

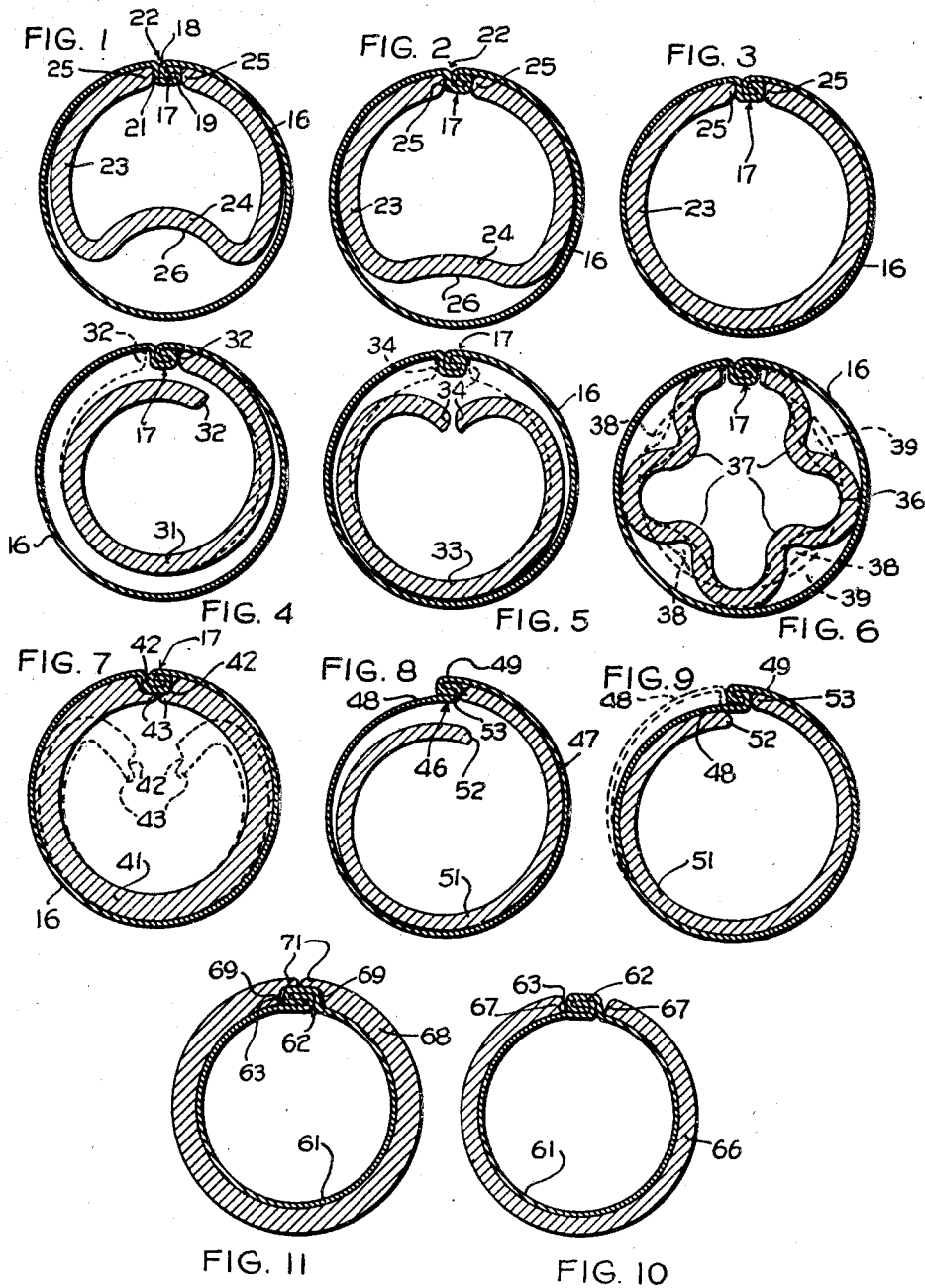
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METHOD OF MAKING COMPOSITE TUBULAR STRUCTURES

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METHOD OF MAKING COMPOSITE TUBULAR STRUCTURES

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1 Claim. (Cl. 113—33)

This invention relates to a method of making composite tubular metallic structures.

This application is a division of application Serial No. 98,474 filed August 29, 1936, which matured into Patent 2,172,429 granted September 12, 1939.

An object of the invention is to provide simple, easily made composite tubular structures consisting of two or more metals of different characteristics each of which endows the structures with predetermined desired qualities.

