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Asselborn et al.

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[54] **TUBE CORRUGATING APPARATUS**

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[30] **Foreign Application Priority Data**

May 10, 1971 Germany ..... P 21 22 906.1

[52] **U.S. Cl.** **72/78**

[51] **Int. Cl.** **B21d 15/06**

[58] **Field of Search** 72/77, 78, 95, 96, 72/100, 112, 126

[56] **References Cited**

UNITED STATES PATENTS

3,672,196	6/1972	Levacher et al.	72/77
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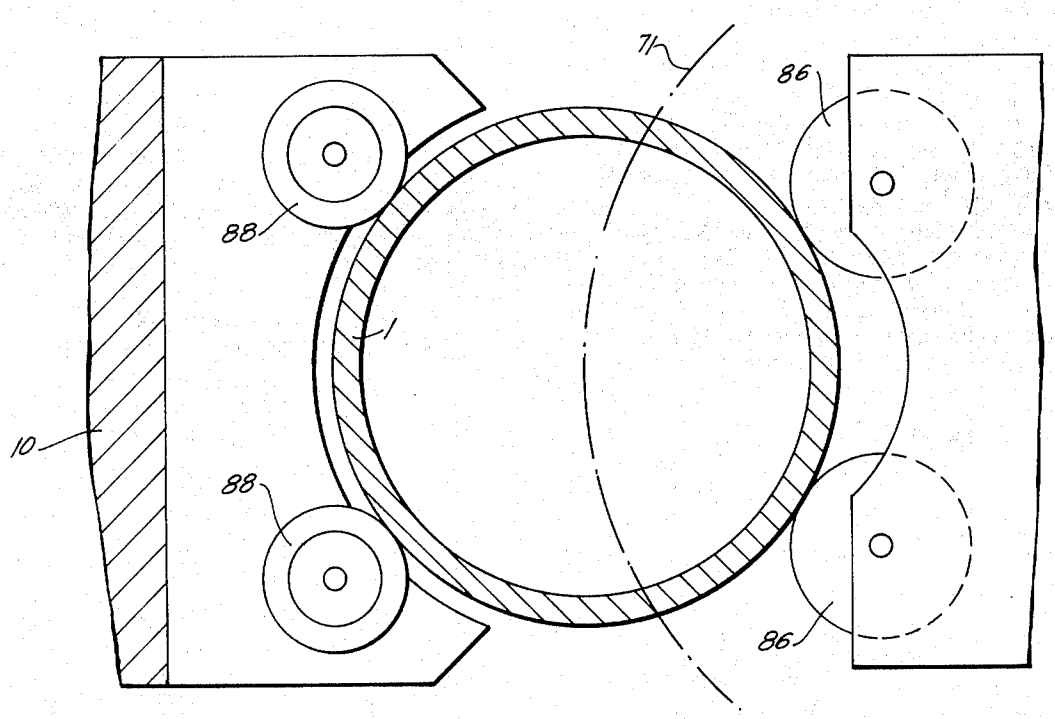
[57] **ABSTRACT**

A tube is advanced lengthwise through passages provided in two longitudinally spaced universally movable bearing means of which each surrounds a portion of the path of advancement of the tube. That section of the tube which is located between the bearing means can thus flex transversely of the path without appreciable stretching of its material. A grooving unit is located between the bearing means and can orbit about the tube, engaging the same individually and successively with a plurality of grooving tools each of which comprises at least two pressure rolls, with the tools traveling about an axis at least substantially normal to the path of advancement of the tube and at such a rate of speed that the tube section is contacted by one tool at a time.

