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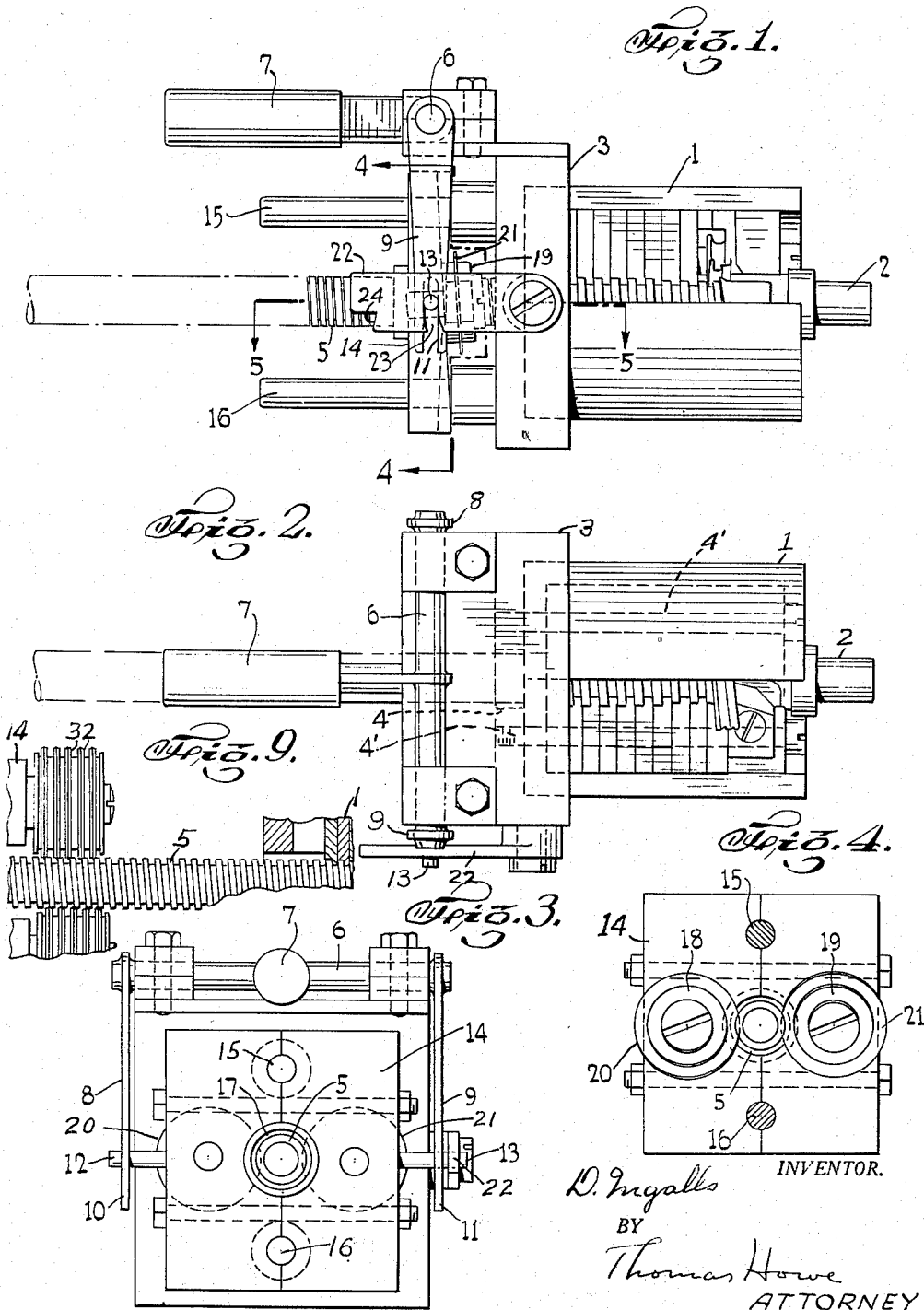
D. INGALLS

