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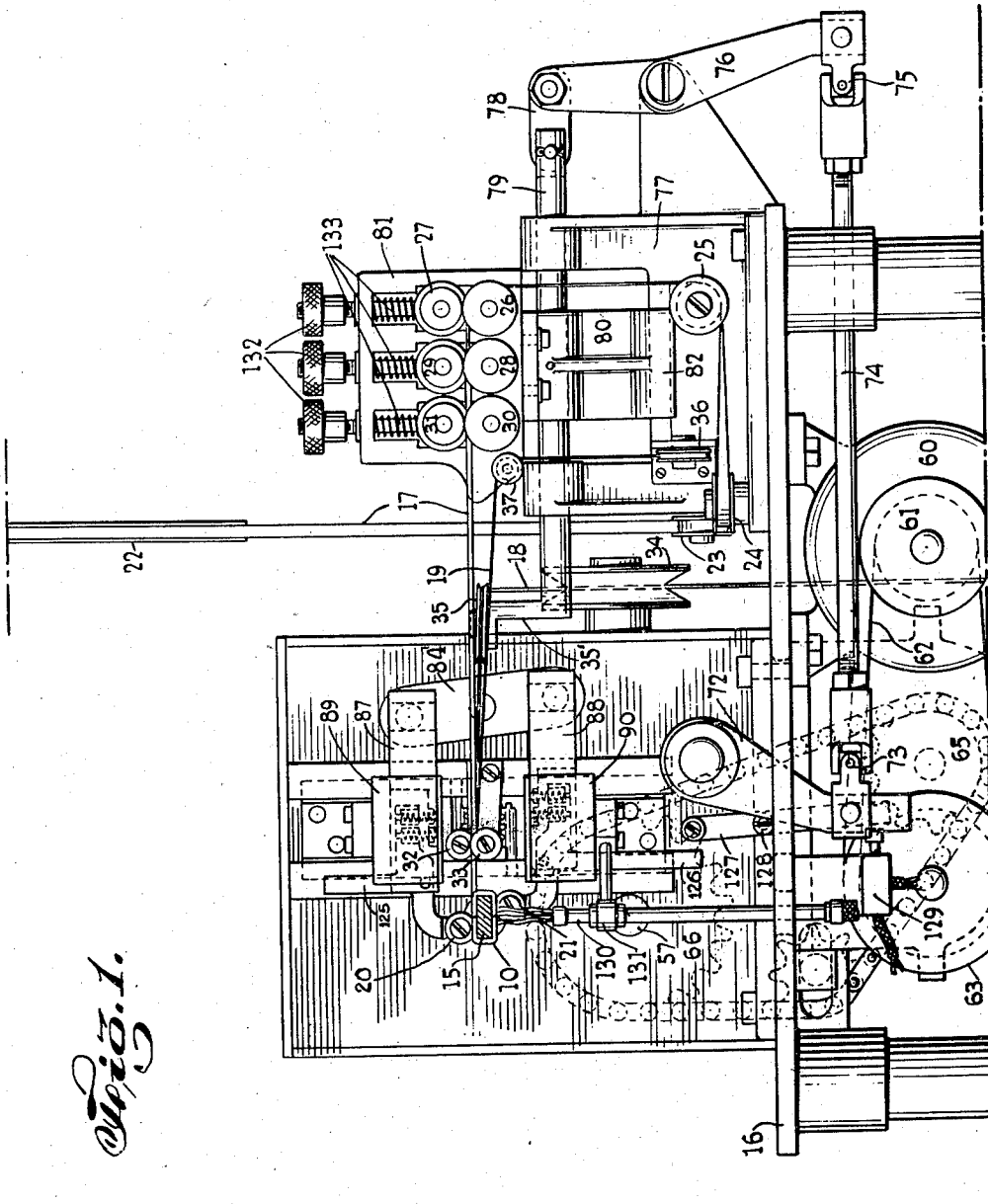
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2,440,792

METHOD AND MEANS FOR FORMING RECTANGULAR FLEXIBLE METAL TUBING

Filed June 6, 1946

8 Sheets-Sheet 1



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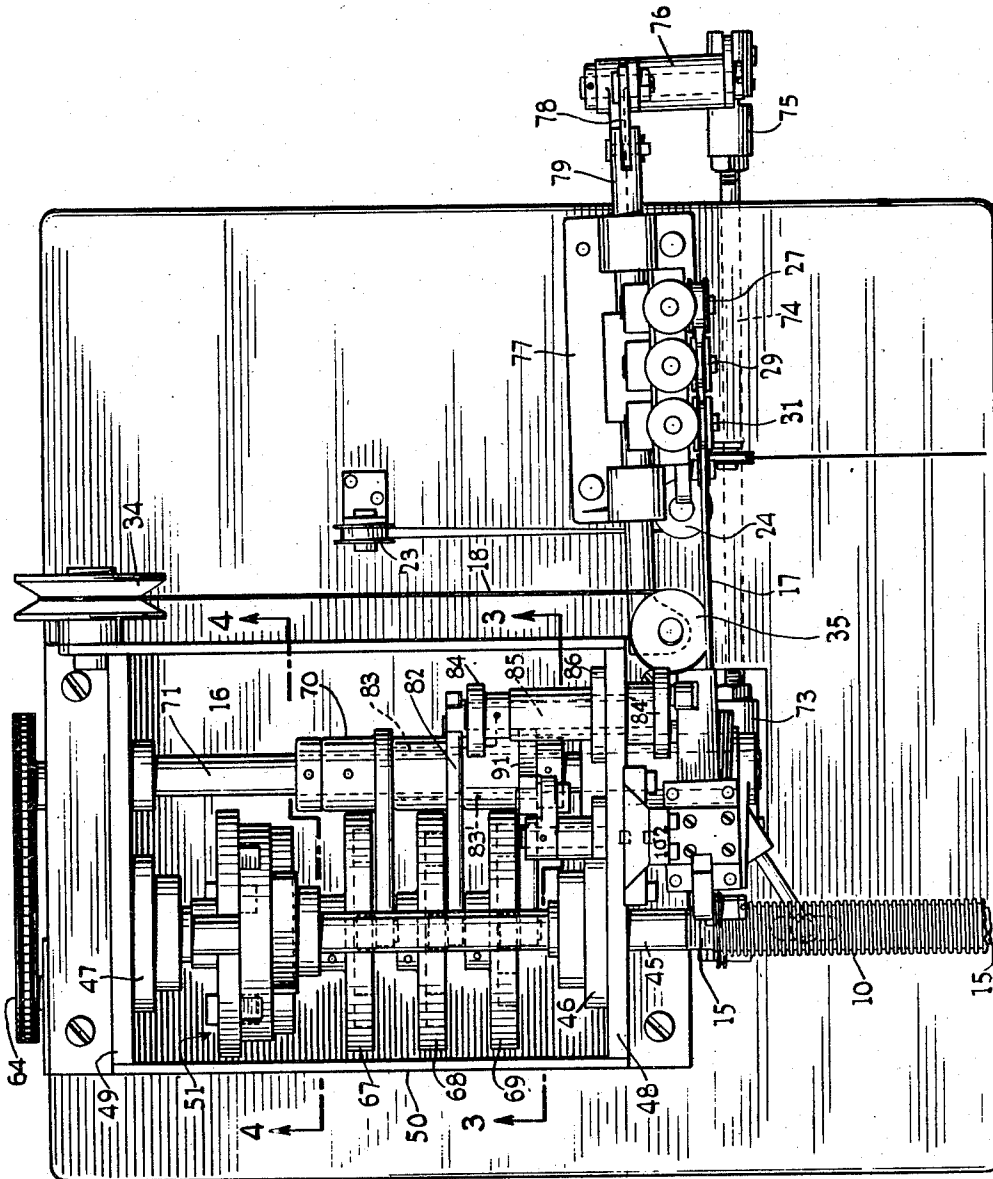


Fig. 2.

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Fig. 4.

