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APPARATUS AND METHOD FOR FORMING CORRUGATED TUBES

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3 Sheets-Sheet 1

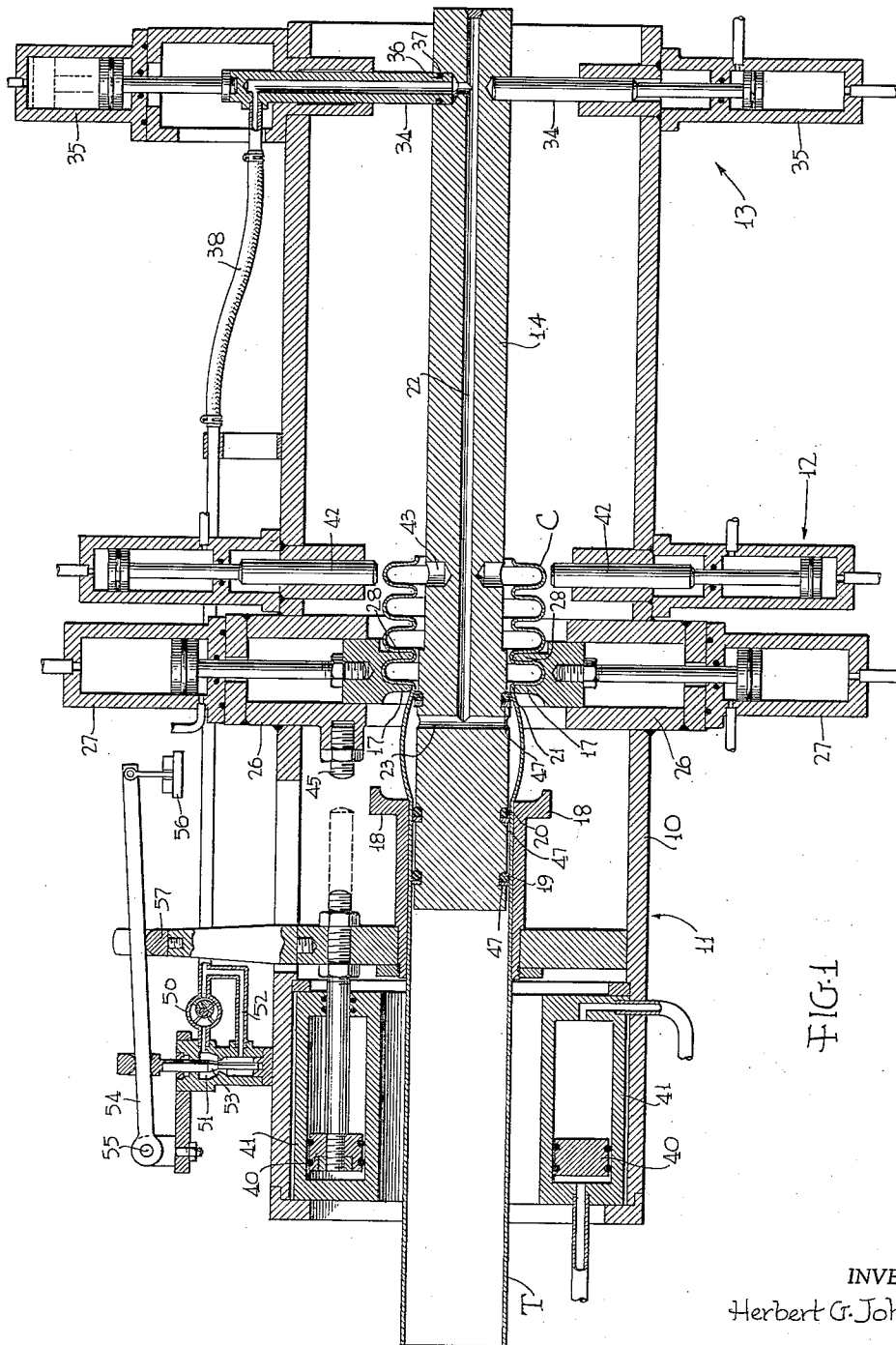


FIG. 1

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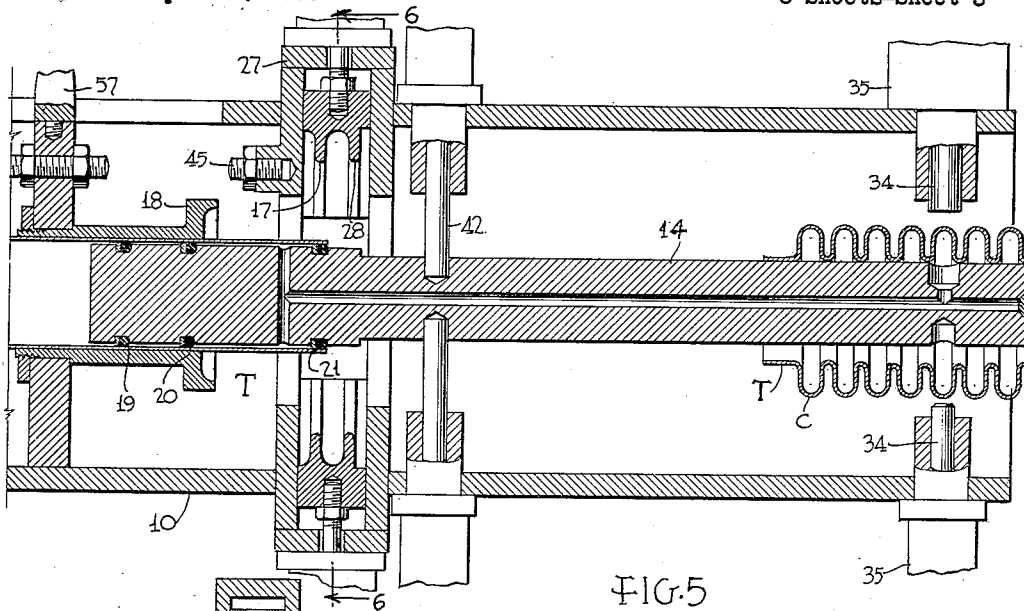


FIG. 5

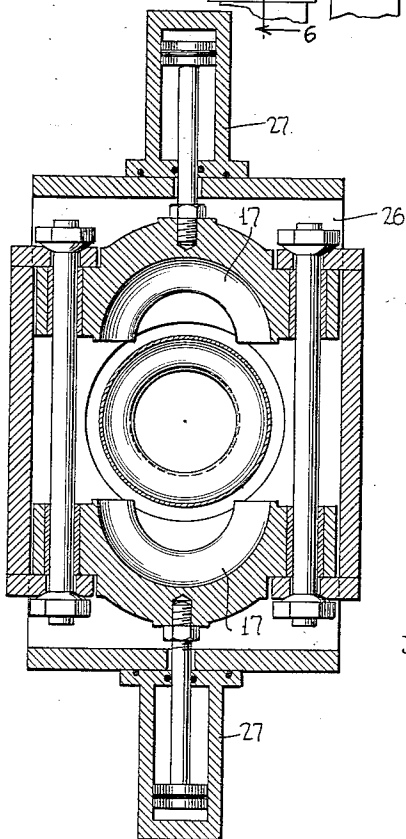


FIG. 6

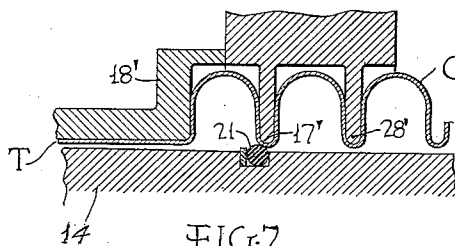


FIG. 7

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APPARATUS AND METHOD FOR FORMING CORRUGATED TUBES

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This invention relates to apparatus and method for forming corrugated tubes and has for an object the provision of improvements in this art.

One of the particular objects of the invention is to provide improved but simple apparatus and method for forming corrugated tubes by a combined pressure expanding and axial compressing action.

Another object is to provide improved internal sealing means for securing reliable internal pressure on the tube.

Another object is to provide apparatus for forming corrugated tubes in a uni-directional movement.

Another object is to provide means for varying the expanding pressure during the formation of a corrugation.

The above objects and various features of novelty will be apparent from the following description of an exemplary embodiment of the invention, reference being made to the accompanying drawings thereof, wherein:

FIG. 1 is a vertical longitudinal section through a machine for forming corrugations in tubes according to the present invention, parts being shown in the stage after the initial bulge of a corrugation has been formed;

FIG. 2 is a similar view in part showing the stage after the complete formation of a corrugation;

FIG. 3 is a similar view with the tube holding dies retracted;

FIG. 4 is a similar view with the tube pushed forward;

FIG. 5 is a similar view showing a completed tube being removed and a new tube being introduced;

FIG. 6 is a transverse vertical section taken on the line 6-6 of FIG. 5 showing the split holding and forming dies in retracted position and with a corrugated tube in position and the mandrel removed; and

FIG. 7 is a partial longitudinal section showing modified forming dies.