A further object of the invention is to teach convenient methods through the practice of which the composite tubular structures may be produced.

As is well known, metal tubes and tubing are widely used for ornamental purposes and for utilitarian purposes not related to the conduction of fluids. For example, metal tubes and tubing are used for hand rails, hand grips, and guard rails in architectural structures, as on stairways, and in public conveyances such as railway coaches, motor coaches, and street railway cars. They are used in the construction of fixtures, particularly for the support of articles to be moved by sliding, as in tray supports associated with the counters of cafeterias, and as foot rests and foot rails. Tubing is being used extensively in the manufacture of frames for certain articles of furniture, such as chairs and settees, and in the frames of seats of railway and motor coaches.

In all of the above uses of metal tubes and tubing it is the nearly universal custom to provide a smooth, highly reflecting external surface, not only to present a pleasing ornamental appearance, but also to facilitate cleaning and the maintenance of a reasonable degree of sterility, having reference to accumulations of bacteria and disease germs deposited principally by human hands.

An optimum freedom from surface oxidation or other corrosion is also highly desirable, as frequent scourings are required to combat rapid corrosion, and in addition, corroded surfaces accelerate the accumulation of bacteria and disease germs.

From the foregoing discussion of the modes of employment of metal tubes and tubing, the use for the conduction of fluids was excepted. Sanitary and ornamental conditions of the external surfaces of tubing through which are conducted fluids is not ordinarily of great importance, although under certain circumstances such condition may be highly desirable. The nature of the interior of the tubing through which fluids are

to be conducted is usually of primary importance, particularly if fluids of a generally corrosive character, or fluids that must be kept substantially free from contamination of any sort, are to be flowed through the tubing. Fluid substances intended for human use or consumption are among the last mentioned types of fluids.

Heretofore, metal tubes most widely used for utilitarian as well as ornamental purposes, and the exposed surfaces of which were capable of being kept reasonably clean and sanitary, owed these desirable properties not directly to any characteristics of the metal of which the tube was fabricated, but to treatment of the surface in various ways, among the more common of which were the application of thin films of such metals as nickel, chromium, or cadmium, by processes of electrodeposition. The processes by which such metals were applied to tubes were relatively costly, and frequently the coatings peeled or flaked off and were not particularly resistant to corrosion. Another undesirable characteristic of the plated tubes was that they were susceptible of marring, such as by scratching or breaking of the electrodeposited coating. Tubes having the surfaces treated as outlined above were used because of the lack of better products, although in many instances they were admittedly far short of ideal.

Among the alloys recently developed and brought into commercial use are certain ferrous alloys that contain carbon and substantial percentages of chromium, and in some instances various percentages of other metals, and that are designated as steel, and in particular are identified by the adjective "stainless." These chromium steel alloys are characterized by great resistivity to corrosion and the capability of being burnished to a high luster which they retain for a long period of time. Dirt does not cling to smooth surfaces of such alloys and they are easily kept clean. Certain of these chromium steel alloys are relatively hard and resist surface marring. It will thus be observed that the corrosion-resisting chromium steel alloys afford all of the characteristics that are desired in ornamental and utilitarian tubular structures.

From the standpoint of fluid conduction, the stain resistant chromium steel alloys exhibit properties greatly desired. They resist the damaging attack of corrosive fluids, and thus require replacement much less frequently than do previously known metals used for conductive tubes. They remain clean and bright, and do not rapidly disintegrate nor otherwise contaminate fluids

which must be kept in a high state of purity, such as substances intended for human use or consumption.

The hereinbefore described chromium steel alloys have not come into widespread commercial use in the manufacture of tubes and tubing for ornamental and utilitarian use as rails, hand grips, and posts, nor for the conduction of fluids even though they possess the ornamental and stain resisting properties most suited to such uses. The principal reasons for this situation are that these alloys, in sufficient metal thicknesses to constitute rigid, durable, self-sustaining tubes, are very difficult to work, and the tubes which have been produced are so costly as to prohibit their use in quantities. Accordingly, a large field of uses to which the properties of the corrosion-resistant chromium steel alloys are particularly suited have heretofore been and are now being-deprived of these materials.

Other alloys which exhibit properties of high resistivity to corrosion and the ability to acquire and retain a luster, or other desired characteristics, may be employed instead of the chromium steel alloys, among which are a number of non-ferrous chromium alloys, as well as alloys of precious or semi-precious metals.

