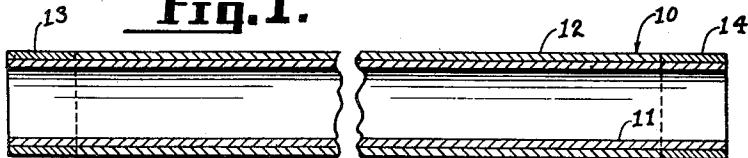


Fig. 2.



Fig. 3.

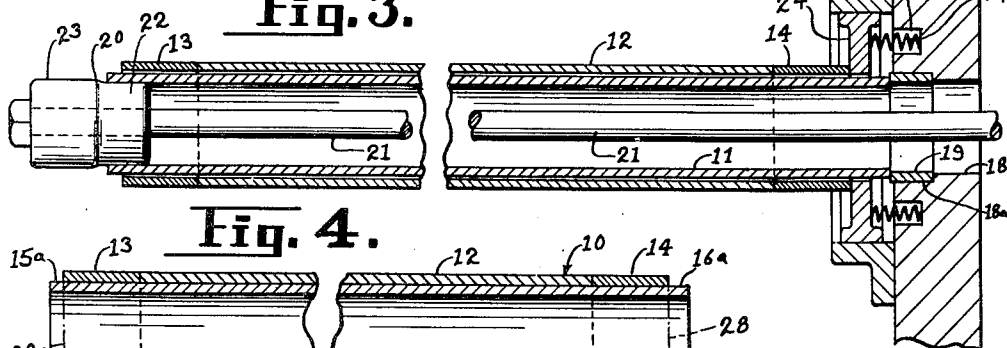


Fig. 4.

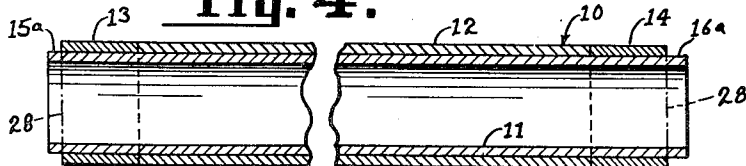


Fig. 5.

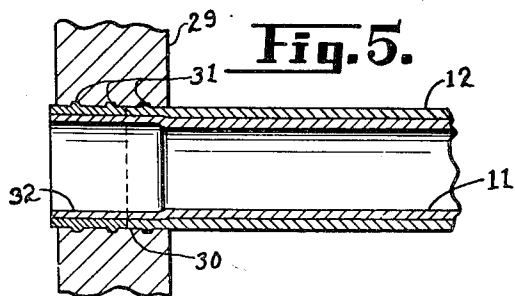
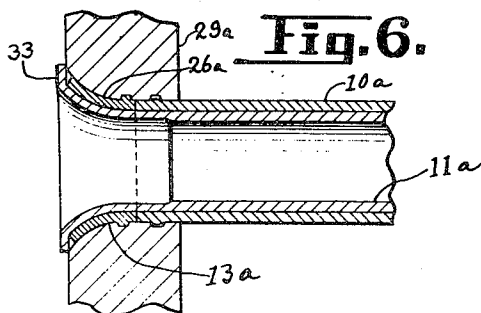


Fig. 6.



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BIMETAL TUBING WITH FERRULED ENDS

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4 Claims. (Cl. 138-64)

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This invention relates to bimetal or composite tubes for use in heat exchangers or similar devices and to the method of making the same.

An object of this invention is to improve the structure of bimetal tubes that is manufactured for use in installations wherein different media are employed, and the tube is made of two different alloys, so as to make that portion of the tube corrosive and erosive resistant to the medium to which it is exposed. Specifically the invention resides in the manufacture of bimetal tubes in which the outer tube is made to a predetermined length and considerably short of the ends of the inner tube so as to provide projecting ends of the inner tube over which are assembled ferrules or bushings of the same basic alloy as the inner tube, and wherein all parts are mechanically united together into one solid tube by an expanding operation of the inner tube. Another object is to provide as a complete article of manufacture a bimetal tube unit with which metal ferrules are assembled on the tube ends so that the unit can be furnished ready for insertion in the tube plates without trimming and without the need for the user acquiring and handling the ferrules as separate parts.