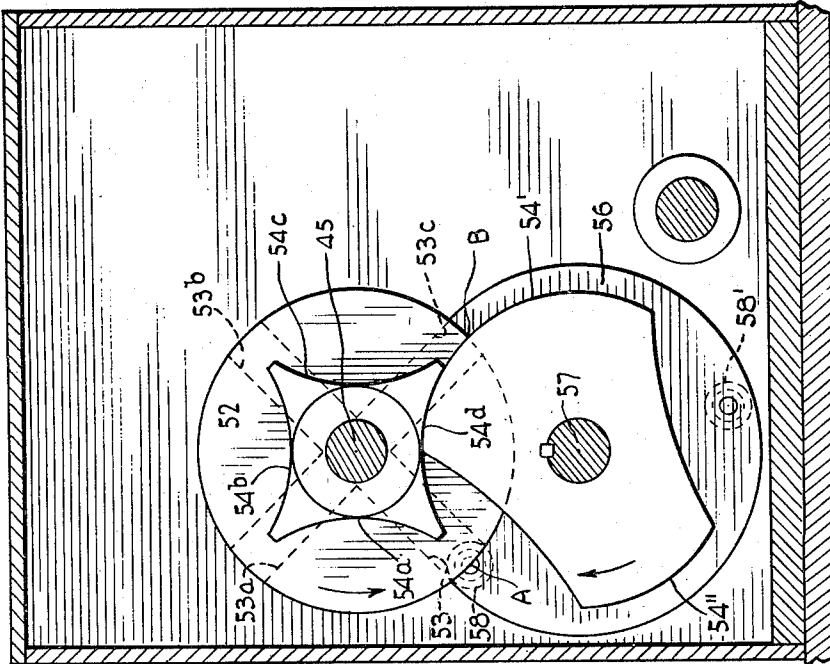
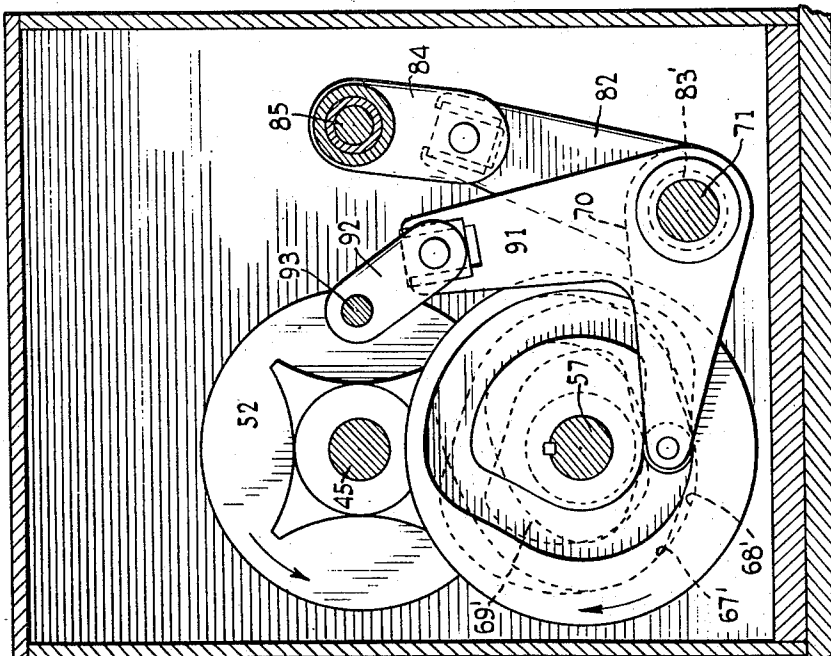


Fig. 3.



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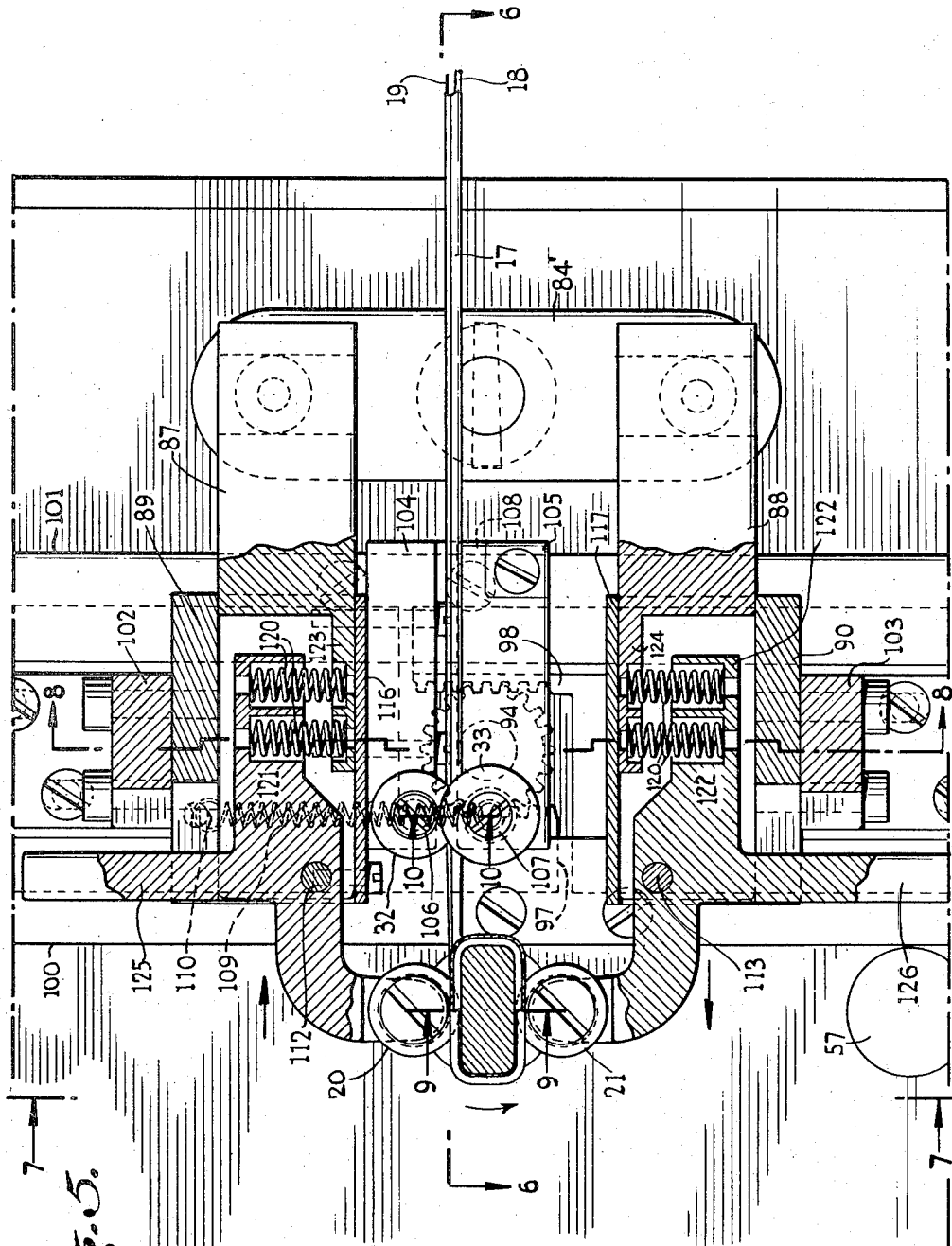
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8 Sheets-Sheet 4



