

Aug. 16, 1966

E. JENSEN

3,266,285

PRODUCTION OF TUBING

Filed Jan. 25, 1963

4 Sheets-Sheet 1

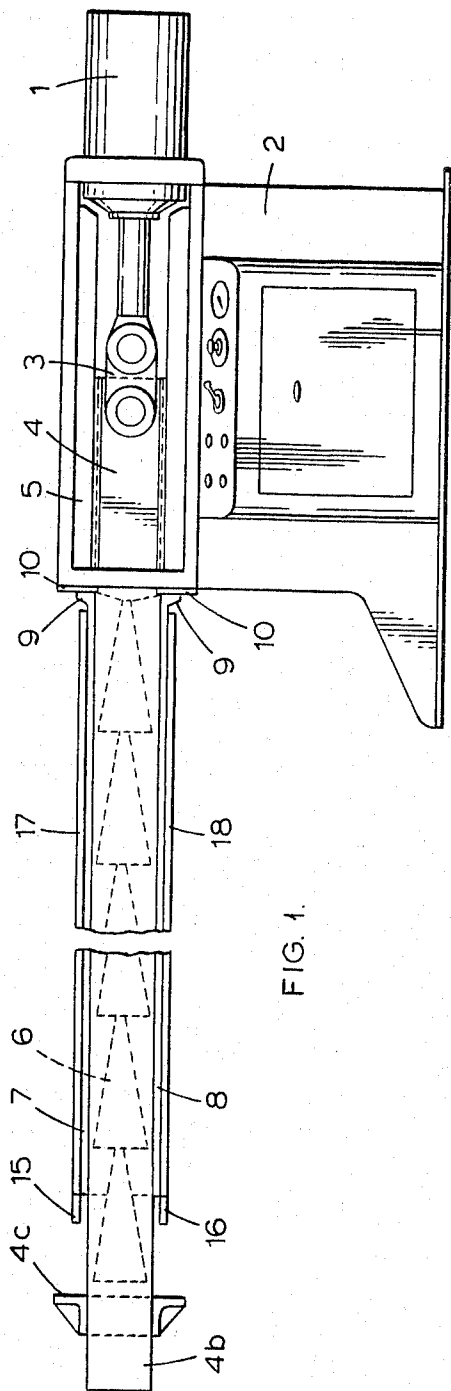


FIG. 1.

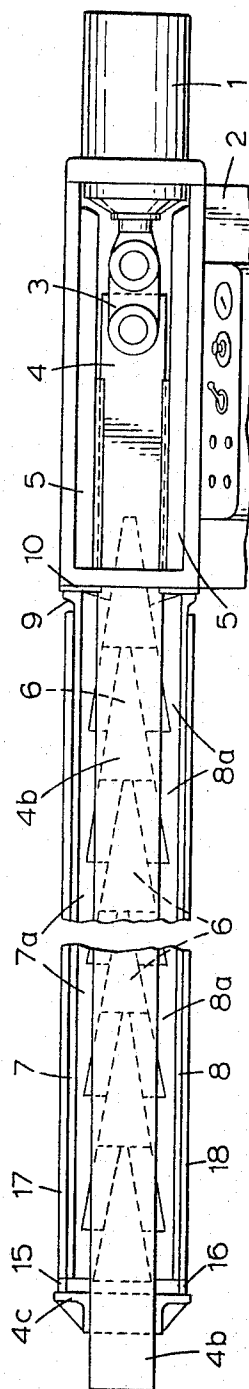


FIG. 2.