2,383,253

APPARATUS FOR MAKING CORRUGATED TUBING

Filed Oct. 31, 1942

2 Sheets-Sheet 1



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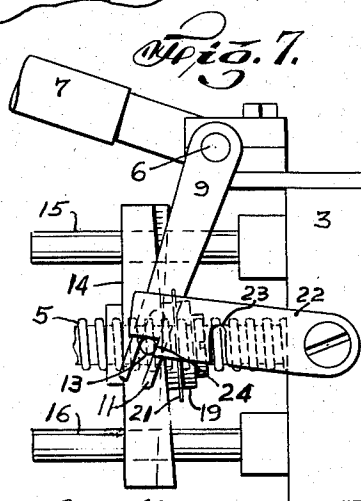
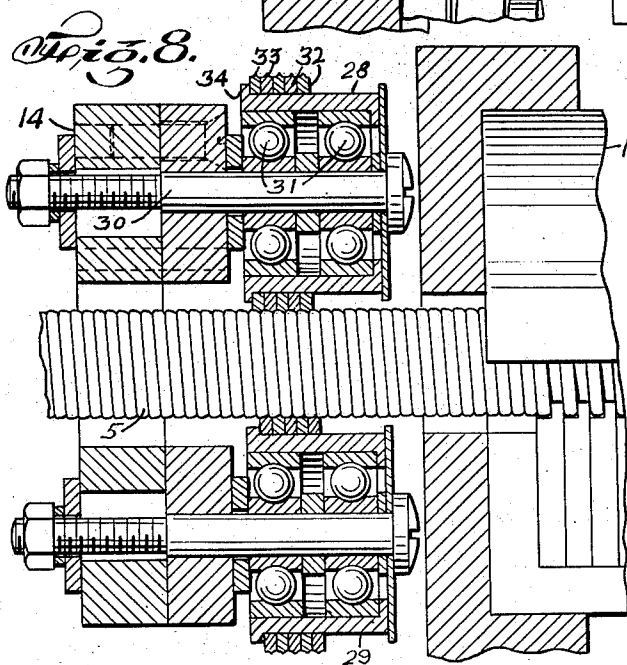
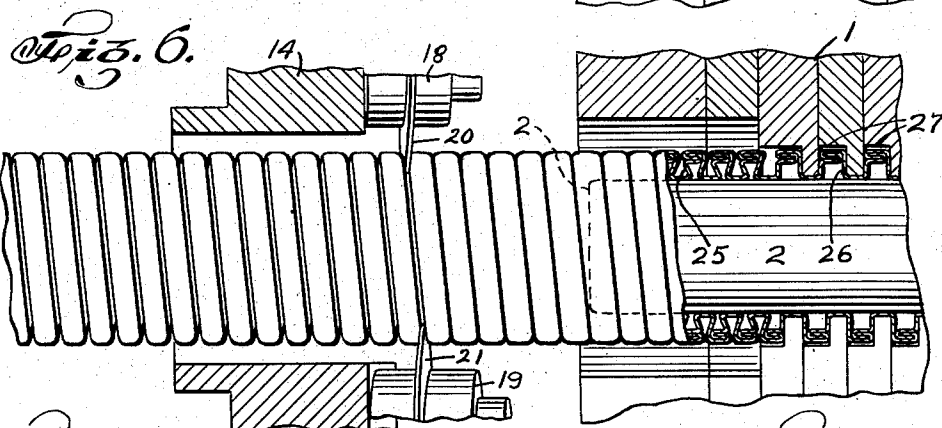
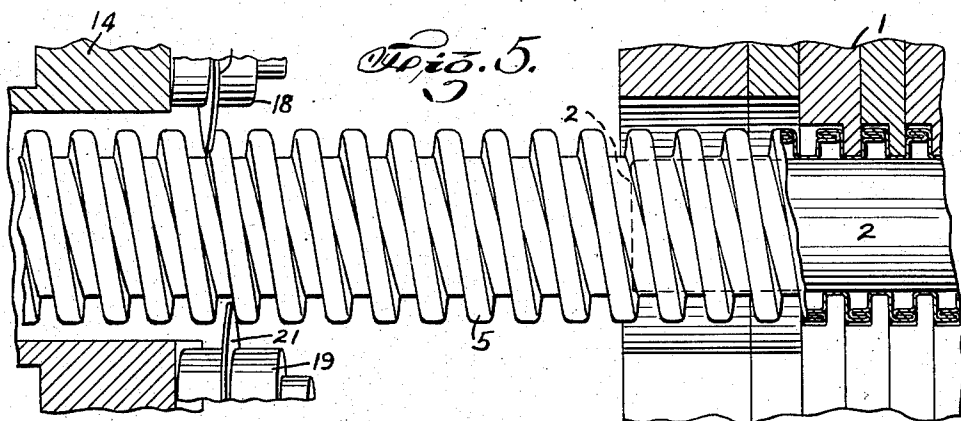
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APPARATUS FOR MAKING CORRUGATED TUBING