5 Claims, 4 Drawing Figures



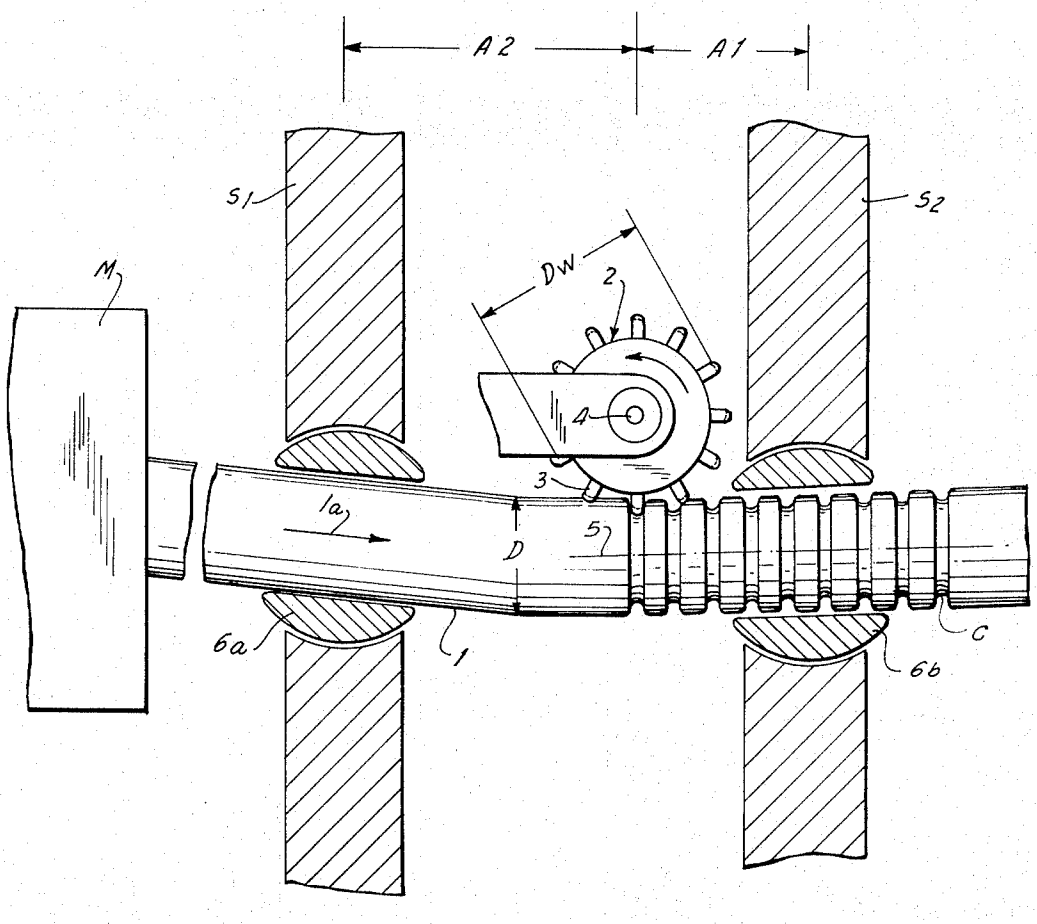


FIG. 1

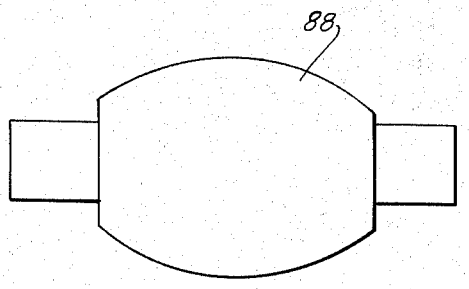


FIG. 4

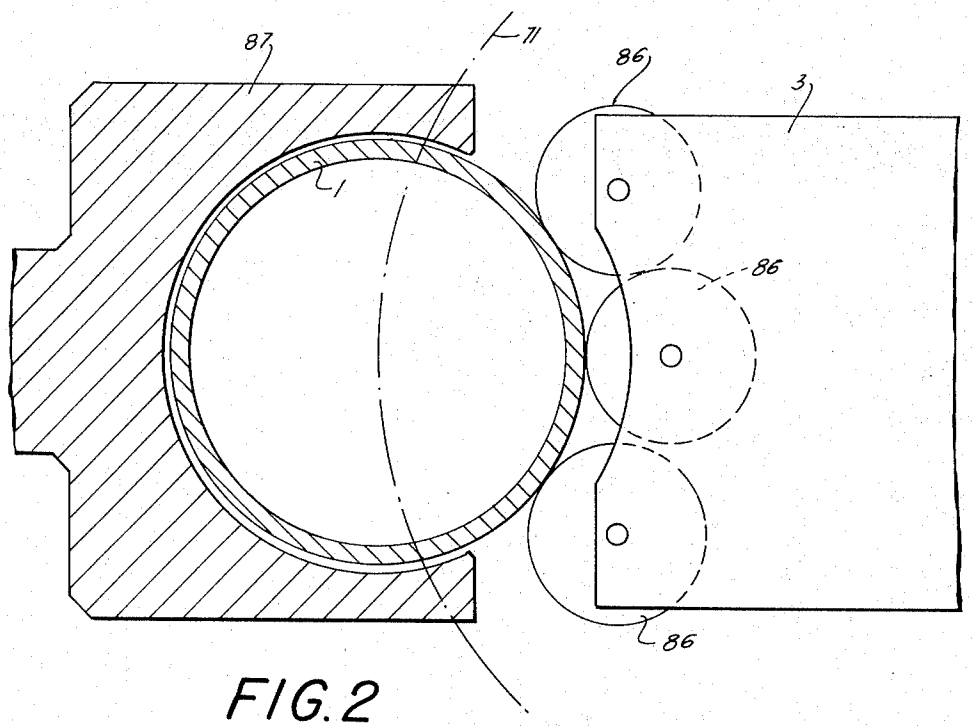


FIG. 2

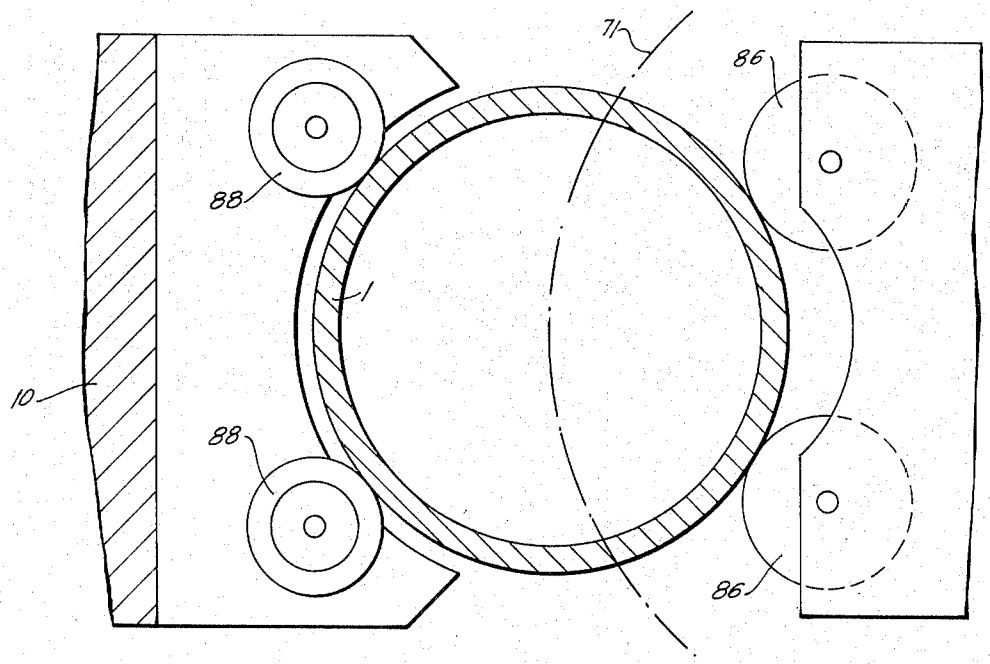


FIG. 3

TUBE CORRUGATING APPARATUS

BACKGROUND OF THE INVENTION

The present invention relates generally to an apparatus for forming corrugations or similar grooves in tubes of ductile material.

More particularly, the invention relates to such an apparatus for forming circumferential, helical and/or other corrugations or grooves in metallic or plastic tubes of ductile material, in particular of tubes which can be used as sheaths for electric cables or the like.

The use of corrugated sheaths for electric cables is by now already well established. Their purpose is to provide both mechanical and electrical protection for the cable while at the same time permitting ready flexing of the cable. This, of course, requires that the protective sheath itself should offer as little resistance as possible to flexing of the cable in any desired direction so that the cable can be employed and installed substantially in the same manner as if the corrugated sheaths were not present.