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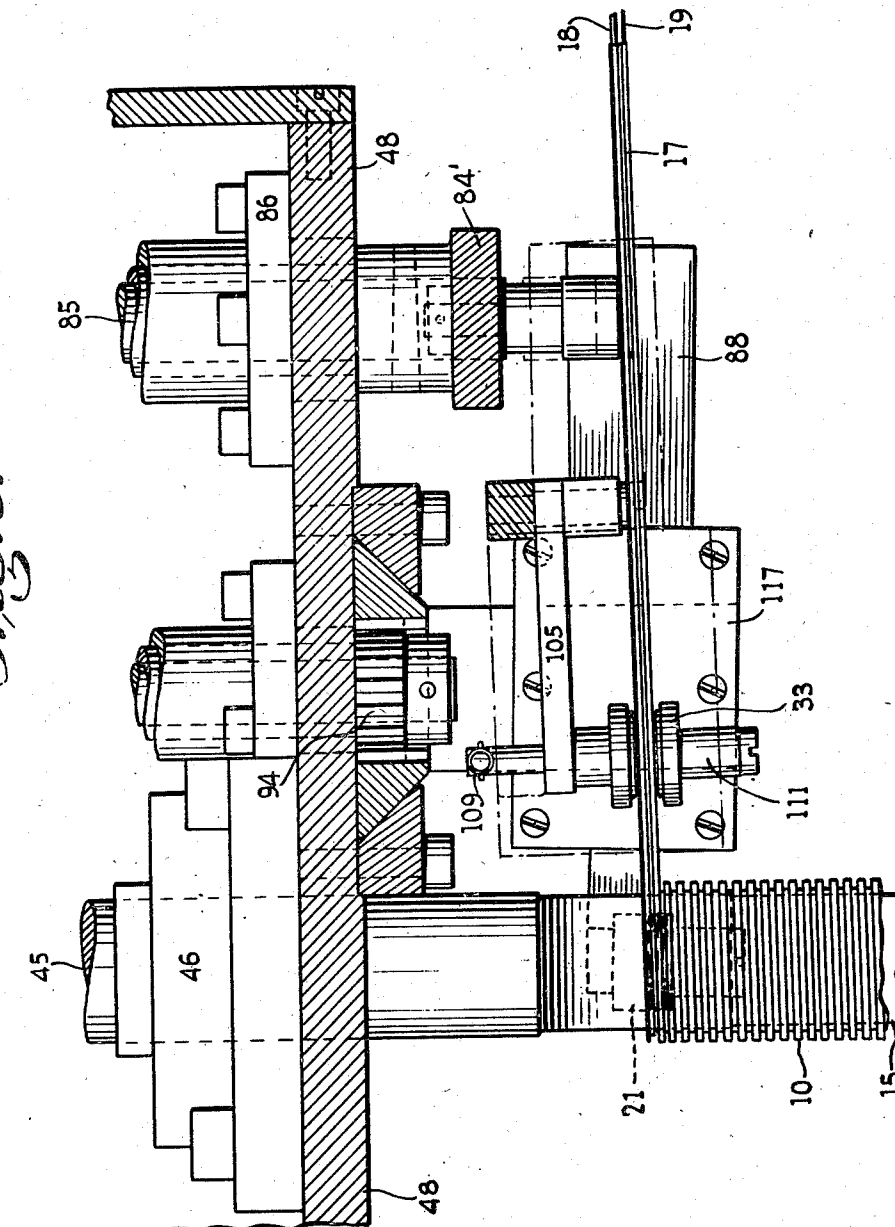
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METHOD AND MEANS FOR FORMING RECTANGULAR FLEXIBLE METAL TUBING

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8 Sheets-Sheet 5



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METHOD AND MEANS FOR FORMING RECTANGULAR FLEXIBLE METAL TUBING

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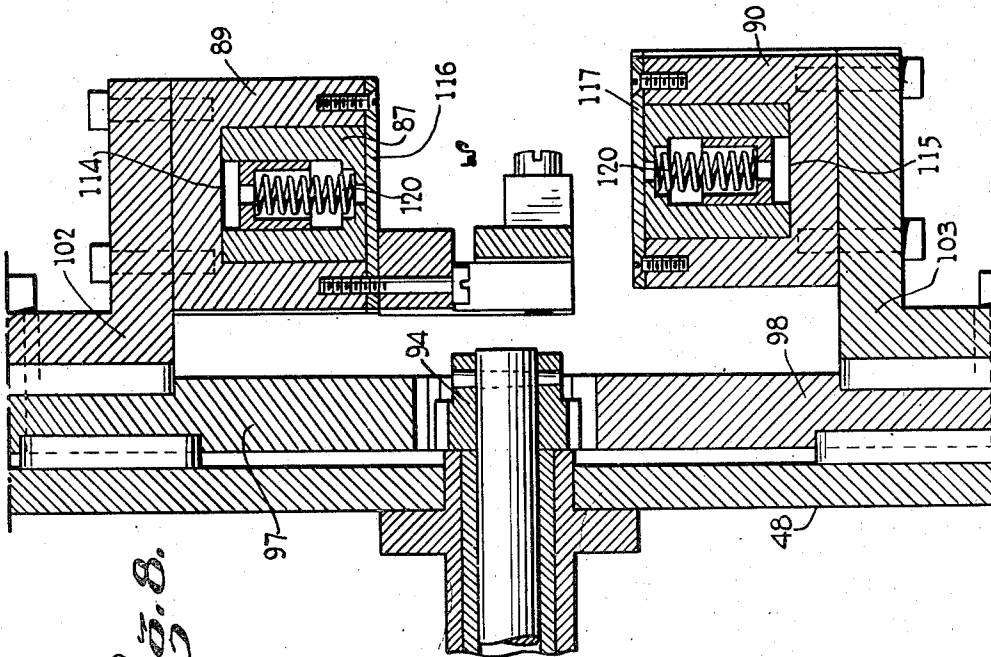


Fig. 8.

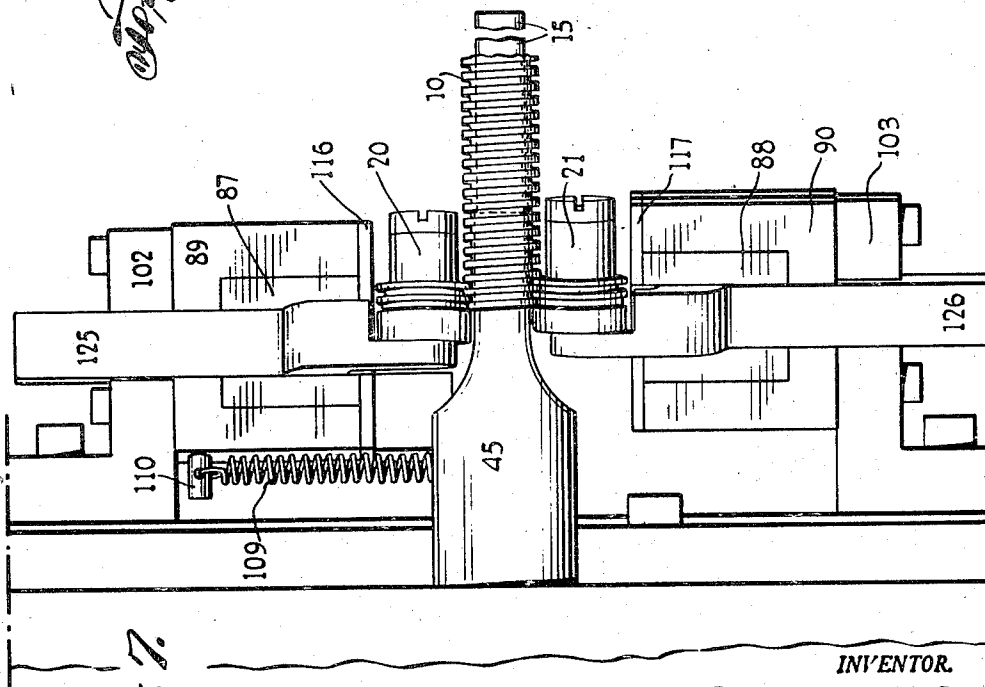


Fig. 7.

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METHOD AND MEANS FOR FORMING RECTANGULAR FLEXIBLE METAL TUBING

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Fig. 10.

