Feb. 16, 1954 R. C. ANDERSEN 2,669,278

TUBE CORRUGATING MACHINE

Filed March 6, 1948

3 Sheets-Sheet 1

Fig. 1.

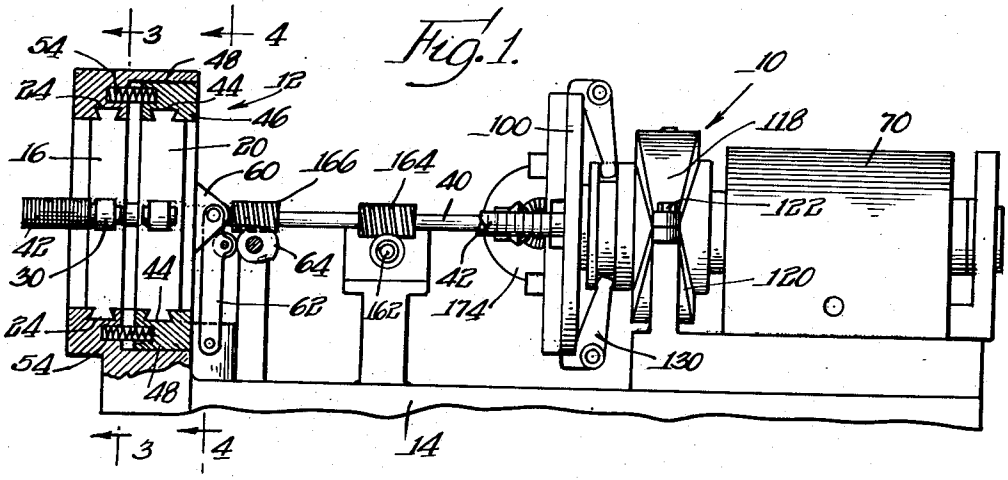


Fig. 2.

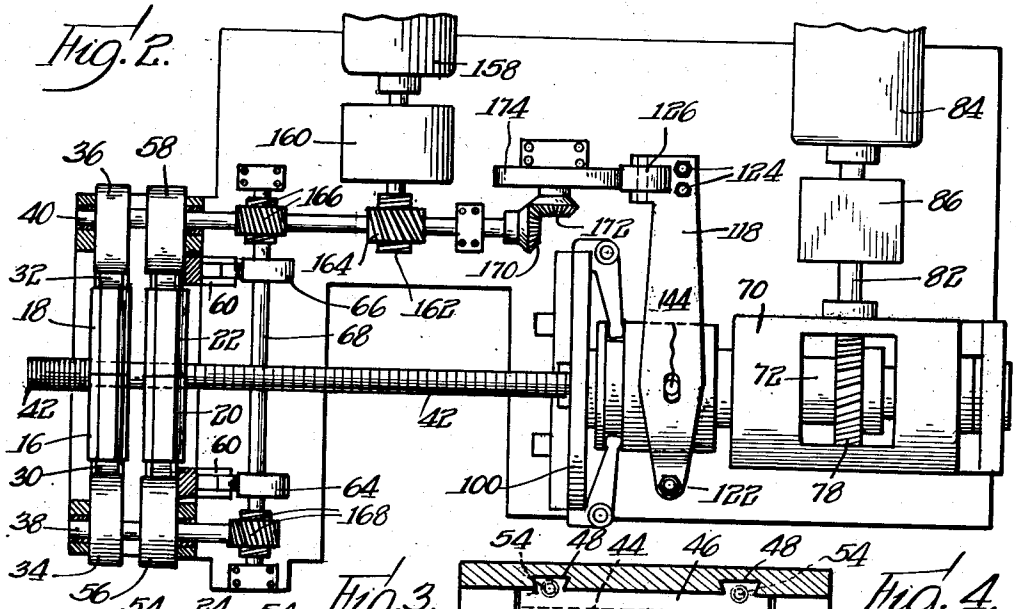


Fig. 3.