Apparatus for making corrugations or other types of grooves in tubes are of course not novel. Generally speaking such apparatus uses pressing or deforming tools which travel about the tube in order to form therein a circumferentially complete or a helical groove. To reduce friction between the ductile material of the tube and the material of the tool, the tool is often configurated as a roll whose deforming action is similar to that of a pipe cutter, that is the formation of grooves or corrugations results in a stretching or elongation and resulting reduction in the wall thickness of the tube. This is undesirable, especially because it is often accompanied by localized hardening of the tube material, especially if the material is metallic.

Other types of corrugating devices used for this purpose have similarly been found unsatisfactory.

However, an apparatus which is suitable for the purposes for which the present invention is concerned, is disclosed in U.S. Pat. application Ser. No. 54,247 of Levacher et al, now U.S. Pat. No. 3,672,196. Reference may be had to this application for further details.

Generally speaking, this last-mentioned prior art apparatus provides two spaced universally movable bearings through passages of which a tube to be corrugated advances, so that the section of the tube which is located between these bearings can flex sideways without any appreciable elongation or hardening of its material. The grooves or corrugations are formed in this section by tools having concave tube-engaging faces and being rotatably mounted in a holder which orbits about the tube between the two bearings. The tools engage the tube section and first flex it slightly away from themselves, so that the corrugating action takes place at the concave side of the thus flexed tube section. Because this flexing takes place before the actual corrugation begins, that is before the individual tool contacting the section effects corrugation of the tube, less force is required for the corrugation; this is due to the fact that each tool flexes the tube section away from itself to an appreciable extent which is, however, smaller than the extent of the flexing which would be required to form a kink or bend in the tube. Nevertheless, the tool which subsequently effects the corrugation contacts the section at that point at which such a kink or bend would occur if the flexing of the section were carried further than the tool is capable of doing.

This known apparatus has been found to be highly effective, except that difficulties were found to occur if tubes — especially steel tubes — are to be corrugated at high speeds, in which case parts of the tube tend to become "welded" to the concave pressure tools at their contact points therewith. It was found that the reason for this phenomenon is due on the one hand to the high temperatures which result from friction at the high advancement speed of the tube and the substantial pressure forces acting between the tube and the pressure tools. On the other hand, the uneven distribution and dissipation of the frictional heat thus developing is a further reason, aided by the fact that mechanical vibrations of the tube which occur tend to aid such uneven dissipation.

SUMMARY OF THE INVENTION

It is, accordingly, a general object of the present invention to further improve the apparatus set forth above.

More particularly, it is an object of the present invention to provide an apparatus for forming corrugations or similar grooves in tubes of ductile material which apparatus avoids the problems which have been out-lined above.

Still more particularly, it is an object of the present invention to provide such apparatus in which the friction between the tube and the grooving or corrugating tools is substantially decreased, whereby the development of high temperatures due to such friction is eliminated or at least reduced.

Another object of the invention is to provide such an apparatus in which the initiation of mechanical vibrations of the tube being corrugated is suppressed or at least made more difficult.

In pursuance of these and other objects of the invention which will become apparent hereafter, one feature of the invention resides in an apparatus for forming corrugations or similar grooves in tubes of ductile material, particularly in tubular sheaths for electrical cables. This apparatus comprises, briefly stated, advancing means for advancing a tube longitudinally in a predetermined path. A pair of universally movable bearing means are spaced along and each surround a portion of the path, having respective passages for the advancing tube so that a section of the same between the bearing means can flex transversely of this path without appreciable stressing of its ductile material. A grooving unit is located between the bearing means and includes holder means arranged to orbit about the path of the tube, and a plurality of grooving tools supported by said holder means for movement about an axis which is at least substantially normal to the aforementioned path. Each of the tools comprises at least two pressure rolls which are located sufficiently close to the path to flex and simultaneously groove the sections of the tube and the tools are so arranged that they travel about the afore-mentioned axis at a rate of speed such that the section is contacted by one tool at a time.

It has been found to be particularly advantageous if the rolls of each tool are made of chromium steel because such rolls have been found to have an excellent lifetime.

