June 9, 1936. L. IVERSEN ET AL 2,043,665

APPARATUS FOR FORMING TUBES

Filed Dec. 2, 1932 7 Sheets-Sheet 1

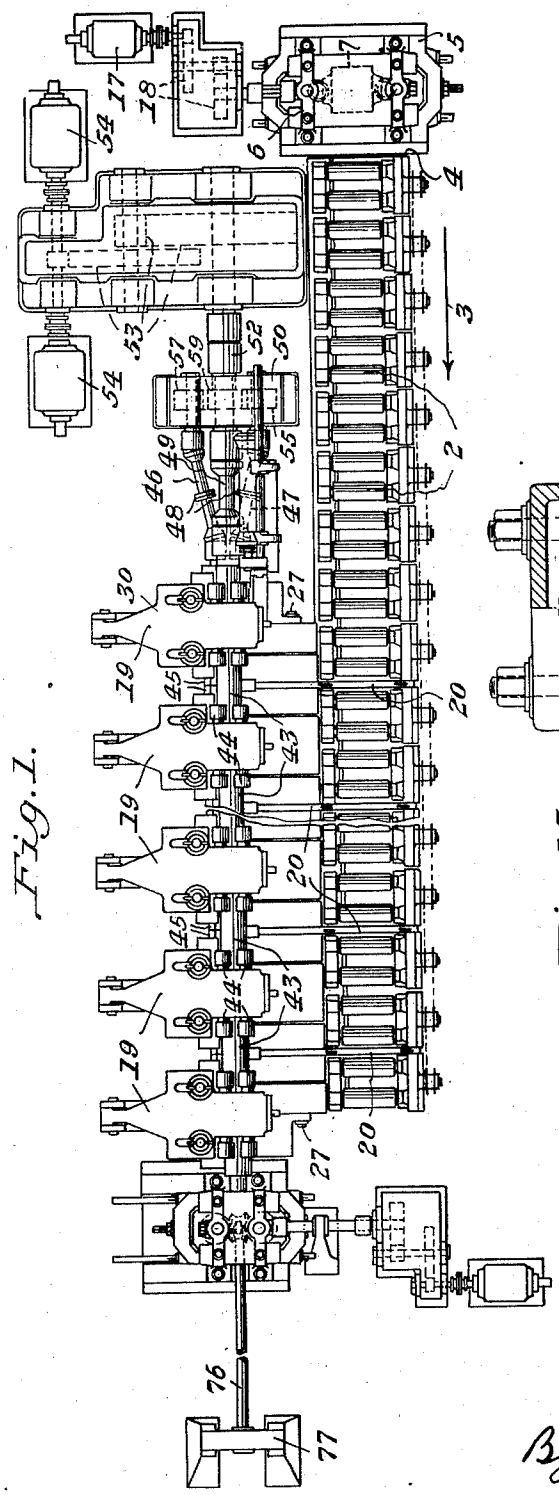


Fig. 1.

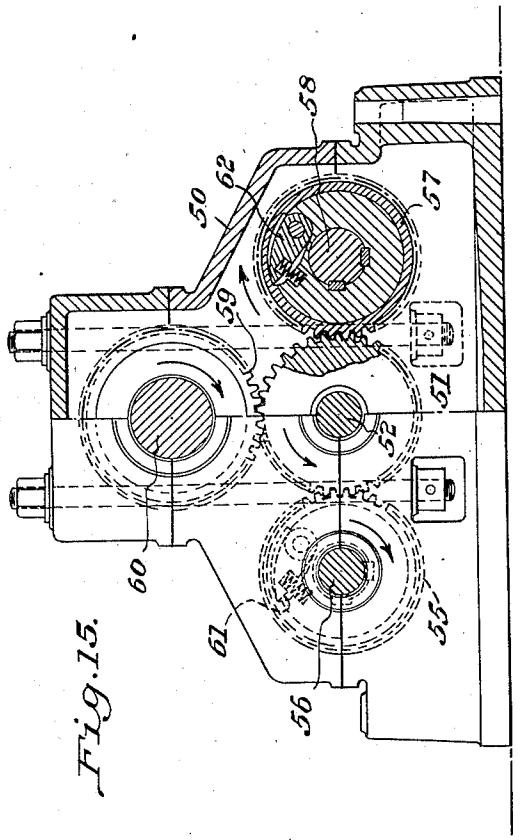


Fig. 15.

