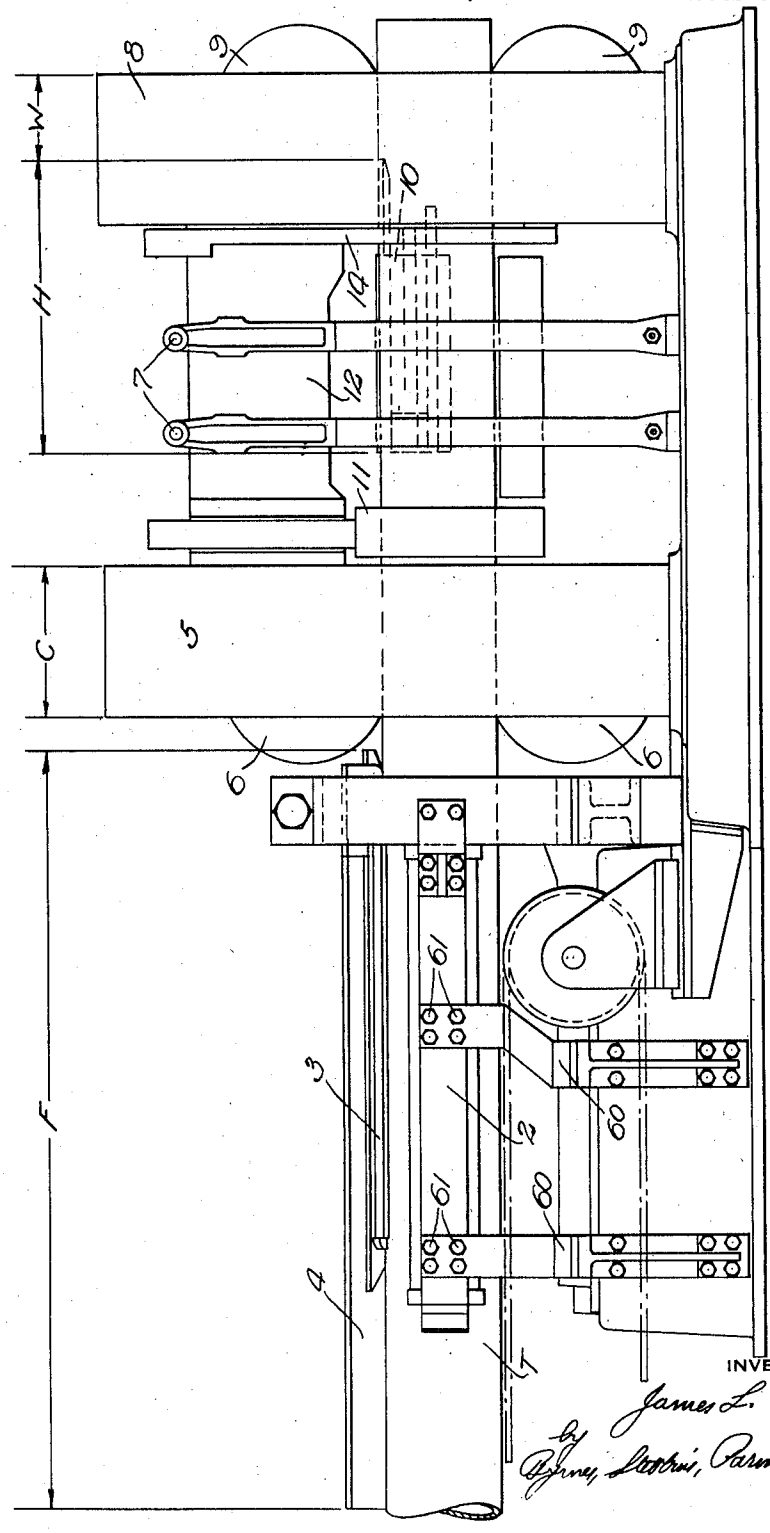
Dec. 19, 1933. J. L. ADAMS, JR 1,940,479

METHOD AND APPARATUS FOR FORMING TUBULAR OBJECTS

Filed Feb. 13, 1932 8 Sheets-Sheet 1

Fig. 1.



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Dec. 19, 1933. J. L. ADAMS, JR 1,940,479

METHOD AND APPARATUS FOR FORMING TUBULAR OBJECTS

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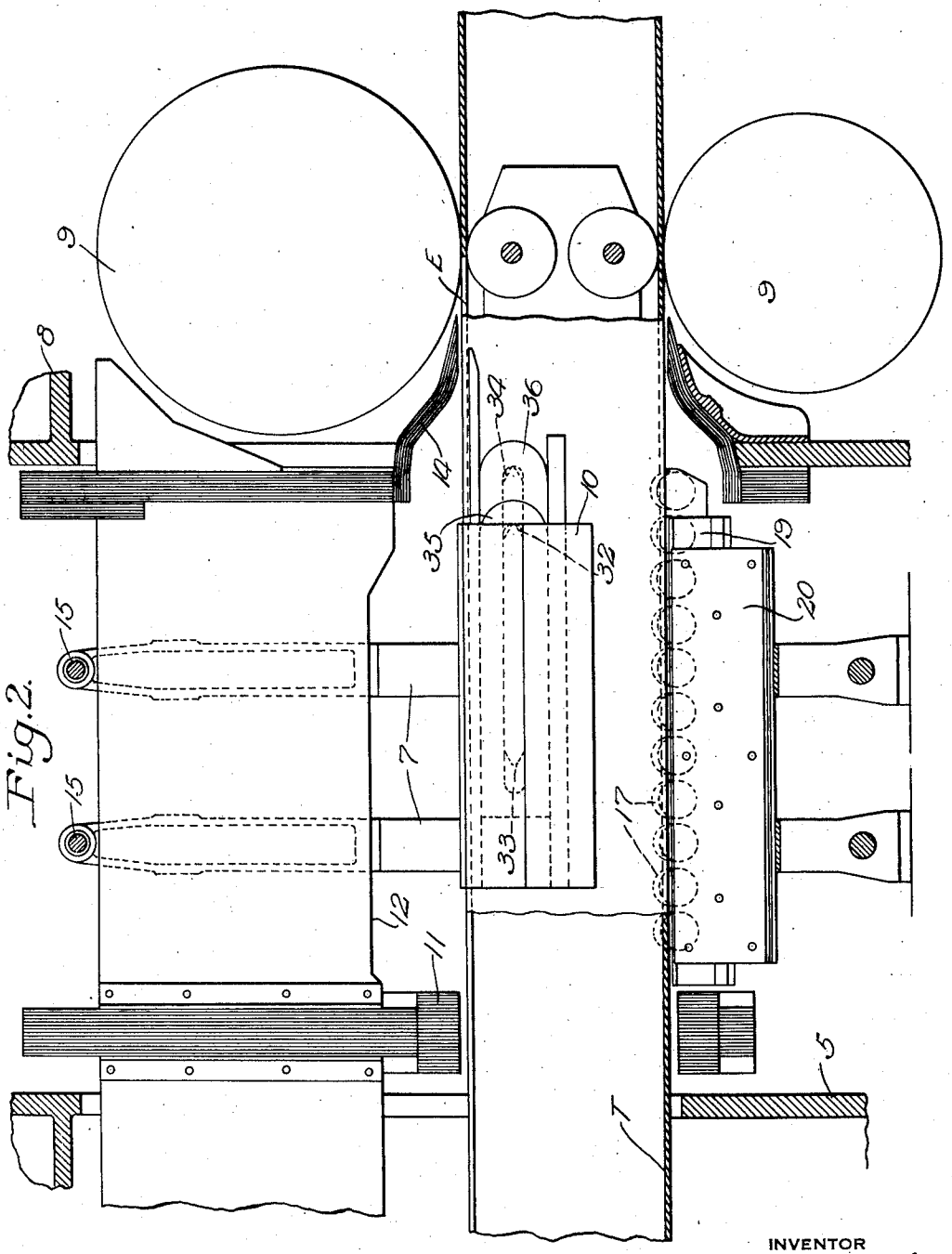