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2 Sheets-Sheet 2



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2,383,253

APPARATUS FOR MAKING CORRUGATED TUBING

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Application October 31, 1942, Serial No. 464,004

11 Claims. (Cl. 113—35)

This invention relates especially to the compression of, and reflexing the corrugation sides of helically corrugated tubes, but it may have application in connection with other devices involving helical structures.

In helically corrugated, flexible tubes for instance the tube as shown and described in the patent to L. H. Brinkman No. 1,198,392 patented September 12, 1916, which tube may be made by the apparatus as shown and described in the patent to W. H. Fulton et al. No. 1,492,075 patented April 29, 1924, and also the patent to R. H. Stone No. 1,905,762 patented April 25, 1933, the flexibility and other desirable properties of the tube are increased by compressing the tube as it comes from the die and thereby reflexing the corrugation sides with relation to the axis of the tube. This has been accomplished, as set forth in the said Patent No. 1,198,392 by passing a rod through the tube, there being nuts on the rod at the ends of the tube which, when screwed up, compress the tube and reflex the corrugation sides. It is also proposed in the said Patent No. 1,198,392 that the tube might be compressed in a hydraulic press. Such operations, however, require that the tube operated upon shall be in comparatively short lengths so that the operation of forming the compressed tube shall be intermittent as contrasted with continuously forming such tube for as long a time as may be desired, and also the operation was laborious and required great care to prevent inaccuracies in the product.

It is an object of the present invention to provide a means for continuously operating upon a helically corrugated tube to compress the same and to reflex its corrugation sides.

It is a further object of the invention to provide an improved means for compressing the helically corrugated tube and reflexing the sides of its corrugations by providing means for operating upon the tube comprising means for forcing the tube longitudinally, continuously and indefinitely, and retarding the longitudinal movement of the tube whereby it is compressed and the corrugation sides reflexed with relation to the tube axis. Although this may be accomplished by various other apparatus, one embodiment for effecting this object may comprise two abutments between which the tube is compressed, there being at one abutment means for defining a helical path of a given pitch and at the other abutment means for defining a helical path of less pitch for the helical corrugation, with means for rotating the tube whereby it is caused to pass through

the said paths and the tube is compressed between the abutments and the corrugation sides reflexed. In this embodiment, the abutment path of greater pitch in conjunction with the tube rotating means, constitutes the means for forcing the tube longitudinally and the abutment path of less pitch constitutes the means for retarding the longitudinal movement of the tube. This construction also permits the continuous formation of the compressed tube.

It having been found that the compression of the tube between the abutments as specified is facilitated by initially compressing the tube to the desired condition, it is a further object of the invention to provide means to operate in conjunction with the said abutments for initially compressing the tube.

It is a further object of the invention to provide for the initial compression of the tube as referred to by making the abutments relatively movable.

A further object of the invention is to provide for the proper relative locations of the abutments when in continuous tube-compressing relation to the other abutment.

A further object of the invention is to provide means for properly relatively locating the abutments in position for initially compressing the tube as referred to.