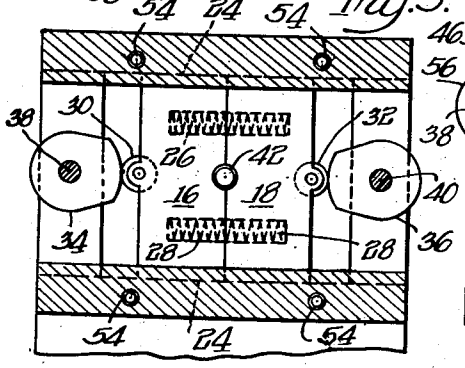
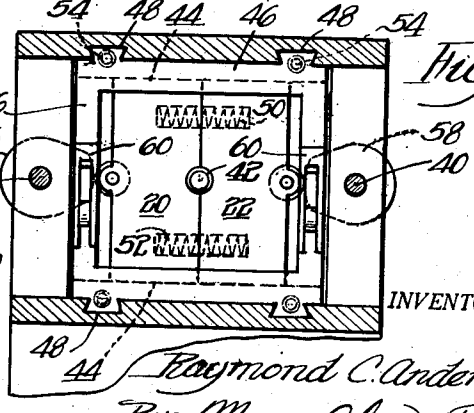


Fig. 4.



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TUBE CORRUGATING MACHINE

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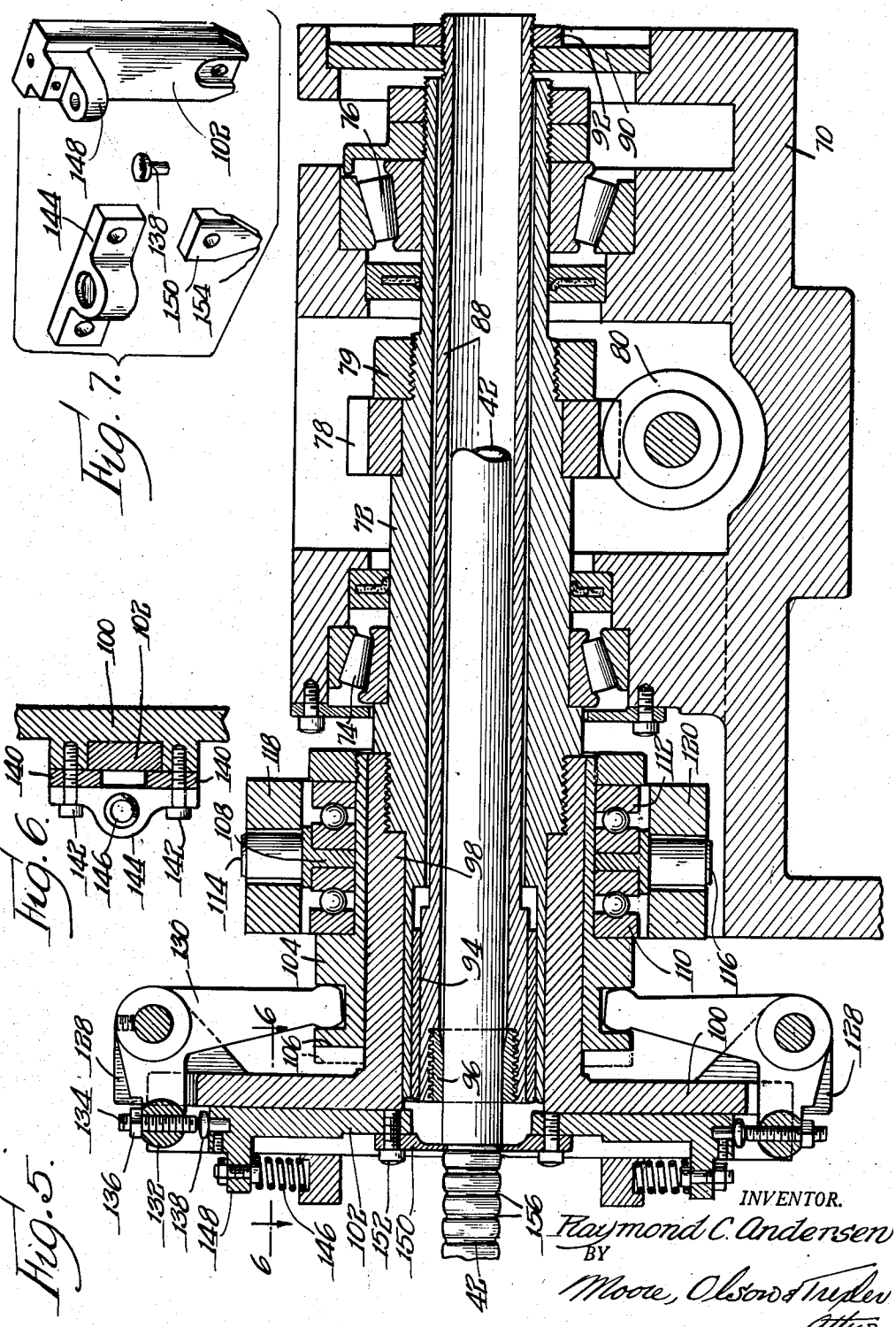

