United States Patent [19]

Brunken

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[54] **TUBE FORMING METHOD AND APPARATUS**

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[52] **U.S. Cl.**.....**72/176,** 72/181

[51] **Int. Cl.**.....**B21d 5/08**

[58] **Field of Search** ..72/176, 181, 182; 29/234, 330; 219/59, 8.5

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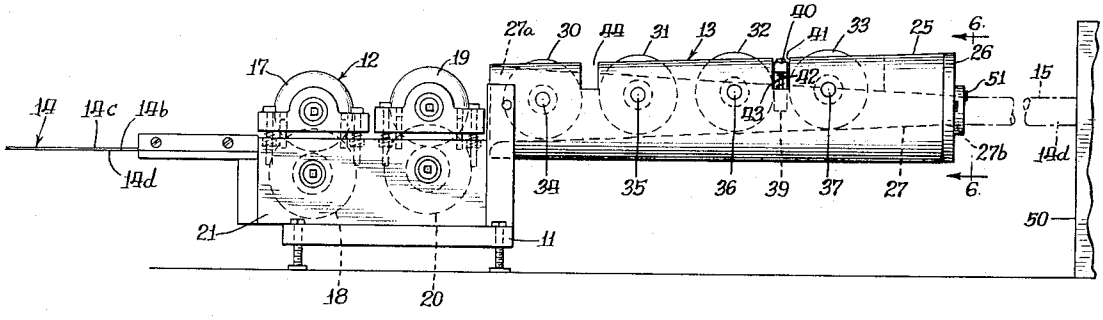
[57] **ABSTRACT**

A flat strip of metal moving lengthwise first has its edges turned up by roll-forming. Thereafter it moves into the large end of a horn and along one side of the horn so that that side gradually imposes an increasing curvature on the metal and at the exit end of the horn the metal is substantially cylindrical. A non-galling surface is used on the contact face of the horn. A pin between the edges of the sheet at the exit end of the horn orients the cylindrical tube.

10 Claims, 6 Drawing Figures



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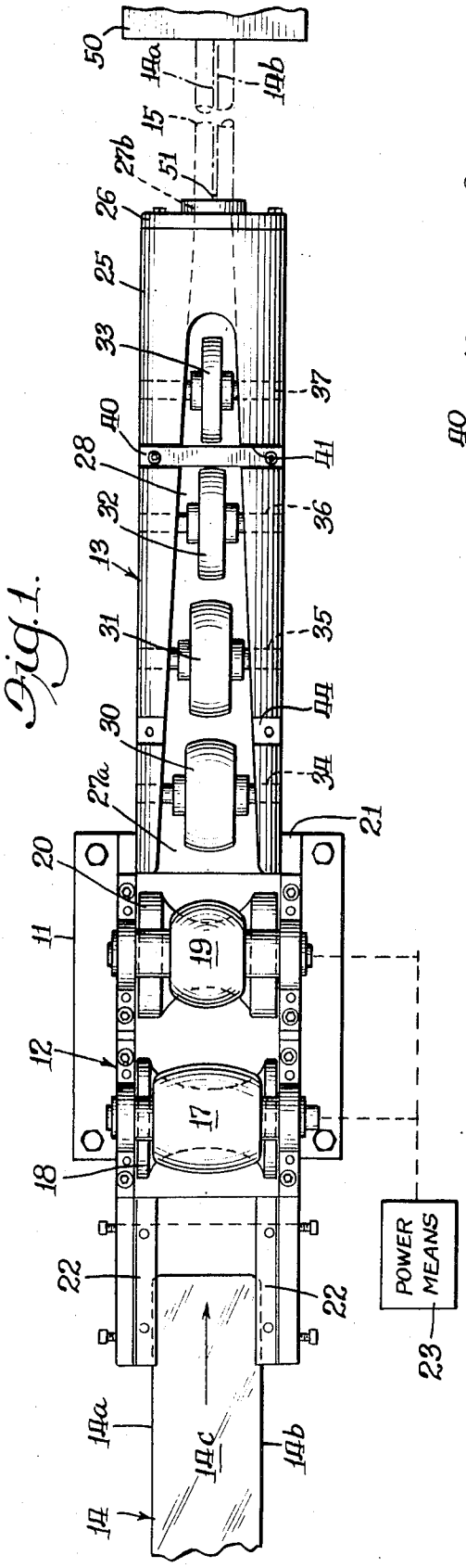

Fig. 1.