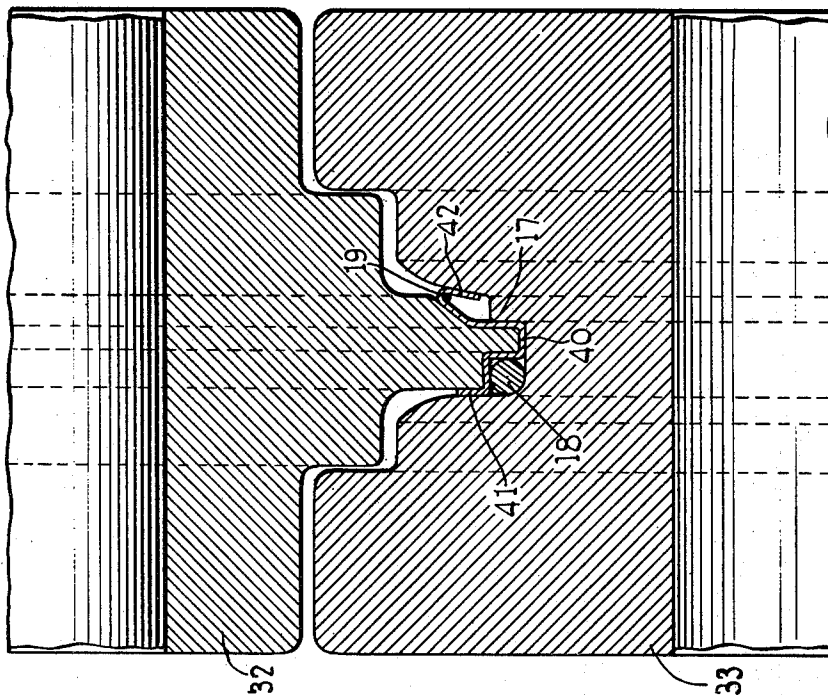
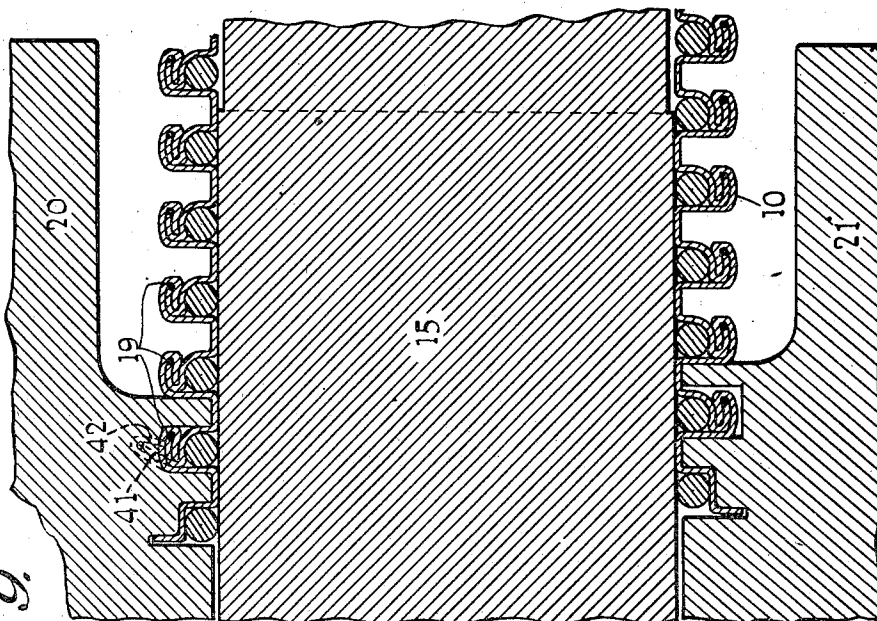


Fig. 9.



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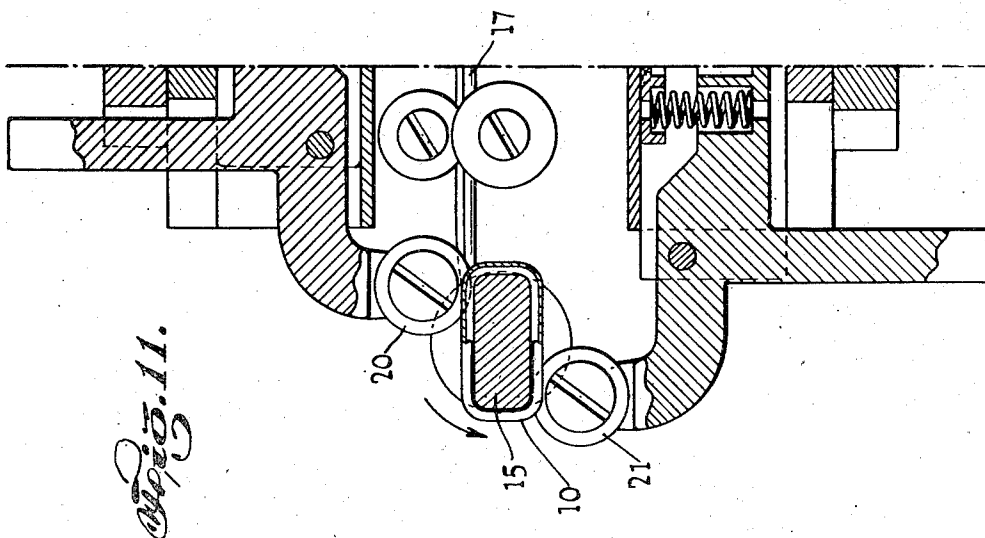
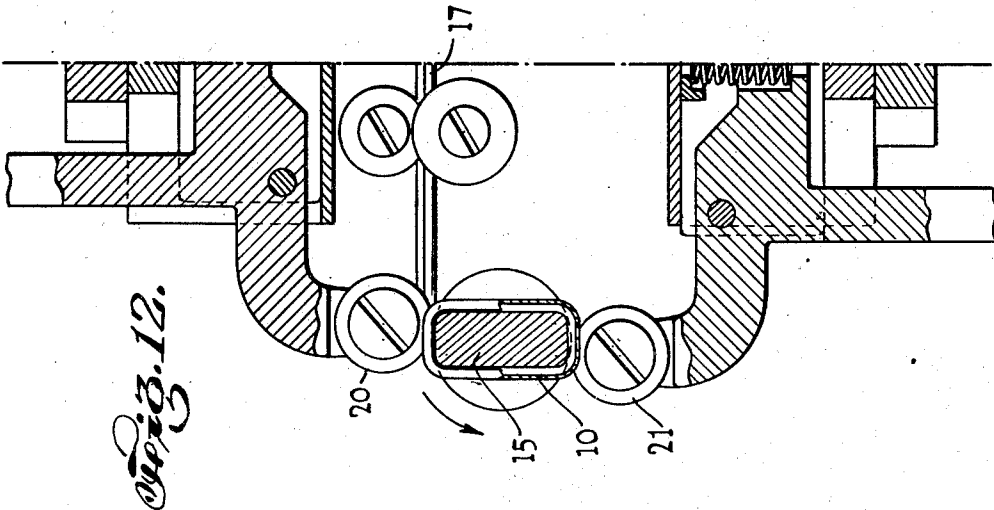
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METHOD AND MEANS FOR FORMING RECTANGULAR FLEXIBLE METAL TUBING

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8 Sheets-Sheet 8



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UNITED STATES PATENT OFFICE

2,440,792

METHOD AND MEANS FOR FORMING RECTANGULAR FLEXIBLE METAL TUBING

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Application June 6, 1946, Serial No. 674,806

20 Claims. (Cl. 113—35)

1

This invention relates to improvements in the production of flexible metal tubing which is sometimes called flexible metal conduit. It has to do particularly with the production of flexible metal tubing having a convoluted wall fabricated by helically winding and seaming a preformed strip of metal which does not have the usual circular cross section.

The principal object of the invention is to provide a machine and method of operation by which tubing of the character described having other than circular cross section may be produced efficiently and economically. Further objects and advantages of the invention will appear from the following detailed description of a preferred embodiment thereof.

The embodiment of the present invention selected for illustration provides an arbor conforming in cross section to that of the tube to be formed thereon, and upon which a metal strip of suitable preformed cross section is wound and interlocked into a continuous tube. The arbor shown is rectangular and is arranged for intermittent rotation in steps corresponding in number to the number of flat surfaces of the arbor. Cooperating rollers are so mounted above and below the arbor that they will act to interlock the strip and advance the tube along the arbor regardless of its position, the roller located above the arbor performing a seaming operation and both being used for stripping the formed tube from the arbor. Mechanism is provided whereby each of these rollers is moved horizontally and vertically to accommodate itself to the position of the arbor surface as the arbor assumes different positions, and to roll along the strip on the flat surfaces of the arbor when the latter is at rest. The preforming of the metal strip is effected by a set of forming rollers which act upon the strip as it is drawn toward the arbor. Due to the shape of the arbor and to the fact that it is not rotated at uniform speed, the movement of the strip toward the arbor will not be at a uniform speed. It is desirable that the strip proceed through the preforming rollers at a uniform speed and therefore these rollers are mounted in a moveable carriage which is positively actuated toward and away from the arbor in such timed relation to the rotation thereof that the passage of the strip through the form-

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ing rollers will be at a substantially uniform speed. On the arbor the preformed strip is assembled with a deformable wire and a thread of solder, both of which are fed in with the strip. The deformable wire and solder thread may be guided to move with the forming roll carriage so that they will not be subject to irregular deleterious strain.

The foregoing illustrative embodiment of the invention is shown in the accompanying drawings wherein:

Figure 1 is a front elevation view of a machine embodying my invention for producing rectangular flexible tubing or conduit, some of the extremities of the machine having been omitted to include the view the confines of the page,

Figure 2 is a top plan view of the machine of Figure 1 with a casing cover removed to show driving elements,

Figure 3 is a cross section view taken along the lines 3—3 of Figure 2 to show cam operation,

Figure 4 is a cross section view taken along lines 4—4 of Figure 2 showing the mechanism producing intermittent motion,

Figure 5 is an enlarged front elevation view, partly in cross section, showing certain tube forming and seaming mechanisms,

Figure 6 is a horizontal cross section view taken along the lines 6—6 of Figure 5,

Figure 7 is a side elevation view from the left side of Figure 5 taken along the lines 7—7,

Figure 8 is a vertical cross section view taken along the lines 8—8 of Figure 5,

Figure 9 is an enlarged vertical cross section view taken along the lines 9—9 of Figure 5,

Figure 10 is an enlarged vertical cross section view taken along the lines 10—10 of Figure 5,

Figure 11 is a fragmentary front elevation view, partly in section, showing the arbor and seaming roller mechanism used in tube forming at a particular stage in the machine cycle, and

Figure 12 is a view similar to the view in Figure 11 taken at a different stage in the machine cycle.