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TUBE CORRUGATING MACHINE

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Fig. 8.

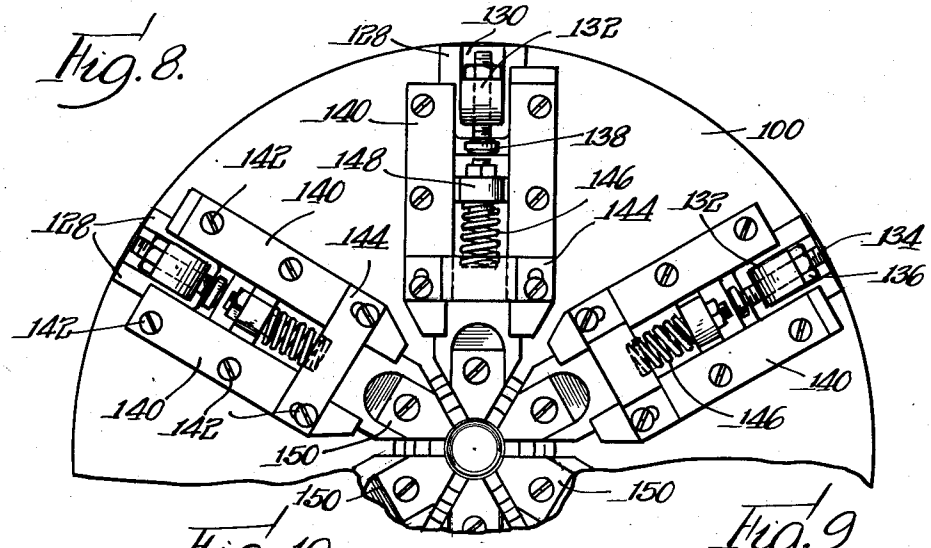


Fig. 9.

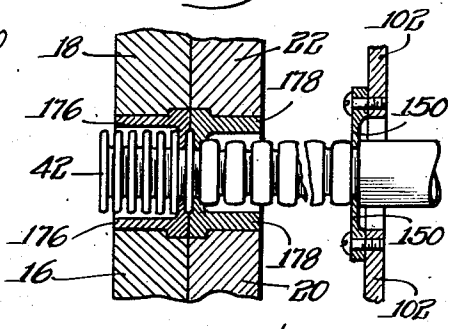


Fig. 10.

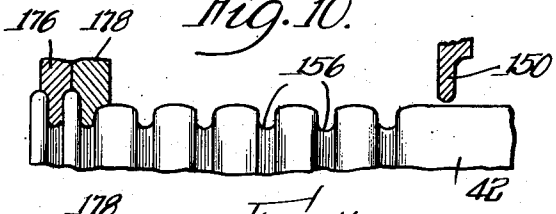


Fig. 11.

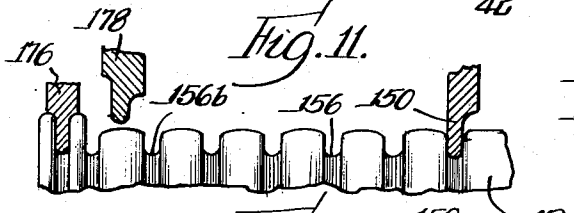


Fig. 12.

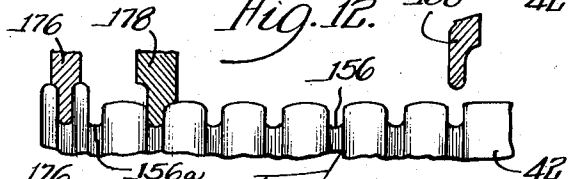


Fig. 13.