In the passage of the tube through the abutments having paths of different pitch as referred to, it is found that the tube has a tendency to "squirm" or turn about the axis independently of the means for rotating the tube as a whole, and it is an object of the invention to provide means for permitting this "squirming" of the tube so as to permit the tube to properly adjust itself to the apparatus. This may be accomplished by making the tube corrugation engaging members at one of the abutments rotary so that the tube is permitted to "squirm" into position and is not held in a distorted condition.

It is a further object of the invention to provide means whereby the die forming the corrugated tube from the strip acts as one of the two compressing abutments and the mandrel operating in conjunction with the die forming the tube acts as means for rotating the tube in the compressing operation. This greatly simplifies the apparatus, making the formation and compression of the tube a continuous operation, the apparatus being practically unitary and the tube as delivered by the apparatus being in its compressed condition. Among other advantages it may be noted that the

tube being in compressed condition as it leaves the apparatus, much space is economized over the situation where it is necessary to make provision for the length of tube as delivered by the die in its uncompressed condition. This is of great importance under congested factory conditions.

It will appear that means herein disclosed may be used to compress or change the pitch of other helical members than a tube corrugation and further objects of the invention are to provide improved means applicable to the compression or changing the pitch of helical members other than tube corrugations.

Other and ancillary objects of the invention will appear hereinafter.

In the accompanying drawings which illustrate the invention—

Fig. 1 is a side elevation of apparatus embodying the invention, the movable abutment being shown in continuous compressing position;

Fig. 2 is a top plan view of the apparatus of Fig. 1;

Fig. 3 is an end elevation of the apparatus of Fig. 1 looking from the left of the latter figure;

Fig. 4 is a section, with certain of the parts omitted for the sake of clearness, on the line 4—4 of Fig. 1;

Fig. 5 is an enlarged view, partly broken away and partly in section, showing the relative positions of the abutments to each other and to the tube and also the condition of the tube with the parts in position for the initial compression;

Fig. 6 is a view similar to Fig. 5 but showing the relative positions of the abutments and tube and the condition of the tube after initial compression and during the continuous compressing operation;

Fig. 7 is a side elevation of the apparatus of Fig. 1 and to the same scale, certain of the parts being omitted and to the movable abutment being in extended position for the beginning of the initial compression of the tube;

Fig. 8 is a horizontal section with certain of the parts omitted and others broken away, showing a modified structure of the movable abutment in continuously compressing position; and

Fig. 9 is a section on a reduced scale of a portion of the movable abutment of Fig. 8 showing relative positions of the rotary members of the abutment with relation to the tube when in non-compressing position, but in position for initiating the initial compression.

Referring to the drawings, and first to Figs. 1 to 7 inclusive, the apparatus comprises a die with a centrally rotating mandrel 2 for forming a flexible, metal, helically corrugated tube from a strip, which may be substantially as shown in the patent to R. H. Stone No. 1,905,762 issued April 25, 1933.

To one end of the die is secured a supporting cap 3 by means of the clamping screws 4' for the parts of the die, which are screwed into the cap. The cap has a central hole 4 through which the tube 5 discharged by the die may pass.

Rotatably mounted upon the cap 3 is a shaft 6 having a central operating handle 7. Fixed to the ends of the shaft 6 are arms 8 and 9 having forked ends 10 and 11. The forks 10 and 11 embrace the pins or gudgeons 12 and 13 fixed in the side of a frame 14 sliding on the guide rods 15 and 16 fixed in the cap 3. The frame 14 has a central opening 17 for the passage of the corrugated tube and rotatably mounted in the frame 14 are the rollers 18 and 19, which are upon diametrically opposite sides of the tube. These

rollers have flanges 20 and 21 adapted to extend in between the corrugations of the tube and longitudinally displaced from each other so as to define a helical path for the outer portions of the corrugation which is of the pitch of the tube corrugation when compressed the desired amount. In the apparatus of Figs. 1 to 7 the corrugation engaging portions of the flanges are on diametrically opposite sides of the tube so that such engaging portions are displaced longitudinally along the tube by a distance equal to one-half the corrugation pitch when the tube is in compressed condition. The flanges 20 and 21 are also set at angles corresponding to the corrugation pitch of the compressed tube.