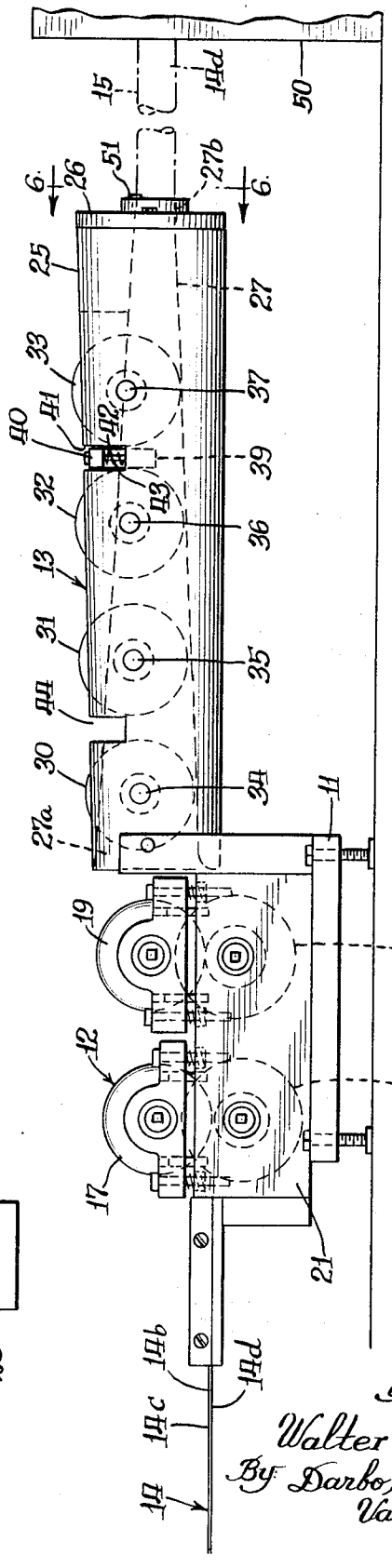

Fig. 2.

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Fig. 3.

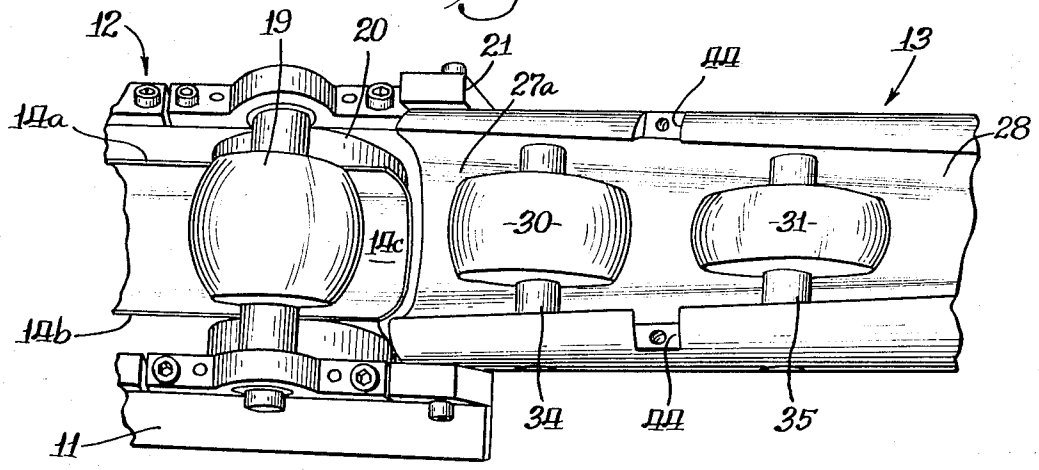


Fig. 4.

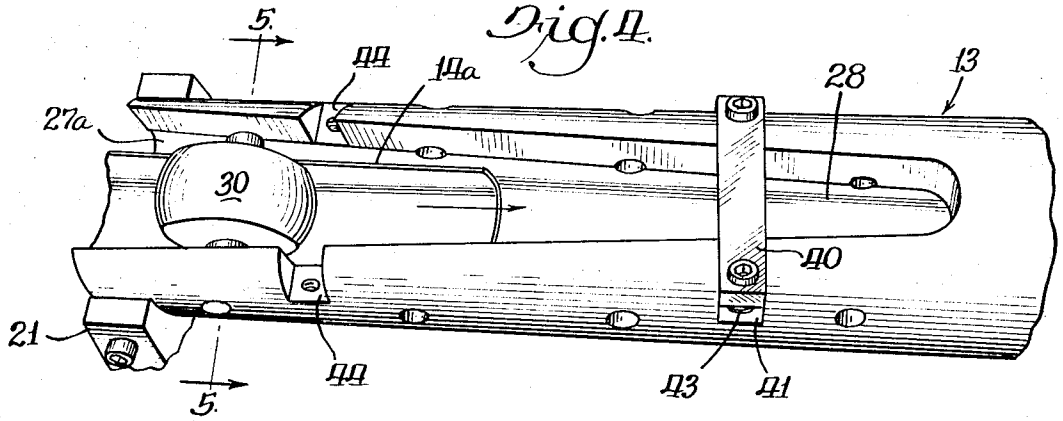


Fig. 5.

