April 13, 1965 F. E. BIALAS 3,177,694

MEANS OF MINIMIZING RIB PROJECTION ON ROLLED TUBE

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FIG.1.

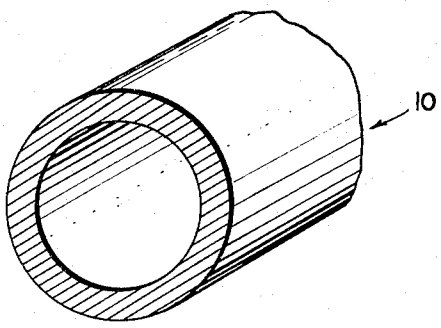


FIG.2.

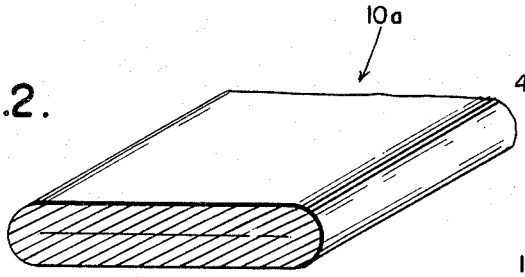


FIG.3.

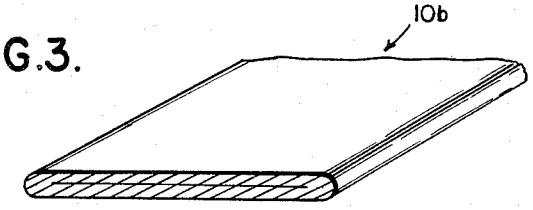


FIG.4.

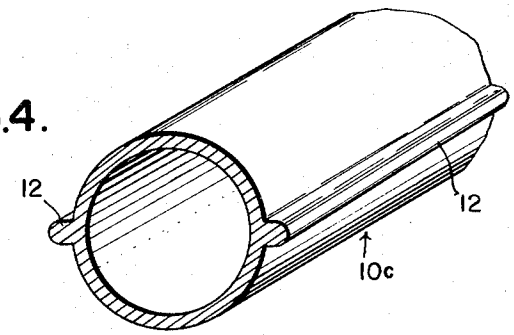
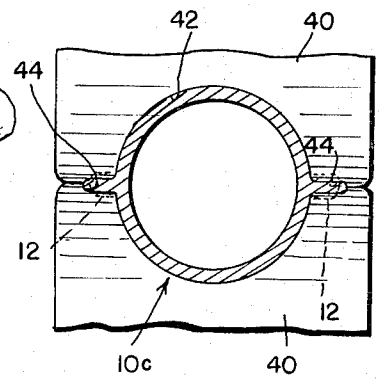


FIG.18.



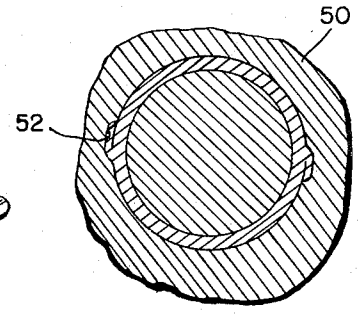


FIG.19.

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FIG.5.

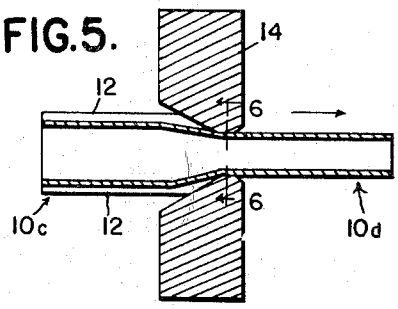


FIG.6.

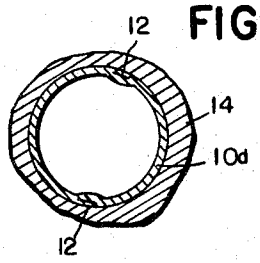


FIG.7.

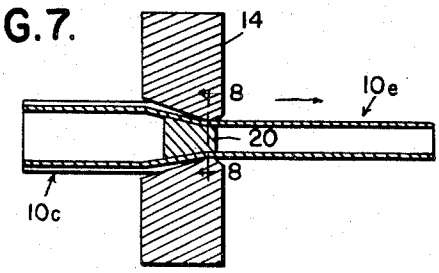


FIG.8.