The present invention contemplates tubular structures comprising thin-walled inner or outer tubes of metals, such as the chromium steel alloys, having particularly desired surface characteristics, reenforced, respectively, by outer or inner tubes, characterized by relatively thick walls to provide rigidity, the latter tubes being fabricated from baser grades of metal, such as mild steel, since their principal purpose is to reenforce the thin-walled tubes, and appearance or corrosion resistivity are minor considerations. More specifically the invention contemplates a thin-walled tube formed of sheet material having its edges oppositely reversely bent and interengaged in folded form to provide a seam lock, surrounding or surrounded by, as the case may be, a tube of thicker, and in all probability baser sheet metal, the edges of which are spaced apart so as to abut and thus confine the seam lock of the thinner tube. In order that the seam lock may enter the space between the edges of the sheet of which the thick-walled tube is formed, the seam lock of an external thin-walled tube is formed interiorly thereof, and the seam lock of an internal thin-walled tube is formed exteriorly thereof.

The invention contemplates not only the composite tubular structures described briefly above, but also certain convenient methods through the practice of which the tubes may be produced.

For a full and complete understanding of the invention, reference may be had to the following detailed description, taken in connection with the accompanying drawing in which

Figs. 1 and 2 are sectional views showing partially completed tubes in accordance with one embodiment of the invention in different stages of fabrication;

Fig. 3 is a sectional view showing a completed tube according to one embodiment of the invention;

Figs. 4 to 9 inclusive are sectional views showing partially completed tubes which, by different methods of treatment, are convertible into completed tubes in accordance with Fig. 3; and

Figs. 10 and 11 are sectional views showing additional embodiments of the invention.

Referring now to the drawing, in which like reference numerals designate corresponding parts throughout the several views, and particularly to Figs. 1 to 3 inclusive, the reference numeral 16 indicates a relatively thin-walled tube which may be fabricated of a chromium steel alloy or other material having desired surface properties including high resistance to corrosion and the ability to be burnished to a durable luster. Tube 16 may be produced from sheet material by any of several processes, one of which, for example, may be performed by the forming rolls of the well-known tube-forming rolling machine. Such a machine includes a plurality of sets of rotatable forming rolls, which, in several steps, may form sheet material into a cylindrical tube having the edges mutually inter-engaged and inter-folded to form the seam lock 17 interiorly of the tube 16. The seam lock 17 is formed by bending the edges of the sheet metal back upon themselves inwardly and outwardly, as shown at 18 and 19 respectively, and inter-engaging the reversely bent portions. The finished seam locked tube 16 has the portion 21 which is spaced leftwardly from the outward bend 19 extending outwardly in abutment with the inward bend 18, whereby the seam 22 is closed and a substantially smooth surface contour is provided at that point.

Into the tube 16 is introduced the relatively thick-walled open seam tube 23 which is to serve as the strengthener or bodily support for the thin-walled tube 16. The tube 23 may be formed of any easily worked and preferably inexpensive metal, such as mild steel, and has the edges 25 of the sheet of which it is formed spaced apart a distance as great as or greater than the width of the seam lock 17. When ready for insertion into the tube 16, tube 23 is not completely cylindrical, but has an upset portion 24 which presents a concavity 26 on the surface of the tube 23. By means of the upset portion 24, tube 23, which in the completed tube is to closely engage and interiorly support tube 16, has a lesser cross-section than tube 16, whereby it may be inserted into tube 16 easily. After tube 23 has been inserted into tube 16, the former may be expanded by a suitable forming operation to shape it into the ultimately desired form, which is substantially cylindrical. This may be accomplished in several ways, such as, for example, by drawing a forming plug or a series of forming plugs through tube 23, meanwhile confining tube 16 or successive portions thereof in a sizing die, if necessary. The use of the sizing die insures continued maintenance of tube 16 in cylindrical form and of the desired diameter.

Fig. 2 shows the composite tubular structure of the invention after the shaping of tube 23 has been partially completed. It will be noted that upset portion 24 has been worked so that very little of the surface concavity 26 remains.

Fig. 3 shows the completed tubular structure, tube 23 having been completely shaped into cylindrical contour so that it engages the interior of tube 16 at every point in the wall thereof. Edges 25 which define the opening along tube 23 abut the sides of seam lock 17, and may in fact exert some pressure on the opposite sides thereof, if tube 23 has been dimensioned to exert pressure when finally shaped. Thus the seam lock 17 is engaged, confined, and positively retained locked by tube 23. It will be noted that in the embodiment shown in Fig. 3, internal tube 23

affords no support in a radial direction for that portion of external tube 16 where seam lock 17 is formed, although in a modification to be described later, support is provided for seam lock 17. For ordinary uses, the extra thicknesses of metal provided by the seam lock should render that portion of tube 16 entirely self-supporting.