Referring now to Figure 1 in the drawings for a description of the machine, I employ, as a principal element, a power driven rectangular arbor 15 situated at the left central portion of

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this view above the base plate 16. Arbor 15 is rotated intermittently counter-clockwise and, as it turns, it draws in preformed strip 17, soft metal wire 18 and a solder thread 19, to be suitably associated and wrapped therearound. Interengaging edges of the strip are locked and seamed to form a tube as the strip is wrapped around the arbor by a seaming roller 20 and the strip formed tube is advanced on the arbor by the cooperation of rollers 20 and 21, located above and below the arbor respectively.

The strip metal 17 used in fabricating tubing is fed from a supply coil 22 which is suspended over the machine in a suitable manner. Strip 17 leaves the coil 22 as a flat metal ribbon and passes downwardly to the machine, around the directional guide rollers 23, 24, and 25, located just above the base plate 16 and then feeds upwardly into the bight of a pair of first operation forming rollers 26, 27. From the first forming rollers the strip feeds horizontally toward the arbor between two additional pairs of forming rollers 28, 29 and 30, 31, which complete a transformation in the cross section of the strip from at flat metal ribbon to a prescribed shape, which will be later described. The formed strip is then directed between a pair of guide rollers 32, 33 adjacent the arbor 15 and from these guide rollers to the arbor.

In like manner the soft round wire 18 and solder thread 19 are fed from suitable supply reels, the soft wire traveling upwardly centrally of the machine from its reel, not shown, over the guide rollers 34 and 35 after which it moves horizontally toward the arbor and becomes associated with the strip 17 as it passes between the guide rollers 32 and 33. The solder thread 19 is guided from its reel over rollers 36 and 37, and also becomes associated with the strip as it passes between the above-mentioned guide rollers.

The cross section of the strip 17 after it has passed through the last pair of forming rollers and as it approaches the arbor 15 between guide rollers 32 and 33 is shown in Figure 10, consisting of a U-shaped portion 40, to the left of which extends an angle shaped portion having an upstanding edge 41, and to the right of which is a hook shaped portion 42. It will be noted at this point that the soft wire 18 becomes associated with the strip at the left side of the U-shaped portion 40 and under the angle portion, also that the solder thread 19 is located in the V of the hook shaped portion 42 on the right. Figure 9 shows the cross section of the strip approaching and resting on the arbor 15, the dotted lines indicating the overlapping association of the hook shaped portion 42 of the incoming strip with the upstanding edge 41 of the strip on its previous turn about the arbor. After the upper seaming roll 20 has passed over these overlapping edges, a locked seam is formed as shown in the full lines which is tightly compressed having the solder thread interlocked therewith for a subsequent solder fusing operation which securely joins the mating edges of strip. Soft wire 18, resting on arbor 15, supports this seaming operation and tends to regulate the configuration of the metal of the seam, so that convolutions are uniform and so that sharp bends and kinks are avoided. Suitable clearance is provided on roller 21 so that it does not bear against the seam and so that it performs thrust stripping only as will be understood as the specification continues.

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Referring now to Figure 1, 2, and 4, the arbor 15 may be a rectangularly formed projecting end of shaft 45, Figure 2, having rounded corners. Shaft 45 is suitably journaled for rotation in front and rear bearings 46 and 47 located on the front and rear plates 48 and 49 of the casing 50. Intermittent drive for the arbor shaft 45 is provided by the Geneva drive 51, the arrangement of parts for this Geneva drive being shown in Figure 4 wherein a star wheel 52 having radial slots 53, 53a, 53b, 53c, and cam surfaces 54a, 54b, 54c, 54d, is affixed to the shaft 45. The cam wheel 56 therebelow is carried on the constant speed drive shaft 57 and has two cam pins 58 and 58' which are arranged to engage the radial slots 53 on the star wheel and to rotate shaft 45 for 90 degrees during each pin and slot engagement. Cam surfaces on the cam wheel are arranged for sliding and locking engagement with the cam surfaces on the star wheel, two such surfaces being provided on the cam wheel, one of these 54' being a long surface for an extended dwell in rotation of shaft 45 and the other 54'' being a short cam surface for short dwell. The purpose of this action is described later in the specification.

The drive for the constant speed shaft 57, Figure 1, originates at the motor 60 mounted under the base plate 16, and is transmitted through a suitable motor mounted V pulley 61 and belt 62 to a V pulley 63 situated on a speed reducing mechanism, which is likewise mounted under the base plate. From the speed reducer sprocket 65, transmission is effected to the shaft 57, transmitted by a link chain 64 to sprocket 66 on shaft 57. An idler sprocket adjustably fixed to the base plate 16 maintains suitable chain tension.

Referring now to Figure 2, three closed path cams 67, 68, and 69, are fixedly mounted on shaft 57, and timed with the arbor, the first of these, a form roll cam 67, being employed to impart horizontal reciprocation to a support bracket for the three pairs of strip forming rollers above-mentioned. Form roll cam 67 actuates crank arm 70 fixed to shaft 71 which is journaled in the front and rear casing plates 48 and 49. Shaft 71 terminates at the rear plate and extends through the front plate a sufficient distance for fastening thereto a lever 72, Figure 1. Motion of this lever which has been derived from cam 67 is oscillatory and is transmitted through a universal link 73, rod 74, and a second universal link 75, to a bell crank 76 pivoted on bracket 77. Motion from the bell crank is transmitted through a pivot link 78 to a rod 79 slideably guided in bracket 77. As rod 79 is reciprocated, motion is imparted to the form roll carrier 80 to which is fastened the form roll support casting 81. Carrier 80 is pinned to rod 79 and has its lower section 82 guided over a machined portion on bracket 77 to maintain the form rollers in vertical alignment.

It will be noted at this point that all three of the feeding-in materials which are employed in fabricating tubing, namely the strip 17, wire 18, and solder thread 19, are reciprocated by the above-described cam mechanism, the form rolls being attached to the carrier 80, the wire guide roller 35 being fastened to a bracket 35' clamped to the left end of rod 79, and the solder thread guide pulley 37 being mounted on the form roller support casting 81. The result of this reciprocatory motion will be described later.

The second cam 68 pinned to shaft 57, Figure 2, is provided for the purpose of imparting horizontal movement to the rollers 28 and 21 asso-

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ciated with arbor 15. Cam 68 drives a bell crank 82 which is free to pivot on a bronze bushing 83 fitted over shaft 71. Bell crank 82, in turn, drives an oscillating crank 84 fixed to the stub shaft 85 which is journaled in bearing 86 mounted on the front casing plate. Shaft 85 projects a short distance on the outside of plate 48 to carry the double crank 84', see also Figure 5, which actuates the slides 87 and 88 through pin and slot connections. Slides 87 and 88, detail construction of which will be described later, carry the rollers 20 and 21 respectively and are free to move horizontally in blocks 89 and 90.

Referring now to Figure 3, I employ well known cam and follower construction, and have indicated the paths of superposed cams 67, 68, and 69, as 67', 68', and 69' respectively. The third cam 69, also pinned to shaft 57, oscillates a bell crank 91 which is also free to pivot on a bushing 83' on shaft 71. Motion of the bell crank 91 is transmitted through arm 92 on shaft 93 to actuate pinion gear 94, Figures 5 and 8. Oscillation of the pinion 94 will alternately raise and lower a pair of racks integral with the supports 97 and 98. Supports 97 and 98 are vertically slideable against the front casing plate, keyed for alignment therewith and with their angular side faces restrained against horizontal movement by the gibs 100 and 101 fixed to the casing plate. The supports 97 and 98 further carry angle pieces 102 and 103 to which are attached the blocks 89 and 90. It may be seen at this point in the description that both horizontal motion and vertical motion may be transmitted to the rollers 20 and 21 in combination by cams 68 and 69.