To hold the frame 14 and its carried rollers at the proper distance from the die to effect the desired compression, during operation after initial compression, a latch 22 is pivoted on the cap 3 and has a slot 23 adapted to receive the pin 13 on the frame 14 when the last is in compressing position and to hold such frame in that position against the pressure upon it of the advancing corrugated tube.

The frame 14 and its carried parts may be slid outwardly upon the rods 15 and 16 away from the die to a predetermined position prior to initiating the compressing operation, by raising the handle 7 when the turning of the shaft 6 will swing the arms 8 and 9 so as to move the frame 14 outwardly to a position as shown in Fig. 7, such position being defined by the latch 22 by having the shoulder 24 come against the pin 13 (see Fig. 7). From this position the frame 14 may be moved inwardly toward the die into the position of Fig. 1 by moving the handle 7 downwardly and thereby swinging the arms 8 and 9 toward the die and moving the frame 14 into position for the pin 13 to be engaged in the slot 23.

In the use of the apparatus, the frame 14 will be located at the predetermined initial distance from the die by means of the shoulder 24 of the latch 22, as shown in Fig. 7. The tube 5 turning with the mandrel 2 will be forced to the left (Fig. 5) by the engagement of the helical corrugation on the tube with the helical channels in the die, and the outer end of the tube will be threaded between the roller flanges 20 and 21 so that the flanges will extend into the spaces between adjacent convolutions of the corrugation as shown in Fig. 5, the condition of the tube and the relative position of the parts being then as shown in Fig. 5. The latch 22 being then lifted to free the pin 13, the tube will be initially compressed by lowering the handle 7 thereby forcing the roller flanges 20 and 21 against the tube corrugation and toward the die whereby the corrugation convolutions will be forced toward each other between the abutment formed by the die and the other abutment comprising the frame 14 and roller flanges 20 and 21. The forcing of the convolutions of the helical corrugation toward each other will close, to a greater or less extent, the spaces between the outer portions of the corrugation convolutions which lie between the abutments.

This initial compressing movement of the abutment comprising the flanges 20 and 21, toward the die may be continued to a desired position for instance as shown in Fig. 6 where the corrugation convolutions come in substantial contact with each other. This compression between the abutment comprising the rollers 20 and 21 on the one hand and the abutment pro-

vided by the exit end of the die on the other hand, not only forces together the outer portions of the tube corrugation convolutions as specified, but also acts to reflex the sides of the corrugations, as shown at 25, with relation to the axis of the tube, the sides of the corrugation as delivered by the die being substantially radial as shown at 26.

Also the pressing of the corrugation convolutions toward each other as described effects a compression or shortening of the tube, and it will be observed that the corrugation helix against which bear the roller flanges 20 and 21 will become of a less pitch than was the case with the tube as delivered by the die (see Fig. 5). The flanges 20 and 21 of the diametrically opposite rollers are, as above set forth, so longitudinally displaced and set at such angles as to correspond with the helical pitch of the corrugation in the condition of the apparatus and tube as shown in Fig. 6, so that the path of the helical corrugation past the flanges 20 and 21 is defined by such flanges as a helical path of less pitch than that of the helical corrugation as delivered by the die (see particularly Fig. 5).