Fig. 2.

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METHOD AND APPARATUS FOR FORMING TUBULAR OBJECTS

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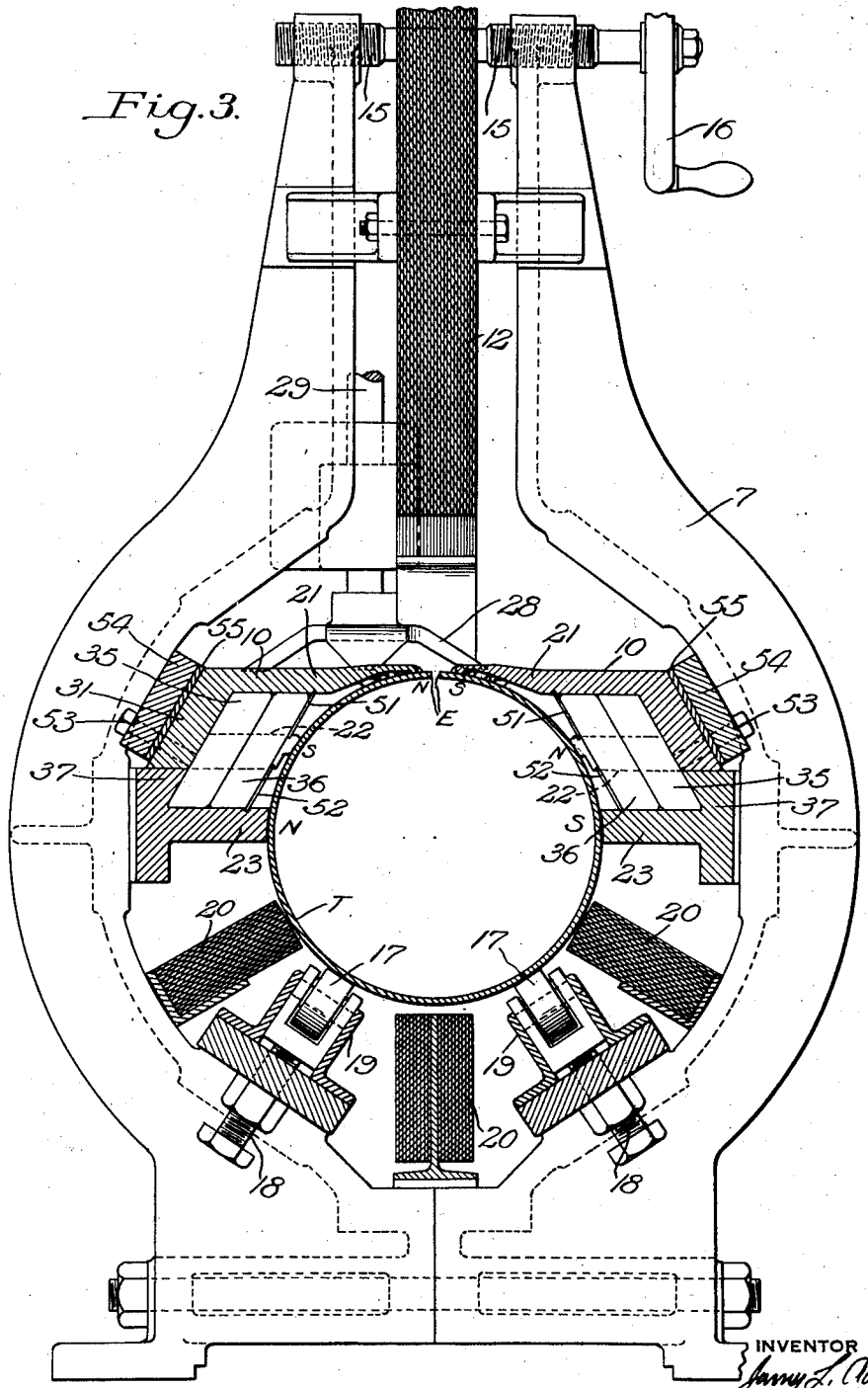
Fig. 3.



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METHOD AND APPARATUS FOR FORMING TUBULAR OBJECTS

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Fig. 4.

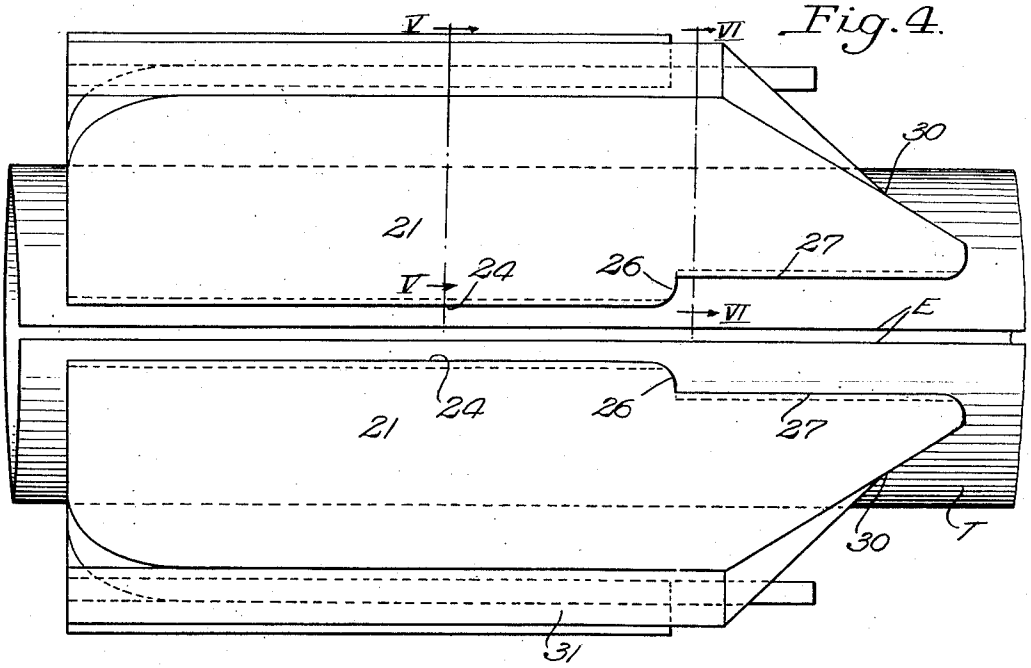


Fig. 5.

