

[54] **METHOD OF AND APPARATUS FOR THE FORMATION OF TUBULAR ARTICLES**[72] Inventor: **Raymond Jean Bernard Tellot**,
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France[22] Filed: **Dec. 4, 1970**[21] Appl. No.: **95,195**[52] U.S. Cl. **72/59**[51] Int. Cl. **B21d 15/10**

[58] Field of Search.....72/59, 62, 57, 58, 61, 60

[56] **References Cited****UNITED STATES PATENTS**

R19,890	3/1936	Bezenberger	72/59
349,718	9/1886	Hollerith et al.	72/59
1,835,314	12/1931	Lord	72/59
2,080,211	5/1937	Mantle	72/59

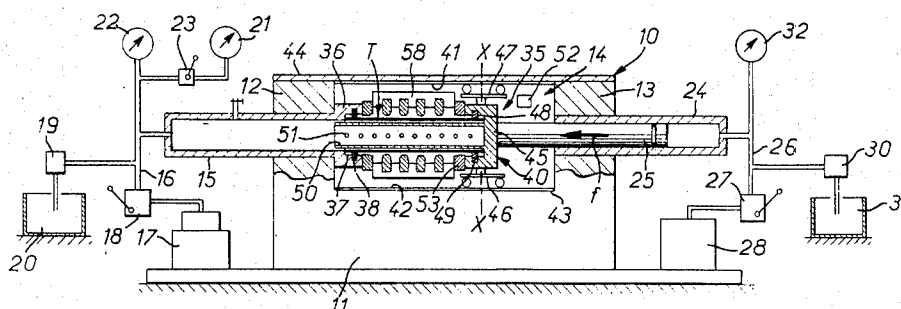
2,522,915	9/1950	Woods	72/59
2,842,182	7/1958	Cate	72/59
2,919,740	1/1960	Poitras	72/59
3,015,354	1/1962	Wood	72/59
2,495,059	1/1950	Grant	72/62
3,358,489	12/1967	Hutchins	72/62