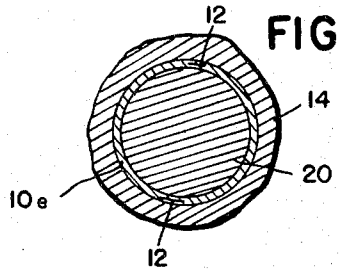


FIG.9.

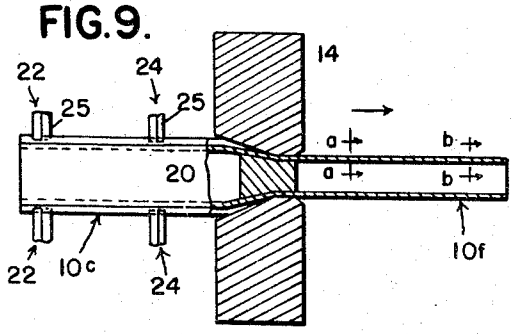


FIG.10a.

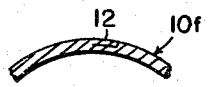
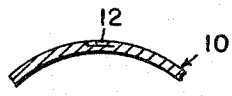


FIG.10b.



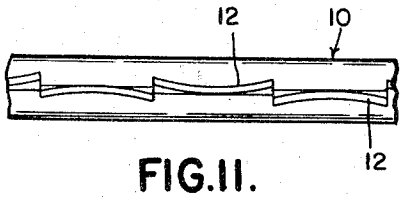


FIG.11.

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MEANS OF MINIMIZING RIB PROJECTION ON ROLLED TUBE

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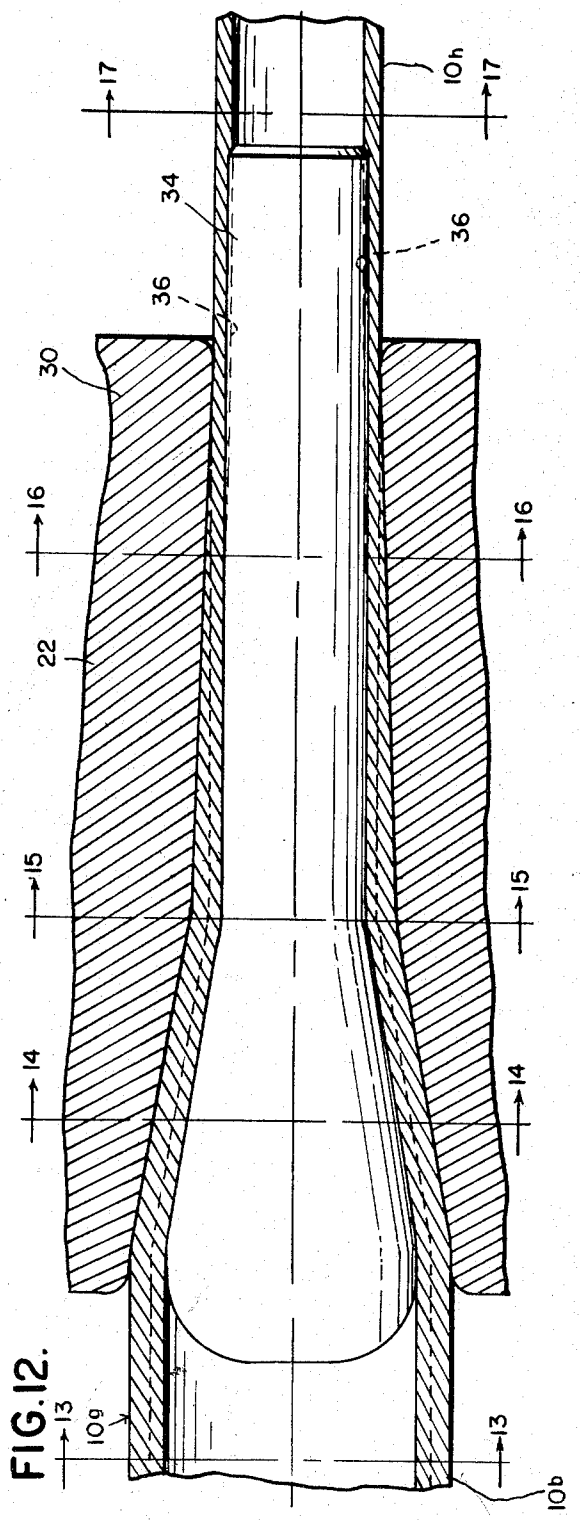


FIG.12.