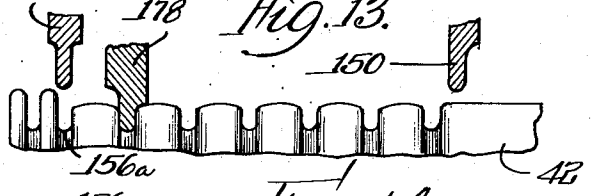


Fig. 14.

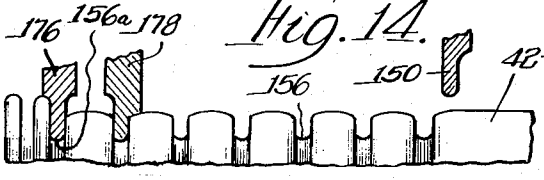
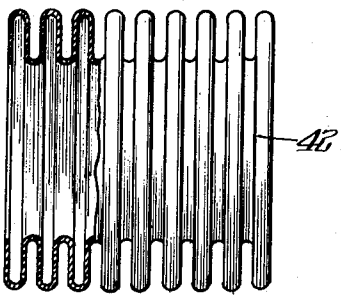


Fig. 15.



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TUBE CORRUGATING MACHINE

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Application March 6, 1948, Serial No. 13,412

3 Claims. (Cl. 153—73)

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This invention relates to apparatus and methods for making corrugated tubing, and concerns particularly means and methods for making tubing of the one piece annularly corrugated type.

It is an object of the invention to provide improved methods and apparatus for making annularly corrugated tubing. More specifically stated it is an object of the invention to provide improved means and methods for making annularly corrugated tubing wherein a preformed cylindrical blank is first annularly grooved at predetermined spaced intervals, the tubing wall sections between the grooves being thereafter collapsed or compressed to form the juxtaposed flexible annular corrugations.

One of the principal objects of the invention is to provide improved means and methods for effecting the annular grooving operations, which are faster and more reliable in operation, and impart a more uniform and accurately controlled contour to the tubing walls.

A further object of the invention is to provide, in tube making apparatus of the type defined, improved means and methods for correlating and controlling the grooving and tube wall compressing apparatus, and for effecting the continuous operation thereof to provide the finished flexible tubing wall section.

Various other objects, advantages and features of the invention will be apparent from the following specification, when taken in connection with the accompanying drawings, wherein a preferred embodiment is set forth for purposes of illustration.

In the drawings, wherein like reference numerals refer to like parts throughout:

Fig. 1 is a side elevation of a tube making apparatus constructed in accordance with and embodying the principles of the invention, in accordance with one preferred embodiment thereof; certain parts being broken away or illustrated in section to show the details of the apparatus;

Fig. 2 is a plan view of the structure of Fig. 1 with certain parts broken away and sectioned for clarity of illustration;

Fig. 3 is a transverse section of a part of the tube wall compressing apparatus, taken as indicated by the line 3—3 of Fig. 1;

Fig. 4 is a transverse sectional view of another part of the tube wall compressing apparatus, taken as indicated by the line 4—4 of Fig. 1;

Fig. 5 is an enlarged longitudinal sectional view of the grooving apparatus;

Fig. 6 is a sectional detail view of one of the grooving slides and associated parts, taken as indicated by the line 6—6 of Fig. 5;

Fig. 7 is an exploded view of certain of the parts of the grooving slide assembly;

Fig. 8 is a front view of the support plate of the grooving apparatus, showing several of the grooving fingers;

Fig. 9 is an illustrative view, more particularly

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showing the correlative action of the grooving and wall compressing mechanisms;

Figs. 10–14 are illustrative views showing successive steps in the operation of the parts of Fig. 9; and

Fig. 15 is a view of the completed tubing as made by the apparatus of the invention.

Referring more particularly to the drawings, and first to Figs. 1 and 2, the tube making apparatus shown comprises a grooving mechanism, generally indicated by numeral 10, and a mechanism 12 for compressing or collapsing the wall sections of the grooved tubing, said mechanisms being carried by a main base or frame 14 of the machine.