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APPARATUS FOR FORMING TUBES

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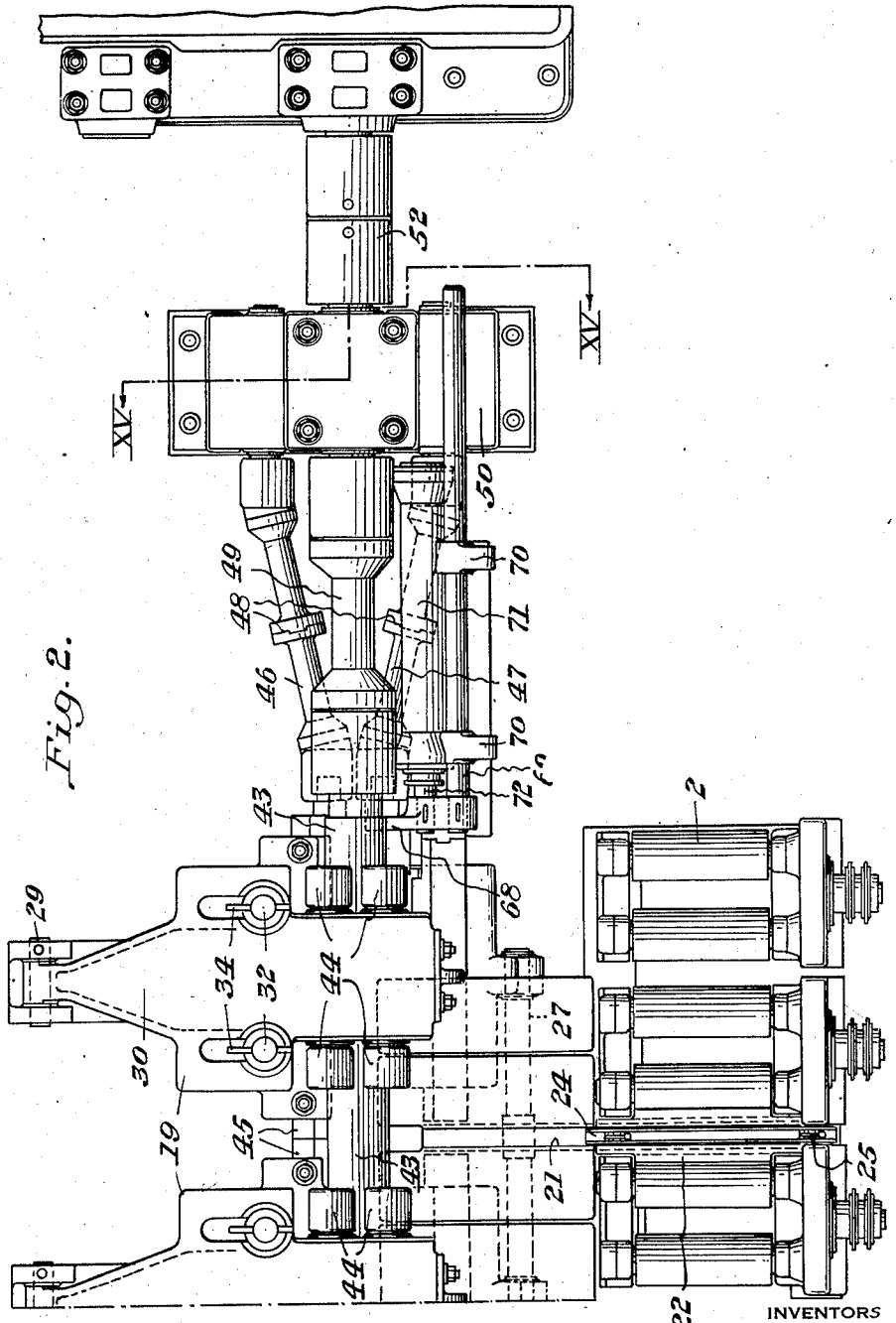


Fig. 2.

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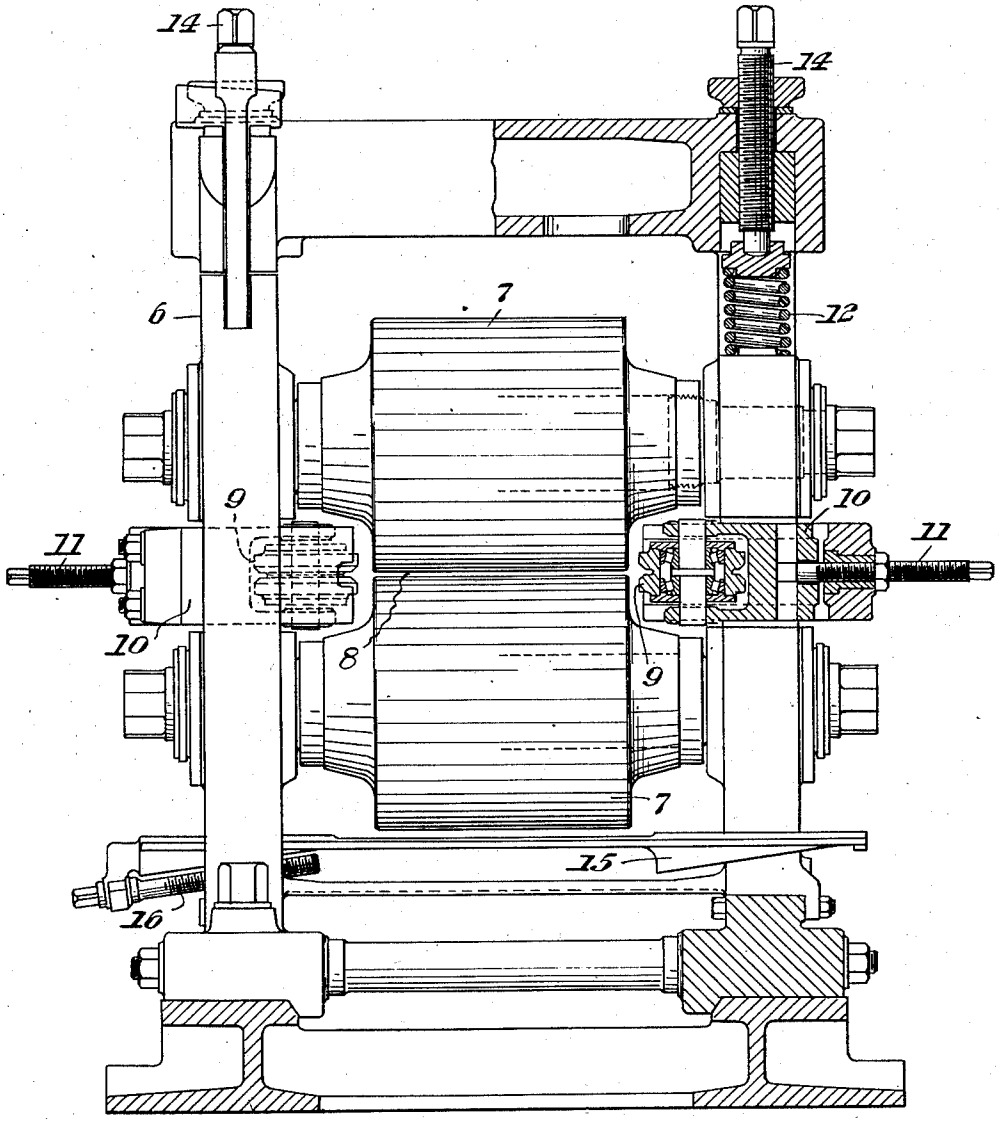
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APPARATUS FOR FORMING TUBES

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Fig. 3.