It will be observed that in the original position (before the initial tube compression) of the movable abutment including the roller flanges 20 and 21 as shown in Fig. 5, there will be a certain number of convolutions of the tube corrugation, with spaces between succeeding convolutions, between the abutments. When the movable abutment has been moved to initially compress the tube, as for instance into the position as shown in Fig. 6, there will be the same number of corrugation convolutions between the abutments as in the position of Fig. 5, but the tube will be shortened by a longitudinal distance equal to the distance moved by the movable abutment in this preliminary or initial compression, as from the position of that abutment as shown in Fig. 5 to that as shown in Fig. 6. This movement of the movable abutment causes the shortening of the tube by closing up the spaces between the corrugation convolutions to a greater or less degree, the degree of closing depending upon the distance moved by the abutment, the sum of the amounts of closing of all of the spaces between the convolutions being equal to the distance moved by the abutment. The tube being uniform in dimensions, quality of material and in other respects, the sum of the closures of all of the spaces between the abutments will be approximately equally divided between the spaces and thus the degree of closure of each of the spaces will depend upon the distance moved by the movable abutment and the number of spaces between the abutments, the degree of closure of the space between any two adjacent convolutions being equal to the distance moved by the movable abutment divided by the number of inter-convolution spaces of the corrugation between abutments. In the case illustrated the inter-convolution spaces between the abutments are substantially closed up so that adjacent convolutions substantially touch each other. In such case the distance moved by the movable abutment would be substantially equal to the sum of the inter-convolution spaces between the abutments and there would obviously be no chance of inequality of closing of the inter-convolution spaces on account of lack of uniformity in the tube. With the parts in the position as shown in Fig. 6, the tube, turning with the mandrel, will be forced to the left (Figs. 5 and 6) from

the die at a rate proportional to the pitch of the helical channels 27 in the die, through which the tube corrugation passes. As has been stated, however, the pitch of the corrugation at the flanges 20 and 21 is less than that of the corrugation at the exit of the die whereby the tube will not move through the roller flanges 20 and 21 at as great a speed as it is delivered by the die but will have its longitudinal movement retarded. In one revolution, the tube at the die will move axially a distance equal to the corrugation pitch at that point while at the flanges 20 and 21 it will axially move in one tube revolution a less axial distance which is equal to the corrugation pitch at that point.

From the foregoing it will be seen that the helically corrugated tube formed from a strip by the die will issue therefrom at a certain pitch and will be engaged by the roller flanges 20 and 21 of the movable abutment which is in extended position, that is at its position in readiness for initially compressing the tube as delivered by the die, this condition and relation of the parts being as shown in Fig. 5. The handle 7 may then be depressed to move the movable abutment toward the die by a predetermined distance which will give the desired compression by closing the inter-corrugation convolution spaces to the desired extent as shown in Fig. 6, the corrugation sides being correspondingly reflexed with relation to the tube axis. The rotating tube issuing from the die with a corrugation pitch as shown in Fig. 5, will have its longitudinal movement retarded at the roller flanges 20 and 21 which define a pitch of the corrugation corresponding to the compressed condition. This latter pitch being less than the pitch of the tube issuing from the die, it will be apparent that the longitudinal rate of feeding of the tube into the space between the abutments will be at a greater rate than the exit of said tube from the space between the abutments past the roller flanges 20 and 21. The result is that the tube must be compressed to compensate for this difference in rate of feeding of the tube into the space between the abutments and its exit therefrom. This compression for each revolution of the tube is equal to the difference in pitch of the corrugation at the die on the one hand and at the roller flanges 20 and 21 on the other hand, and consequently each inter-corrugation convolution space between the abutments will be closed by an amount equal to the difference in pitches at the two abutments as referred to, and this will continue while the corrugated tube is fed into the space between the abutments by the rotation of the mandrel and engagement with the helical channels in the die. The result is that the tube will continuously pass outside the roller flanges 20 and 21 in the desired compressed condition and with the corrugation sides correspondingly reflexed. Inasmuch as the flanges 20 and 21 extend in between the convolutions of the corrugation, the corrugation convolutions in passing these flanges will be separated to a slight extent, without being substantially touching in the space between the abutments as referred to, and if the material of the tube and other conditions are such that the corrugations will not spring back into their contacting position after passing beyond the flanges 20 and 21, such small spaces between the corrugation convolutions will exist in the tube as delivered by the apparatus as illustrated by the tube at the left of the flanges 20 and 21 in Fig. 6. If, however, the tube is of such material and con-

struction that the corrugations will spring back together after passing the flanges, the tube as delivered by the apparatus will have its corrugation convolutions in substantial contact as it is between the abutments as shown in Fig. 6 at the right of the flanges 20 and 21.