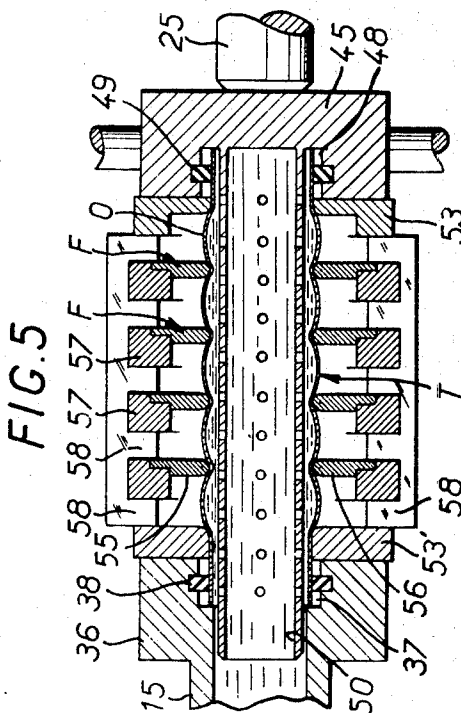
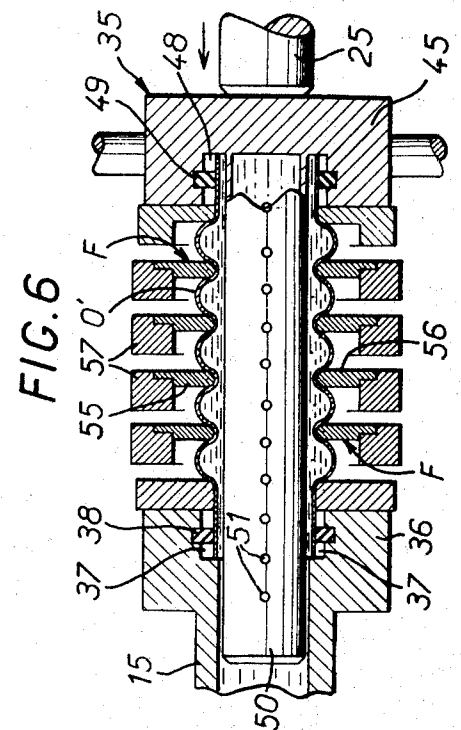
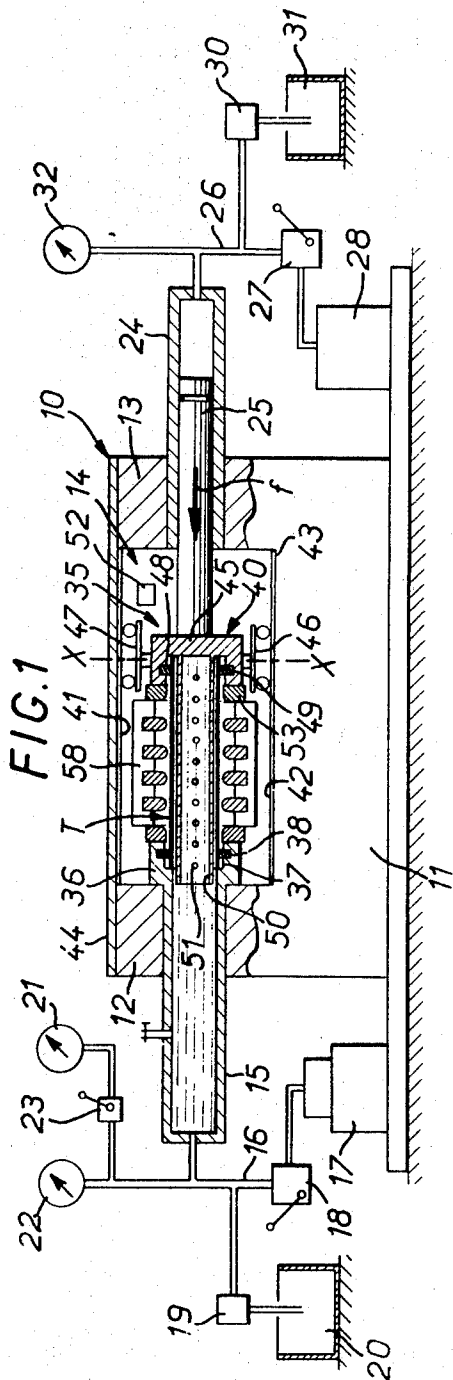
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[57] **ABSTRACT**

In the formation of corrugated tubes, forming members are arranged around the periphery of the tube at spaced axial intervals. The forming members are first locked in their axial positions and hydraulic pressure is applied internally of the tube to form initial corrugations in the tube between the forming members. The forming members are then released for axial movement and the internal pressure is continued simultaneously with the application of axial pressure through the forming members.