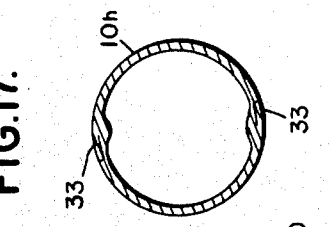


FIG.17.

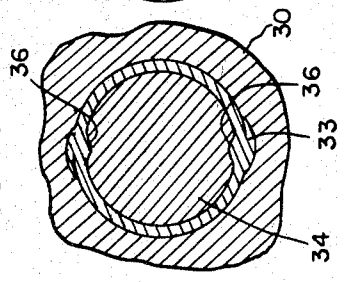


FIG.16.

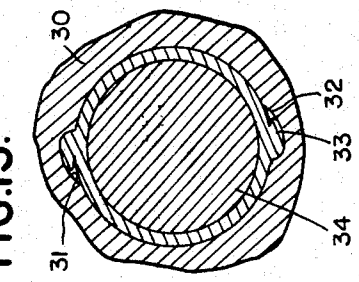


FIG.15.

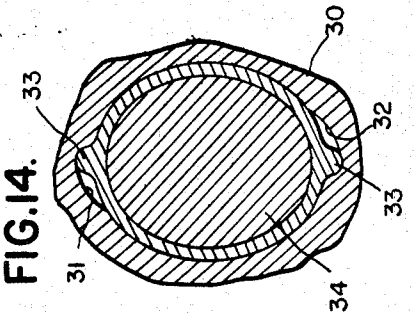


FIG.14.

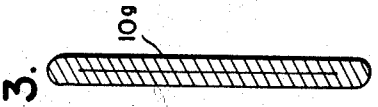


FIG.13.

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MEANS OF MINIMIZING RIB PROJECTION ON ROLLED TUBE

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Filed Mar. 28, 1960, Ser. No. 18,014
24 Claims. (Cl. 72—358)

The present invention relates to a method of and apparatus for minimizing rib projection on rolled tube.

When metallic tubes are produced by flattening, roll reducing, and subsequent reforming into tubular shape, two diametrically opposite ribs are formed as an integral part of the finished product. In some applications these ribs are not particularly desirable, and it is therefore advisable to significantly reduce or minimize the rib projection.

Accordingly, one object of the invention is to provide a method and apparatus for significantly reducing or minimizing the rib projection on a rolled tube.

Another object of the invention is to provide a method of and means for significantly reducing or minimizing the rib projection on a rolled tube while at the same time elongating and reducing the outside diameter of the tube.

A further object of the invention is to provide means, preferably in the form of a draw die, to fold both ribs flat against the wall of the tube, and in some instances to press the ribs into the metal of the tube wall to eliminate partially or altogether any projecting surface.

Another object of the invention is to provide, in structure as described above, a mandrel for supporting the tube in opposition to the draw die and thereby determine the interior configuration of the tube.

A still further object of the invention is to provide means for reducing the thickness of the ribs before they are folded flat against the wall of the tube.

Another object of the invention is to provide means which may include a draw die and an internal supporting mandrel for reforming a flattened and roll-reduced tube to tubular shape and at the same time minimizing the rib projection.

Other objects of the invention will become apparent as the following description proceeds, especially when taken in conjunction with the accompanying drawings, wherein:

FIG. 1 is a sectional view in perspective of a length of tubing.

FIG. 2 is a sectional view in perspective of the tube after it has been flattened.

FIG. 3 is a sectional view in perspective of the flattened tube after it has been roll-reduced.

FIG. 4 is a sectional view in perspective of the tube expanded to tubular shape.

FIG. 5 is a longitudinal sectional view of the expanded tube shown being drawn through a die to minimize the rib projection and simultaneously elongate and reduce the outside diameter of the tube.

FIG. 6 is a sectional view on the line 6—6 of FIG. 5.