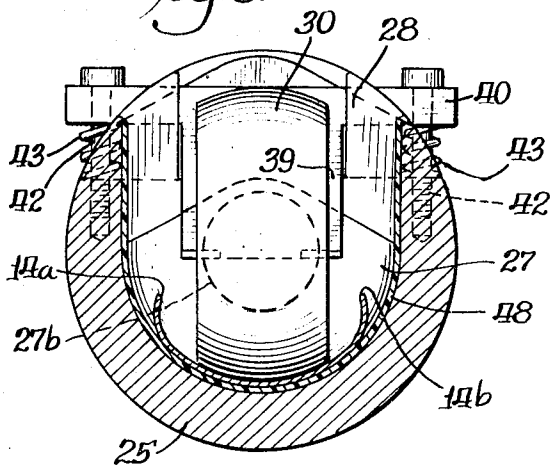
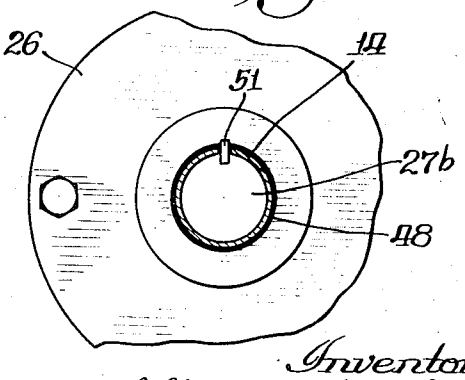


Fig. 6.



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TUBE FORMING METHOD AND APPARATUS

BACKGROUND AND SUMMARY OF THE INVENTION

A conventional way of manufacturing welded metal tubing is to roll-form a strip of metal into a tubular form and then weld the butting edges of the strip at the joint. For many purposes this is an emanately satisfactory procedure. However, under certain circumstances it is difficult, if not impossible, to satisfactorily roll-form the strip into a cylinder before it is delivered to the welder. For example, a conventional limit is that the diameter of the finished tube must be less than 100 times the wall thickness (i.e., the thickness of the sheet from which the wall is made). This limitation becomes particularly significant when it is desired to form tubing of relatively thin material. At the same time, there is a substantial commercial demand for tubing having a relatively thin wall. It can, for example, be used in automobile radiators and other applications where the pressure differential across the wall is not particularly great.

Efforts have been made to roll-form this relatively thin metal. It can be done but it is a slow, laborious process. Lineal speeds are relatively slow, e.g., about sixty inches per minute. One factor in this is that the two edges of the cylinder, before welding, will not maintain a constant linear orientation but tend to move back and forth across and at opposite sides of a desired alignment. This requires constant adjustment of the welding apparatus to meet the actual alignment and even so is likely to result in "puckering" along the seam.

Another problem that is encountered in the use of conventional practices is that after welding there is a tendency (particularly with relatively thin wall thicknesses) for the cross section of the tube to assume a "teardrop" cross-sectional shape, with the weld at the narrow portion of the teardrop. In the industry this is referred to as "peaking." The strip making up the tube is not sufficiently curved, i.e., deformed, during the roll-forming operation so that, of its own volition, it will maintain a cylindrical form. To some extent, the material wants to relax and resume its original flat configuration and it is the force resulting from this relaxing tendency that causes a non-circular configuration of the welded tube. Following the present invention, this is avoided and no observable peaking results in the welded tube.

The principal object of the present invention is to provide a method and apparatus by which even very thin walled material may be quickly and accurately formed into a cylinder for welding. Furthermore, a constant alignment of the two edges of the material is obtained thus speeding and simplifying the welding of those two edges together. For example, a prototype of the invention has operated very satisfactorily at speeds of 170 inches a minute and there is no apparent reason why speeds much in excess of that cannot be obtained. After welding, the quality of the tubing is so exceptionally good that those skilled in the art are skeptical from looking at the finished product that it could have been produced at speeds even comparable to those conventionally employed.

In this invention the edges of the strip are first curved by roll-forming and the finished forming of the tube is done by confining the strip in a horn which has an exit

diameter approximately that desired for the finished tube.