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APPARATUS FOR FORMING TUBES

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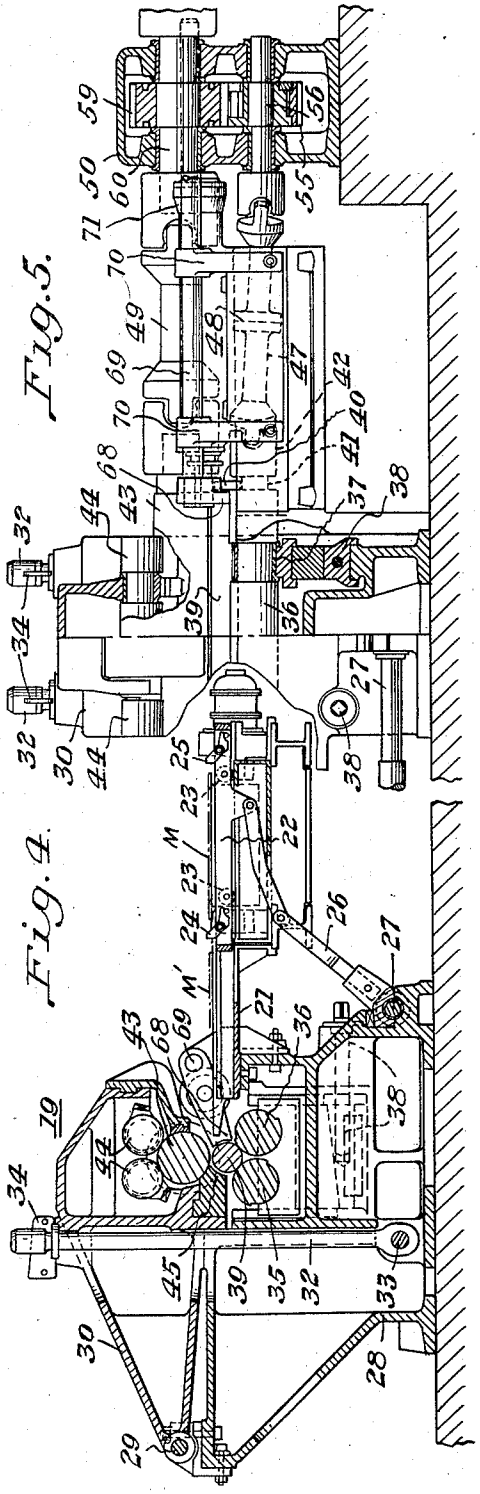


Fig. 5.

Fig. 4.

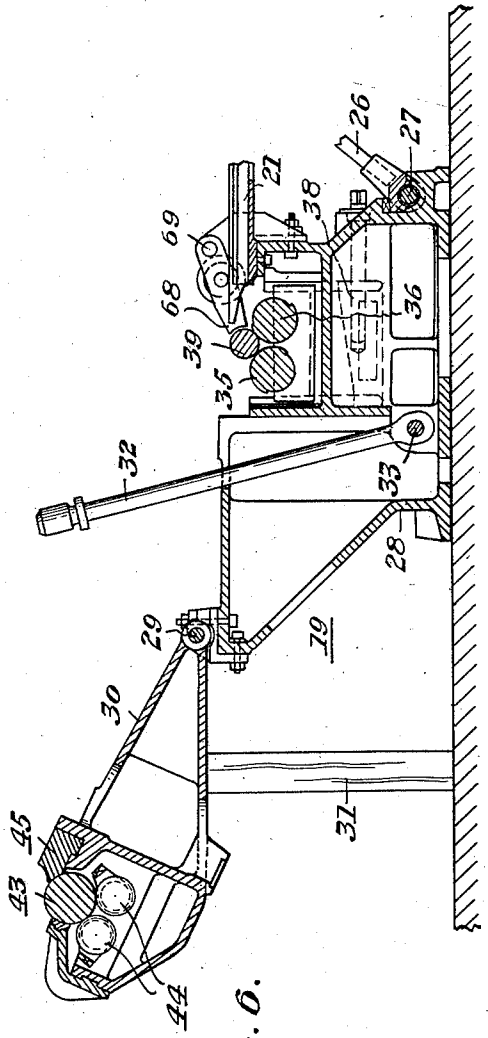


Fig. 6.

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Fig. 7.

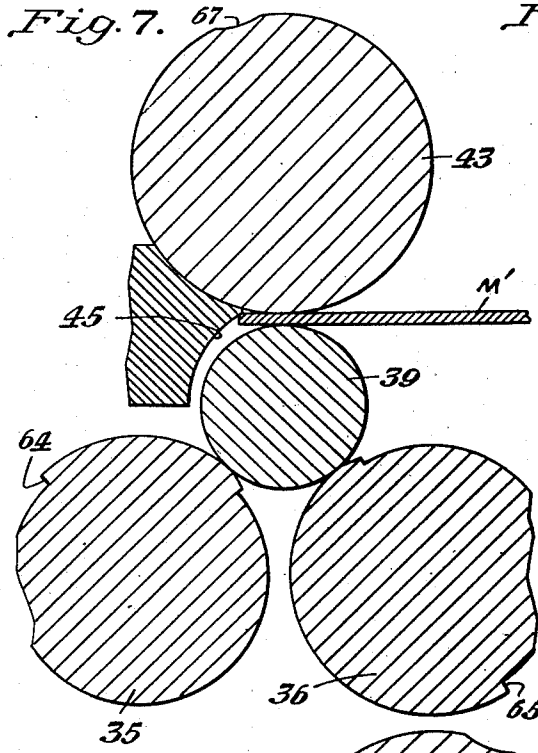


Fig. 8.