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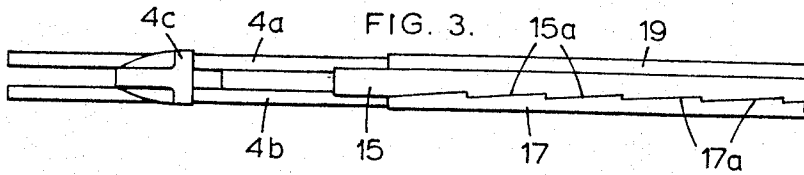
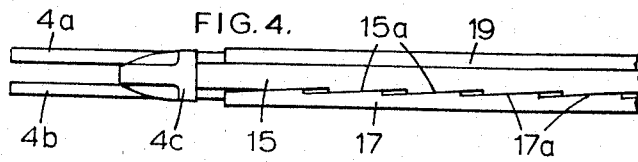
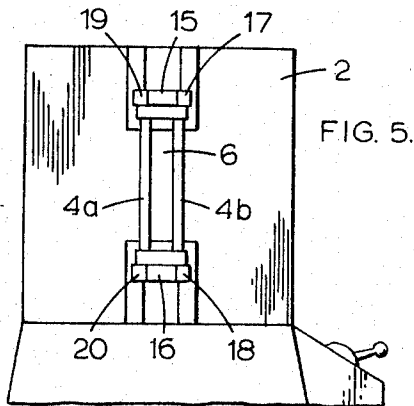
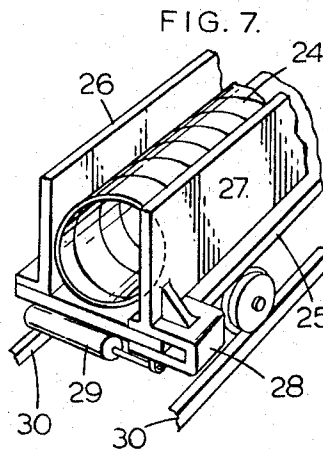
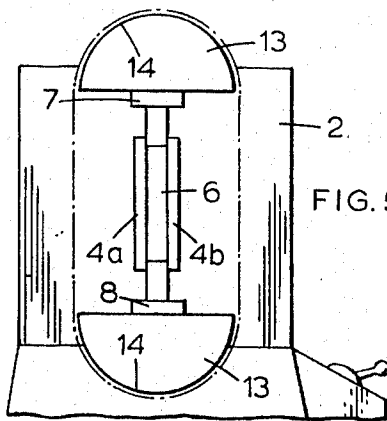
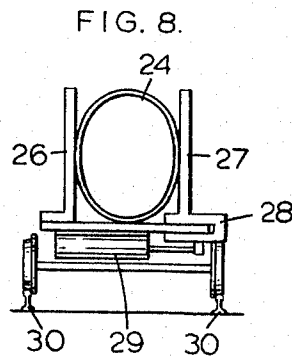