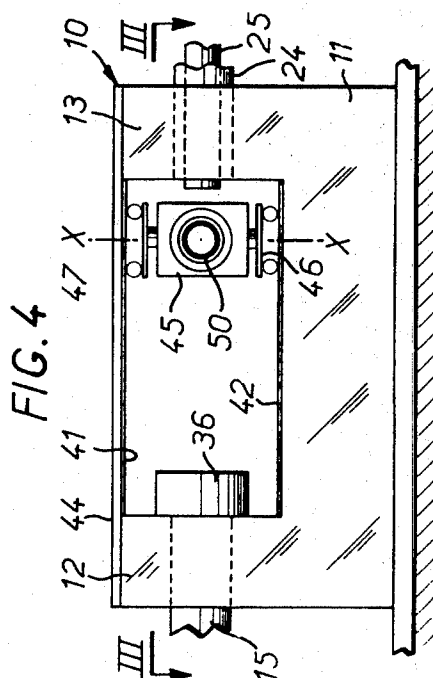
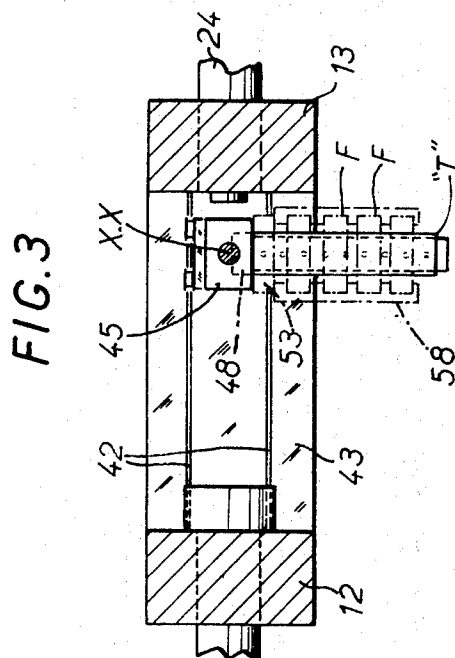
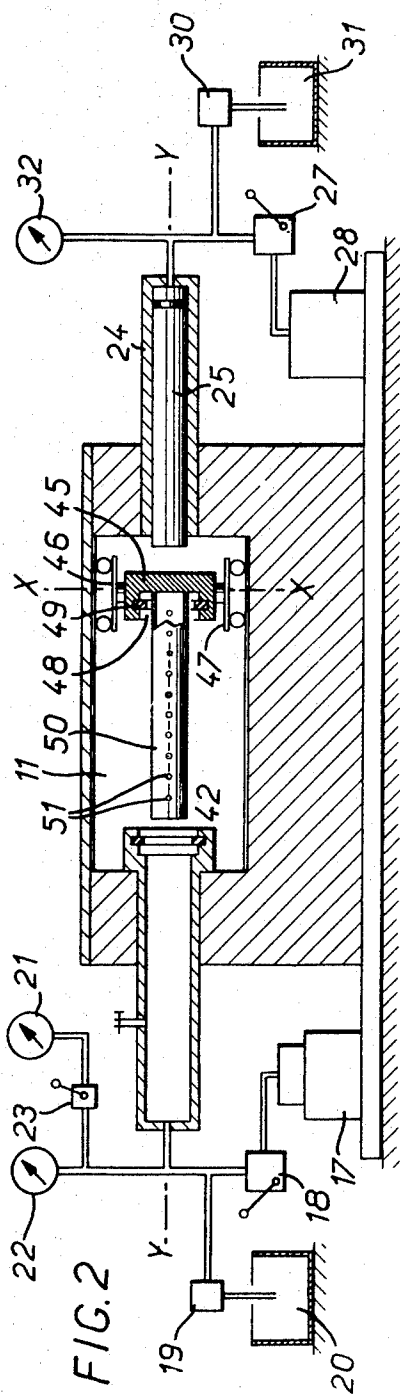
4 Claims, 8 Drawing Figures



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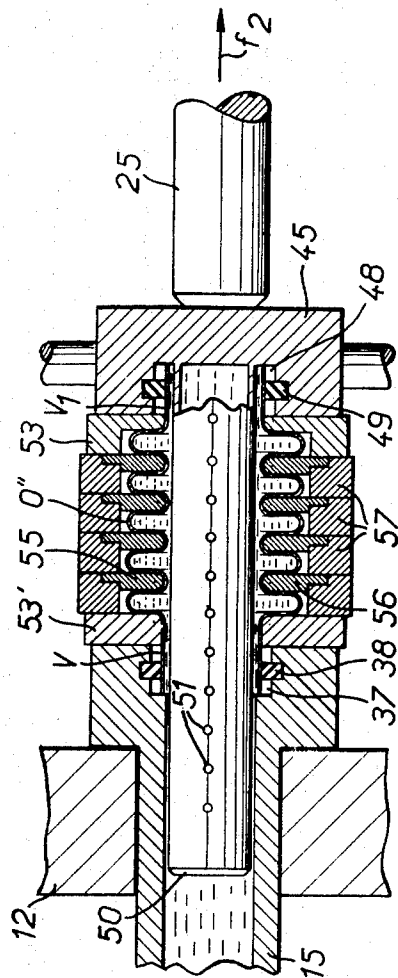