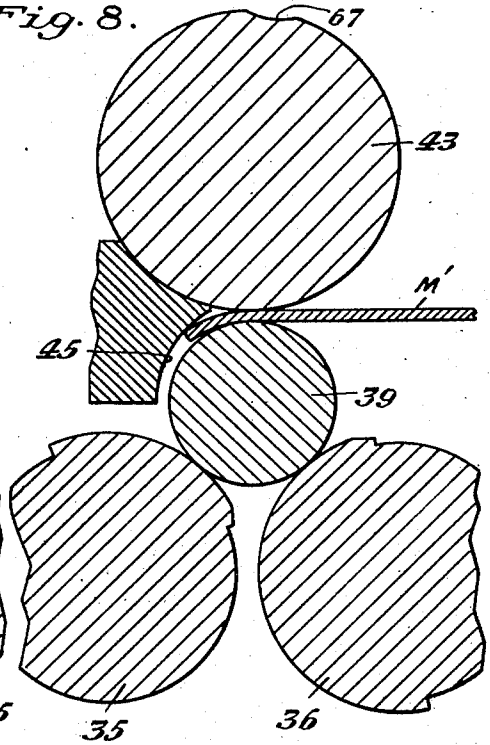
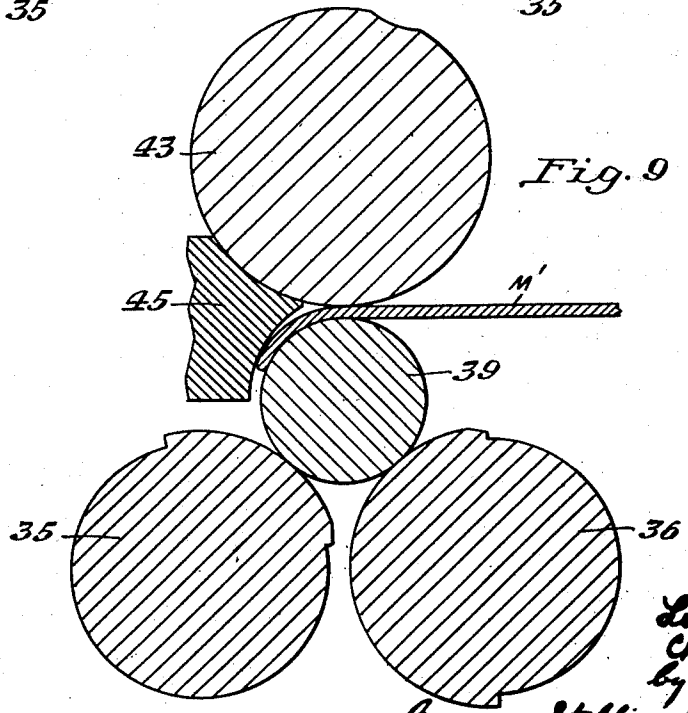


Fig. 9



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June 9, 1936. L. IVERSEN ET AL 2,043,665

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Fig. 10.

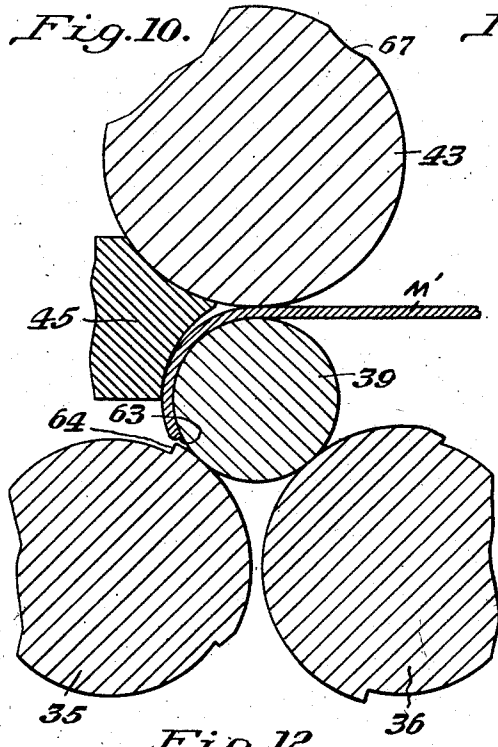


Fig. 11.

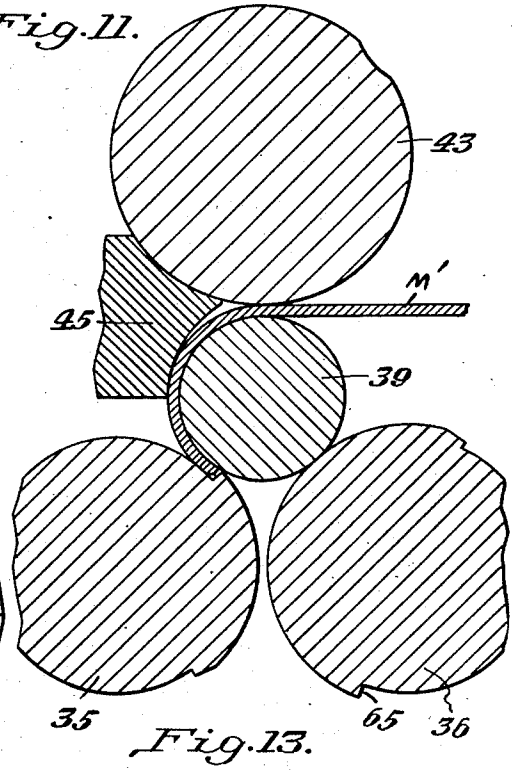


Fig. 12.