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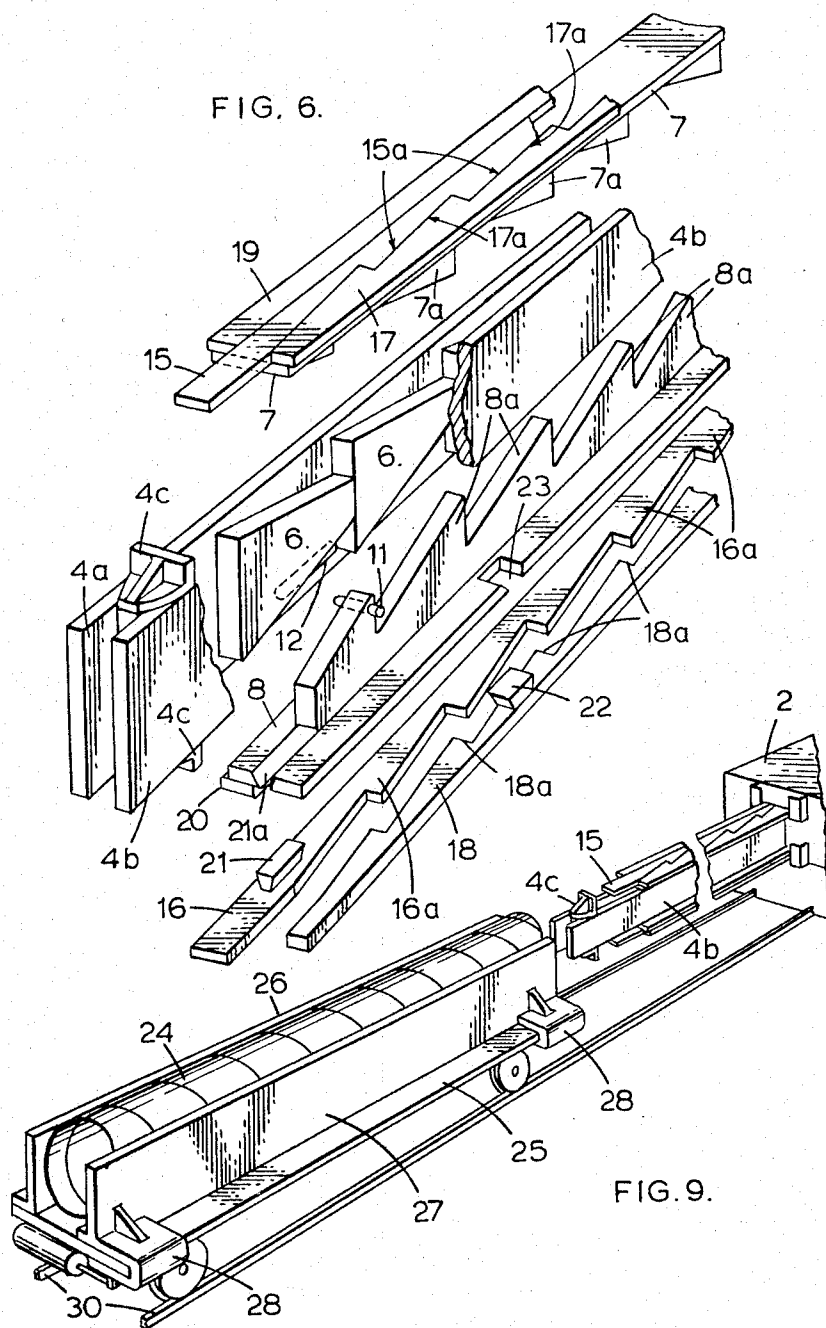
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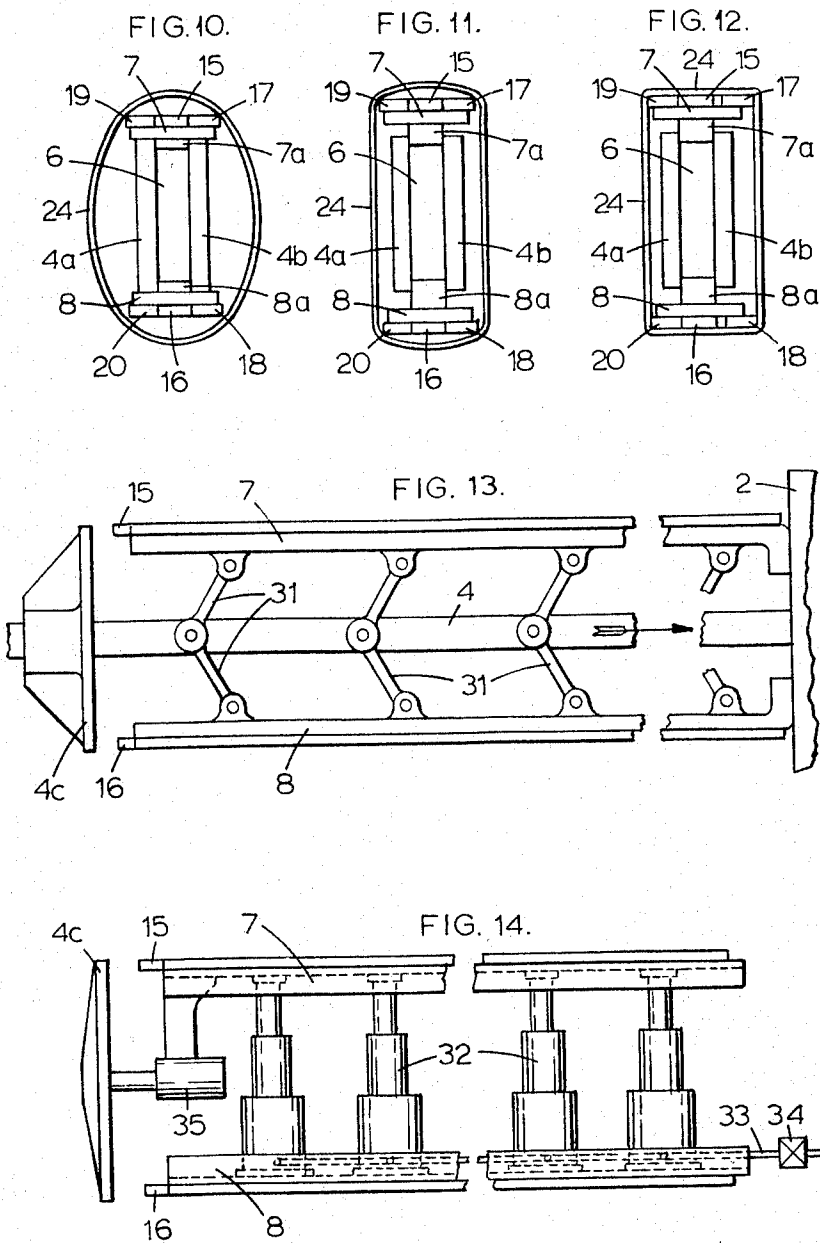
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PRODUCTION OF TUBING