Another point of this invention is in the method of manufacture wherein it has been discovered that in expanding the inner tube into the outer tube there is a shortening of the overall length of the inner tube. This will naturally cause some amount of slippage of the inner tube relative to the outer tube and the ferrule adjacent the final expanded end of the tube. To compensate for this condition in the expanding of the inner tube, the inner tube is abutted against a firm stop on the machine for expanding the tube while the outer end of that ferrule adjacent the final expanded end of the composite tube is abutted against a resilient member or one that is capable of moving under tension relative to the firm stop.

Another object of this invention is to provide an improved method of manufacture for the above type of tube and one which will compensate for the foreshortening of the inner tube relative to the outside tube and end ferrule during the expanding operation of said inner tube.

With these objects in view and others not specifically referred to, the invention consists in the features, combinations, details of construction and arrangement of parts of the tubes and also apparatus which will be first described in connection with the accompanying drawing and then more particularly pointed out.

Referring now to the drawing:

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Fig. 1 is a longitudinal sectional view of a bimetal or composite tube embodying the invention as it appears in its finished form.

Fig. 2 is an exploded sectional view showing the parts employed in the composite tube and with the end ferrules in position to be received over the exposed ends of the inner tube.

Fig. 3 is a longitudinal sectional view showing all the parts of the composite tube in relative assembled position and with the tube positioned in portions of the apparatus employed for expanding and effecting a mechanical bond between the various parts of the composite tube.

Fig. 4 is a sectional view of the composite tube as it appears immediately after the expanding operation.

Fig. 5 is a sectional view of one end of the tube showing it as secured into a hole or opening in a tube sheet or end plate, and

Fig. 6 is a view similar to Fig. 5 and showing a modified form of assembly of the tube into an end plate.

Referring now to the drawing in which like reference numerals designate like parts throughout the several views, the numeral 10 represents generally a bimetal or composite tube with the end ferrules that forms the subject of this invention.

Specifically the composite tube 10 comprises an inner tube 11 of one alloy surrounded by an outer tube 12 of a different alloy and a pair of end ferrules or bushings 13 and 14 of an alloy having similar physical and corrosion resistant properties to those of the alloy of said inner tube 11. The alloys for the inner and outer tubes are selected in accordance with the conditions to which the outer and inner surfaces of the composite tube are to be exposed.

For many types of heat exchangers to which our composite tube will be applicable, the outer tube 12 will be one of the ferrous alloys while the inner tube 11 and end ferrules 13 and 14 will be one of the non-ferrous alloys. It should be understood, however, that there are conditions where this selection of alloys for the respective tubes may be reversed, or where both inner and outer tubes may be of either ferrous or non-ferrous alloys having different corrosion resistant properties, and in general the tubes and ferrules may be constructed of any material suitable for resisting the particular corrosive action of the fluids or substances to which they are exposed.

The outer tube 12 will be of a predetermined length for reasons that will appear later and which length is considerably less than the length of the inner tube 11, thus allowing for exposed

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ends 15 and 16 over which the end ferrules 13 and 14 are telescoped. Fig. 2 shows in a general manner the amount that the ends of the outer tube 12 are removed from the ends of the inner tube 11, thus leaving an exposed end 15 at the left end of the inner tube, and an exposed end 16 at the right end of said inner tube. The O. D. and I. D. of the ferrules 13 and 14 are dimensioned to be the same as the O. D. and I. D. of the outer tube 12, and the axial length of these ferrules 13 and 14 preferably are somewhat shorter in length than the exposed ends 15 and 16 of the inner tube as will be observed in Fig. 3. Also it will be observed that the positioning of the outer tube 12 to the inner tube 11 is such that the right exposed end 16 is of greater length than the left exposed end 15, for reasons that will be explained later.

While Figs. 2 and 3 of the drawing show the tubes and ferrules to be in spaced relationship relative to each other, it should be understood that in the preliminary stages, the inner tube 11 is dimensioned so as to allow for a free sliding fit into the outer tube 12 and end ferrules 13 and 14. In general it has been found that in making composite tubes in the order of one inch size, a clearance of .030" between the O. D. of the inner tube and the I. D. of the outer tube and end ferrules is sufficient to produce a free sliding fit between the telescoped parts employed to make the composite tube.

The method and the apparatus by which the various parts are united into one single tubular structure or composite tube is shown in Fig. 3. After the various parts that make up the assembled tube are positioned as shown in Fig. 3, the tubing is conveyed to an expanding machine, the essential parts only of which are employed for the expanding operation being disclosed in said Fig. 3.