FIG. 7

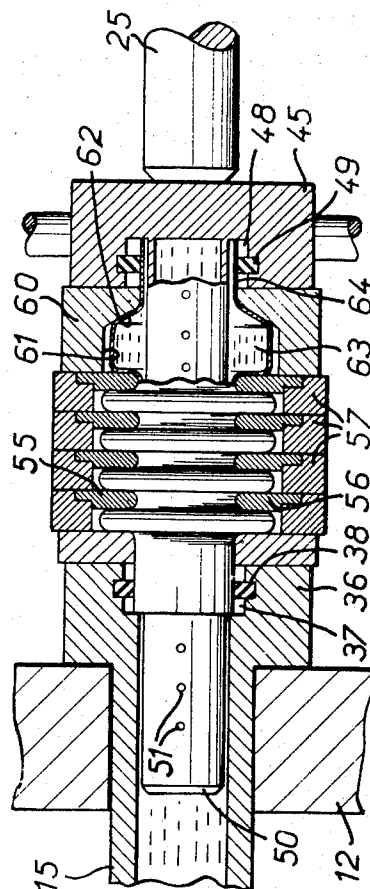


FIG. 8

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METHOD OF AND APPARATUS FOR THE FORMATION OF TUBULAR ARTICLES

The present invention relates to a method of forming tubular articles having one or several walls and in particular thin walled tubes of any cross section.

The invention also relates to apparatus for carrying out the above method, which, as well as being a simple and economical construction, is particularly simple to use.

The method of the invention is characterized by the fact that a length of tube is subjected to combined radial and axial pressures by forming means at the exterior of the tube until the desired profile is obtained.

According to one aspect of the invention, the forming is carried out in two steps, the first of which, called the preforming step, consists in forming a bellows portion in the tube by imparting corrugations thereto, during which step locking of the aforesaid external forming means is effected, and a second step during which the forming proper is effected in a continuous and progressive manner as aforesaid.

According to one aspect of the invention, the radial pressures are imparted hydraulically in a direction from the interior to the exterior of the length of tube to be shaped, whilst the axial pressures are imparted by means of pressure means such as a jack cooperating with a movable mechanism carrying the element or elements to be shaped.

The invention also relates to apparatus for forming such articles and characterized in that it comprises, between two vertical limbs of a frame, a mechanism movable in a horizontal direction and carrying a mandrel adapted to rotate in a direction perpendicular to the aforesaid direction, one limb of the frame carrying pressure means and the other limb carrying a hydraulic device or cylinder connected to a source of fluid, the movable mechanism and the aforesaid device having respectively opposed abutment recesses having sealing means for the ends of the tube, the interior of which latter is in communication through the mandrel with the hydraulic device.

Such a simple method and apparatus offer many advantages.

One important advantage is that it is possible to observe visually during the formation proper the progressive deformations imposed and this enables the operation of the apparatus to be stopped if necessary in the event of mishaps during manufacture, or enables corrections to be made during the forming.

Another important advantage is that the apparatus permits a slow formation facilitating good flow of the metal into the desired shape, whilst enabling control of the internal pressure conditions and the rate of advance of the deformations to be maintained throughout the whole operation.

It will be observed that the machine, which is particularly reliable in operation, noticeably reduces the losses and rejects due to malformations caused by more rapid forming processes, which is important since the materials used are sometimes very expensive.

Moreover, another important advantage is that the machine of the invention allows the manufacture of articles of very different diameters and shapes requiring a range of equipment, suitable independent collars and the like.

Other characteristics and advantages of the invention will moreover appear from the following description given by way of example, with reference to the accompanying drawings, in which:

FIG. 1 is a diagrammatic view of the machine in elevation;

FIGS. 2 to 7 illustrate different successive phases during the formation of a bellows; and

FIG. 8 shows an alternative embodiment of a bellows with recessing.

In the embodiment selected and shown, the apparatus comprises a frame shown generally at 10 including a base 11 and two lateral extensions 12, 13 respectively extending upwardly and defining a cavity 14.

The extension 12 carries a horizontally extending hydraulic cylinder 15 which is connected by a conduit 16 to a pressure fluid generator 17 controlled by a distributor 18. On a branch of the conduit 16 there is provided a pressure limiting device 19 discharging into a receiver 20. On other branches of the conduit 16 are provided a first measuring device 21 intended to measure the low preforming pressures in the hydraulic cylinder, and a second device 22 isolated from the first by a valve 23 and which is intended to measure the high pressures developed during the phases of the forming proper.