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Claims priority, application Great Britain, Jan. 26, 1962,

3,129/62

14 Claims. (Cl. 72-304)

This invention relates to the production of tubing involving the conversion of circular section tubing into rectangular or other non-circular section tubing. For example, the present invention is most useful for extending the field of use of helical seam sheet metal tubing such as produced by machines in which continuous strip metal is fed through or around a head provided with means or shaped to cause the strip metal to follow a helical path with its edges brought together and pinched at its marginal parts into interlocking mating parts to form the helical seam or welded at its contact helical edge. Helical lock seam tubing to which the present invention is suited for the conversion mentioned aforesaid, may be that produced by the machine described in British Patent No. 830,504.

Although the present invention is concerned with the conversion of helical lock seam tubing into quadrilateral or other non-circular section tubing its use may be extended to the conversion of plain cylindrical tubing, particularly as the requirements for treating plain cylindrical tubing are not so exacting as for the treatment of helical lock seam tubing in which in applying to the tubing for deformation stresses the non-circular section end product must retain substantially the same rigidity and closeness of the lock seam as in its cylindrical form. Consequently, in effecting the conversion the deformation stresses must be so applied as to prevent unlocking or weakening of the lock seam or of the sheet metal particularly at the corners or acute bends. An object of the present invention is to provide a method of and means for converting helical lock seam tubing, as well as plain cylindrical tubing, into non-circular section tubing with negligible weakening of the tubing.

In accordance with the present invention a method of converting circular section sheet metal tubing into non-circular section tubing comprises locating the circular section tubing with an easy fit along an expansible mandrel extending the length of the tubing, and expanding said mandrel uniformly throughout the length of the tubing so as to deform the tubing into the desired non-circular cross-section by internally applied pressure of the mandrel, restoring the mandrel to or towards the tube-receiving condition and effecting relative axial movement between the tubing and the mandrel to withdraw the tubing from the restored mandrel.

Further in accordance with the present invention apparatus for converting circular section sheet metal tubing into non-circular section tubing comprises a mandrel which comprises at least one pair of formers having a length at least equal to the length of tubing to be converted into non-circular section and displaceable apart in a direction normal to the axis of the mandrel to apply inwardly to the tubing an outward deforming pressure, and power actuated means operating to effect the displacement apart of the formers.

In order that the invention may be clearly understood, and readily carried into effect, drawings are afforded hereto illustrating embodiments thereof and wherein:

FIGURE 1 is a side elevation of one embodiment of the present invention, showing the use of an expansible mandrel having axially displaceable mandrel bars and relatively laterally displaceable tube engaging former bars, and in which the machine is shown in the condition ready

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to receive a circular section tube to be deformed into a quadrilateral section tube;

FIGURE 2 is also a side elevation but showing the formers of the mandrel fully displaced to the tube deforming positions;

FIGURE 3 is a broken detail plan showing an auxiliary mandrel carried by the formers, for obtaining a final stage deformation of the tube, this figure showing the condition of the former bars immediately following the actuation of the formers to the position shown in FIGURE 2;