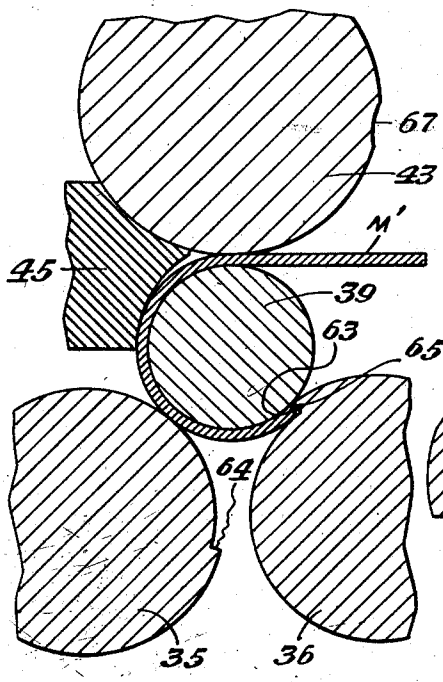
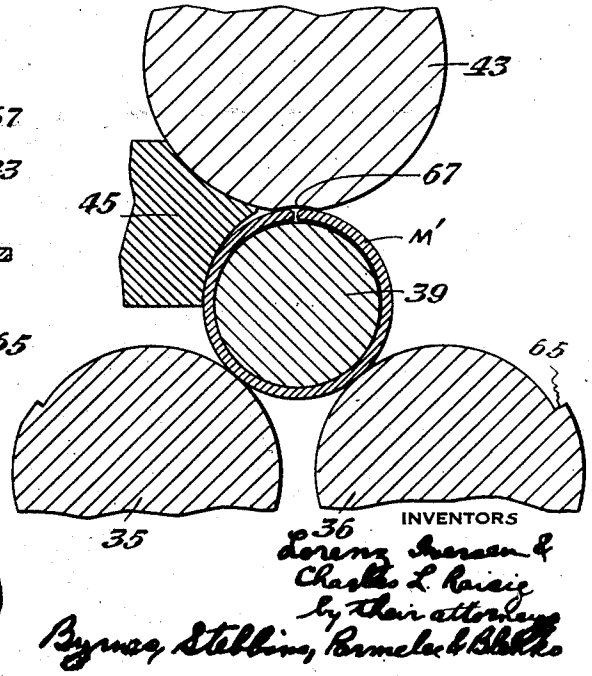


Fig. 13.



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APPARATUS FOR FORMING TUBES

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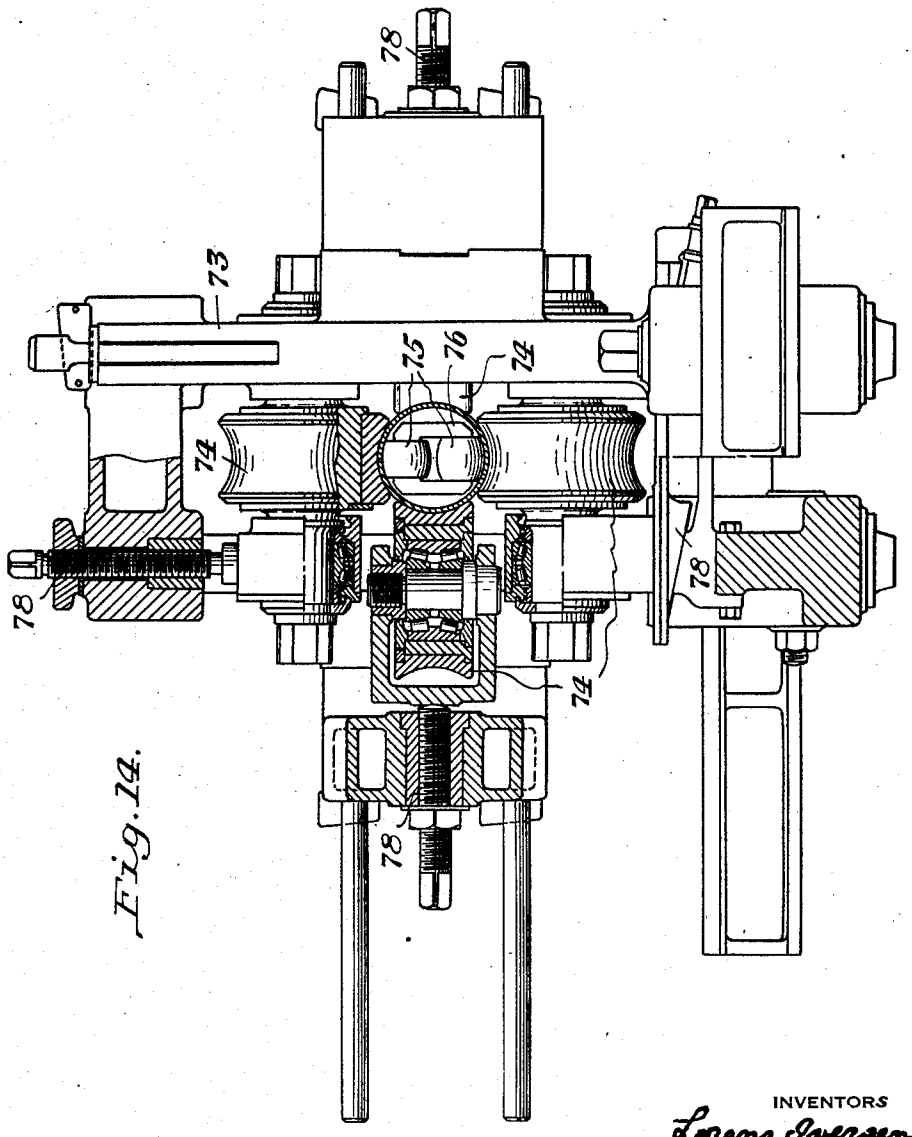


Fig. 14.

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Patented June 9, 1936 2,043,665

UNITED STATES PATENT OFFICE

2,043,665

APPARATUS FOR FORMING TUBES

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Application December 2, 1932, Serial No. 645,390

17 Claims. (Cl. 153—61)

The present invention relates broadly to the art of metal working, and more particularly to metal bending and shaping whereby substantially flat sheets or plates may be formed into tubes, pipes and the like. In this connection the term "tubes" will hereinafter be utilized in its generic sense as definitive of shapes having the general characteristics in question.

At the present time, there are two general methods in vogue for the forming up, usually cold, of long sheets or plates into tubular shape. In accordance with one of these methods the flat material is fed in a direction generally parallel to its longitudinal axis through a succession of roll stands providing passes of successively changing contour such that the edges are first curled up slightly to provide a channel shaped section, and then the curling up operation completed. While such a forming means may be satisfactorily utilized for accomplishing the intended purposes, the number of stands required in order to complete the forming up operation represents a very large investment. The spacing incident to the location of the stands also extends the complete unit to such a length that a comparatively large floor area is required.

In accordance with the second method, a similar piece of material is fed endwise into the space between a pair of generally converging endless belts, which belts are effective for progressively curling up either one or both edges. The difficulties involved with respect to camber in these endless belt formers, as well as the problems incident to the control of the edges in order to prevent twisting or deformation thereof, have been such as to prevent any extended use of formers of this type.