The opposite vertical extension 13 carries a pressure device, for example a hydraulic jack 24 with a rod 25 as illustrated, the jack being located coaxially with the aforesaid hydraulic cylinder 15.

The jack is connected externally by a conduit 26 through a distributor 27 to a hydraulic pump 28, whilst a branch of the conduit 26 is connected, on the one hand, to a pressure limiter 30 discharging into a receiver 31 and, on the other hand, to a device 32 for measuring the deformation force, this device being in the case considered a manometer and the pressure force being obtained by means of a jack.

It will be understood that the pressure forces could be obtained by other means, such as screws. The rod 25 of the jack 24 is adapted at its free end to cooperate with a movable mechanism indicated generally at 35, whilst the end portion of the hydraulic cylinder 15 located on the side nearest to the cavity 14 has in a head 36 a recess 37 with a fluid-tight seal 38, the purpose of which will appear from the following.

The aforesaid movable mechanism comprises a carriage 40 movable axially of the jack 24 and hydraulic cylinder 15 on upper rails 41 and lower rails 42 fixed respectively to an upper plate 44 fixed to the frame and to the floor 43 of the cavity.

The carriage has a body 45 which is pivotally mounted about a vertical axis X—X on roller races 46, 47. This body itself has a recess 48 with a fluid-tight seal 49, and an axial mandrel 50 having holes 51 therethrough, the purpose of which will become apparent later.

There is also provided in the path of the pressure jack 24 a micro-switch 52 adapted to control the travel of the rod 25.

The operation of the above described apparatus can be analysed in the following manner, for which purpose there is taken as an example the formation of a bellows type connecting element particularly useful for joining tubes subjected to expansion.

In the first stage the movable mechanism 35 is located in a withdrawn position, as will be seen from FIG. 3, since the jack 24 is not supplied with fluid; in a second stage, the mandrel 50 is caused to pivot about its axis X—X; then there is engaged on this mandrel first a shim 53 and then the tube T to be shaped, until the latter abuts at one end against the bottom of the recess 48 where sealing takes place.

External guides such as collars or other means are then placed in position around the tube T to be shaped.

FIGS. 5 and 6 particularly show external guides in the form of collars F, themselves constituted each in two halves 55, 56 which are of a type quickly assembled by means of a bayonet ratchet, itself well-known and not shown, on mountings 57.

When a predetermined number of external guides have been engaged around the tube, they are retained in predetermined spaced relation by means of supports 58 or other similar means (see FIG. 5 in particular).

It will be observed that an assembly of external guides such as those described above, is adapted to each kind of work according to the desired result and in particular according to the nature of the materials to be shaped, and the amplitude of the deformations. A second shim 53' is engaged on the mandrel and the mechanism 35, thus loaded, is then pivoted about the axis X—X, so as to bring the mandrel and its tube into line with the axis Y—Y of the jacks and the hydraulic cylinder.

The free end of the mandrel, and of the tube to be shaped is then introduced into the recess 37 of the hydraulic cylinder where the sealing takes place.

This latter stage is effected by operating the distributor 27 which, by actuating the jack 24 brings the piston 25 first into contact with the movable mechanism 35, after which it causes the latter to advance (arrow f FIG. 1) to a position predetermined by the micro-switch 52. At this moment, the tube or tubes to be shaped are in contact at their respective ends, on the one hand with the bottom of the recess 48 of the body of the carriage, and on the other hand with the bottom of the recess 37 of the hydraulic cylinder, sealing being effected by the seals 38 and 49 respectively. The pressure device, i.e., the jack 24 has completed its first displacement operation and remains at rest. Fluid under pressure is then admitted through the distributor 18 (FIG. 5) into the chamber formed by the hydraulic cylinder 15, the hollow mandrel 50 and the tube T to be shaped until a predetermined preforming pressure is reached which is read on the first control device 21.

The object of this preforming is to effect an initial expansion of the tube or tubes which creates corrugations O between the collars F, the effect of which is to retain the collars rigidly on the tube to be shaped, so that the collars are no longer axially movable on the tube.

At this moment the spacing supports 58 or the like are removed.