FIGURE 4 shows the final condition of the auxiliary mandrel;

FIGURE 5 is a front end elevation corresponding to FIGURE 1;

FIGURE 5A is a diagrammatic end elevation showing the use of supplementary former heads for obtaining a non-circular section tube with two parallel opposed walls and two symmetrical arcuate section walls;

FIGURE 6 is an exploded perspective view showing the mandrel integers of the machine shown in FIGURES 1 to 4;

FIGURES 7 to 12, inclusive, show the successive stages in the operation involved in converting a circular section helical seam tube into a substantially rectangular section tube when employing the machine shown in FIGURES 1 to 4;

FIGURE 13 is a broken plan view showing another embodiment of the present invention, in which an expanding action is obtained through the medium of parallel link means; and,

FIGURE 14 is a broken perspective view showing a further embodiment of the invention.

Referring to FIGURES 1 to 4 and 6 to 12 of the drawings, the machine includes a hydraulic ram 1 mounted at one end on a horizontal axis on the rear end wall of a housing 2 supported on the floor. The piston rod of the hydraulic ram is connected by a link 3 to the rear end of a mandrel 4 (hereinafter described). The mandrel 4 is supported on channelled guides 5 for a length adequate to maintain the mandrel supported horizontally beyond the front end of the housing 2.

The mandrel 4 extends beyond the frame for a distance at least equal to and desirably slightly greater than the length of the tubing to be treated, e.g. ten feet. The mandrel 4 comprises a longitudinal pair of parallel bars 4a, 4b between which are secured fixedly, by suitable means, a succession of identical triangular shaped wedges 6, these wedges having their apices slightly truncated and directed towards the housing 2 and abutting end to end so that each wedge, excepting the leading one i.e. that at the housing-supported end of the mandrel, abuts by its apex against the base of the next wedge in succession. For normal purposes each wedge 6 may comprise a steel block the apex angle of which for one range of diameter of tubing to be worked may be approximately 20°, and for normal purposes approximately eight of these wedge members are employed. By reason of the wedge apices abutting against the successive bases thereof there is provided between the two parallel bars a succession of sloping steps arranged in inward relation to the upper and lower edges of the bars. However, the angle of the apices of the wedges and the number thereof may be varied depending upon the diameter and length of tubing being treated.

It will be apparent that each step comprises an inclined or ramp part comprising one inclined face of a triangular shape wedge, so that a longitudinal section taken through the succession of wedges produces the effect of a symmetrical double ratchet bar.

If desired a plurality of triangular members may be integral i.e. formed as a single ratchet bar.

Engaged over the upper and lower edges of the two parallel bars are a pair of T-section formers 7 and 8

which are free to be displaced away from each other in a symmetrical manner to effect the deformation of the tubing. For this purpose the central or vertical limbs 7a, 8a of the two formers are shaped along their opposed edges to mate in a co-planar manner with complementary inclined upper and lower edges of the wedge members 6. That is to say, each vertical limb of the T-section formers comprises a ratchet member which is complementary with the opposed ratchet or cam formation of the triangular wedges 6.

Each former thus comprises a longitudinal steel T-section member the horizontal or transverse limb part of which abuts against the opposed edges of the two bars 4a, 4b and affords by its outer face a plane surface to apply a flat or other desired deformation to the tubing to form one wall of the ultimate rectangular section tubing. Thus, assuming that the tube to be deformed into quadrilateral cross-section is fitted easily around the two formers 7 and 8, it will be apparent that movement apart of the formers will so deform the tube as to produce two parallel substantially flat side walls along the tube. From the foregoing, it will be seen that in accordance with the present invention conversion of circular section sheet metal tubing into quadrilateral section tubing is effected by the symmetrical displacement of the two formers 7 and 8, one upwards and the other downwards relative to the mandrel 4, such displacement being derived from the relative axial displacement of the mandrel and the pair of formers and the formation integral with the transverse portions of the formers of depending and up-standing wedge shaped limbs 7a and 8a which are complementary with the said steps formed in the mandrel by the said succession of triangular members 6.