In accordance with the present invention, there is provided a forming apparatus, which may be of a length such as to properly accommodate sheets or plates to be formed into tubes, and effective for producing such a forming operation by gradually curving the parent metal around a mandrel, and accurately controlling the forming operation during the entire process. In this manner it is possible to produce an accurately formed tube, free from camber, and characterized by a seam line between the meeting edges which extends in a truly longitudinal direction and does not extend spirally of the blank. Such a blank is admirably suited to present day welding methods, and facilitates the performance of a seam welding operation thereon.

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

Figure 1 is a top plan view of an apparatus in accordance with our invention;

Figure 2 is a top plan view of a portion of the apparatus illustrated in Figure 1;

Figure 3 is a detail view partly in section and partly in elevation of the initial sizing pass;

Figure 4 is a transverse sectional view partly in elevation through one of the forming units;

Figure 5 is a side elevational view partly broken away and partly in section of the forming unit of Figure 4;

Figure 6 is a view generally similar to Figure 4, but illustrating the former unit in opened condition;

Figures 7 to 13 both inclusive are diagrammatic views showing successive operations incident to the formation of a tube;

Figure 14 is a view partly in section and partly in elevation of the sizing pass; and

Figure 15 is a detail sectional view, on an enlarged scale, along the line XV—XV of Figure 2, looking in the direction of the arrows.

Referring to Figure 1, a metal forming or shaping apparatus in accordance with the present invention includes a conveyor unit conveniently in the form of a roll table 2 of suitable construction and including a plurality of rolls adapted to be driven in synchronism for effecting a feeding movement therealong of material placed thereon. In actual practice, the rolls are driven in such direction as to effect a feeding movement in the direction of the arrow 3 of Figure 1.

Cooperating with the receiving end 4 of the conveying unit 2 is a metal forming unit 5. This metal forming unit is illustrated in detail in Figure 3 as comprising a roll stand 6 containing upper and lower rolls 7 providing a pass 8 therebetween shaped to accommodate a flat sheet or plate to be formed into a tube.

In line with the pass 8, and constituting edge engaging and forming means for such a sheet or plate, are edge forming rolls 9 carried in suitable bearings 10 adapted to be adjusted inwardly or outwardly by means of adjusting screws 11. In this manner, it is possible to vary the position of the edge forming means 9 to cooperate with sheets or plates of different widths. The pressure exerted by the rolls 7 through the medium of springs 12 may be increased or decreased at will by proper operation of spring adjusting screws 14. In like manner, the position of the rolls and the width of the pass may be varied through a suitable roll adjustment 15, as understood in the art

comprising adjusting wedges operated by a screw 16.

With a metal forming unit of the general character referred to, the main portion of the sheet or plate is gripped between the rolls 7 and flattened simultaneously with the performance of an edge shaping operation thereon. This edge shaping, in addition to being effective for truing up the edges, is also effective for insuring uniform overall width throughout the length of the sheet or plate being passed through the forming unit.

The rolls 7 are adapted to be driven in any desired manner, as by a motor 17 and gear stand 18, the direction of rotation of the rolls being such that as the material is flattened, brought to width and the edges trued, it passes onto the conveying unit 2. The conveying unit being in operation, the material is conveyed to a point adjacent the left hand end of the conveyor in front of a series of curling units 19, the number of which may be varied in accordance with the length of the metal being handled.

As will be apparent generally from Figure 1, there is a cross conveyor mechanism 20 effective for transferring material from the conveying unit 2 to the curling units 19. In Figure 4 of the drawings this cross conveyor mechanism is illustrated as comprising a series of suitable guides 21 in each of which is adapted to travel from a position in line with the conveying unit to a position adjacent the curling units, a pusher 22 carried on suitable rolls or wheels 23 and including pusher dogs 24 and 25.

It may be assumed by way of illustration that a piece of material M to be formed into a tube has passed through the forming unit 5 and has been delivered by the conveying unit to the position illustrated in chain lines in Figure 4. In this position, an operation of the pusher 22 to the left will move the material from a position over the conveying unit to a position adjacent the conveying unit and intermediate the same and the curling units 19, as indicated at M' in Figure 4. Upon a return movement of the pusher 22 into the full line position illustrated in Figure 4, each dog 25 will rotate about its pivotal mountings and pass freely under the next piece of material M on the conveying unit. Upon a succeeding movement of the pusher 22 to the left as viewed in Figure 4, the dogs 24 on the respective pushers will engage the material M' and move it into the curling units, while the dogs 25 will move a piece of material M from the conveying unit into the position M'. Upon the next return movement, the dogs 24 will pivot and pass freely under the material M', while the dogs 25 will pivot and pass freely under the next piece of material M, if in position on the conveying unit. In most cases, however, the second piece of material will not arrive in the position M shown in Figure 4 until after the piece has been moved from position M' into the curling units.

The operation of the pusher 22 is obtained by means of suitable operating links 26 operatively connected at one end to the pusher 22 in each of the guides 21, and operatively connected at their other ends to an oscillating shaft 27. This shaft is conveniently journaled in suitable bearings in the curling units 19, and may be operated in any desired manner for effecting the requisite movements of the pushers 22. Inasmuch as these pushers are all secured to the same shaft, it is apparent that they will operate in unison upon each movement of the shaft, and thereby exert a simultaneous and distributed feeding action on the material.

As will be apparent more particularly from Figures 4, 5 and 6 of the drawings, each of the units comprises a base 28 of suitable construction providing a pivotal mounting 29 about which the upper housing section 30 is openable from the full line position of Figure 4 to the full line position of Figure 6. In this opened position, the upper housing sections may rest on suitable supports 31. In closed position the parts may be clamped against opening movement by means of tension bolts 32 having a pivotal mounting 33 in the base section 28, and constructed at their upper ends to receive wedges 34 by means of which the desired clamping action may be obtained.

Extending through all of the curling units is a pair of shaping shafts 35 and 36, of generally similar construction. These shafts in all of the curling units are mounted in suitable bearings 37 in each of the curling units, as indicated for example in Figure 5, the bearings being adjustable vertically by means of suitable wedge adjusting mechanism 38. Carried by shaping rollers 35 and 36 is a mandrel 39, also extending through the various curling units and common thereto.