The function of the micro-switch 52 is cancelled and the control device 21 is isolated by operating the valve 23; the device 22 intended to measure pressures occurring during forming is then active. From this moment, the apparatus can be controlled by sight by the operator, who is able to watch all the continuous and successive stages of forming the tube.

By simultaneous or non-simultaneous operations on the distributor 18 and 27, the operator can at will in-

crease or decrease the pressure of liquid in the aforesaid chamber, or increase or decrease the deformation force, it being understood that the pressure and force in question cannot exceed certain limits imposed by the limitors 19, 30 respectively associated with the hydraulic cylinder circuit and the pressure jack circuit.

Thus, by virtue of the good visibility of the tube during forming and of the combined actions of the fluid under pressure in the chamber and of the axial pressure force developed by the jack, these two factors being controllable at will, the forming is carried out under excellent conditions.

In FIG. 6, which shows an intermediate stage after extraction of the supports, it can be seen that the corrugations indicated at O' are clearly more accentuated than in the preceding example.

In FIG. 7 the forming of the tube or tubes is finished, because there is no longer any space between the different elements, viz. shims, collars, body of the carriage and corresponding portion of the hydraulic cylinder. It will be easily understood that the corrugations O' have a depth and width determined by the external guides.

In order to extract the formed article, which has connecting sleeves at its ends (indicated at V and V₁), the hydraulic cylinder 15 is exhausted; the rod 25 of the pressure jack 24 is returned to its inoperative position, i.e., to the right, as shown by arrow f₂; the assembly comprising the mechanism, tube, and exterior guide is moved rearwardly to disengage it from the hydraulic cylinder and enable the mandrel and elements carried thereby to be rotated about the axis X—X.

At this stage, the entire assembly of the tube, collars, and shims can be moved for dismantling away from the apparatus, or the elements can be removed separately by dismantling the shims 53', mountings 57 and collar portions 55, 56, enabling the article to be extracted. It should be noted that as seen from FIG. 8, the main part of which is similar to FIG. 7, a block can be provided having a cavity 61 with a conical bottom 62 adapted to form a chamber 63 extended by a connecting sleeve 64.

The invention is not limited to the embodiment chosen and illustrated, which, on the contrary, may receive various modifications without departing from the scope of the invention. Thus, it is easy, with the method and apparatus described above, to effect all types of shaping of tubular elements; it is possible, for example, to produce bulges in the length of a tube, or to form circular housings also in a tubular element to receive fluid-tight seals or the like. In another application the arrangements according to the invention also permit the formation of fins on tubes to produce for example a heat exchanger.

What I claim is:

1. Apparatus for forming tubular articles, comprising a plurality of aligned forming elements, support means releasably maintaining the forming elements in spaced apart relation, a hollow perforate mandrel for receiving a length of tube, a carriage supporting the mandrel, means mounting the carriage for movement longitudinally relative to the forming elements, means mounting said mandrel on the carriage for pivotal movement between a position in which the mandrel extends between the forming elements, and a loading and unloading position in which the mandrel extends out of the apparatus, a source of fluid pressure in communica-

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tion with the mandrel and the interior wall of the length of tube when the mandrel is in position extending between the forming elements, and a hydraulic jack for exerting a longitudinal force on the tube and for moving the forming elements closer to one another once said support means for maintaining the forming elements in spaced apart relation has been released.

2. Apparatus according to claim 1, wherein the source of fluid includes a hydraulic cylinder coaxial with the forming elements and at the side thereof opposite the hydraulic jack, a first seal at the end of the hydraulic cylinder adjacent the forming elements for sealing with one end of the tubular article to be formed, and a second seal mounted on the carriage for sealing

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with the other end of the tubular article to be formed.

3. Apparatus according to claim 1, and a hydraulic pump feeding said hydraulic jack, a distributor valve downstream of said pump, a pressure limiting device downstream of said valve, and switch means in the path of the jack for controlling the travel thereof.

4. Apparatus according to claim 1, and manometric control devices adapted to be isolated from one another for providing low fluid pressure for a pre-forming operation when said forming elements are maintained spaced apart and higher fluid pressure for a forming operation when said forming elements are released.

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