DESCRIPTION OF THE DRAWINGS

FIG. **1** is a plan view of an embodiment of the invention;

FIG. **2** is a side elevation of the embodiment of FIG. **1**;

FIG. **3** is an enlarged partial perspective view;

FIG. **4** is a slightly different partial perspective view;

FIG. **5** is a section as seen at line **5**—**5** of FIG. **4** with portions broken away; and

FIG. **6** is a view at line **6**—**6** of FIG. **2**.

DESCRIPTION OF SPECIFIC EMBODIMENT

The following disclosure is offered for public dissemination in return for the grant of a patent. Although it is detailed to ensure adequacy and aid understanding, this is not intended to prejudice that purpose of a patent which is to cover each new inventive concept therein no matter how others may later disguise it by variations in form or additions or further improvements. The claims at the end hereof are intended as the chief aid toward this purpose, as it is these that meet the requirement of pointing out the parts, improvements, or combinations in which the inventive concepts are found.

In addition to a base **11**, the disclosed embodiment includes a first section, generally **12**, for initially bending the edges of a metal strip **14**, and a second section, generally **13**, in the form of a horn for curling the strip **14** into a generally cylindrical form **15**.

The edge forming section **12** comprises two pairs of opposed forming rolls, the first pair comprising rolls **17**, **18**, and the second pair comprising rolls **19**, **20**. These rolls are suitably journaled in the frame portion **21**. Rolls **17** and **19** are convex and mate with the respective concave rolls **18** and **20**. A pair of guides **22** on frame **21** align the strip **14** as it moves into the forming rolls. One or more of these rolls can be connected to a suitable power means **23** to provide the driving impetus to move the strip **14** through the apparatus.

The second section **13** can be called a horn. It comprises a solid body **25** with a cap **26** at one end and with the two defining a tapered opening **27** therethrough. Opening **27** is relatively large at the entrance end **27***a* and relatively small at the exit end **27***b*. The diameter of the opening at the exit end **27***b* is only slightly larger than the desired external diameter for the finished tubing. An aperture **28** extends along the upper side of the horn. Extending through the aperture are a plurality of devices for positioning the strip **14** within the horn opening **27**. These comprise four rollers **30**–**33** journaled on shafts respectively **34**–**37**. Also, there is a block **39** having extending ends **40**. The ends of the block extend into slot **41** in body **25**. Pins **42** are journaled in ends **40** and are secured to body **25** so that the block can reciprocate vertically. Springs **43** resiliently urge the block upwardly until the ends **40** are in contact with the heads of pins **42**. A second slot **44** also is provided in body **25** to receive a corresponding block. In the operation of an actual embodiment it was found necessary only to use one such block positioned in slot **41**, and rollers **31**, **32** and **33** were omitted.

The interior of opening **27** is provided with a non-galling lining **48**, as illustrated in FIG. **5**. In the actual prototype this lining was a nylon, which was applied in liquid form and then hardened (a commercially available practice). The particular nylon employed was Corvel NCA–77, Type 11. Various other plastics known for their hardness and lubricity could be employed, such as one of the polymerized tetrafluoro-ethylene plastics such as that sold under the trademark Teflon. It could be a metal, such as a silver plating, often employed for its non-galling characteristics.

In some embodiments it undoubtedly would be possible to do without the non-galling lining of the horn and perhaps employ liquid lubricant. However, the prototype of the present invention was employed to form thin stainless steel strip **14** into tubing. Even on a hard, polished tool steel horn the thin stainless steel was scratched to an extent that its wall thickness was reduced by as much as 12 percent. This could not be tolerated in the finished tubing. With tubing of other materials and perhaps of greater wall thicknesses what galling there might be could perhaps be tolerated. The nylon lining was quite effective in eliminating the galling of the stainless steel sheet being formed into a tube.

Of course, the purpose of the apparatus is to take a flat strip of metal **14** and to turn it into a substantially cylindrical form **15** for movement into a welder **50**. Thus, the two edges **14***a* and **14***b* are brought together, or almost together when the sheet is in the cylindrical form so that they can thereafter be connected in the welder. In the illustrated embodiment these edges are not brought completely together until after they are in the welder. A pin **51** is positioned between the edges **14***a* and **14***b* at the exit opening **27***b* of the horn. This pin is secured to the cap **26** and serves to accurately fix the orientation of the edges **14***a* and **14***b* in their rotational position about the axis of the tube so that they are always in the same place. This greatly facilitates and speeds up the welding operation to have the seam always at a particular location about the axis of the tube, in addition to resulting in a better finished product.