FIG. 7 is similar to FIG. 5 but shows in addition a mandrel or pin for determining the inside shape of the tube.

FIG. 8 is a sectional view on the line 8—8 of FIG. 7;

FIG. 9 is like FIG. 7 but shows another modification.

FIGS. 10*a* and 10*b* are sectional views on the lines *a*—*a* and *b*—*b*, respectively, of FIG. 9.

FIG. 11 is an edge view of one of the ribs acted on by the cutters.

FIG. 12 is a longitudinal sectional view illustrating a further modification in which the flattened and roll-reduced tube is expanded to tubular shape and the rib projections are simultaneously minimized.

FIGS. 13, 14, 15, 16 and 17 are sectional views taken on the lines 13—13, 14—14, 15—15, 16—16 and 17—17, respectively, of FIG. 12.

FIG. 18 is a sectional view of the expanded tube of FIG. 4 passing through a set of rollers to reduce the thickness of the ribs prior to their being folded against the wall of the tube.

FIG. 19 is a sectional view showing the reformed tube with the reduced ribs passing through a suitable die for minimizing the rib projection.

Referring now more particularly to the drawings, there is illustrated in FIG. 1 a length of metallic seamless tubing generally indicated at **10** suitable for flattening, roll-reducing, and subsequent expanding to tubular shape. The tube is shown at **10***a* after flattening, and at **10***b* after the flattened tube has been reduced in wall thickness and elongated by rolling. The width of the flattened tube is not increased by roll-reducing. The flattened and reduced tube is thereafter expanded to the form of FIG. 4 as by passing the same between a pair of rolls arranged and constructed to impose a compression force on opposite edges thereof. It is of course necessary to spread apart the flattened walls at the leading end before introducing the tube into the expanding rolls.

As seen in FIG. 4, the expanded tube **10***c* has a pair of integral diametrically opposed ribs **12**, twice as thick as the tube wall, which are produced as an inherent result of the roll-reducing and subsequent expanding to tubular shape. The ribs **12** are in many instances undesirable, and therefore, frequenty it is necessary to reduce or minimize the rib projection.

In order to accomplish the subsequent reduction or complete elimination of the rib projection, the apparatus shown in FIGS. 5 and 6 may be employed. As there shown, a draw die **14** is provided having a die opening of progressively decreasing diameter toward the reduced or constricted outlet end of the die. All sections of the die opening are circular, although of varying diameter. As the tube **10***c* is drawn through the die in the direction of the arrow, it is elongated and reduced in outside diameter. This process is known as "sinking." The drawn tube is shown at **10***d* and it will be seen that the ribs are pressed flat against the tube wall by the die. The ribs are pressed into the metal of the tube so that the outside shape is circular although the inside, while mainly circular, bulges in at the ribs. Before entering the die, the ribs at the leading end of the tube should be bent to one side or the other so that the die will be effective to fold and flatten the ribs progressively as the tube is drawn therethrough.

The die of FIG. 7 is exactly like the one shown in FIG. 5 although a floating pin or mandrel **20** is employed to control the internal shape of the tube. All cross sections of the pin are circular and it will be seen that the inside of the finished tube **10***e* is likewise circular, as is the outside.

It will be understood that while the die **14** in FIGS. 5 and 7 has a circular die opening, the opening may have a cross section such as shown in FIG. 19, wherein it would be relieved by longitudinal grooves at diametrically opposite points to partially or wholly accommodate the folded ribs, in which event the ribs will project above the circular periphery of the finished tube.

FIG. 9 shows a draw die and mandrel of pin exactly like that shown in FIG. 7, and in addition cutters **22** and **24** are provided. Each cutter has blades **25** on either side of the rib, with the blades of cutters **22** reversed with respect to the blades of cutters **24**. The blades are operated by means not shown and they may act together if desired. The blades of the cutters sever or clip the

ribs at spaced intervals of their length as the tube moves toward the die. The blades of cutters 22 bend the leading edge of the severed rib section to one side and the blades of cutters 24 bend the leading edge of the severed rib section to the other side. Hence, when the rib sections enter the die they are alternately folded or flattened to opposite sides. The cutters may be operated at timed intervals by suitable mechanism not shown. FIGS. 10*a* and 10*b* show the finished tube 10*f* with the rib sections folded oppositely, and FIG. 11 shows the ribs after severing and before entering the die.