The mechanism for compressing or collapsing the tubing wall sections, after the grooving operations, is best shown in Figs. 1–4 and will be first described. As indicated in Fig. 9, the function of this mechanism is to compress the wall sections of the previously grooved tubing so as to provide deep and closely spaced flexible annular convolutions. Referring to Figs. 1–4, it will be seen that the compressing apparatus comprises two sets of jaws as indicated respectively at 16—18 and 20—22. Jaws 16—18 are shiftable relative to each other transversely of the tubing axis, so as to clamp the tubing convolutions; whereas the jaws 20—22 are shiftable both transversely and axially of the tubing axis to effect a clamping of the tubing and also the compressing thereof in conjunction with the clamping or holding action of the jaws 16—18.

Referring to Figs. 1 and 3, it will be seen that the jaws 16 and 18 are transversely shiftable along trackways 24 formed in the frame of the machine, there being a pair of compression springs 26 and 28 acting between the jaws to normally urge them into separated position. To effect the inward or gripping movement of the jaws onto the tubing, they are provided with rollers as indicated at 30 and 32 cooperable with and actuated by cams as indicated at 34 and 36. The cam 34 is fixed to a shaft 38 journalled in the frame of the machine on one side of the tubing axis, whereas the cam 36 is secured to a shaft 40 similarly journalled on the machine frame on the opposite side of the tubing axis. It will be seen that upon rotation of the shafts 38 and 40 a predetermined timed reciprocation will be imparted to the jaws 16 and 18, against the action of the compression springs, whereby to effect the sequential clamping and unclamping of the convolutions of the tubing, indicated at 42, which is arranged for central disposition between the jaw members.

The structure and action of the jaws 20—22 will be best understood by reference to Figs. 1, 2 and 4. As shown in Figs. 1 and 4, the jaws 20 and 22 are transversely reciprocable along tracks as indicated at 44, these tracks being formed in a rectangular frame structure 46 disposed in a plane transversely of the tubing axis.

The frame 46 is in turn reciprocable longitudinally of the tubing axis along tracks 48 formed in the main frame of the machine. The jaws 20 and 22 are normally urged away from each other by means of a pair of compression springs 50 and 52, Fig. 4, whereas the rectangular frame 46 is normally urged axially of the tubing away from the clamping jaws 16—18 by a set of compression springs 54, there being four such springs provided in the particular embodiment shown.

To effect the clamping movement of the jaws 20 and 22 relatively toward each other, against the action of the compression springs 50—52, shafts 38 and 40 are provided respectively with a pair of cams 56 and 58 engageable with abutment rollers carried by the jaws and operable to effect the shifting of the jaws toward each other in a similar manner as previously described in reference to the jaws 16—18. To effect the reciprocation of the frame 46, axially of the tubing, the frame is provided at its opposite sides with a pair of yoke projections 60 which, as best shown in Fig. 1, are connected respectively to the upper ends of pivot arms 62 pivotally mounted at their lower ends upon the main frame of the machine. The arms 62 carry rollers adapted for engagement, respectively, by cams 64 and 66 fixed to a cross shaft 68 extending transversely of the tubing slightly below the tubing axis.

It will be seen that by reason of the structures provided, upon operation of the shafts 38 and 40, the cams 56 and 58 will effect the periodic opening and closing of the jaws 20—22, whereas operation of the shaft 68 will cause the cams 64 and 66 to effect axial reciprocation of the frame 46 and of the jaws 20—22 carried thereby, whereby to impart both transverse and axial reciprocative movements to the jaw members. The sequential operating steps of the jaws, in effecting the collapsing of the tubing wall sections, will be later described with reference to Figs. 10–14.

It will be noted that the cams 56 and 58 are sufficiently wide so that operating contact with the jaw rollers is maintained at all times during the reciprocation of the frame 46.

The structures of the grooving mechanism are shown in Figs. 1, 2, 5, 6, 7 and 8. The main frame of the machine carries a housing 70 within which is journalled a drive sleeve 72, Fig. 5, by means of a pair of roller bearings 74 and 76. Means is provided for driving the sleeve comprising a worm gear 78, secured thereto by means of a lock nut 79 and arranged to be driven by a worm 80. This worm is driven by a shaft 82, Fig. 2, powered from an electric motor 84, there being a speed variator mechanism as indicated at 86 for controlling the speed of operation of the drive.