When a tube is to be brought to square section the wedge shaped parts of the formers mate completely in the steps of the mandrel so that effective width vertically of the combined mandrel and formers is such that the tube may be passed freely thereover until the tube abuts against the locating face on said frame.

When deforming a tube, traction is applied to the mandrel so that the tube will tend to press axially against the appropriate part of the frame and, consequently, will be held firmly in position during the whole of the deforming operation. It will be understood that when the formers are in their tube-receiving position the piston rod of the hydraulic ram 1 is at its forward position with the piston at its nearest position in relation to the work.

The upper former 7 rests snugly on the mandrel 4 and, in common with the lower former 8, at its forward end (i.e. adjacent the frame 1) it is formed with a vertical web 9 slidable in a pair of channel guides 10. The other end of the lower former 8 may be supported from the mandrel 4 by suitable means enabling it to rise and fall in conformity with the axial displacement of the mandrel (see FIGURE 6), e.g. by means of a pin 11 passed through the tail end wedge element 8a and engaged in opposed slots 12 in the mandrel bars 4a and 4b.

It is desirable not to attempt to produce, solely by the separation movement of the formers 7 and 8, a quadrilateral tube with all sides substantially flat. In fact, for some classes of work it is sufficient to have two opposed flat walls and the other two walls of arcuate cross-section, such an end product being shown in FIGURE 5A in which the formers 7 and 8 are fitted with detachable heads 13 with semi-circular section profiles 14 so that the tube, indicated by broken lines, takes the latter mentioned configuration. However, it is also found that the horizontal limbs of the T-section formers 7 and 8 will not easily produce flat upper and lower walls in the tubing, these walls acquiring a large radius arcuate formation, and therefore means may be provided to introduce an auxiliary deformation of the tubing to obtain substantially flat upper and lower walls.

As shown in FIGURES 1, 3, 4 and 6, suitable auxiliary deforming means comprises a pair of auxiliary

mandrels each in the form of a flat member supported flush against the associated formers 7 and 8 respectively. The auxiliary mandrels comprise bars 15 and 16 and are formed with a unilaterally arranged succession of wedge profiles 15a and 16a which mate against complementary profiles 17a and 18a on upper and lower horizontally and laterally displaceable former bars 17 and 18 respectively. The auxiliary mandrel bar 15 is adapted to slide between a former guide bar 19 (fixed to a marginal part of the former 7) and the associated former bar 17, whilst likewise, the auxiliary mandrel bar 16 slides between a former guide bar 20 (fixed to the former 8) and the associated former bar 18.

The ends of the auxiliary mandrel bars 15 and 16 remote from the frame 1 extend slightly beyond the formers 7 and 8 as shown in FIGURES 1 and 3, and, not until the formers 7 and 8 have been separated to a substantial extent, are the auxiliary mandrel bars 15 and 16 displaced endwise to project the former bars 17 and 18 laterally relative to the formers 7 and 8 and thereby increase the separation of the vertical side walls of the tube to flatten the upper and lower walls, i.e. to remove the arcs from the upper and lower walls. The endwise displacement of the auxiliary mandrel bars 15 and 16 is effected by engaging their ends with an abutment plate 4c fixed to the mandrel 4 so that there is a lost motion between the mandrel 4 and the mandrels 15 and 16.

The lower auxiliary mandrel may be held in suspension from the lower former 8 (see FIGURE 6) by a dovetail block 21 affixed to the mandrel bar 16 and slidable in a slot 21a in the former 8, this expedient being adopted at both ends of the mandrel.

Likewise, the lower former bar 18 may have two or more dovetail blocks 22 slidable in complementary slots 23 in the former 8.

In FIGURES 7 to 12 is shown the preferred successive stages for converting a circular section helical seam tube into a rectangular section tube. The first operation is shown in FIGURE 7, in which the cylindrical tube 24 is supported on a wheeled carriage 25 between a pair of vertical side walls 26 and 27. The carriage 25 is used to receive the tube and offer it over to the aforesaid mandrel. However, it is preferred to assist the work by using the side walls 26 and 27 to impart an initial deformation to the tube and so reduce the required "stroke" of the mandrel 4.