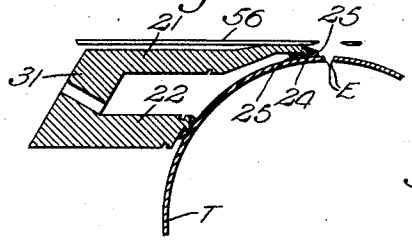


Fig. 6.

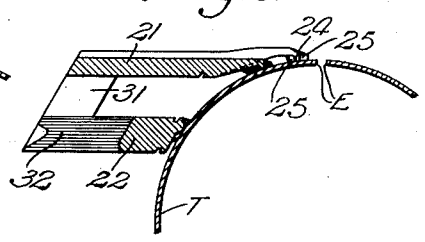
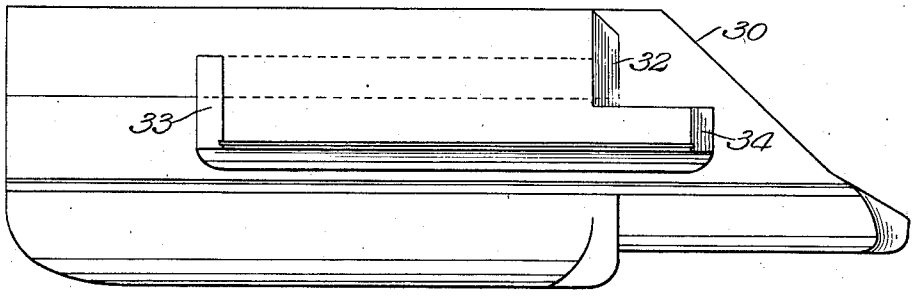


Fig. 7.



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METHOD AND APPARATUS FOR FORMING TUBULAR OBJECTS

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Fig. 8

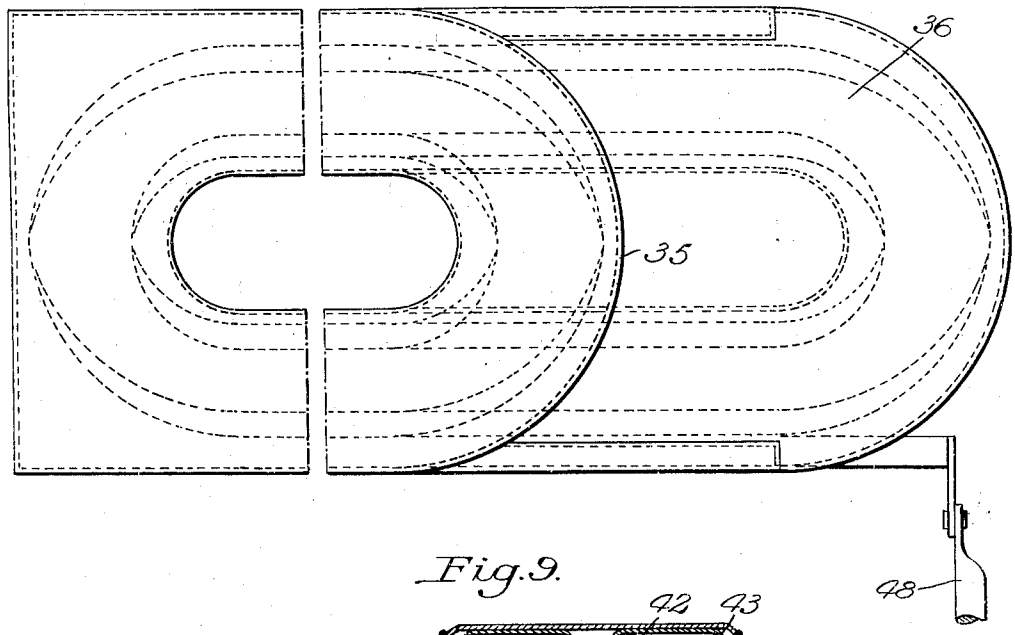


Fig. 9.

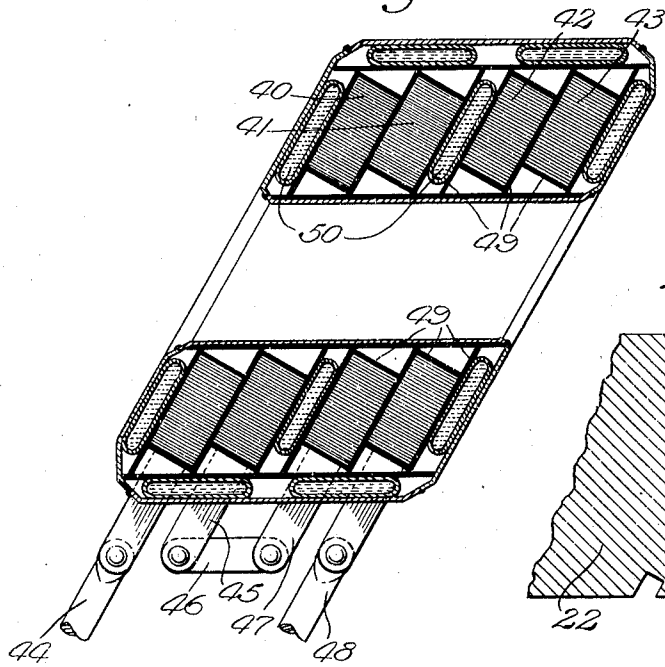
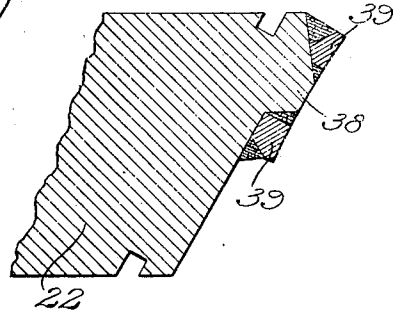


Fig. 10.



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METHOD AND APPARATUS FOR FORMING TUBULAR OBJECTS

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Fig. 11.