Referring back to Figure 3, the three aligned cam paths 67', 68', 69', are shown superposed at a chosen reference point in the machine cycle, with the follower arms on cranks 70, 82, and 91, in alignment. At the same reference point, see Figure 4, the roller 58 on the Geneva cam is about to enter a radial slot 53 in the star wheel 52 at the end of a dwell in rotation of shaft 45. Clockwise rotation of the Geneva driving cam 56 will result in counter-clockwise rotation of arbor shaft 45, and the roller 58 in moving from point A to point B will rotate the arbor shaft 90 degrees. The short dwell cam surface 54'' on the Geneva cam 56 will then interlock with the surface 54a on the star wheel and, during this contact the arbor shaft 45 will remain stationary. Thereafter the roller 58' will in like manner engage slot 53a to rotate the arbor shaft another 90 degrees followed by a more extensive dwell in the rotation of the arbor shaft 45 when the cam surface 54' on cam wheel 56 interlocks with the next succeeding surface 54b on star wheel 52. The Geneva intermittent drive will not be further elaborated upon inasmuch as it is a well known device for imparting intermittent shaft operation, however, it will be noted that in this particular arrangement, rotation of arbor shaft 45 takes place in steps of 90 degrees intermittently and that two complete revolutions of the driving shaft 57 are required for a single revolution of the arbor shaft 45. Likewise, it will be noted that the dwell between periods of rotation of the arbor shaft 45 is alternately short and long, the reason for which will become apparent as the specification continues.

In Figure 11 the arbor 15 is positioned at the reference point in the machine cycle referred to in connection with the description of Figures 3 and 4. As the arbor is rotated counter-clockwise from this point, the top seaming roller 20

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is moved upwardly and to the left by the horizontal and vertical cams 68 and 69 until the 90 degree rotation of arbor 15 has been completed. During this movement of the arbor the lower stripping roller 21 moves downwardly and to the right. The extent of movement of these rollers with respect to the arbor surface will be the traverse of only the radius corner on the upper right and lower left corners of the arbor thereby interlocking and seaming adjacent strip convolutions at those locations. The arbor then remains stationary for a short period of time corresponding to the dwell during contact of surfaces 54'', 54a Figure 4, during which the upper seaming roller 20 will be moved to the right to interlock and seam the short flat side of the tubing being formed and the lower stripping roll will be moved to the left. The seaming and stripper rollers will then again be located at the upper right and lower left corners of the arbor as shown in Figure 12 with the long dimension of the arbor in a vertical position. The Geneva drive cam will then rotate the arbor through 90 degrees and the upper seaming roller 20 will move downwardly and to the left while the lower stripper roller will move upwardly and to the right, again traversing only radius corners of the tubing being formed. A longer dwell follows during which rollers 20 and 21 will move to the right and left respectively during interlocking and seaming of adjacent convolutions of the long flat side of tubing or conduit.

This cycle of operation is repeated, the rollers 20 and 21 being actuated by cams 68 and 69 to perform the locking, seaming, and stripping operations on the corner radii during periods of rotation of the arbor and locking and seaming on the flat sides of the tube formed during periods of arbor dwell, always moving clockwise only with respect to the tube being formed, and at no time traversing any part of the seam more than once. Inasmuch as the formation of rectangular tubing during one complete revolution of the arbor comprises duplicate operations of forming a short and long side with two radius corners, the cam shaft 57, Figure 4, is turned through two revolutions for each single revolution of the arbor.

Referring to Figure 1, the lineal speed of strip 17, wire 18, and solder thread 19, feeding to the rectangular arbor 15 varies, and for the purpose of having the respective supply reels for these materials rotating at a constant angular velocity during machine operation, compensation is provided by reciprocating the form rollers through which the strip passes and also reciprocating the guide rollers 35 and 37 over which the soft wire and solder thread are trained. With such compensation, overrunning and deleterious strains on the materials are avoided and a constant tension is effected in the wrapping of the materials about the arbor.

For an understanding of the above noted compensating arrangements and, considering the operating of the machine from the zero reference of Figures 3 and 11; during the first 90 degrees of arbor rotation the strip feed at the arbor will be substantially harmonic and will correspond to the motion imparted to the arbor by the Geneva cam. Rotation will start slowly then increase to a maximum, followed by a decrease to zero, affected by such variables as the effective radius of the rectangular arbor 15 and the relative position of the strip guide elements, after which the strip feed will remain at zero for a short

dwel period. The strip will then again move at increasing and decreasing speed during the next 90 degrees of rotation of the arbor shaft, followed again by a longer dwell. This irregular feed will be repeated continuously as tubing 10 is formed.

The irregular feed of strip 17 will extend from the arbor 15 to the nearest set of form rollers 30, 31, Figure 1. Horizontal reciprocation of the form roller support 81, which is derived from cam 67, compensates for this irregular strip feed so that the strip passing between the form roller sets travels at a constant speed with respect to the rollers; also so that the ribbon strip drawn from the supply reel 22 is moving at constant lineal speed during the operation of the machine. When the speed of strip feed at the arbor is zero during a dwell in arbor rotation, the form roller support 81 is moved to the right, so that strip is drawn between the form rollers and formed at the average strip speed for the machine cycle. As the arbor rotates and draws strip therewith, the form roller support 81 will be moved either to the left or to the right at a speed which will add in the positive or negative difference between the rate at which the arbor is drawing strip and the average strip feed. Inasmuch as the guide roller 35 for soft wire is fastened to the support 35' on shaft 79 it will also reciprocate with the form rollers, and the same situation of constant withdrawal speed from its supply reels is effected. Likewise, the guide roller 37 fastened to support 81 will reciprocate resulting in constant withdrawal of solder thread.

Referring now to Figure 5, 6, 7, and 8, and particularly to Figures 6 and 7, the blocks 104 and 105 carrying the freely rotating guide rollers 32 and 33, by which the formed strip is guided to the rectangular arbor 15; also the slides 87 and 88 carrying seaming roller 20 and stripping roller 21 and their corresponding guide blocks 89 and 90, are disposed angularly with respect to the machine at an angle which is identical with the helix angle of the convolutions of strip wrapped about arbor 15 to form the tube 10. It will be noted here that the upper slide 87 and block 89 are at a reverse angle with the lower slide 88 and block 90 since this same condition is the case with the convolutions of tubing.

The upper strip guide roll 32, Figure 5, is freely rotatable on pin 106 fixed to block 104 mounted on guide block 89. The lower strip guide roller 33 is free to rotate on pin 107 fixed to block 105 which is pivoted on a depending end 108 of block 104. Coil tension spring 109 is interposed between an inwardly projecting end of pin 107 and a spring pin 110 fastened to guide block 89, the purpose of the spring being to hold the guide rollers together yet permitting strip 17 to pass therebetween. The hub extension 111 on roller 33, Figure 6, permits a machine operator to pivot block 105 downwardly and separate the guide rollers when inserting a strip. This entire guide roller mechanism, being mounted on the guide block 89 moves up and down therewith and keeps the strip feeding horizontally at the level of the top surface of the arbor irrespective of its position during rotation.

Upper and lower slides 87 and 88 Figure 5 are each of two-piece construction assembled with the pins 112 and 113 which permit pivoting of the front piece with respect to the rear section, the rear sections being restrained in and guided between the surfaces 114 and 115 on blocks 89

and 90, Figure 8, and the closure plates 116 and 117, respectively. Compression springs 120 are fitted between the extending legs 121, 122, Figure 5, on the front slide sections and the legs 123, 124 on the rear sections restraining the rollers 20 and 21 against the arbor surface. Extension handles 125 on the upper slide and 126 on the lower slide provide for manual release of the spring pressure so that an operator may provide the initial wrap of the strip 17 about the arbor 15 before proceeding to operate the machine with motor drive. Furthermore in the event of a "jam" of tubing on the arbor piling-up an abnormal thickness of strip metal thereon, the lower extension handle 126 on the lower slide 88 will be moved to the right, Figure 1, to press against the lever 127 pivoted at 128 to actuate a motor trip switch 129 and stop the motor drive.

A gas burner 130 is attached below arbor 15, located a sufficient distance away from tube forming devices so that no harmful effects will result when heating the formed tube on the arbor 15 to fuse the solder thread 19 and so seal the interlocked joint of adjacent convolutions of tube. In the present embodiment this accessory is shown attached by bracket 131 to the sliding piece 98 to move to and away from the formed tube as the arbor turns thus maintaining a constant separation.