FIGS. 12–17 show another embodiment of the invention in which the flattened and roll-reduced tube 10*g* is expanded to tubular shape and at the same time the ribs are folded and flattened. This is accomplished by drawing the flattened and reduced tube 10*g* through a die 30, the opening of which varies from a somewhat oval shape at the entrant end (FIG. 14) to a circular configuration toward the outlet end (FIGS. 15 and 16). The die is also formed with a pair of diametrically opposed recesses 31 and 32 in its opening which extend from the entrant end to the outlet end and which are progressively shallower in depth until at the outlet end they completely disappear.

The recesses 31 and 32 are each shown in FIGS. 14 and 15 as providing a space to one side only of the rib 33, the portion of the recess at the other side bearing against the rib. As the recess diminishes toward the outlet, it is inclined to force the recess laterally toward the open space, that is to the left in the drawings, thereby bending the rib while simultaneously flattening the same against the tube wall. FIG. 16 shows the flattened rib partially embedded, and FIG. 17 shows it entirely embedded.

A mandrel 34 is employed to internally support the tube within the die, the cross sectional shape of the mandrel varying to correspond with that of the die opening, except that the mandrel is provided with recesses only near the outlet end thereof where the diametrically opposed longitudinal recesses 31 and 32 disappear.

Thus, the recesses 31 and 32 in the die opening accommodate the opposite edges of the flattened tube, which edges define the ribs 33 as the tube is progressively opened out. The diminishing character of the recesses 31 and 32 progressively laterally bends the ribs (FIGS. 14–16) and flattens them as the tube is drawn through the die, and the longitudinal recesses 36 in the mandrel are provided to allow the interior surface of the tube to deform slightly as the ribs are pressed into the metal of the tube. Otherwise the inside of the finished tube 10*h* is circular, and the outside is entirely circular. The recesses 36 in the mandrel might be eliminated in which event the interior of the drawn tube would be circular.

Referring to FIGS. 18 and 19, it is sometimes desirable to first reduce the thickness of the ribs of the expanded tube before the ribs are pressed flat against the tube wall. To accomplish this the expanded tube 10*c* may be passed between a pair of rollers 40 having peripheral half-circular grooves 42, the roll peripheries closely approaching one another so that the grooves 42 define a substantially circular opening for the tube. The roll peripheries at opposite edges of the groove 42 are relieved as at 44, and the relief areas cooperate to form recesses for receiving the ribs 12. The recesses are, however, substantially narrower than the ribs so that the ribs are substantially reduced in thickness as the tube is passed between the rolls. The recesses are greater in width than the height of the ribs so that the reduced ribs are raised slightly. The wall of the the tube is not affected by the rolling action. The ribs 12 are shown in dotted lines in FIG. 18 before reduction.

Thereafter the tube may be passed through a die 50 similar to the die 14 shown in FIGS. 5, 7 and 9 during which time the ribs are flattened against the wall of the tube, and due to their reduced thickness, provide a very insignificant projection. A mandrel or pin, similar to the one shown in FIG. 7 may be provided to insure a smooth circular interior. Also the die opening may have longitudinal, diametrically opposed diminishing grooves 52 to wholly or partially accommodate the ribs, whereby they project from the circular exterior of the finished tube. The ribs may be initially bent to one side at the leading ends before entering the die, or the grooves may be so formed, as grooves 31 and 32 in FIGS. 12–17, to control and promote the bending. It might also be said that where longitudinal grooves are employed in a die such as shown at 14 in FIGS. 5–9, the grooves may be formed according to the teaching of FIGS. 12–17 in which they not only diminish toward the outlet end of the die opening but also promote and control bending.

The drawings and the foregoing specification constitute a description of the improved means of minimizing rib projection on rolled tube in such full, clear, concise and exact terms as to enable any person skilled in the art to practice the invention, the scope of which is indicated by the appended claims.

What I claim as my invention is:

1. A method of reducing rib projection on tube having diametrically opposite longitudinal ribs projecting outwardly from the surface thereof, comprising the steps of reducing the thickness of said ribs by rolling, and then laterally bending said ribs and applying a radially compressive force thereon to flatten the ribs against and at least partially embed the same into the surface of the tube.