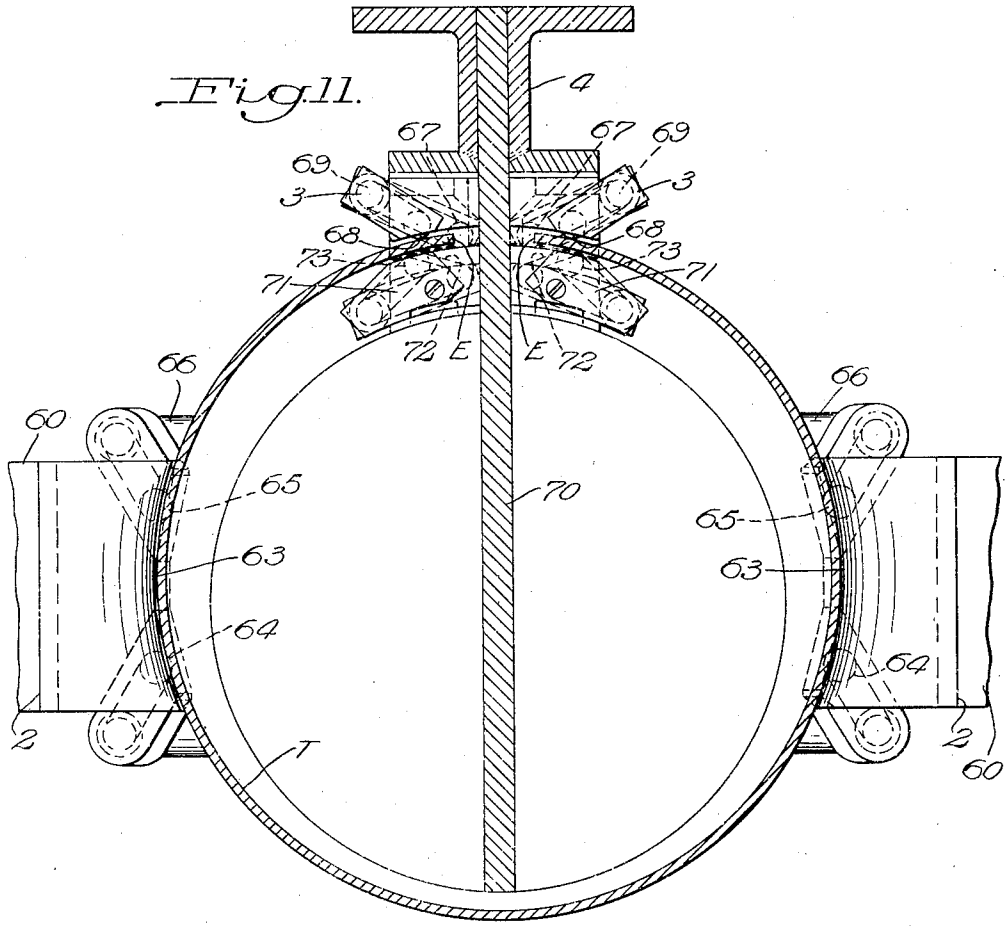
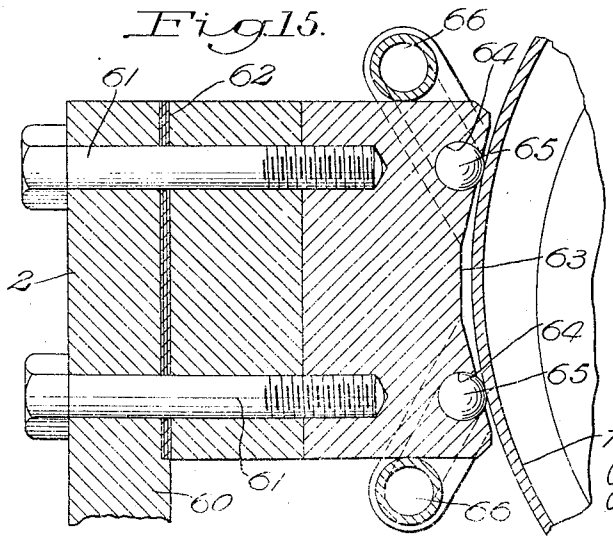


Fig. 15.



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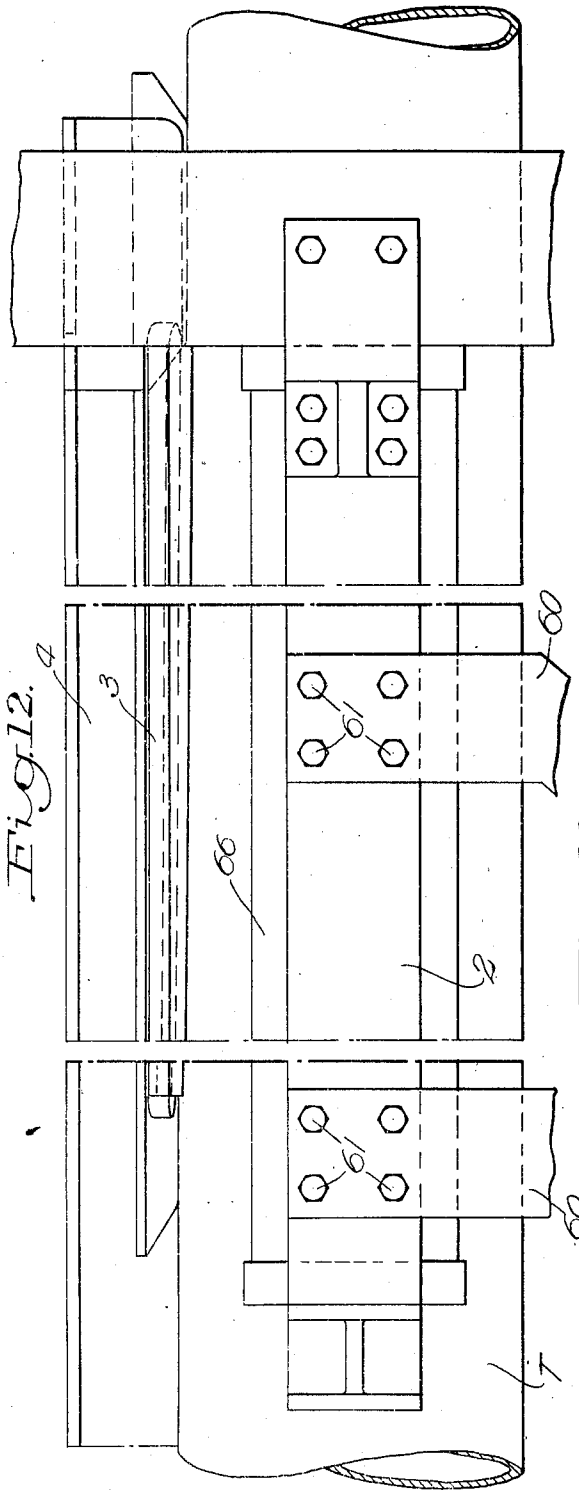
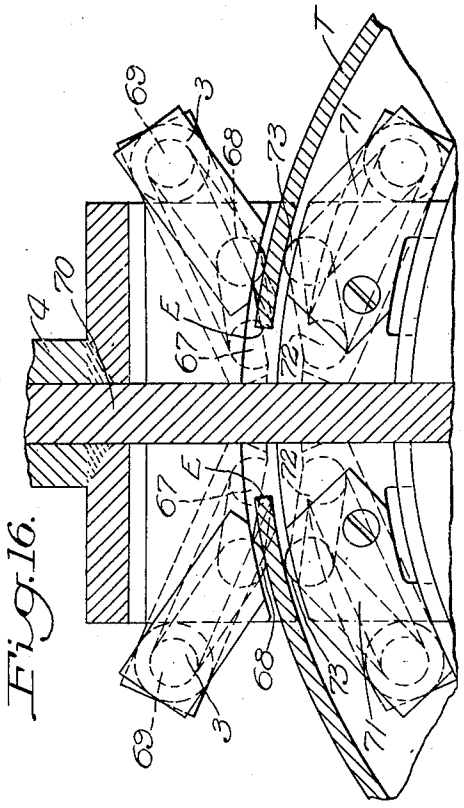
METHOD AND APPARATUS FOR FORMING TUBULAR OBJECTS