The said initial deformation of the tube may be effected by mounting at least one side wall (e.g. the wall 27 as shown) to be slidable laterally on the base of the carriage 25 by means of slides 28 guided horizontally over the carriage bars and drawn towards the other wall 26 by hydraulic jacks 29 so that, as shown in FIGURE 8, the tube 24 is deformed to an oval cross-section.

As shown in FIGURE 9 the initially deformed tube is aligned with the mandrel 4 and the carriage 25 moved along rails 30 until the tube abuts against the opposed end of the frame 1. The relationship between the tube and the formers is now as shown in FIGURE 10. The mandrel bars 4a and 4b are now partially retracted by the jack 1 to produce the deformation of the tube shown in FIGURE 11, and it will be noted that the upper and lower walls of the tube are slightly arched. Ultimately, the complete retraction of the mandrel bars takes place drawing the abutment plate 4c against the projecting ends of the auxiliary mandrels 15 and 16 and thereby displacing the auxiliary former bars 18 and 19 laterally to draw the arched walls of the tube into substantially flat form as shown in FIGURE 12. With this method, at the final stage of the operation there is a simultaneous increase in the effective width of the combined former bars in a vertical and also a horizontal dimension.

The mandrel bars 4a and 4b are now returned to their "start" position to return the formers 7 and 8 to their "start" positions, and the auxiliary mandrel bars 15 and 16 by a light pull to their exposed ends restored to their

"start" position, whereupon the tube may be withdrawn easily from the forming means, it being understood that the carriage 25 was withdrawn once the tube is located fully home on the forming means.

Instead of a wheeled carriage 25, an overhead gantry of a hoist or similar load lifting and transporting means may be employed, in which event the side walls 26 and 27 would comprise load gripping jaws.

It will be understood that by appropriate selection of the apex angle of each wedge 6 an appreciable mechanical advantage is obtained in transmitting the energy of the prime mover or hydraulic ram 1 to the formers 7 and 8, whilst ensuring an easy progressive deformation of the tubing, and by employing the former bars 17 and 18 as hereinbefore described, such mechanical advantage is increased considerably, e.g. from 1:2 to 1:10.

It will be understood that the formers 7 and 8 may be adapted to receive selectively pairs of different widths of supplementary formers or heads, so that the formers 7 and 8 may be employed permanently for different diameters of tubing and different dimensions of walls of the polygonal section end product. In such an event, each distinctive pair of supplementary formers would carry correspondingly dimensioned auxiliary mandrels.

Instead of employing a series of triangular wedges 6, the forming apart of the formers 7 and 8 may be effected by connecting these formers to a mandrel bar 104 by means of parallel links 31 as shown in FIGURE 13, it being understood that with the formers 7 and 8 abutted against the frame 1 and the application of traction to the mandrel bar 104 in the direction of the arrow the formers 7 and 8 will be displaced symmetrically away from each other.

In the embodiment shown in FIGURE 14 the two formers 7 and 8 are supported by a plurality of telescopic hydraulic jacks 32 supplied by a line 33 connected via a valve 34 to a source of hydraulic fluid pressure and a return line. In this arrangement auxiliary mandrels 115 and 116 are operated by a separate hydraulic jack 35. The weight of the upper former 7 is sufficient to return it to its narrowest spaced relationship with the former 8 when the telescopic jacks 32 are connected by the valve 34 to exhaust. The lower former 8 in this arrangement would be fixedly secured at one end to the machine frame. Thus the former 8 acts also as a mandrel bar carrying the shaping means and supported on the machine frame.

I claim:

1. A method of converting circular section sheet metal tubing into non-circular section tubing, which comprises the steps of: effecting an initial flattening of the tubing, locating the initially flattened tubing upon an expansible mandrel with said mandrel extending inside the tubing throughout the entire length of the tubing, deforming the tubing further into the desired non-circular cross-section by expanding said mandrel uniformly throughout the length of the tubing, restoring the mandrel to release the tubing and separating the tubing from the restored mandrel by effecting relative axial movement between the tubing and the mandrel.

2. A method as claimed in claim 1, in which said initial flattening is effected by locating the tubing between a pair of spaced walls and moving said walls towards each other.