In the completed tube, seam 22 is incapable of opening during use, due to the confining action of tube 23, and in those uses in which the presence of seam 22 is not undesirable, the final structure may be as shown in Fig. 3, with seam 22 giving the appearance of a narrow, shallow groove along the surface of tube 16. If, however, an appearance of seamlessness is desired, seam 22 may be filled and closed by the application of such processes as brazing, soldering, or welding.

In Fig. 4 is shown a tube 16 similar in all respects to the external tubes of Figs. 1, 2, and 3, into which has been fitted an internal tube 31. Tube 31 has no concave portion, as in the case of tube 23, but is, instead, somewhat helical in cross-section, one of its edges 32, which correspond to edges 25 of tube 23, overlapping the other, whereby tube 31 may be easily inserted into tube 16. The structure shown in Fig. 4 may be converted into one identical with that shown in Fig. 3, by shaping tube 31, such as by means of a forming plug, to expand tube 31 and shift inner edge 32 leftwardly and outwardly until it is brought into final position abutting the left side of seam lock 17, as indicated in dotted lines. Inner edge 32 may be rounded outwardly to enable it to pass the inner left edge of seam lock 17.

Fig. 5 shows a tube 16 having a seam lock 17 and having fitted thereto an internal tube 33. The latter tube is completely convex in cross-sectional contour, but has the portion adjacent the edges 34 formed on sharply decreasing radii. Edges 34 are thus brought much closer together than the width of seam lock 17. The contour of tube 33, although differing from those of tubes 23 and 31, enables tube 33 to enter tube 16 loosely. Thereafter, tube 33 may be expanded and reshaped to bring the surface thereof into complete engagement with the inside of tube 16 and edges 34 into abutting or compressing engagement with the opposite sides of seam lock 17. It will be noted that edges 34 are rounded outwardly to enable them to pass the inner edges of seam lock 17 without deforming the lock.

Fig. 6 shows thin-walled tube 16 having, as in the case of the previously described structures, internal seam lock 17. This tube has fitted thereto internal, relatively thick-walled tube 36 which is contoured for easy entrance into tube 16 on the same general principle as tube 23 in Fig. 1, except that whereas tube 23 has the single indented portion 24, tube 36 has a plurality of indented portions 37, each of which constitutes a lesser deviation from cylindrical contour than does indentation 24 in tube 23. A forming plug or a series of such plugs may be drawn through the assembly of tubes 36 and 16 to bring it through the stage indicated in dotted lines at 38, and finally to the contour shown in dotted lines indicated at 39, and identical with the structure shown in Fig. 3.

Fig. 7 shows a previously mentioned tube structure in which the internal tube furnishes support for the seam lock as well as for the remainder of the thin-walled tube. As in the heretofore described structures, the outer tube is the tube 16 with the internal seam lock 17. The

internal tube, shown in dotted lines in the condition in which it is introduced into tube 16 and in full lines in the finished condition in order to show clearly the manner in which seam lock 17 is reinforced, is indicated 41. The free edges 42 of the internal tube 41 are provided with flanges 43 coextensive therewith, and these as well as adjacent portions are curved inwardly on decreasing radii as in the case of tube 33 shown in Fig. 5, to provide looseness for easy insertion of tube 41 into tube 16. When tube 41 is expanded, by forming plug or plugs, the outer surface of tube 41 moves into contact with the inside of tube 16, edges 42 coming into abutting relation with the sides of seam lock 17, and flanges 43 become aligned in opposed relation against the inner face of seam lock 17. With this arrangement, the seam lock is confined and supported on all three sides thereof, and the resulting structure is more rigid than those previously described.

Figs. 8 and 9 relate to a single embodiment of the invention, in which the final structure is substantially identical with that of Fig. 3, as indicated in dotted lines in Fig. 9, but in which the method of producing the final structure is different in that the internal tube is fitted to an incompletely processed outer, thin-walled tube.

As pointed out in connection with the description of Fig. 1, a finished tube with an internal seam lock has the portion adjacent to the outwardly bent edge extending outwardly in abutment with the bend of the inwardly bent edge. The portion referred to is designated in Fig. 1 by reference numeral 21. Before the operation of bending this portion outwardly is performed, there is no complete seam lock, but merely an inter-engagement of the oppositely bent edges, as indicated at 46 in the outer tube 47 shown in Fig. 8. The tube 47 is not cylindrical in the condition shown in Fig. 8, as one portion 48 of the wall of tube 47 is displaced from the adjacent portion 49.