Filed Feb. 13, 1932 8 Sheets-Sheet 7





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METHOD AND APPARATUS FOR FORMING TUBULAR OBJECTS

Filed Feb. 13, 1932 8 Sheets-Sheet 8

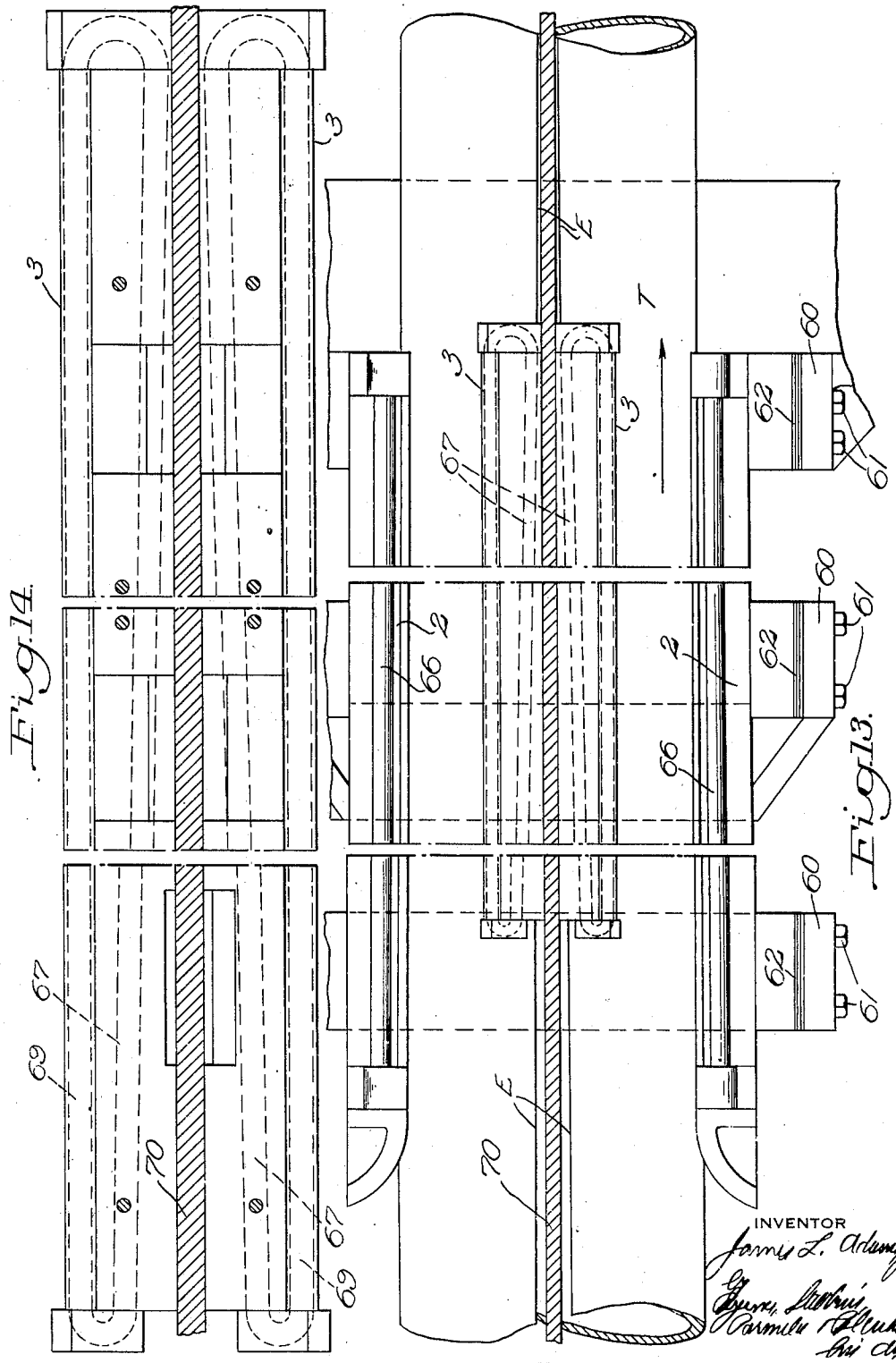

Fig. 14.

Fig. 13.

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Patented Dec. 19, 1933 1,940,479

UNITED STATES PATENT OFFICE

1,940,479

METHOD AND APPARATUS FOR FORMING TUBULAR OBJECTS

James L. Adams, Jr., Youngstown, Ohio, assignor to The Youngstown Sheet and Tube Company, Youngstown, Ohio, a corporation of Ohio

Application February 13, 1932. Serial No. 592,707

12 Claims. (Cl. 219—6)

The present invention relates broadly to the art of metal working, and more especially to the branch thereof which is concerned with the forming of objects, such as tubes, pipes, and the like. Inasmuch as the specific size or contour of the article being formed does not constitute any limitation with respect to the present invention, it is to be understood that the term "tubular" is utilized in its generic sense as defining a shape whose surface may be considered as having been formed by the movement of a line about an axis, whether the article be truly circular, elliptical or polygonal.

In this phase of the art as applicable to the formation of pipes for example, by a butt welding operation, it is customary to roughly form a tubular blank and then deliver that blank to a suitable welding apparatus, or to successively form the blank and weld it as successive steps of a continuous process. With such processes, where the welding is of the so-called butt weld type in which the edges must be brought into accurate abutting engagement, one of the most difficult problems is that of maintaining the necessary accuracy as to edge positioning.

For accomplishing the most desirable results, I have found that a tubular blank after having been formed should be subjected to a crushing and sizing operation, this crushing and sizing being for the purpose of providing a blank of predetermined overall dimensions. The crushed and sized blank may then be more accurately welded. If, however, the edge portions of the previously formed blank are not maintained in directly abutting relationship during the crushing and sizing operation, one edge has a tendency to ride over or distort the other edge. This is reflected in the final product in an uneven weld. In like manner, even though the article is accurately crushed and sized, the subsequent welding pressure with the edges at welding temperature will result in a riding or distorting operation in case the edge portions are not positively controlled in accurately alined abutting relationship.

It is not sufficient merely to exert lateral compression upon the edges of the formed tube blank as it enters the crushing or sizing rolls, in order to obtain accurate alignment thereof. It is a practical impossibility to form long tube blanks of heavy plate while cold without introducing small waves along the edges of the blank which, therefore, are only approximately aligned. These waves persist through the sizing and heating operations unless positively ironed out by means such as I shall describe specifically hereinafter.