This machine comprises in general a die block 17, with a through opening 18, having a counter-sink 18a within which is fitted a hardened support ring 19, against which the adjacent end of the inner tube 11 is adapted to abut during the expanding operation of the inner tube. A plug member 20 of conventional structure is provided on the end of a long pull rod 21 that passes through the entire length of the inner tube and through the opening 18 in die block 17. The opposite end of the pull rod 21 may be attached to any suitable draw-bench mechanism, not shown, for the purpose of pulling the plug 20 through the inner tube 11 for expanding the same. The plug 20 is preferably of a double diameter wherein the leading end 22 is of a size to fit snugly into the open end of the inner tube 11, while the trailing end 23 is of a size for expanding the inner tube the proper amount into the outer tube 12 and end ferrules 13 and 14 to create a firm mechanical bond therebetween, and also giving due consideration in the expanding operation so as not to expand the outer tube and end ferrules beyond their elastic limits.

In the initial assembly of the inner tube 11 into the outer tube 12 and end ferrules 13 and 14, the parts should be so positioned that the right exposed end 16 is of greater length than the left exposed end 15. The reason that the right exposed end 16 of the inner tube 11 is exposed to a greater amount than the left end 15, is that in the operation of pulling the plug 20 through the inner tube 11 for purposes of expanding the same, without necessarily reducing its wall thickness, a shortening of the overall length of said inner

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tube 11 will result. With this physical change of the length of said inner tube 11, but with no change in length of the outer tube 12 and end ferrules 13 and 14 will naturally cause a proportionate amount of axial slippage as between the inner tube 11 and outer tube 12 and right ferrule 14. This added length at the right exposed end 16 is to allow for this reduction in the overall length of the inner tube 11, and still leave a portion of the inner tube exposed and projecting beyond the end of the right ferrule 14 upon completion of the expanding operation, in a manner as shown in Fig. 4.

In compensating for this slippage as between the inner and outer tubes 11 and 12 and right ferrule 14, the exposed end of the right ferrule 14 is abutted against a resilient member, which may be in the form of a floating ring plate 24 slidably mounted in a bracket 25 attached to the adjacent face of the die block 17, illustrated in Fig. 3. A plurality of sockets 26 may be provided in the adjacent face of the die block 17 and annularly arranged about the support ring 19. A plurality of coil springs 27 is provided and being individually fitted into each of the sockets 26 with the outer ends of said springs abutted against the inner face of the floating ring plate 24. From this apparatus construction it will be noted that in the method of manufacture of the composite tube 10, the inner tube 11 is first abutted against a support ring 19, immovably held in the die block 17 and then the outer tube 12 and end ferrules 13 and 14 as a unit are abutted against the floating ring plate 24 that is capable of resiliently giving due to the springs 27. As the expanding plug 20 is being drawn through the inner tube 11 in expanding the same into a firm mechanical bond with the outer tube 12 and end ferrules 13 and 14, the inner tube 11 as a result will contract in length and, in effect, be drawn inwardly from the right ferrule 14 and then cause the outer tube 12 and right ferrule 14 to move to the right carrying the floating ring plate 24 therewith against the influence of the springs 27. When the expanding operation is completed the resulting composite tube 10 will be finished substantially as shown in Fig. 4, with portions of the inner tube 11 exposed beyond the ends of the assembled ferrules 13 and 14, said ends being designated as 15a and 16a. These ends 15a and 16a may subsequently be cut away to the dot-and-dash line 28 (see Fig. 4) so as to bring the ends of the inner tube 11 flush with the exposed ends of the ferrules 13 and 14.

Fig. 5 shows one form of installation to which our bimetal ferruled end tubes may be assembled, it being considered sufficient to show only one end of the tube connection as both ends will be of like construction. The tube 10 is assembled to an end plate or tube sheet 29, having an opening 30 of a size to receive the O. D. of the outer tube 12. Within this plate opening 30 are provided a series of annular recesses 31.

The tube is permanently assembled to the tube sheet or end plate 29 by a suitable tool (not shown) that serves to expand the adjacent open end of the inner tube 11 as at 32, the expanding force being usually of a character to increase the diameters of the inner tube and the surrounding ferrule and adjacent end of outer tube 12. The expansive force in the inner tube 11 should be of a character to cause the material of the outer ferrule to be forced into the annular recesses 31. In case the outer tube 12 happens to be made from a comparatively hard alloy, such

as steel, it is perceived that only a portion of this tubing will be expanded into the adjacent annular recess 31.