Into the tube 47 is inserted the relatively thick-walled reinforcing tube 51 which has a cross-sectional contour similar to that of tube 31 of Fig. 4, which may be described as substantially helical. The free edge 52 is displaced inwardly from free edge 53, in order that tube 51 may enter tube 47 loosely, and for the additional reason that, tube 47 being non-cylindrical and the seam lock being incomplete, only the edge 53 can be placed in engagement with the completed portion thereof.

The solid line portion of Fig. 9 shows the structure of Fig. 8 after a forming operation has been performed to carry the tube forming process forward to the extent that tube 51 snugly engages the interior of tube 47. There remains the operation of eliminating the offset between portions 48 and 49 of tube 47. This operation may be performed by means of a forming plug which acts on that portion of tube 51 which terminates with edge 52 to bring that edge into alignment with edge 53, thus bringing portion 48 of tube 47 into alignment with portion 49 and completing the seam lock and the confinement of that element between edges 52 and 53, as well as perfecting the cylindrical contour of the structure, all as shown in dotted lines in Fig. 9.

The difference between the method exemplified in Figs. 8 and 9, and those exemplified in the previously described figures, and the advantage thereover, is that a forming operation otherwise performed on the outer seam-locked tube, name-

ly, completing the seam lock and the cylindrical contour of the tube, is combined with the operation of expanding or shaping the loose-fitting internal tube into cylindrical contour in reinforcing engagement with the outer tube and in abutting relation with the seam lock. Thus, from the standpoint of manufacturing technique, an independent operation and the attendant handling are eliminated.

With reference to the shaping operations heretofore described, the statement has been made and repeated that a single forming plug or a plurality of such plugs may be employed to carry to completion the shaping of the internal tube, or where shaping operations are combined, the simultaneous shaping of the inner and outer tube. In describing the methods exemplified by Figs. 1, 2, and 3, by Fig. 6, and by Figs. 8 and 9, reference has been made in each instance to an intermediate stage and such intermediate stages are indicated in some of the enumerated figures of the drawing. This is not to be interpreted as implying that a separate forming operation, employing a separate shaping plug is involved in completing each step in the process. By means of a single forming plug, suitably tapered and otherwise contoured, there may be effected the steady shaping of tube 23 from the contour shown in Fig. 1 to that shown in Fig. 3, or the shaping of tube 35 through the several stages shown in Fig. 6, or the processing of the structure of Fig. 8 to achieve the structure shown in dotted lines in Fig. 9. Similarly the final structures represented in the other figures heretofore described may be achieved by continuous forming operations.

Attention is now directed to Fig. 10, wherein is disclosed a tubular structure in which internal rather than external surface characteristics are of primary concern. Accordingly, the thin-walled tube, fabricated from the chromium steel alloy or other material affording any desired characteristics, is the internal tube, as contrasted with previously described embodiments illustrated in the first nine figures of the drawing.

The reference numeral 61 designates a relatively thin-walled tube having a seam lock 62 similar to those previously described, but formed exteriorly of tube 61, whereby a substantially smooth cylindrical interior is afforded by the structure of tube 61. Since the nature of the interior of a tubular structure is of little importance unless such structure is to be used for the conveyance of fluids, it is probable that tube 61 will be used for such purpose, and therefore it is necessary for the tube to be fluid tight. Tube 61 may be made leakproof by brazing, soldering, or welding throughout its length along the locked external seam, indicated by the reference numeral 63. After tube 61 has been made fluid tight, it is inserted into a relatively thick-walled reinforcing tube 66 which, as in the case of the internal reinforcing tubes shown in the previously described figures, may be of mild steel or any other easily worked material which will afford rigidity. Tube 66 may be formed from sheet material, with the free longitudinal edges 67 spaced apart, and the spacing between edges 67 is preferably sufficient to permit tube 61 to enter tube 66 loosely. After tube 61 has been fitted to tube 66, the latter may be shaped, by means of a forming die, sizing die, or other suitable shaping device, to bring tube 66 into reinforcing engagement with tube 61, and to bring

free edges 67 into abutting relation with external seam lock. Tube 66 thus reinforces fluid conductive tube 61 and provides the necessary rigidity for it, and also confines seam lock 62 which, though exposed, provides its own reinforcement, due to the plural thicknesses of metal.