If the heating of the seam edges is effected while the latter are even slightly out of alignment, all portions of the edges are not heated uniformly and under the welding pressure, the edges not only fail to form a perfect weld but act as cutting edges of relatively solid metal, the fluid metal being burned off at an angle to a radial plane. Such edges will readily slide past one another and produce a lap joint which cannot sustain much welding pressure and therefore presents a potentially weak portion in the welded seam.

My invention provides means for holding the edges of the tube in precision alignment during the application of welding pressure, regardless of any minor misalignment or wavy condition of the edges which might not be corrected by the sizing rolls. A material improvement in the accuracy of the alignment of the edges of the moving tube is effected and a superior weld results.

The present invention has for its object the provision of improved guiding and edge holding means, whereby during both the crushing and sizing operation and during the welding operation the edge portions are positively positioned.

In the accompanying drawings I have shown more or less diagrammatically, for purposes of illustration only, a preferred embodiment of the present invention. In the drawings:

Figure 1 is a side elevational view of a portion of a forming and welding apparatus constructed in accordance with the present invention;

Figure 2 is a detail sectional view, on an enlarged scale, of the right hand end portion of the apparatus shown in Figure 1;

Figure 3 is a transverse sectional view, on an enlarged scale, through the portion of the apparatus illustrated in Figure 2;

Figure 4 is a top plan view of a part of the magnetic guiding means of Figure 2;

Figure 5 is a detail sectional view on the line V—V of Figure 4, looking in the direction of the arrows;

Figure 6 is a similar sectional view on the line VI—VI of Figure 4;

Figure 7 is a bottom plan view of one of the magnetic guiding means of Figure 4;

Figure 8 is a side elevational view of the coils of the magnetic guiding means, the coils being partly broken away;

Figure 9 is a detail sectional view through the coils and cooling means provided therefor;

Figure 10 is a detail sectional view, on an

enlarged scale, of one of the pole pieces of the magnetic guiding means;

Figure 11 is a detail sectional view, on an enlarged scale, through the edge guiding means for the crushing and sizing rolls;

Figure 12 is a side elevational view, on a smaller scale, of the structure illustrated in Figure 11;

Figure 13 is a view partly in section and partly in plan, of the structure illustrated in Figure 11;

Figure 14 is a view similar to Figure 13 illustrating the edge guiding means on a larger scale;

Figure 15 is a detail sectional view, on an enlarged scale, through the side guiding means of Figure 11; and

Figure 16 is a detail sectional view, on an enlarged scale, through the edge guiding means of Figures 12, 13 and 14.

The present invention is illustrated as being applicable to a welding apparatus of the general type disclosed in my French Patent No. 715,039 of April 10, 1931, and reference may be had thereto for a more complete understanding of the details of construction with respect to the welding apparatus itself. Inasmuch, however, as such details constitute no part of the present invention, no detailed showing of the same will be made herein.

Referring particularly to Figure 1 of the drawings, there is shown a welding and forming apparatus which may be divided generally into a forming zone F; a crushing and sizing zone C; a heating zone H and a welding zone W.

Disposed in the forming zone is a pair of opposed side guiding means 2 for the tubular blank T. Substantially co-extensive with the side guiding means 2 is a pair of edge guiding means 3 mounted on opposite sides of an I-beam 4.

Within the crushing and forming zone C is a stand 5 containing any desired number of crushing and sizing rolls 6.

Within the heating zone H is a pair of flash regulating stands 7 for the purpose of determining the spacing of the edge portions of the blank T. This zone also contains the current supply means (not shown) for heating purposes, such current supply means conveniently being of the type adapted to effect a pre-heating between spaced edge portions either entirely or largely by reason of a flash heating operation. The edges preheated by such flash heating are subsequently brought into contact and further heated by resistance heating, after which they pass through a stand 8 containing welding rolls 9 applying the necessary pressure to the blank for effecting welding of the heated edges.

The heating zone is further characterized by a pair of magnetic guiding means 10 which will be hereinafter referred to in greater detail.

In Figure 2 of the drawings, there is shown in greater detail the heating zone and the welding zone. In this figure there is shown a portion of the crushing and sizing stand 5 with the blank T issuing therefrom. Upon issuing from this stand, it passes through an opening in a pole piece 11 carried by a magnetic yoke 12. This yoke at its opposite end carries a second pole piece 14 of generally similar laminated construction and extending well forwardly into the pass of the welding rolls 9.

By reference to Figure 3 of the drawings, it will be noted that the flash regulating stands 7 comprise opposite sections adapted to be moved toward or from each other by a suitable screw 15 actuated by a hand wheel 16. These flash regulating stands control the spacing between the edges E of the tubular blank T and accurately maintain the same in the desired spaced relationship for the most accurate flash or other heating operation. The guiding of the blank is further assisted by means of suitable rollers 17 carried by the flash regulating stands and adjustable by means of screws 18 in guides 19. The flash regulating stands further carry exterior magnetic yokes 20 for the purpose disclosed in my French patent before referred to.

In accordance with the present invention, the flash regulating stands are utilized for supporting the magnetic guiding means 10 before referred to and illustrated diagrammatically in Figure 1. Each of these side guiding means, both of which are of similar construction, with the exception that one is right hand and the other left hand, comprises an E-shaped core formed by an upper leg 21, a central leg 22, and a bottom leg 23.

The upper legs 21 are preferably of the general contour illustrated in Figure 4 in top plan view, and in Figures 5 and 6 in section. The general plane of the upper legs 21 conveniently includes a plane tangent to the tubular blank T at the edge portions E, the inner ends of the upper legs throughout the major portion of their length being inwardly extended to overlie the blank and provide upper edge guiding pole pieces 24. These pole pieces, as will be clearly apparent from Figures 5 and 6 of the drawings, are of relatively small cross sectional area, whereby to provide a limited area of contact with the tubular blank adjacent the edges thereof. Not only is the limited area of contact desirable from the standpoint of minimizing friction, but it is particularly desirable from the standpoint of the possibility of obtaining a greater magnetic flux density and therefore a greater magnetic attraction at these poles, it being understood that the magnetic pull varies approximately as the square of the flux density.

Adjacent these active pole pieces 24 are welded strips 25 of suitable non-magnetic material, such as manganese steel having a manganese content of from 7 to 12%. These strips do not conduct materially more flux than would an air path of the same size, but being of very hard steel which is somewhat self-lubricating, they afford an excellent non-galling wearing surface for the blank to slide upon without in effect widening the magnetic pole tip area and without cutting down the total pull.