When setting up the machine for operation, the operator threads the ribbon strip 17 from the reel 22 over the pulleys 23, 24, and 25, and inserts it between the three pairs of form rolls 26, 27; 28, 29; 30, 31. Knurled spring release nuts 132 are provided above the form roll support 81 to release compression springs 133 so that the rollers may be moved away from one another and so that the strip may be inserted therebetween. The nuts 132 are then brought down against the springs 133 to exert the necessary pressure between the form rolls to bend the strip so that it will conform to their shape as it passes between them. The operator then grasps the strip with a pair of pliers and draws a sufficient length through the forming rollers to extend to and be wrapped several turns about the arbor 15. The strip, soft wire, and solder thread are subsequently inserted between the guide rollers 32, 33 and given several turns about the arbor with the edges of adjacent convolutions of strip interlocking, during which time the engagement of the rollers 20 and 21 has been released by manipulation of handles 125 and 126. The rollers are then permitted to bear against the tube forming convolutions and the motor for the machine is started whereafter a sufficient amount of tubing is formed to insure that the machine is operating properly and the machine is stopped so that the gas burner may be lighted. The machine is then again started to form the tubing with a soldered seam.

During operation when the arbor 15 is stationary and the seaming roller 20 and stripping roller 12 move horizontally to interlock and seam a flat side of a convolution of tubing, there is no axial thrust of either roller against the tube convolutions tending to discharge the tubing along the arbor. As the arbor rotates, interference is progressively effected between the shoulders on the formed surfaces of rollers 20, 21 and the tube convolutions, tending to move the formed tube along the arbor for discharge in a similar manner to the axial movement of a screw when turned in a fixed nut.

The soft wire 18 may be permitted to remain in the tube after formation or may be removed, depending upon the nature of the rectangular tubing application. If it is left within the tube, it is useful as a reinforcement and if removed, the tube will be improved from a standpoint of weight and flexibility.

It will be understood that changes may be effected in the physical embodiment of my invention to adapt the machine to various other shapes of tubing such as triangular, octagonal, or any commercially desirable shape having flat sides and radius corners by altering the stop motion drive and the cam arrangements; furthermore, that changes may be made in the size, shape, and arrangement of the parts of the machine without departing from the spirit of my invention.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. In a machine for producing non-circular flexible metallic tubing, in combination, a rotatable arbor shaped to conform with the desired shape of the tubing and over which a metal strip may be helically wound into successive engaging convolutions, driving means to rotate the arbor intermittently and to provide a period of arbor dwell between successive periods of arbor rotation, and means to interlock the seam of adjacent convolutions of metal strip, said interlocking means being in position to operate on corners of the tube during arbor rotation, and mechanism for causing relative movement of the interlocking means across other surfaces of the tube during periods of arbor dwell.

2. In a machine for producing non-circular flexible metallic tubing, in combination, a rotatable arbor shaped to conform to the desired shape of the tubing and over which a metal strip may be helically wound into successive engaging convolutions, driving means to rotate the arbor intermittently and to provide a period of arbor dwell between successive periods of arbor rotation, and means also to interlock the seam of adjacent convolutions of strip while progressively discharging tubing along the arbor, said interlocking means being located in position to operate on corners of the tube and to progressively discharge the tube along the arbor during periods of arbor rotation, and mechanism for causing relative movement of the interlocking means across other surfaces of the tube during periods of arbor dwell.

3. In a machine for fabricating flexible corrugated flat sided metal tubing, in combination, a flat sided arbor about which a formed strip may be helically wound to form a tube, driving means to rotate the arbor intermittently, roller means to interlock adjacent edges of strip used for forming the tube during rotation of the arbor, and mechanism for intermittently reciprocating the roller means for limited distances lengthwise of the seam.

4. In a machine for fabricating flexible corrugated flat sided metal tubing, in combination, a flat sided arbor about which a formed strip may be helically wound to form a tube, driving means to rotate the arbor intermittently, roller means to interlock adjacent edges of strip used for forming the tube during periods of rotation of the arbor and during periods when the arbor is stationary, and mechanism for intermittently reciprocating the roller means for limited distances lengthwise of the seam when the arbor is stationary.

5. In a machine for fabricating flexible corrugated metal tubing having flat sides and radius

corners, in combination, a flat sided arbor having radius corners about which a formed strip may be helically wound to form a tube, driving means to rotate the arbor intermittently, roller means to interlock adjacent edges of strip used for forming the tube on the radius corners during arbor rotation and on the flat sides during periods when the arbor is stationary, and mechanism for moving the roller means along the seam when the arbor is stationary.

6. In a machine for fabricating flexible corrugated metal tubing having flat sides and radius corners, in combination, a flat sided arbor having radius corners about which a formed strip may be helically wound to form a tube, driving means to rotate the arbor intermittently, roller means to interlock adjacent edges of strip used for forming the tube on the radius corners during arbor rotation and on the flat sides during periods when the arbor is stationary, and means to move said roller means with respect to the arbor and lengthwise of the strip during periods of rotation of the arbor.

7. In a machine for fabricating flexible corrugated flat sided metal tubing, in combination, a flat sided arbor about which a formed strip may be helically wound to form a tube, driving means to rotate the arbor intermittently, roller means for interlocking the seams of the tube and for discharging the tube from the arbor during arbor rotation, and mechanism for causing the roller means to interlock the seams without discharging the tube during periods between the intermittent movements of the arbor.

8. A machine for fabricating flexible, corrugated, flat sided metal tubing including in combination a flat sided arbor, mechanism for rotating the arbor about its axis, means from which a formed strip is supplied to the arbor in a direction to cause the strip to wind in a helix about the arbor, means in position to interlock the edges of the helical seam of the tube as the tube is formed on the arbor, guides along which the interlocking means reciprocate in the direction of the portion of the seam on which the interlocking means operate, and mechanism for moving the interlocking means on the guides.

9. In a machine for fabricating flexible corrugated flat sided metal tubing, in combination, a flat sided arbor about which a formed strip may be helically wound to form a tube, driving means to rotate the arbor intermittently, roller means having ridges and grooves cooperating with the corrugations of the tube for interlocking the seams of the tube during periods when the arbor is rotating and when the arbor is at rest, said interlocking means being also arranged to discharge the tube from the arbor during periods of rotation thereof, and mechanism for causing relative movement of the roller means along the seams when the arbor is at rest.

10. In a machine for fabricating flexible corrugated polygonal cross section metal tubing, in combination, a polygonal section arbor about which a formed strip may be helically wound to form a tube, driving means to rotate the arbor intermittently, means to interlock adjacent edges of strip used in forming the tube, and means to move the strip edge interlocking means vertically and horizontally with respect to the arbor axis in time relationship with the arbor driving means.

11. In a machine for fabricating flexible, corrugated, polygonal cross section metal tubing, in combination, a polygonal section arbor about which a formed strip may be helically wound to

form a tube, driving means to rotate the arbor intermittently, means to interlock adjacent edges of strip used in forming the tube, supporting structure for the interlocking means, guides on which the supporting structure is movable transversely with respect to the arbor axis, and mechanism for causing movement of the supporting means in the direction in which the strip moves as the strip approaches the arbor.

12. A machine for fabricating flexible, corrugated, metal tubing including in combination an arbor of polygonal cross section, mechanism for rotating the arbor intermittently, rollers from which formed strip is supplied to the arbor, a carriage for holding a supply of strip material, mechanism for moving the carriage toward and from the arbor in such timed relation with the movement of the arbor that the rate of feed of strip material from the carriage is uniform in spite of variations in the rate at which the strip material is required at the arbor, roller means in contact with the arbor and having portions overlapping the strip on the arbor and shaped to interlock the edges of the helical seam of the tube as it forms upon the arbor, guides on which the roller means are movable in the direction of the portion of the seam with which they co-operate, mechanism for moving the roller means along the seam during periods when the arbor is stationary and for causing the roller means to feed the formed tube axially on the arbor during periods of arbor rotation.

13. In a machine for fabricating flexible corrugated polygonal cross section metal tubing, in combination, a polygonal section arbor about which a formed strip may be helically wound to form a tube, driving means to rotate the arbor intermittently, means to interlock adjacent edges of strip used in forming the tube, cam means to move the strip edge interlocking means vertically with respect to the transverse arbor axis, and cam means to move the strip edge interlocking means horizontally with respect to the arbor axis, the vertical movement and horizontal movement cam means being operative in timed relationship with the intermittent rotation of said arbor.

14. In a machine for fabricating flexible corrugated metal tubing, having rectangular cross section, in combination, a rectangular section arbor about which a formed strip may be helically wound to form a tube, driving means to rotate the arbor intermittently, and roller means to interlock adjacent edges of strip used in forming the tube, said roller means being located in position to interlock adjacent edges of strip on radius corners of the tube during periods when the arbor is rotating, and mechanism for causing said roller means to move across and interlock adjacent edges of strip on flat sides of the tube when the arbor is not rotating.