The strip **14** is driven through the apparatus by any suitable means. As the flat strip enters the machine the guides **22** serve to accurately align the strip with respect to the forming rolls **17–20**. The two pair of rolls bend the strip **14**, particularly in the areas adjacent the two edges **14***a* and **14***b* into a curved configuration. See particularly FIGS. **3**, **4** and **5**. This is very important, not only to provide proper movement of the strip through the horn, but also with respect to avoiding peaking of the welded tube. Thereafter, the strip moves through the horn and as it does so it gradually acquires additional curvature corresponding to the curvature of the interior of the horn until it is substantially circular in cross section at the exit opening **27***b*. The rolls **30–33** are employed for the purpose of forcing the strip **14** to conform to the interior configuration of the horn. They bear against the face **14***c* and urge face **14***d* into immediate juxtaposition with the face of the horn about opening **27**. As already mentioned, it has been found with the prototype operated on thin stainless steel to be necessary to use only a single roll **30**. The block **39** has a rounded bottom edge which is positioned just above the line traversed by the two sheet edges **14***a* **14***b* when the sheet is centered in the bottom of the horn. Should the sheet **14** tend to curl to one side, i.e., no longer be centered at the bottom of the horn, the respective edge **14***a* or **14***b* will contact the bottom of block **39** and prevent the sheet from shifting very far out of its proper position at the bottom of the horn.

Within limits a single set-up can be employed for different diameters of tubing, merely by changing the cap **26** and adjusting the guides **22**. Thus, for example, were a tube **15** to be formed of slightly smaller diameter, a strip **14** having a width between edges **14***a* and **14***b* proportionately smaller would be employed. The guides **22** would be adjusted in width to conform to the sides of the new sheet. A different cap **26** having an opening **27***b* of the desired diameter would be substituted for that used in the set-up illustrated. Using this revised set-up the substituted sheet **14** would be formed into a tube **15** having the slightly smaller diameter. The limits within which this can be achieved are determined by the necessity of the rolls **17–20** to significantly curl the edge areas of the sheet and the avoidance of too great a taper in that portion of the opening **27** lying within cap **26**.

The horn should be sufficiently long to result in a gradual bending of the edge-curved strip into the finished cylindrical form. An effort to cause an abrupt transition in this respect will result in difficulties. To avoid this, the horn should have a length substantially greater than the width of the strip to be formed, i.e., at least several times the width of the strip.

I claim:

1. A method of forming an elongated flat strip of metal having opposed faces between two edges substantially into an elongated cylinder, said method comprising the steps of:

moving said strip lengthwise along a path;

at a first location along said path roll forming the edge portions of the strip in curves out of the plane of the strip and in the same general direction therefrom with the curves of the edge portions being greater than the curve of the part of the strip between the edge portions, thereby forming a concave face and a convex face; and

along a subsequent length of said path, which length is at least several times the width of said strip, continuously contacting the convex face of said strip and forcing said strip gradually into cylindrical form as it moves through said length.

2. A method as set forth in claim **1**, wherein the contact over said length is made by a comparatively rigid non-metallic material.

3. A method as set forth in claim **2**, including the step of applying a force against the concave face in the direction of said one side of said path.

4. In an apparatus for forming an elongated flat strip of metal having opposed faces between two edges and moving along a path substantially into an elongated cylinder of a given diameter, the improvement wherein said apparatus comprises:

two components positioned sequentially along said path;

the first of said components being roll-forming means for bending the portions of the strip adjacent the edges into curves out of the plane of the

strip with the curves of the edge portions being greater than the curve of the part of the strip between the edge portions thereby forming a concave face and a convex face;

the subsequent component being in the form of a horn having a relatively flat curvature at the entrance end and an exit end of approximately said given diameter, means on the interior of said horn defining a non-galling surface.

5. In an apparatus as set forth in claim **4**, wherein said means defining said non-galling surface is a plastic facing.

6. In an apparatus as set forth in claim **5**, wherein the convex face of said strip contacts a side of said horn between said ends,

and including pressure means between said ends for contacting said strip and applying a force against said strip in the direction of said side.

7. In an apparatus as set forth in claim **6**, wherein said pressure means is a roller which contacts the concave face of the strip.

8. In an apparatus as set forth in claim **6**, wherein said pressure means is a transverse bar which contacts one or the other edges of the strip depending upon the orientation of the strip in the horn.

9. In an apparatus as set forth in claim **4**, wherein, at a location at or adjacent said exit end an orientation pin is positioned between the edges of the strip.

10. In an apparatus as set forth in claim **4**, wherein the convex face of said strip contacts a side of said horn between said ends,

and including pressure means between said ends for contacting said strip and applying a force against said strip in the direction of said side.

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