3. A method as claimed in claim 2, in which said locating step is performed while holding said initially flattened tubing between said spaced walls.

4. A method of converting circular section sheet metal tubing into non-circular section tubing, which comprises the steps of: locating the tubing upon an expansible mandrel with said mandrel extending inside the tubing throughout the entire length of the tubing, deforming the tubing to a section comprising an opposed pair of substantially flat parallel side walls joined by arcuate walls by expanding said mandrel in a first direction uniformly throughout the length of the tubing, deforming the tub-

ing further to a rectangular section by expanding said mandrel in a direction normal to said first direction, restoring the mandrel to release the tubing, and separating the tubing from the restored mandrel by effective relative axial movement between the tubing and the mandrel.

5. Apparatus for converting circular section sheet metal tubing into non-circular section tubing, comprising: a pair of spaced walls for receiving said tubing therebetween, means for moving said walls towards each other for effecting an initial flattening of the tubing, an expansible mandrel which comprises a pair of formers having a length at least equal to the length of tubing to be converted into non-circular section, and means for displacing said formers apart in a direction normal to the axis of the mandrel to apply inwardly of the initially flattened tubing an outward deforming pressure and for restoring the formers to their tube-receiving portions.

6. Apparatus as claimed in claim 5, in which a carriage is provided to carry said walls, which in turn carry the initially flattened tubing, and means are provided to move said carriage to the mandrel and to withdraw the carriage from the mandrel.

7. Apparatus as claimed in claim 5, in which said formers comprise heads of semi-cylindrical form.

8. Apparatus as claimed in claim 5, in which said mandrel comprises a mandrel bar and two series of wedge faces are provided on said bar, a series of complementary wedge faces is provided on each of said formers, and means are provided for effecting relative axial movement between said mandrel bar and said formers to displace said formers apart through the action of said wedge faces.

9. Apparatus for converting circular section sheet metal tubing into rectangular section tubing, comprising an expansible mandrel which comprises a pair of formers having a length at least equal to the length of tubing to be converted into non-circular section, means for displacing said formers apart in a first direction normal to the mandrel to apply inwardly of the tubing a first outward deforming pressure, two pairs of former bars mounted one pair on each of said formers, means for moving at least one of the bars of each pair to move the bars relatively apart in a second direction normal to said first direction and to said mandrel to apply to the tubing a second outward deforming pressure.

10. Apparatus as claimed in claim 9, in which a series of wedge faces is provided on each of said former bars which is movable and a mandrel bar formed with complementary wedge faces cooperates with said movable bar, and wherein said means for moving at least one of the bars comprises means for effecting relative axial movement between said mandrel bar and said one former bar to displace said former bar laterally under the action of said wedge faces.

11. Apparatus for converting circular section sheet metal tubing to non-circular section tubing, comprising: a pair of spaced walls for receiving said tubing therebetween, means for moving said walls towards each other for effecting an initial flattening of the tubing, an expansible mandrel which comprises a pair of parallel formers having a length at least equal to the length of the tubing, a mandrel bar extending between and parallel with said formers, a series of pairs of links having pivotal connection to the mandrel bar and to the formers, the pivotal connections of the links of each pair being in transverse alignment, and means for moving the mandrel bar and formers axially relative to each other to move the formers apart to apply to inwardly of the initially flattened tubing an outward deforming pressure in a direction normal to the mandrel.

12. Apparatus as claimed in claim 11, in which said formers comprise heads of semi-cylindrical form.

13. Apparatus for converting circular section sheet metal tubing to non-circular section tubing, comprising: a pair of spaced walls for receiving said tubing therebetween, means for moving said walls towards each other

for effecting an initial deformation of said tubing, an expansible mandrel which comprises a base former, a movable former parallel with said base former and having a length at least equal to the length of the tubing, a series of hydraulic jacks mounted on the base former and upon which the movable former is mounted, and a hydraulic power supply for actuating said jacks to effect hydraulically powered movement of the movable mandrel relative to said base former to apply inwardly of the initially flattened tubing an outward deforming pressure in a direction normal to said parallel formers.

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14. Apparatus as claimed in claim 13, in which said formers comprise heads of semi-cylindrical form.

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