2. A method as defined in claim 1 including interiorly supporting said tube wall inwardly of the point of application of said compressive force.

3. A method of forming expanded tube having reduced rib projection from a length of tubing in which the side walls are pressed flat against each other, comprising imposing a continuously longitudinally moving compressive force along the opposite edges of the flattened length of tubing to progressively spread the flattened sides thereof to expanded shape and simultaneously to progressively flatten the diametrically opposite ribs developed upon expansion of the tube, and interiorly supporting the tube in opposition to the compressive forces along the opposite edges thereof.

4. Apparatus for reducing rib projection on a tube having diametrically opposite longitudinal ribs projecting outwardly from the surface thereof, comprising a die having a die opening through which the tube is longitudinally movable, said die opening having diametrically opposite surfaces spaced apart a lesser distance than the maximum spacing of said ribs so as to have a continuous engagement with said ribs during such relative longitudinal movement and to impose thereon a radial compressive force sufficient to laterally bend and at least partially imbed the same into the surface of the tube.

5. Apparatus as defined in claim 4 including a mandrel within the die opening for determining the internal shape of the tube.

6. Apparatus for reducing rib projection on a tube having diametrically opposite longitudinal ribs projecting outwardly from the surface thereof, comprising a die having a die opening through which the tube is longitudinally movable, the opposite sides of said die opening being provided with surfaces having a continuous engagement with said ribs during such relative longitudinal movement to impose thereon a radial compressive force sufficient to laterally bend and at least partially imbed the same into the surface of the tube, and means at the entrant side of said die opening for laterally bending the leading edges of said ribs to one side and the other prior to entering the die opening.

7. Apparatus for reducing rib projection on a tube having diametrically opposite longitudinal ribs projecting outwardly from the surface thereof, comprising a die having a die opening through which the tube is longitudinally movable, the opposite sides of said die opening

having a continuous engagement with said ribs during such relative longitudinal movement to impose thereon a radial compressive force sufficient to laterally bend and at least partially imbed the same into the surface of the tube, and longitudinally spaced cutters at the entrant side of said die opening for cutting said ribs into sections and for bending the leading edges of said cut sections alternately to one side and the other prior to entry into the die opening.

8. Apparatus for reducing rib projection on a tube having diametrically opposite longitudinal ribs projecting outwardly from the surface thereof, comprising a die having a die opening through which the tube is longitudinally movable having a continuous engagement with said ribs during such relative longitudinal movement to impose thereon a radial compressive force sufficient to laterally bend and flatten the same into the surface of the tube, and longitudinally spaced cutters at the entrant side of said die opening for cutting said ribs into sections and for bending the leading edges of said cut sections alternately to one side and the other prior to entry into the die opening.

9. Apparatus for reducing rib projection on a tube having diametrically opposite longitudinal ribs projecting outwardly from the surface thereof, comprising a die having a die opening through which the tube is longitudinally movable, said die opening being smaller in diameter than the tube to reduce and elongate the same and having diametrically opposite surfaces adapted to have a continuous engagement with said ribs during such relative longitudinal movement to impose thereon a radial compressive force sufficient to laterally bend and at least partially imbed the same into the surface of the tube.

10. Apparatus as defined in claim 9 in which the surfaces of said die opening engageable with said ribs are in the form of longitudinal grooves which progressively decrease in depth toward the exit end of said opening so shaped in cross-section as to progressively bend and at least partially imbed said ribs as aforesaid.

11. Apparatus for reducing rib projection on a tube having diametrically opposite longitudinal ribs projecting outwardly from the surface thereof, comprising a die having a die opening through which the tube is longitudinally movable having a continuous engagement with said ribs during such relative longitudinal movement to impose thereon a radial compressive force sufficient to laterally bend and flatten the same into the surface of the tube, and means at the entrant side of said die opening for laterally bending the leading edges of said ribs to one side or the other prior to entering the die opening.