For preventing endwise movement of the mandrel 39 relatively to the shaping shafts 35 and 36, the mandrel is provided with a collar 40 (Figure 5) adapted to interfit with suitable grooves 41 in the driving spindles 42 for the shaping shafts. Due to this construction, when the upper housing sections 30 are thrown to their open position as illustrated in Figure 6, access to the mandrel may be freely had, and the mandrel bodily removed. Suitably journaled in the upper housing sections is a backing up roll or shaft 43 adapted with the housing sections in closed position to overlie the mandrel 39. The backing up shaft 43 is in turn backed up in each of the curling units by a pair of independent rollers 44. Also carried by each of the housing sections 30 is a die 45, the various dies being of such length as to abut end for end, as shown in Figure 2 and thereby provide a continuous die surface as hereinafter more fully pointed out.

The shaping shafts 35 and 36 are adapted to be driven through suitable spindles 46 and 47 respectively, each spindle including universal joints and adjustable couplings 48. By reason of the adjustability of the couplings 48, it is possible to properly index the shaping shafts 35 and 36 to bring them into the desired cooperative relationship one to the other and to the other parts of the shaping units, as will be hereinafter more fully described. The backing up shaft 43 is also adapted to be driven by a suitable spindle 49 of any desired construction.

As will be apparent more particularly from Figures 2 to 15, the spindles 46 and 49 all extend from the respective parts which they drive to a position adjacent a drive housing 50. This housing contains an intermediate gear 51 carried by a shaft 52 adapted to be driven through a suitable gear train 53 and motors 54. Meshing with the gear 51 is a similar gear 55 on a shaft 56, which shaft is operatively connected to the spindle 47. On the opposite side of the gear 51 is a second gear 57 on a shaft 58 constituting the driving means for the spindle 46, while above the gear 51 is a gear 59 on a shaft 60 constituting the driving means for the backing up spindle 49. For purposes which will hereinafter be

more fully set forth, the operative connection between the gear 55 and the shaft 56 includes a pawl 61, while a similar pawl 62 constitutes an operative connection between the gear 57 and its shaft 58.

In Figure 15 the direction of rotation of each of the parts is indicated by suitable arrows. By reason of the pawls 61 and 62, the gears 55 and 57 when rotating in a clockwise direction as viewed in Figure 15 and as indicated by the arrows, will transmit rotation to the respective shafts 56 and 58, but the shafts may move ahead relative to the gears in case the drive for the shaping shafts 35 and 36 is transferred from the spindles 46 and 47 to some other portion of the apparatus.

In Figure 7, we have indicated one edge of a piece of material M' which has been advanced by the pushers 22 into a position between the mandrel 39 and the backing up shaft 43 with its front edge against the die 45. Rotation of the parts will cause the leading edge to gradually curl downwardly over the shaping surface of the individual die sections 45, and between the same and the mandrel 39, as indicated in Figure 8, this operation continuing as indicated in Figure 9.

Further rotation will bring the parts into the relative position illustrated in Figure 10, wherein the leading edge 63 of the material is about to engage a shoulder 64 on the shaping shaft 35. In Figure 11 this engagement has been effected and the material has been advanced into a position between the mandrel 39 and the shaping shaft 35. Up until the time that the leading edge 63 of the material engages the shoulder 64, the periphery of the shaping shaft 35 at its portion of maximum diameter is in engagement with the mandrel 39. After this engagement, the effective radius of the mandrel 39 is increased by the thickness of the material so that the peripheral speed of the mandrel plus the material, or the peripheral speed of the outer surface of the material is greater than the peripheral speed of the mandrel itself. Thus, with the parts in the position illustrated in Figure 11, the mandrel tends to rotate the shaping shaft 35 faster than it is driven by the gear 57. Therefore, the shaft 35 tends to drive the shaft 58 in a clockwise direction as viewed in Figure 15 ahead of the gear 57, which relative movement is permitted by the pawl 62.

Continued rotation of the parts brings the leading edge 63 out of engagement with the shoulder 64 on the shaft 35 and into engagement with a shoulder 65 on the shaft 36. With the parts illustrated in the position of Figures 10 and 11, the portion of maximum diameter of the shaft 36 is in driving engagement with the mandrel 39, but when the parts reach the position of Figure 12 and the effective radius of the mandrel 39 is increased, the shaft 36 tends to move ahead of its driving shaft 56 for reasons described, this relative motion being permitted by the pawl 61.

Continued rotation will bring the parts into the position of Figure 13 wherein the material is completely formed around the mandrel with the adjacent edges thereof in opposed relationship and accommodated by a longitudinally extending depression 67 in the backing up shaft 43. The edges naturally tend to spring apart to some extent and unless the groove 67 were provided, there might be a binding action between the material, the mandrel and the backing up shaft 43 which would prevent endwise stripping of the blank from the mandrel. The slight springing apart permitted by the depression, however, loosens the blank from the mandrel, as indicated in Figure 13, so that it may be stripped axially therefrom.

In Figure 4, we have illustrated the stripper as comprising an arm 68 which extends inwardly toward the mandrel and has its inner end contoured to substantially conform to the periphery of the mandrel. At its extreme outer end it is carried by a guide rod 69, as shown more particularly in Figure 2, guided in lugs 70 projecting outwardly from a cylinder 71. The piston rod 72 of the cylinder engages the stripper 68 intermediate its inner end and the guide rod 69. Upon admitting fluid to the stripper cylinder 71, the stripper will be moved to the left as viewed in Figure 2. During this time its inner end will be in engagement with the end of the blank and the blank will thus be stripped endwise of the mandrel, bringing its left hand end as viewed in Figure 1 into the pass of a sizing unit 73 illustrated in detail in Figure 14.