Referring to the drawings, the apparatus comprises a main frame 10 carrying tube guiding and compressing means 11 at one end, tube corrugating means 12 at the middle, and mandrel holding means 13 at the other end. A mandrel 14 is disposed within the tube T while corrugations C are being formed on it, the mandrel being releasably held at one end, here the exit end by the holding means 13 referred to, so that the length of corrugated tube may be slipped off the end of the mandrel, or alternatively, so the mandrel can be pulled out of the tube after both are removed from the machine.

The basic corrugation forming elements comprise a longitudinally divided tube-embracing ring die 17, an axially moving compression die 18, sealing rings 19, 20 and 21 carried in grooves in the mandrel, and means for introducing fluid under pressure into the mandrel and from it out into a tube between the split ring die 17 and the compression die 18, the means shown comprising an axial fluid passage 22 in the mandrel with ports 23 opening through the mandrel into the tube between the rings 20 and 21. Rubber O-rings disposed in grooves of rectangular cross section have been found very satisfactory for retaining fluid at the highest pressures required if properly dimensioned and located, as will be explained. The arrangement is such that the pressure of the fluid tightens the seal between the O-rings, mandrel and tube.

The parts of the split ring die 17 operate in radial guides 26 carried by the frame and are moved in and out

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for the formation of each corrugation, as by fluid operated device 27.

A second split ring die 28, which may be integral with the first split ring die, as shown, or made and operated separately, is located on the exit side of the split ring die 17 to back it axially and engage the last-formed corrugation to aid in holding the tube against axial movement.

The mandrel holding means 13 is here shown to comprise radially movable pins 34 operating in radial fixed guides by power devices 35, one of the pins being tubular and being sealed in the hole 36 in the mandrel by O-rings 37 to conduct fluid. A supply tube 38, which may be flexible, supplies fluid under pressure to the tubular pin. Fluid pressure in the tube is relieved through the same channels.

The compression die is moved axially by any suitable means such as an annular piston 40 operating in a cylinder 41 carried by the frame.

Other radially movable pins 42 may be provided for holding the mandrel while the pins 34 at the outer end are disengaged for removal of a finished tube, the tube being first pushed past the pins 42 before they are engaged with the sockets 43 in the mandrel. After the pins 42 have been engaged with the mandrel the pins 34 at the outer end of the mandrel are removed and the corrugated tube slipped off.

In operation, a tube T is pushed through the tubular throat of the compressing die 18 past the sealing rings 19, 20 and 21 to a position where its front end is forward of the split ring dies 17, these dies being open, as shown in FIG. 6, to permit the tube to be fed in. Power means may be used for feeding in the tube, if desired.

The dies 17 are now brought down on the tube forward of the front sealing ring 21 and pressure fluid is introduced into the tube between the rings 20 and 21 by way of the ports 23 until the tube takes an initial bulge, as shown in FIG. 1. When the bulge is sufficiently high the compressing die 18 is pushed forward and carries the rear end of the bulged portion forward with it. The fluid pressure inside the tube is continued as the die 18 moves forward until a corrugation is fully formed and the forward end of the die 18 brings up against the rear side of the split ring dies 17, as shown in FIG. 2.

The dies 17 are then withdrawn, as shown in FIG. 3, the forward pressure on the die 18 being relaxed if desired to facilitate the withdrawal of the split dies 17, after which, as shown in FIG. 4, the die 18 is pushed forward further to feed up the whole tube by the length of the corrugation which has been formed. An adjustable stop pin 45 is provided to halt the die movement caused by the piston 40. The tube-feeding movement of the die 18 is merely representative of some feeding means. Other means of known character which grip the tube and feed it forward, separately from the die 18, may of course be used. In cases where friction is not too great the tube could be fed forward to proper position for forming another corrugation by hand.

The die 18 is withdrawn to the FIG. 1 position and the split dies 17 and 28 are brought down to engage the tube about the formed corrugation, as shown in FIG. 1.

Further corrugations are formed successively in the same manner until the whole length of tube—or so much of it as may be desired—has been corrugated, after which the split dies 17 and 28 are raised and the tube pushed forward past the inboard holding pins 42, these pins then being engaged with the mandrel and the outboard pins 34 withdrawn to permit the tube to be removed, as shown in FIG. 5. Then pins 34 are reengaged with the mandrel and pins 42 withdrawn. A new tube is fed in, as shown in FIG. 5, while either set of pins is holding the mandrel.