12. Apparatus for expanding a flattened tube and simultaneously reducing projection of the diametrically opposite ribs developed by the expansion of the tube, comprising a die having a die opening which is narrow at the entrant end and becomes progressively wider toward its exit end, a mandrel extending longitudinally within said opening and generally corresponding in shape thereto to determine the inside shape of a tube expanded from flattened condition by drawing through said opening and over said mandrel, opposite surfaces of said die opening being continuously engageable with said ribs to impose sufficient radial compressive force thereon to flatten said ribs with respect to the surface of the expanded tube.

13. Apparatus as defined in claim 12 in which the opposite sides of said mandrel are relieved to allow an inward bulge of tube material radially inwardly of said ribs.

14. Apparatus as defined in claim 12 wherein the surfaces of said die opening engageable with said ribs are in the form of longitudinal grooves which progressively decrease in depth toward the exit end of said opening and are circumferentially inclined to progressively bend and at least partially imbed said ribs in the surface of the expanded tube, and the opposite sides of said mandrel opposed to said grooves are relieved near the exit end of the die opening to allow an inward bulge of tube material radially inwardly of the ribs.

15. Apparatus for expanding a flattened tube and simultaneously reducing projection of the diametrically opposite ribs developed by the expansion of the tube, comprising a die through which the tube is longitudinally movable, said die having diametrically opposite grooves which gradually approach one another toward the exit end of the die and which engage opposite edges of the tube during longitudinal movement of the tube through the die to impose a compressive force on said opposite edges sufficient to progressively spread the flattened sides of the tube to expanded shape, said grooves progressively decreasing in depth toward the exit end of the die to progressively flatten the ribs developed upon expansion of the tube with respect to the surface of the expanded tube.

16. A method of forming expanded tube having reduced rib projection from a length of tubing in which the side walls are pressed flat against each other, comprising the steps of positioning said tube coaxially within and axially moving the same with respect to a die having diametrically opposite surfaces which gradually approach one another toward the exit end of the die and which engage and impose a compressive force on the opposite edges of the tube to progressively spread the flattened sides thereof to expanded shape and simultaneously to progressively laterally bend and flatten the diametrically opposite ribs developed upon expansion of the tube, and interiorly supporting said tube in opposition to the compressive forces on the opposite edges thereof.

17. A method of reducing rib projection on a tube having longitudinal ribs projecting from the surface thereof, comprising the steps of reducing the thickness of said ribs by rolling, and then applying a radial compressive force on said ribs to flatten the same with respect to the surface of the tube.

18. Apparatus for reducing rib projection on a tube having diametrically opposite longitudinal ribs projecting outwardly from the surface thereof, comprising a die having a die opening through which the tube is longitudinally movable, and die opening having diametrically opposite confronting surfaces spaced apart a lesser distance than the maximum spacing of said ribs to have a continuous engagement with said ribs during such relative longitudinal movement and to impose thereon a radial compressive force sufficient to flatten said ribs with respect to the surface of the tube.

19. The apparatus defined in claim 18, including a mandrel within said die opening to interiorly support said tube in opposition to the radially compressive forces thereon.

20. Apparatus for reducing rib projection on a tube having diametrically opposite longitudinal ribs projecting outwardly from the surface thereof, comprising a die having a die opening through which the tube is longitudinally movable, said die opening having diametrically opposite confronting grooves spaced apart a lesser distance than the maximum spacing of said ribs to have a continuous engagement with said ribs during such relative longitudinal movement and to impose thereon a radial compressive force sufficient to flatten said ribs with respect to the surface of the tube.

21. The apparatus defined in claim 20, wherein said grooves extend longitudinally through said die opening and progressively decrease in depth toward the exit end of the die opening.

22. The apparatus defined in claim 21, wherein said grooves are laterally inclined to bend said ribs sidewise during flattening thereof.

23. A method of reducing rib projection on a tube having diametrically opposite longitudinal ribs projecting from the surface thereof, comprising the steps of po-

sitioning the tube coaxially within a die opening having opposed confronting surfaces spaced apart a lesser distance than the maximum spacing of said ribs for engaging said ribs at limited points in the length thereof under pressure sufficient to flatten the ribs at the points of engagement therewith, and relatively axially moving said tube and die opening to correspondingly move the points of pressure engagement of said die surfaces with said ribs and thereby progressively flatten the ribs.

24. The method defined in claim 23, including interiorly supporting the tube at the points of pressure engagement.

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