This sizing unit conveniently comprises a series of rolls 74, herein illustrated as being four in number, providing a substantially enclosed pass around inner shaping rolls 75 carried by a mandrel 76 supported at its extreme outer end in a stand 77, the mandrel 76 when so supported, being of such length as to receive the entire length of the blank. It will be apparent, however, that the mandrel may be otherwise supported at points intermediate its ends by means adapted to project between the spaced edges of formed pieces, thus making it possible to use a shorter mandrel. All of the rolls 74 are individually adjustable through suitable adjusting means 78 so that the desired sizing pressure may be exerted on the blank for accurately crushing the same to the desired contour and accurate diameter. After moving through the sizing unit 73, it may be stripped from the mandrel 76 in any desired manner and subjected to any further operations, such for example as a welding operation for completing the blank into a tube, pipe, or conduit or the like.

Since the apparatus includes a plurality of curling units arranged in side by side relationship with sectional dies, the dies may be replaced individually as required to insure the maintenance of an accurate forming surface. Since all of the curling units are simultaneously operable on a blank throughout substantially its entire length, the curling up operation may be accomplished without any tendency to impart a camber to the blank. At the same time, the shoulders 64 and 65 on the shaping shafts 35 and 36 constitute a positive guide means for the leading edge 63 of the material preventing it from twisting around the mandrel 39. In the absence of any twisting, the edges will be brought into opposed relationship as illustrated in Figure 13 along a substantially straight line free from any discernible spiral.

The provision of the indexing adjustments 48 in the spindles 46 and 47 enables the position of the shoulders 64 and 65 to be properly initially positioned one with respect to the other so that they will constitute edge engaging means and guiding means for the material being shaped into a blank.

The simultaneous curling of a blank throughout its entire length into a tube of standard dimensions, while accurately controlling the position of the blank, constitutes an important advantage of our invention by reason of the superior product thereby obtainable.

While we have herein illustrated and described certain perferred embodiments of our invention, it will be understood that changes in the construction and relationship of the parts may be made without departing either from the spirit of our invention or the scope of our broader claims.

We claim:

1. Tube forming means, comprising a mandrel, a shaping shaft cooperating therewith and having portions of different diameters, and means for driving the shaping shaft, said means including a connection permitting the shaping shaft to move at a speed equal to or greater than the speed of the driving means.

2. Tube forming means, including a mandrel, a shaping shaft, and a backing up shaft, said backing up shaft having a depression adapted to receive the meeting edges of a blank formed around the mandrel.

3. Tube forming means including a mandrel, a shaping shaft, a backing up shaft, said backing up shaft having a depression adapted to receive the meeting edges of a blank formed around the mandrel, and means for stripping a blank from said mandrel.

4. In a tube forming apparatus, a mandrel, means for feeding material around the mandrel, and a shaping shaft cooperating with the mandrel, said shaft having shoulders extending longitudinally thereof, substantially equal in height to the thickness of the material, providing an annular space for receiving successive portions of the material as it is bent around the mandrel, to maintain shaping pressure between the mandrel and shaft with a fixed spacing of their axes.

5. Tube forming means comprising a mandrel and a shaping shaft cooperating therewith for bending a plate of substantial thickness around the mandrel while passing between the mandrel and shaft, said shaft having a raised peripheral shoulder extending longitudinally, substantially equal in height to the thickness of the plate, for engaging the mandrel before entry and after passage of the plate between the mandrel and shaft.

6. Tube forming means, comprising a mandrel, means for feeding material around the mandrel, a shaping shaft supporting the mandrel, and longitudinally extending shoulders on the shaping shaft providing a pass between the mandrel and shaft for receiving the material while being bent around the mandrel and maintaining a fixed spacing of the axes of the mandrel and shaft before entry and after passage of the material therebetween.

7. The apparatus defined by claim 5 characterized by means for feeding the plate longitudinally into side-by-side relation with said tube forming means, and means for moving the plate laterally into the tube forming means.

8. The apparatus defined by claim 5 characterized by a plurality of spaced, individually removable bending dies cooperating with the mandrel.

9. The apparatus defined by claim 5 characterized by the fact that the tube forming means comprises a series of alined bending units, each including a separable bending die, the mandrel and shaping roll being common to all said units.

10. The apparatus described by claim 5 characterized by means for adjusting the position of the shaping shaft relative to the mandrel.

11. The apparatus defined by claim 5 characterized by a drive for said shaping shaft, and means for adjusting the position of the shaping shaft relative to said driving means.

12. Tube forming means comprising a unit for curling metal plate, the unit having a mandrel and a shaping shaft cooperating therewith, the mandrel and the shaft being rotatable about axes spaced a substantially fixed distance apart, the shaping shaft having a sector of such radius that the peripheral surface of the sector lies in substantial engagement with the peripheral surface of the mandrel when such sector is presented to the mandrel by rotation of the shaft, the shaft having another sector of smaller radius, the difference in radii of the two sectors being substantially equal to the thickness of the metal plate to be curled, whereby the last mentioned sector, when presented to the mandrel by continued rotation of the shaft, has its peripheral surface spaced from the peripheral surface of the mandrel a distance sufficient to accommodate the metal plate being worked, the last-mentioned sector being of sufficient peripheral length to accommodate the successive portions of the plate as it is fed between the mandrel and the shaft.

13. Tube forming means as defined in claim 12, characterized by a plurality of curling units of the character referred to, the mandrel and shaping shaft being common to all of said units.

14. Tube forming means as defined in claim 12, characterized by driving means for the shaping shaft including a releasably engaging connection to permit the shaping shaft to move at a speed greater than the speed at which it is positively driven.

15. Tube forming means as defined in claim 12, in which the curling unit includes openable sections, a backing up shaft carried by one of the sections, the shaping shaft being carried by another of the sections.

16. Tube forming means as defined in claim 12, in which the curling unit includes openable sections, a backing up shaft carried by one of the sections, the shaping shaft being carried by another of the sections, the mandrel being rotatably supported at least partially by said shaping shaft.

17. Tube forming means as defined in claim 12, in which the curling unit includes openable sections, a backing up shaft carried by one of said sections, a plurality of shaping shafts carried by another of said sections, the mandrel being rotatably supported on said shaping shafts, and means on the shaping shafts for holding the mandrel against axial movement relatively thereto.

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