It will now be apparent that the helically corrugated tube continuously formed and delivered by the die will be continuously and indefinitely compressed so that the operation of forming the compressed, helically corrugated tube may be continuously carried on for any length of time desired.

Referring to Figs. 8 and 9 of the drawings, there is therein shown a modified form of rotatable members for engaging the tube corrugation on the movable abutment in place of the rollers 18 and 19 with the flanges 20 and 21. Otherwise the apparatus may be of the same construction as that already explained in connection with Figs. 1 to 7 inclusive.

Thus in Fig. 8 there is the die 1 for forming the helically corrugated tube 5 from a strip and forming one of the abutments for compressing the tube as described in connection with apparatus of Figs. 1 to 7. Also as described in connection with Figs. 1 to 7 the frame 14 of the movable abutment is slidably mounted in relation to the die 1 and may be moved and located with relation thereto by apparatus the same as described in connection with the foregoing figures.

In place, however, of the rotatable rollers 18 and 19 with flanges 20 and 21, there is rotatably mounted upon the frame 14 at diametrically opposite points, drums 28 and 29, each such drum being rotatably mounted in the frame by means of a bolt as 30 and ball bearings as 31, and each of the drums has longitudinally sliding and rotatable upon it a plurality of rings or annular plates 32. Upon the outer periphery of each of the rings 32 is a circumferential ridge 33. It will be observed that the outer periphery of the tube corrugation is slightly rounded in cross section so that even when the convolutions are pushed together so that they touch there is a helical groove or between crevice adjacent convolutions, and the ridges 33 are of such shape and size that they will enter such groove or crevice and engage a corrugation convolution without preventing the convolutions from coming together. The thickness of each of the rings 32 is such that the distance between ridges 33 on two adjacent rings when they are in contact with each other as shown in Fig. 8, shall be equal to the pitch of the helical tube corrugation when the tube is in the desired compressed condition and the ridges 33 on one drum are longitudinally displaced with relation to the ridges on the other drum to correspond with the pitch of the tube corrugation when in compressed condition.

While the radial extent of each of the ridges 33 within the corrugations is relatively small and its engaging surface with the corrugation in the compressing operation is correspondingly reduced, it is to be noted that there are a plurality of ridges succeeding each other which engage succeeding convolutions of the tube corrugation so that the aggregate engagement, at each of the drums, of the ridges with the tube convolutions will be sufficient to successfully accomplish the compressing operation, it being clear that the engagement of one ridge 33 on a drum is reenforced by the engagement of the other ridges on that drum with other of the corrugation convolutions.

Preliminary to the initial compressing of the

tube, the movable abutment will be in its outermost position (farthest removed from the die) when the tube 5 will be in uncompressed condition as delivered from the die 1, and the annular rings 32 will be separated and distributed along the tube as shown in Fig. 9. The frame 14 then being moved toward the die in its initial compressing movement as described in connection with the apparatus of Figs. 1 to 7 inclusive, namely to the position as shown in Fig. 8, the tube will be compressed as shown in the figure last mentioned and the rings on each of the drums will slide longitudinally upon the drum until they come against each other and against the flange as 34. The tube then rotating with the mandrel will be fed from the die with the corrugation at a greater pitch than is defined at the rings 32 of the moving abutment wherefore the longitudinal progress of the tube will be retarded in passing the projections 34 whereby the tube will be compressed and the sides of the corrugation reflexed as explained in connection with the apparatus of Figs. 1 to 7 inclusive, and the continued rotation of the mandrel will continuously form the tube from the strip, force it from the die and cause the retardation at the moving abutment and consequent compression of the tube for any length of time desired.

While the invention has been illustrated in what are considered its best applications it may have other embodiments without departing from its spirit and is not therefore limited to the structures shown in the drawings.