At their forward ends adjacent the welding housing 8, the upper legs 21 are provided with offsets 26 providing continuation pole tips 27 which are spaced a slightly greater distance from the edges E, but which lie more nearly tangent to the blank. As a matter of fact, the supplemental active pole tips 27 preferably lie below a plane tangent to the blank so as to accommodate a rotary seam trimmer 28 carried and operated by a shaft 29 as indicated in Figure 3. The outer end portions of the upper legs 21 are cut away to provide bevelled portions 30 affording ample clearance for the welding rolls 9. By reason of this construction, it is possible to extend the active edge engaging pole tips well forwardly toward the actual welding zone without interfering with the pressure applying means in this zone.

Extending downwardly from the upper legs 21 in angular relationship thereto are connecting means 31 for magnetically and structurally ty-

ing the upper legs 21 to the central legs 22. These central legs are of the construction shown more particularly in Figures 5, 6 and 7, wherein they are shown as having bevelled or rounded end portions 32, 33 and 34. Surrounding the central leg 22 of each of the magnetic guides and extending around the curved end 32 and a part of the curved end 33, is a relatively short outer coil 35, this coil being shortened up so as not to interfere with the welding rolls 9, as will be apparent more particularly from Figure 2 of the drawings. Also surrounding the central leg is a similar coil 36 of relatively greater length, the coil on each guide extending around a portion of the curved end 33 and the curved end 34. It is of a length greater than the outer coil 35 by an amount determined by the extra room available at its point of termination.

The bottom leg 23 is preferably formed of a separate piece structurally, as apparent more particularly from Figure 3, and provides an upstanding portion 37 abutting against the bottom surface of the central leg and forming backing up means for the outer coil 35 of each guide. The central pole piece of each guide is preferably narrowed down as illustrated more particularly in Figure 10 to provide a narrow active pole tip 38, the width of which is increased by non-magnetic strips 39 of the character referred to suitably welded in position thereon.

The outer coil 35 may comprise a pair of sections 40 and 41, as shown in Figure 9, and the inner coil 36 a similar pair of sections 42 and 43. These sections are electrically connected in such manner that current may be supplied thereto through a terminal 44 to the section 40 in such manner that the current will flow from the outer to the inner winding and thence through a suitable connection (not shown) to the inner winding of section 41. From the inner winding the current flows through the coil to a terminal 45 and thence through a connector 46 to a terminal 47 for the outer winding of the section 42. The current flows through this section similarly to its flow through the section 40 and thence to the section 43 which is leaves through a terminal 48.

These sections are preferably insulated from each other by suitable insulation 49 such as mica, similar insulation being utilized for preventing short circuiting with water cooling means 50. By utilizing mica ribbon insulation, for example, between the turns of each coil with built up mica sheets between and around the coils, there is provided insulation which is capable of withstanding heat much more effectively than any other available insulation material. This permits the energizing current to be run up to a high value. Inasmuch as mice has about 1/500 of the heat conductivity of copper, it is excellent for transmitting the generated heat of the coils to the adjacent water ducts. While air gaps might be utilized between the coil sections and the water ducts, such air gaps only provide a conductivity of .000249 at 20° C., thus preventing the desired heat conduction from the coils to the ducts.

The coil sections having been formed and slipped into position on the central legs 22 of the magnetic guides, they may be held in position by coil retainers 51 interlocking with grooves formed in the lower surfaces of the upper legs 21 and the upper surfaces of the central legs 22, and by other coil retainers 52 similarly interlocked with grooves on the lower surface of the central leg and the upper surface of the lower leg 23. The units as a whole may then be secured in position by bolts 53 extending through spacer bars 54 carroied by the flash regulating stands. Interposed between the spacer bars 54 and the magnetic guides may be shims 55 by means of which extremely accurate positioning of the magnetic guides may be obtained. Having been initially properly positioned, the guides will thereafter be adjusted with the flash regulating stands and thus au omatically accommodate themselves to changes in the position of the parts as determined by each adjustment of the flash regulating stands.

It may be assumed that the sections of the coils are so wound that the pole pieces of the magnetic guides will be of the polarity indicated in Figure 3. With this polarity there will be a flow of flux between the active pole pieces 24 of the respective upper legs of the opposed guides, so that some little flux will travel across the seam between the edges E and increase the density of flux flowing to and from the blank into these pole tips. In this manner the blank will be held more tightly in engagement with the tips 24 and 27 and kept more accurately in the desired alinement. It is entirely possible, however, to make the right and left hand magnets symmetrical as to polarity without suffering any great loss in the general efficiency of the magnetic guiding means.

With the construction just described, the edge portions E of the blank will be magnetically held in contact with the pole pieces of the magnetic guides. By initially accurately determining the location of the pole pieces, and more especially the pole pieces 24 and 27 (see Figure 4), the extreme edge portions of the blank may be held in accurately spaced opposed abutting relationship as shown in Figure 3 irrespective of whether a given edge may tend to spring inward slightly at some points or not, whereby after having been heated to the desired temperature the edge portions may be closed by the action of the welding or pressure rolls 9 with definite assurances that a joint with truly aligned edges will be formed.

In addition to providing space for a trimmer 28, the construction and location of the magnetic guides has two further distinct advantages. In the first place, the construction of the guides is such as to permit the operator to have a substantially unobstructed view of the seam at all times. In the second place, the upper legs 21 may be utilized to support a plate 56 effective for receiving the "spittings" from the seam during the heating up operation. By collecting such spittings on a plate, the spittings are kept from collecting on other parts of the welding apparatus. From time to time as required, the plates 56 may be removed and new plates substituted.

While a magnetic guiding means of the character described is effective for maintaining the edge portions of a blank in the desired relationship for accurate welding, their efficiency is dependent to a marked degree upon the accuracy with which the edge portions are bent into position and the accuracy with which they are crushed. I have found that if the edges are not accurately controlled during the preforming operation in such manner that they are delivered to the crushing and sizing stand in the proper precisely opposed relationship irrespective of the normal tendency to spring, the crushing operation will so distort the edges that the maximum efficiency of the magnetic guides cannot, in any case, be realized. For this reason, I preferably provide supplemental guiding means in advance

of the crushing and sizing stand, the guiding means being of such construction as to be effective on the sides of the blank and on the edge portions thereof.

In Figure 1, the side guiding means are illustrated more or less diagrammatically in outline. In Figures 11, 12 and 15 they are shown in detail. From these figures, it will be noted that each of the side guides comprises supporting brackets 60 for the side guides, the side guides being held in position thereagainst by bolts 61 extending through shims 62 and serving for accurately spacing the parts. The inner portion of each of the side guides 2 presents a concave face 63 of such nature as to freely accommodate the contour of the blank being formed. In the blank side of the guide it is formed with a pair of ball races 64 adapted to receive balls 65 in such manner that a portion of the periphery of each of the balls will project through the race and contact the blank surface. The ball races 64 are each connected to a ball return tube 66 in such manner that the balls form an endless chain adapted to travel with the blank and then return to blank engaging position through the return tubes 66.

By reference to Figure 13 of the drawings, it will be noted that the side guides 2 are in slightly converging relationship in the direction of travel of the blank, the amount of convergence being determined by the rapidity with which it is desired to cause the blank edges to approach each other. These side guides serve to accurately control the side portions of the blank. They are not effective, however, for definitely alining the edge portions and maintaining such edge portions in accurately positioned opposed relationship.