It has been noted that the sealing rings 19, 20 and 21 are forced outwardly by fluid pressure into tight sealing

engagement with the inside of the tube, at the same time sealing against a wall of the groove to completely block the outflow and escape of fluid. The location of the sealing O-ring 21 is just behind the crown of the inner surface of the dies 17 so that the ring will not blow out even though the inner span of the corrugation may be quite short. However, this O-ring is placed sufficiently forward so that it will be held down beneath the dies, as shown in FIG. 2, and not forced out into the corrugation.

In order to avoid excessive wear on the rubber O-rings by the drag of the tube over them the grooves may be provided with spacer rings 47 of harder material, such as metal, nylon or other plastic, or the like. When the O-rings are retracted in their grooves the spacer rings prevent heavy pressure of the tube from coming on them.

The external corrugation on the tube will be curved in longitudinal cross section whether the dies are curved or not, so long as there is space for the corrugation at the pressure used. This is illustrated in FIG. 7 where the dies 17', 18' and 28' are formed with square-cornered inner surfaces and enough depth to clear the corrugations.

It is desirable to increase the fluid pressure within the tube as a corrugation is being formed. One form of apparatus for accomplishing this is shown in FIG. 1. Here the fluid supply tube 38 is served by a pump 50 taking fluid from a supply source 51. A by-pass 52 around the pump is provided with an adjustable valve 53 which is operated by a lever or beam 54 pivoted at 55. The free end of the lever is held down by a weight 56 and a slide 57 connected with the compressor piston 40 moves along the lever to progressively close the valve as the piston moves forward. As the valve reduces the effective passage through the pump by-pass the amount of liquid forced through the supply tube 38 per unit of time will increase and hence the pressure for forming the corrugation will increase.

It is thus seen that the invention provides simple, reliable and economical means and method for corrugating tubes.

While one embodiment of the invention has been disclosed by way of illustration, it is to be understood that there may be various embodiments and modifications within the general scope of the invention.

What is claimed is:

1. The method of forming a transversely corrugated tube having a plurality of corrugations along its length which comprises, feeding the tube forward on a rigid stationary mandrel having circumferential seals at spaced fixed points therealong for engaging the inside surface of the tube and with a channel and outlets for admitting fluid into the tube between the seals; gripping and supporting the tube on said mandrel circumferentially exteriorly thereof and immediately above and in front of the forward seal between said tube and said mandrel and holding it fixed against axial movement at this point; exteriorly supporting the tube on said mandrel above and behind the rearward seal between said tube and said mandrel, the axial space between said seals being such as to provide a sufficient length of tube to form a corrugation and the tube being initially unsupported exteriorly between said seals; applying fluid pressure directly within the tube

between the spaced seals to form an initial annular external bulge between the spaced points of external support; holding the tube gripped at the forward interior seal; and engaging the rearward end of the bulge exteriorly and pushing the rearward portion of the tube forward past the fixed-positioned rearward sealing means and, at the same time, continuing to apply fluid pressure within the tube between the spaced seals to increase the diameter of the bulge until a corrugation is fully formed; and, when one corrugation is thus formed, releasing the tube exteriorly at the forward seal, continuing to push on the rearward side of the formed corrugation to move the tube forward to carry the formed corrugation past the forward seal, and repeating said operations to form another corrugation.

2. The method of forming a transversely corrugated tube as defined in claim 1 wherein the fluid pressure applied within the tube between the spaced seals is progressively increased as a corrugation is formed.

3. The method of forming a transversely corrugated tube having a plurality of corrugations along its length which comprises, feeding the tube forward on a rigid mandrel having circumferential seals at spaced fixed points therealong for engaging the inside surface of the tube and with a channel and outlets for admitting fluid into the tube between the seals; gripping and supporting the tube on said mandrel circumferentially exteriorly thereof and immediately in front of the forward seal between said tube and said mandrel and holding it fixed against axial movement at this point; exteriorly supporting the tube on said mandrel behind the rearward seal between said tube and said mandrel, the axial space between said seals being such as to provide a sufficient length of tube to form a corrugation and the tube being initially unsupported exteriorly between said seals; applying fluid pressure directly within the tube between the spaced seals to form an initial annular external bulge between the spaced points of external support; holding the tube gripped at the forward interior seal; and engaging the rearward end of the bulge exteriorly and pushing the rearward portion of the tube past the fixed positioned rearward sealing means and, at the same time, continuing to apply fluid pressure within the tube between the spaced seals to increase the diameter of the bulge until a corrugation is fully formed; and, when one corrugation is thus formed releasing the tube exteriorly at the forward seal, continuing to push on the rearward side of the formed corrugation to move the tube forward to carry the formed corrugation past the forward seal, and repeating said operations to form another corrugation.

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