Referring further to Fig. 5, it will be seen that a stationary sleeve 88 lies within the rotatable drive sleeve 72, this stationary sleeve being adjustably held in fixed position by threaded engagement with a disc member 90, carried by the housing 70, and a lock nut 92. The forward or leftward end of the rotatable drive sleeve 72 has a bushing 94 press fitted therein, the bushing being rotatable upon the forward end of the stationary sleeve 88. The stationary sleeve interiorly of its forward end carries a collar or bushing 96 accurately sized to the diameter of the tubing blank and within which the tubing blank is longitudinally slidable with a close sliding fit.

The forward end of the drive sleeve 72 has

further secured thereto the hub portion 98 of a head plate 100 arranged to carry a series of slides 102, there being six such slides, Fig. 8, in the particular embodiment illustrated, in three symmetrically disposed pairs.

A sleeve 104, Fig. 5, is mounted upon the plate hub 98, said sleeve being arranged for rotation with the hub and for limited axial movement in respect thereto between the limits indicated by the full and dotted lines 106. A collar 108 is rotatably carried on the sleeve 104 by means of a pair of anti-friction bearings 110 and 112, said collar having a pair of oppositely projecting pins as indicated at 114 and 116. The pins 114 and 116 engage, respectively, within slots formed in a pair of yoke arms 118 and 120. These arms which are bowed to collectively embrace the collar 108, are pivotally mounted at one end upon the frame of the machine, as indicated at 122, and secured together at their opposite ends for movement as a unit, by bolts 124. The ends of the arms, adjacent the bolts 124, rotatably carry a roller member 126, the function of which will be presently described. It will be seen that by reason of the connections provided, as the arms 118 and 120 are pivotally actuated, for example by the roller 126, corresponding motion will be imparted to the sleeve 104 longitudinally of the tubing axis, the sleeve at the same time being freely rotatable for movement with the main drive sleeve 72.

The axial movements of the sleeve 104 are employed to control the movements of the grooving slides 102, the latter being radially shiftable on the face plate 100 to effect the tube grooving operation. More particularly, referring to Figs. 5, 6, 7 and 8, it will be seen that the face plate is provided, at circumferentially spaced intervals with pairs of ears 128 forming the pivot mounting means for a plurality of rocker levers 130, there being one lever for each grooving slide. One arm of the levers 130 projects radially inwardly for engagement within a recess of the sleeve 104, whereas the other arm of the lever projects forwardly to provide a lug or extension member 132. Each lug 132 carries a screw 134 held in adjusted position by mean of a lock nut 136, the end of the screw being adapted to bear against a hardened abutment piece 138 carried in the upper end of the grooving slide 102. Each slide is guided for movement radially of the face plate by means of a pair of guide members 140 suitably bolted to the plate by screws 142. A bridge piece 144 is adjustably carried by the innermost screws 142, and a compression spring 146 reacts between this bridge piece and a projecting portion 148 of the grooving slide so as to normally hold the slide radially outwardly of the face plate. The inner end of each grooving slide carries a grooving tool 150 replaceably held in position by means of a screw 152.

It will be seen that by reason of the connections provided, as the sleeve 104 is shifted longitudinally of the tubing axis, simultaneous movement will be imparted to the several grooving slides 102 and the grooving tools carried thereby, radially of the face plate structure, the several rocker levers 130 effecting movement of the slides against the action of the compression springs 146. It will be seen that the spring tension may be adjusted by the adjustable positioning of the bridge members 144, and that the position of each slide is readily independently adjusted by the adjustment of the screws 134 and their associated lock nuts 136.

Particular attention is directed to the action of the several grooving tools, in effecting the grooving of the tubing blank. It will be seen that the inner end of each tool is provided with a curved spinning face 154 which engages the tubing and spins a groove therein as the several slides 102 are actuated radially inwardly. The provision of a plurality of slides and tools, simultaneously actuated and in balanced disposition, produces a balanced structure permitting high speed operation of the face plate 100, whereby to facilitate a rapid grooving operation. Furthermore, the several simultaneously operating grooving or spinning tools impart a uniform contour to the grooves 156 formed in the tubing, even though the grooving slides may be reciprocated relatively rapidly to produce a maximum number of grooving operations for any given time interval of machine operation. This uniform contour, thus imparted to the grooves 156, facilitates the proper placement and operation of the jaws 16—18 and 20—22, forming a part of the tube wall collapsing mechanism previously described. The degree of penetration of the spinning tools into the tubing blank may be readily controlled by the screws 134, as previously described, and substitution of proper spinning tools in accordance with the requirement of a particular tubing blank may be readily effected by means of the screws 152 without replacement or substitution of the slide structures.