15. The improvement in the art of fabricating flexible polygonal corrugated metal tubing which consists in forming a strip of metal with ridges and grooves formed by a longitudinally extending corrugation between up-turned edges one of which is flanged and the other folded over to engage the flange of the other edge when the strip is wrapped around an arbor in successive convolutions, helically winding a formed strip of said metal having the ridges and grooves over a rotatable arbor having a smooth surface with a plurality of flat sides of different widths joined by rounded corners, guiding the strip to bring the folded over edge into engagement with the flanged edge of the next preceding convolution by

applying restraining force to the strip at the region where the run of the approaching strip is tangent to the rounded corners during the time that the strip is winding on the rounded corners and shifting the region of application of said restraining force as the point of tangency moves angularly about the axis of the arbor, and guiding the strip also by applying restraining force to a run of the strip that is substantially straight and at various points along the length of said run across the width of each flat side of the arbor during the time that each flat side is substantially in alignment with the run of the strip approaching the arbor, feeding a solder wire into the folded edge of the strip prior to the engaging of the folded over edge with the flange of the next preceding convolution, feeding a soft metal wire under the strip into position to come within a convolution thereof as the strip is wound about the arbor, seaming inter-engaging edges of the formed strip against the soft metal wire resting on the arbor, and discharging the tube formed along the arbor progressively as it is formed and by means of a flange that extends into an outside corrugation of the tube and that transmits longitudinal thrust against and through a side wall of said outside corrugation to and through the soft metal wire to a side wall of the next corrugation of the tube.

16. The improvement in the art of fabricating flexible polygonal corrugated metal tubing which comprises rotating an arbor having flat sides joined by rounded corners, forming a strip with a longitudinally extending corrugation between up-turned edges one of which is flanged and the other folded to engage the flange of the other edge when the strip is wrapped around the arbor in successive convolutions, feeding the strip to the arbor in a direction that causes the strip to wind on the arbor with a predetermined pitch that brings the folded edge into engagement with the flanged edge of the next preceding convolution, guiding the strip to bring the folded over edge into engagement with the flanged edge of the next preceding convolution by applying restraining force to the strip at the region where the run of the approaching strip is tangent to the rounded corners during the time that the strip is winding on the rounded corners and shifting the region of application of said restraining force as the point of tangency moves angularly about the axis of the arbor, and guiding the strip also by applying restraining force to a run of the strip that is substantially straight and at various points along the length of said run across the width of each flat side of the arbor during the time that each flat side is substantially in alignment with the run of the strip approaching the arbor, wrapping a metal wire around the arbor with a pitch equal to the pitch of the strip and with the convolutions of the wire in position to come within inside convolutions of the tubing under the seam formed by the engaging edges of the strip, locking the seam edges together by pressing the engaging edges down against the metal wire within the tubing, and stripping the tubing from the arbor by pressure applied against a side wall of an outside corrugation of the tubing.

17. A machine for fabricating flexible, corrugated, flat-sided metal tubing including, in combination, a flat-sided arbor with rounded corners, mechanism for rotating the arbor about its axis, feed means that supply a formed strip to the arbor in a direction to cause the strip to wind in a helix about the arbor, apparatus for guiding

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the strip edges of successive convolutions into engagement, for seaming the engaged edges, and for stripping the tube from the arbor, said apparatus comprising a device on one side of the arbor that interlocks the engaged edges of the helical seam of the tube, a device on another side of the arbor that extends into a corrugation of the tube and exerts a pressure against the side of the corrugation to strip the tube from the arbor, one of the devices being located at the region where the strip first comes into contact with the arbor, and having guide surfaces thereon for guiding an edge of the strip into engaging relation with the next preceding convolution on the arbor, movable supports for said interlocking and stripping devices, said movable supports including one on which the device with the guide surfaces is movable to maintain the guide surfaces in contact with the strip at the region where the approaching strip is tangent to the rounded corners during the time that the strip is winding on the rounded corners and while the point of tangency moves angularly about the axis of the arbor, and means for moving the device with the guide surfaces to bring said surfaces into contact with the strip at various points along the length of the seam across substantially the full width of each flat side of the arbor during the time that each flat side is substantially in alignment with the run of the strip approaching the arbor.

18. A machine for fabricating flexible, corrugated, flat-sided metal tubing including, in combination, a flat-sided arbor with rounded corners, mechanism for rotating the arbor about its axis, means from which a formed strip is supplied to the arbor in a direction to cause the strip to wind in a helix about the arbor, means from which a metal wire is supplied to the arbor in position to wind about the arbor and to serve as a filler for an inside corrugation of the tube beneath interengaging edges of the helical seam of the tube, an element on one side of the arbor in position to interlock the interengaging edges of the seam, an element on another side of the arbor extending into an outside corrugation of the tube in position to exert a pressure axially of the tube against a side wall of the corrugation and through said side wall to the wire filler that in turn transmits the axial pressure to the side wall of the next convolution for stripping the tube from the arbor, one of the elements being located at the region where the strip first comes into contact with the arbor and having guide surfaces thereon for guiding an edge of the strip into engaging relation with the next preceding convolution on the arbor, movable supports for said interlocking and stripping elements, said movable supports including one on which the element with the guide surfaces is movable to maintain the guide surfaces in contact with the strip at the region where the approaching strip is tangent to the rounded corners during the time that the strip is winding on the rounded corners and while the point of tangency moves angularly about the axis of the arbor, and means for moving the device with the guide surfaces into contact with the strip at various points along the length of the seam across substantially the full width of each flat side of the arbor during the time that each flat side is substantially in alignment with the run of the strip approaching the arbor.

19. A machine for fabricating flexible, corrugated, flat-sided metal tubing including, in com-

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bination, a flat-sided arbor with rounded corners, mechanism for rotating the arbor about its axis, means from which a formed strip is supplied to the arbor in a direction to cause the strip to wind in a helix about the arbor, two devices located at different angular positions about the arbor, one of said devices being located at the region at which the strip first comes into contact with the arbor and having guide surfaces thereon for guiding an edge of the strip into engagement with an edge of the next preceding convolution on the arbor, the other of said devices being located beyond the first device and at an angular distance around the arbor in the direction of rotation of the arbor, movable supports for said devices including one on which the element with the guide surfaces is movable to maintain the guide surfaces in contact with the strip at the region where the approaching strip is tangent to the rounded corners during the time that the strip is winding on the rounded corners and while the point of tangency moves angularly about the axis of the arbor, and means for moving the device with the guide surfaces into contact with the strip at various points along the length of the seam across substantially the full width of each flat side of the arbor during the time that each flat side is substantially in alignment with the run of the strip approaching the arbor, and resilient means urging each of said devices toward the tube, at least one of said devices comprising interlocking means for seaming adjacent convolutions of the strip, and at least one of said devices comprising a stripper for advancing the tube longitudinally on the arbor during relative movement of the arbor and said stripper.

20. A machine for fabricating flexible, corrugated, flat-sided metal tubing including, in combination, a flat-sided arbor with rounded corners, mechanism for rotating the arbor about its axis, means from which a formed strip is supplied to the arbor in a direction to cause the strip to wind in a helix about the arbor, means from which a metal wire is supplied to the arbor in position to wind about the arbor and to serve as a filler in an inside corrugation of the tube beneath interengaging edges of the helical seam of the tube, two devices located at different angular positions about the arbor, one of said devices being located in position to guide the strip as it bends around the corners of the arbor and at the region where the approaching run of the strip is tangent to the rounded corner, to guide the strip as straight runs of the strip first come into contact with the flat sides of the arbor, the other of said devices being located beyond the first device and at an angular distance around the arbor in the direction of rotation of the arbor, a separate support for each of said devices, one of said supports being movable to cause the guiding device to move and maintain its guidance in the region of tangency while the point of tangency moves angularly about the axis of the arbor, resilient means urging each of said devices in a direction toward the arbor and with a predetermined pressure, at least one of said devices comprising interlocking means for seaming adjacent convolutions of the strip, and at least one of said devices comprising a stripper extending into an outside corrugation of the tube in position to exert a pressure axially of the tube against a side wall of the corrugation and through said side wall to the wire filler that in turn transmits the axial pressure to the side wall of the next

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convolution for advancing the tube axially on the arbor during relative movement of the arbor and said stripper.

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