Inasmuch as it is one of the points of this invention to have an outer tube 12 of a predetermined length, which is determined before the expanding operation, the length of the outer tubing should be such as to fit part way into the openings 30 in each of the end plates 29, and to a distance wherein said outer tube will be in connection with at least one and most adjacent of the annular recesses 31 of each end plate 29, as shown in Fig. 5. In a composite tube wherein the outer tube 12 is of a harder ferrous material, experience has taught that the material of this tube will be only partially expanded into the adjacent annular recess 31 surrounding said tube, whereas the end ferrules 13 and 14 being usually of a non-ferrous and softer material, the material thereof will expand into substantially the full depth of the one or more recesses 31 surrounding the same to assure an adequate mechanical bond and leak-proof joint as between the tubes 10 and end plates 29.

In Fig. 6 is shown a modified form of joint wherein the composite tube 10a may be secured into an end plate 29a having a flared opening 26a. In fabricating a composite tube for this particular installation, the length of the inner tube 11a will be initially predetermined so that when the mechanical bond is effected with the outer tube and end ferrules, the exposed ends 15a and 16a will be somewhat longer than what would be required for the Fig. 5 installation (it being understood that for the latter installation the inner tube is cut off flush with the end ferrules before the installation). The reason that these exposed lengths or ends 15a and 16a are left longer is because of the difficulty of control in the expanding operation. By leaving a longer length to the exposed ends 15a and 16a of the inner tube, these lengths can then be cut off to a predetermined length from the ends of the end ferrules to fit the required need of the Fig. 6 installation. In assembling the composite tube 10a in the flared opening 26a, the inner tube 11a and also the adjacent bushing 13a will be first expanded by a suitable tool in the manner as described in connection with Fig. 5, and then by another suitable tool flared outwardly in the manner as shown in Fig. 6. By reason of the predetermined cut length or exposed end 15a of the inner tube 11a that is exposed beyond the end of the outside tube 10a and adjacent ferrule 13a, even after the end of the composite tube is expanded by the first flaring operation, the exposed end 15a of the inner tube 11a will be of sufficient length to allow said length 15a to be further flared over as at 33 and conceal the exposed end of the flared bushing 13a, and serve to make a neat joint with the end plate 29a.

One of the advantages of this invention is that the entire composite tube 10 can be made and shipped as a unit from the place of manufacture without resorting to any cutting or milling operations of the tube for the purpose of

assembling end ferrules at the place where the tube is to be assembled into a heat exchanger unit.

Also by reason of the fact that it is only necessary to remove the short end portions 15a and 16a of the inner tube by a cutting operation to produce the finished tube as shown in Fig. 1, there is eliminated the problem of mixed scrap which has heretofore been one of the problems of fabricating bimetal tubes for the various installations.

While we have herein described and upon the drawing shown an illustrative embodiment of the invention and apparatus for producing the same, it is to be understood that the invention is not limited thereto, but may comprehend other constructions and arrangements without departing from the spirit of the invention and details of parts.

What is claimed:

1. As an article of manufacture, a bimetal tube comprising an inner tube of one alloy and an outer tube of a different alloy extending over the greater part of the length of the inner tube, the ends of said inner tube projecting beyond the ends of the outer tube, ferrules of an alloy comparable to the inner tube surrounding the exposed ends of said inner tube and extending over at least the greater part of the length of said exposed ends, and said tubes and ferrules being mechanically bonded together as one integral tube unit ready for assembly with a heat exchanger or the like.
2. As an article of manufacture, a bimetal tube comprising an inner tube of relative soft metal and an outer tube of relatively hard metal extending over the greater part of the length of the inner tube, the ends of said inner tube projecting beyond the outer tube, and ferrules of a metal comparable in hardness to the inner tube, surrounding the exposed ends of said inner tube and extending over at least the greater part of the length of said exposed ends, said tubes and ferrules being mechanically bonded together as one unit ready for assembly with tube sheets of a heat exchanger or the like.
3. The bimetal tube defined in claim 1 wherein the inner tube extends slightly beyond the ferrules at each end of the finished tube.
4. The bimetal tube defined in claim 1 wherein the length of the ferrules is the same as the length of the exposed ends of the inner tube.

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