Means is provided for effecting the timed actuation of the grooving tools in relation to the operation of the clamping jaws 16—18 and 20—22 of the tube wall compressing mechanism 12, the jaws 20—22 thus acting as means for feeding the tubing blank in respect to the spinning mechanism 10. Referring to Figs. 1 and 2, it will be seen that there is provided a drive motor 158 operating through a change speed gearing or speed variator mechanism 160 to actuate the helical drive gear 162. This gear meshes with and drives a helicoid gear 164 secured to the shaft 40 of the tube wall compressing mechanism, previously described. Shaft 40 is interconnected with cross shaft 68 by means of a pair of helicoid gears 166, and shaft 68 is in turn interconnected with the cam shaft 38 by means of helicoid gears as indicated at 168. Cam shaft 40 is extended past the main drive gear and carries on its end a bevel gear 170 arranged to mesh with and drive a bevel gear 172 fixed to a stub shaft which carries a cam 174 engageable with and arranged to actuate the roller 126 carried by the arms 118 and 120 of the grooving mechanism, previously described. By reason of the connections thus provided the several actuating cams 34, 36, 56, 58, 64, 66 and 174 are all operated in synchronized relation so that the grooving and wall collapsing mechanisms may be continuously operable upon a common tubing blank.

The action of the tools will be best understood by reference to Figs. 9 and 10–14. Referring to Fig. 9, it will be seen that the several jaws of the tube compressing mechanism carry tools as indicated at 176 and 178, shaped to conform to the desired contours of the tubing convolutions. Referring to Figs. 10–14, in Fig. 10 the tools 176 and 178 are shown in engagement with the tubing, and the spinning tool 150 retracted. In Fig. 11 the tool 176 is holding the tubing while the tool 178 is retracted and moving rightwardly so as to engage into a new tubing groove 156b. During this interval of operation the spinning tool 150 moves inwardly and effects the spinning of the tubing groove.

In Fig. 12 the tool 178 has reached its new position and the tool 150 has been retracted. In Fig. 13 the tool 176 has been retracted and the feeding tool 178 has moved partially toward the left, so as to bring a new tubing groove as indicated at 156a into position in alignment with the tool 176.

In Fig. 14 the tool 176 has moved into engagement with the tubing, after which the tool 178 continues its motion to the left, to the position of Fig. 10, to collapse the tubing wall and complete the cycle of operation.

The completed tubing blank is shown in Fig. 15. As will be understood, the formed tubing may be used in longer lengths, as hose, or in shorter lengths, as bellows, or otherwise as desired to provide a fluid-tight flexible tubing structure.

It is obvious that various changes may be made in the specific embodiments set forth without departing from the spirit of the invention. The invention is accordingly not to be limited to the particular embodiments shown and described, but only as indicated in the following claims.

The invention is hereby claimed as follows:

1. Apparatus for making flexible metal tubing and comprising a rotatable tool support, a plurality of grooving tools mounted on the tool support with the operative ends thereof disposed adjacent and peripherally around the space in which a tubular work piece is positioned, means for supporting the work piece, said means including a fixed collar adjacent the grooving tools and engaging the work piece with a close sliding fit, and said means acting to prevent material rotation of the work piece but permitting positive axial feeding of the work piece through said collar; means for simultaneously reciprocating the grooving tools to progressively engage the work piece for effecting the complete grooving thereof to a predetermined depth upon each stroke of the grooving tools into engagement with the tubular work piece, and means independent of the grooving tools and spaced therefrom for compressing the work piece wall sections between adjacent grooves and including an axially reciprocable compressing member effective to feed the work piece axially of the space within the operative ends of the grooving tools upon their withdrawal from engagement with the work piece.

2. Apparatus as claimed in claim 1, wherein the rotating means for the tool support includes a hollow rotatable shaft within which said collar is positioned adjacent the operative ends of the grooving tools.

3. Apparatus as claimed in claim 1, wherein the grooving tools are each individually adjustable relative to the work support.

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