Fig. 11 shows a multiple tube structure similar to that shown in Fig. 10, except that it includes the equivalent of the feature by which the structure shown in Fig. 7 differs from that shown in Fig. 3. The tube 61 having external seam lock 62 rendered fluid tight at 63 is shown in Fig. 11 and is identical with the correspondingly numbered tube in Fig. 10. Reinforcing tube 68 differs from tube 66 in that adjacent to its longitudinal edges 69 it is provided with flanges 71 which overlie and enclose and protect seam lock 62, when tube 68 has been shaped to engage the surface of tube 61, in much the same manner that flanges 43 in Fig. 7 underlie and support seam lock 17. If desired, the narrow seam or groove between the edges of flanges 71 may be closed by any suitable process, such as welding.

Composite tubes in accordance with the invention may be bent into various permanent shapes on such radii as the nature of the metals employed will permit.

In the foregoing description, the reinforcing tube has, in each instance, been described as having its free edges abutting the sides of the seam lock of the thin-walled tube. This is considered the preferred construction, but the seam lock is a sufficiently permanent element that the thick-walled tube may, if desired, be dimensioned to engage the inner or outer surface of the thin-walled tube without actually engaging the seam lock.

It is to be understood that the terms "thin-walled" and "thick-walled" as used herein are purely relative, and that the principal and reinforcing tubes may be proportioned as desired. Since the invention primarily contemplates that metallic materials having such properties as will be desired in the seam-locked tubes will be costly by comparison with materials of which the reinforcing tubes may be made, and may be relatively difficult to form if thick, it is considered probable that the seam-locked tube will be as thin as practical considerations may dictate, and that the metallic body needed for rigidity will be supplied by the open seam tube.

The foregoing description of the assembly of the internal and external tubes and the shaping of one within or about the other has been premised on the condition that the internal and external tubes are previously formed separately and are fitted one to the other and shaped and sized to the desired condition. It should be clearly understood that such preforming of both tubes intended for a composite structure is not essential, but that the internal tubes may be preformed, and the external tubes formed around them from suitable sheets in such processing devices as presses or rolling machines, and such machine forming of the external tube around the internal may include the formation of the seam lock. By means of rolling machines, both tubes may, if desired, be fabricated simultaneously, in their proper interfitted relation, from sheets having suitable characteristics and thicknesses. It should also be understood that the shaping of the assemblies shown in the drawing, or the fabrication of one tube from sheet material about or within a preformed tube, or the simultaneous

shaping of two superposed sheets, may be accomplished in a draw bench.

The drawing heretofore described discloses cylindrical tubes exclusively, but it is not to be concluded that the invention is limited to cylindrical tubes and processes by which they may be produced. The invention contemplates tubular structures having any desired cross-sectional contour, such as oval, square, rectangular, triangular, etc., may be produced by any of the methods described herein.

At an early point in the foregoing description, there was set forth the probable use of chromium steel alloys for the fabrication of seam-locked thin-walled tubes in order that they may have desired properties, such as resistance to corrosion and durable luster. Such alloys are by no means the only alloys exhibiting those properties, nor are those properties the only ones which may be desired. It should therefore be understood that many other alloys, ferrous or non-ferrous, and containing various metals or combinations of metals, whereby various properties are exhibited, may be employed for the production of the sheets from which the thin-walled tubes are formed.

Although specific embodiments of the invention have been shown in the drawing and described in the specification, and specific methods by which such embodiments may be achieved have been outlined, it will be understood that the

invention is not limited to such embodiments and methods, but that it is capable of modification and substitution, as to structures and methods, within the scope of the appended claim.

What is claimed is:

- 5 A method of making composite tubular structures which comprises forming sheet metal into a tubular element and interfolding the longitudinal edges tightly to the extent of forming a partially complete seam lock with the oppositely presented portions of said element adjacent to said lock disposed at different radial distances from the center of each element, forming from other sheet metal a substantially tubular element 10 having the free longitudinal edges spaced apart and dimensioned to enter the first tubular element freely without being compressed, inserting the substantially tubular element into the first tubular element, and shaping and expanding the 15 internal tubular element into surface engagement with the external tube and simultaneously shaping the first mentioned tubular element into cylindricity, completing the seam lock by bringing the portion of the first element of lesser radial distance into the same radial distance from the center of the element as the oppositely presented portion and confining said lock between the free edges of said internal tubular element 20 to securely retain the first mentioned edges in interfolded relation.

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