For guiding the extreme edge portions, I provide edge guides 3 of the character shown more especially in Figures 11 and 16. These edge guides are of the same general character as the side guides 2 in that they provide inner race ways 67 adapted to receive balls 68 effective for engaging the outer edge portions of the blank, the balls returning through suitable ball tubes 69. There is provided one edge guide on each side of a central plate 70, these guides being symmetrically disposed with respect to the plate. The race ways 67, as will be apparent more particularly from Figure 13, are likewise in converging relationship. In this figure, it will be noted that the race ways converge slightly more rapidly than the convergence of the edge portions E of the blank. This construction facilitates the entering of the blank into engagement with the guiding balls, and the angular path of travel of the balls tends to move the edge portions toward each other.

It will be apparent that the balls 68 in the edge guides 3 can only be effective for exerting pressure in an inward direction. In order to oppose this pressure, I preferably provide supplemental edge guides 71 generally similar to the edge guides 3, but located within the blank. Each of these guides provides a ball race 72 having an open face adapted to permit the balls 73 therein to contact the inner surface of the tube. Just as the race ways 67 converge toward each other as well as toward the axis of the blank, it being apparent that the outer diameter of the blank decreases as the edges move toward each other, so the race ways 72 converge toward each other and toward the tube axis. In this manner the balls 68 and 73 in the respective outer and inner edge guides 3 and 71 constantly oppose each other and act in effect as travelling vises for positively gripping and controlling the edges. These edges gripped and controlled in this manner gradually travel toward the crushing and sizing rolls 6 so that when subjected to the crushing and sizing operation they are so squarely opposed that they are not distorted and do not have a tendency to ride one another.

From the foregoing description taken in connection with the accompanying drawings, it will be apparent that I have provided a forming and welding apparatus characterized by means in the forming zone for accurately positioning and controlling the location of the edge portions during the forming up operation and prior to delivery to a crushing and sizing stand in such manner that the crushing and sizing can be more effectively obtained without fear of distorting the edges. The crushed and sized blank is then delivered to a heating zone wherein the portions to be welded are brought to a welding temperature, the entire body of the blank and more especially the edge portions, being accurately controlled during the heating up operation in such manner that when the heated edges are delivered to the welding or pressure rolls they are in such condition as to insure the formation of a true butt weld with the edges squarely opposed one to the other.

Certain advantages arise from the accurate guiding more particularly of the edge portions prior to a crushing and sizing operation and the precise guiding thereof in a plane transverse to that of the edges themselves, even up to a point closely adjacent the welding rolls.

Other advantages arise from the accurate guiding more particularly of the edge portions after a crushing and sizing operation and during the heating which is effected prior to the application of welding pressure.

Still further and complete advantages, however, arise from the combination of guiding means of the character referred to, whereby more especially the edge portions of a blank are continuously controlled during a forming operation for delivery to a crushing and sizing means and during a heating operation for delivery to a welding means.

Other important advantages accrue from the use of guiding means for holding the two edges of the tube blank in precise alignment at points adjacent the crushing and welding rolls.

Other advantages result from the arrangement of the apparatus by which successive tubes are closed initially as they enter the first roll stand, to prevent the initial lapping of the edges of the blank at the leading end thereof.

While I have herein illustrated and described a preferred embodiment of the present invention, it will be understood that changes in the construction and arrangement of the parts may be made without departing either from the spirit of the present invention or the scope of my broader claims.

I claim:

1. In a continuous welding apparatus, the combination with means for feeding material to be welded with the seam edges adjacent for heating, and means for pressing the heated edges together for welding, of means for positively aligning the edges preparator to welding comprising guides extending along the path of material movement, having reduced portions for engaging the material at spaced points laterally of the seam, wear resistant means carried in said reduced portions, and a winding for magnetizing said guides to hold the seam edges in engagement therewith.

2. In a continuous tube welding apparatus, the combination with a stand of rolls for feeding a

tube blank, and means for pressing together the edges of a seam in the blank to weld the latter after heating, of means for aligning the seam edges comprising guide yokes supported on opposite sides of the seam, the yokes having portions for engaging the blank laterally of the seam at points spaced circumferentially of the blank, and windings on said yokes for magnetizing them to hold the seam edges in engagement therewith.

3. In a tube welder, the combination with means for feeding a tube blank and means for welding the edges of a seam therein, of guides positioned on opposite sides of the seam and adjacent thereto, extending along the path of movement of the blank between said means, said guides being of substantially E-shape in cross-section, the free edges of the guides engaging the blank, and windings on said guides for magnetizing them to hold the seam edges thereagainst.

4. In an apparatus including pressure rolls, for welding together the edges of a seam in a tube blank, a magnetic guide for the blank having a yoke shape in cross-section, and a winding embracing the yoke, the free edges of the yoke engaging the blank at circumferentially spaced areas, and the ends of the guide being shaped to extend between said rolls.

5. In a magnetic guide for blanks moving through a tube welder, a member having spaced arms engaging the blank, a magnetizing winding for said member, and wear resistant means at the ends of said arms for contact with the blank.

6. In a magnetic guide for blanks moving through a tube welder, a member having spaced arms engaging the blank, and a magnetizing winding for said member, the ends of said arms being reduced to increase the attractive effect thereof.

7. In a welder for closing the edges of a seam in a tube blank, an adjustable guide pass for controlling the opening between the seam edges, guides mounted in said pass on opposite sides of the seam for engaging the blank, said guides having an E-shaped cross-section and free edges adapted to contact with the blank, and magnetizing windings thereon to maintain the seam edges in engagement with the guides.

8. In a welder for closing the edges of a seam in a tube blank, guides for engaging the blank adjacent the seam edges to position the latter for welding, and means removably carried on said guides for catching material ejected from the seam prior to welding.

9. In a welder, means for feeding material to be welded to heating and welding means, and a guide for the material comprising a member having a ball race therein, a plurality of balls in said race partly projecting therefrom to engage the material, and means for conducting balls from the exit to the entrance of said race.

10. In a welder, means for feeding a formed tube blank to be welded to heating and welding means, and guides for said blank comprising members adjacent the blank at substantially diametrically opposite points, having ball races therein, a plurality of balls in said races partly projecting therefrom to engage the blank, and means for conducting the balls from the exits to the entrances of said races.

11. In a welder, means for feeding to heating and welding means a tube blank having an open seam to be welded, and guides for the edges of said seams comprising members positioned adjacent the edges having ball races therein, a plurality of balls in said races projecting partly therefrom to engage said edges, and means for conducting the balls from the exits to the entrances of said races.

12. In a welder, means for feeding to heating and welding means a formed tube blank having an open seam to be welded, and guides for the edges of the seam comprising members disposed adjacent said edges inside and outside the blank, ball races in said members, a plurality of balls in said races projecting partly therefrom to engage said edges internally and externally, and means for returning the balls of each race from the exit to the entrance end thereof.

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