What I claim is:

1. In means for compressing a helically corrugated tube, the combination with an abutment defining a helical path of a given pitch for the helical corrugation of said tube passing there-through, of a second abutment defining a helical path for the helical corrugation of less pitch than the aforesaid path, said second abutment being adapted to receive the said tube from said first mentioned abutment, and means for relatively rotating said tube and said abutments, said abutments being relatively longitudinally movable to initially compress the said tube.

2. In means for compressing a helically corrugated tube, the combination with an abutment having a helical channel at a certain pitch for the passage of the tube corrugation, a second abutment defining a helical path for the said helical corrugation, the last mentioned helical path being of less pitch than that of said channel, means for relatively rotating said tube and said abutments, guide bars extending from the first mentioned abutment and upon which said second abutment slides, and lever means for moving said second abutment along said guide bars.

3. In means for compressing a helically corrugated tube, the combination with a die adapted to form a helically corrugated tube from a strip and forming an abutment defining a helical path of a given pitch for the corrugation of said tube, of a second abutment defining a helical path for said corrugation of less pitch than the aforesaid path, said second abutment being adapted to receive the said tube from said die and being in substantial alignment therewith and a rotating mandrel centrally of said die and rotating the said tube within said die and said second abutment, said die and second abutment being relatively movable to initially compress the said tube.

4. Means for making flexible metal tubing comprising a die to form a tube, said die having helically disposed tube corrugation forming means

of a given pitch, helically disposed roller means of a different pitch associated with the die to engage the tube corrugations after formation thereof, and means to move said roller means longitudinally with respect to said die.

5. Means for making flexible metal tubing comprising a die to form a tube, said die having helically disposed tube corrugation forming means of a given pitch, roller means helically disposed on opposite sides of the tube of different pitch associated with the die to engage the tube corrugations after formation thereof, and means to move said roller means longitudinally with respect to said die.

6. Means for making flexible metal tubing comprising a die to form a tube, said die having helically disposed tube corrugation forming means of a given pitch, helically disposed roller means of a different pitch associated with the die to engage the tube corrugations after formation thereof, said roller means being adapted to fit between adjacent corrugations of the tube, and means to move said roller means longitudinally with respect to said die.

7. Means for making flexible metal tubing comprising a die to form a tube, said die having helically disposed tube corrugation forming means of a given pitch, helically disposed roller means of a different pitch associated with the die to engage a group of adjacent tube corrugations after formation thereof, and means to move said roller means longitudinally with respect to said die.

8. Means for making flexible metal tubing comprising a die to form a tube, said die having helically disposed tube corrugation forming means of a given pitch, helically disposed roller means of a different pitch associated with the die to engage the tube corrugations after formation thereof, means to fix the location of said roller means at one position longitudinally with

respect to said die, and means to move said roller means to a second fixed location longitudinally with respect to said die.

9. Means for making flexible metal tubing comprising a die to form a tube, said die having helically disposed tube corrugation forming means of a given pitch, helically disposed roller means of a different pitch associated with the die to engage the tube corrugations after formation thereof, means to fix the location of said roller means at one position longitudinally with respect to said die, and a manually operable lever to move said roller means to a second fixed location longitudinally with respect to said die and to initially compress said tube.

10. Means for making flexible metal tubing comprising a die to form a tube, said die having helically disposed tube corrugations forming means of a given pitch, helically disposed roller means of a different pitch associated with the die to engage the tube corrugations after formation thereof, adjustable means to fix the location of said roller means at one position longitudinally with respect to said die, adjustable means to move said roller means to a second fixed location longitudinally with respect to said die.

11. Means for making flexible metal tubing comprising a die to form a tube, said die having helically disposed tube corrugation forming means of a given pitch, helically disposed roller means of a different pitch associated with the die to engage the corrugations after formation thereof, means to fix the location of said roller means at a position corresponding to a pre-determined open-corrugation position longitudinally with respect to said die, and means to move said roller means to a second fixed location corresponding to closed-corrugation position longitudinally with respect to said die.

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