According to another aspect of the invention the grooving unit also comprises means for limiting the flexing of the tube section, either in form of a guide element or in form of at least two rollers but in either case

the guide element of the rollers will orbit with the holder means and engage the tube section to thereby reduce or suppress the development of mechanical vibrations of the latter. The rollers, if such are utilized, are particularly suited for the purpose at hand, from a point of view of their movement about the tube section, if they are configurated as approximately barrel-shaped bodies of rotation.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a diagrammatic partly elevational and partly sectional view of an apparatus for carrying out the invention;

FIG. 2 is a diagrammatic fragmentary partly sectioned detail view of one embodiment of the tools of the apparatus in FIG. 1 and of one embodiment of the means for limiting flexing of the tube sections;

FIG. 3 is a view similar to FIG. 2 but illustrating a further embodiment; and

FIG. 4 is an elevational view illustrating an advantageous configuration of a roller for limiting flexing of the tube section.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Discussing firstly the apparatus illustrated in FIG. 1, it is emphasized that this apparatus is known from the afore-mentioned patent, except for the particular details of its grooving tools and of the means utilized for limiting the flexing of the tube section intermediate the bearing means. With this in mind it will be seen that the apparatus comprises a suitable mechanism M for feeding a metallic tube 1 axially in the direction inindicated by the arrow 1*a*. The tube passes through and is guided by a first universally movable hollow spherical bearing 6*a* mounted in a stationary support S1. Then it passes through a second universally movable hollow spherical bearing 6b mounted in a second support S2. The corrugating or grooving station is located between the bearings 6*a* and 6*b* and accommodates a wheel-shaped tool holder 2 which is rotatable about the axis of a shaft 4 and caused to orbit circumferentially about the axis of the travelling tube 1. A set of equidistant radially extending corrugating or grooving tools 3 is provided on the holder 2. The axis of the shaft 4 is normal to the axis of the tube and the holder 2 is assumed to rotate about the axis of the shaft 4 in response to lengthwise movement of the tube, but it should be understood that the holder 2 can also be driven by a gear train or the like.

According to an important aspect the distance between the shaft 4 and the path for the tube 1 is so selected that the tool 3 which engages the tube causes the latter to flex transversely of its path of advancement, that is downwardly as seen in FIG. 1. Such flexing takes place simultaneously with the formation of a circumferential corrugation C and will not result in any elongation because the tube travels through the passages defined therefor by the spherical bearings 6*a* and 6*b*. The corrugations C are therefore formed without localized reduction in the wall thickness of the tube and without hardening of the metallic material. To permit and aid the flexing in this manner, the axis of the passage formed in the bearing 6*a*, that is the bearing which is adjacent the as yet uncorrugated part of the tube section between the supports S1 and S2, is offset somewhat in radial direction towards the axis of the shaft 4 with respect to the axis of the tube 1.

The spacing between successive ones of the tools 3 — that is spacing as seen in the circumferential direction of the tool holder 2 — is so selected that a tool engages the tube 1 only when the formation of the preceding corrugation C by the circumferentially proceeding tool 3 has been completed. The reason for this is that simultaneous engagement of the tube by two tools 3 would interfere with the desirable flow of metallic material of the cylindrical tube wall.

The corrugated portion of the tube 1 is of course more readily flexible then the as yet uncorrugated portion, and for this reason the distance A1 between the center of the right-hand bearing 6*b* and the axis of the shaft 4 is less than the distance A2 between the axis of the shaft 4 and the center of the left-hand bearing 6*a*, and advantageously the distance A2 should be at least 2.5 times and the distance A1 should be at least 1.5 times the diameter D of the tube 1. The vertical plane including the axis of the shaft 4 intersects the tube 1 in the region where a tool 3 begins to move away from the axis 5 of the tube, and reference Dw denotes the diameter of the corrugator or grooving unit including in the central plane of the holder 2.

Thus far the apparatus is known, as pointed out before. In FIG. 2, however, we have illustrated that the tools — which in this Figure will be understood to orbit about the tube 1 in the plane of the drawing — are each in form of two or more pressure rolls 86 which are journalled for turning movement about their respective longitudinal axes. It will be clear that the frictional forces between tube and pressure rolls 86, which result during the corrugation, will be negligible with respect to the forces necessary for effecting the corrugation.

FIG. 2 also shows means for limiting the flexing of the tube section between the bearings 6a and 6b of FIG. 1, that is to thereby suppress or reduce vibrations in the tube. This guide means is here illustrated in the form of a substantially C-crossectioned guide sleeve 87 which embraces the tube 1 on a side thereof which is diametrally opposite the tool 3. The sleeve 87 orbits about the tube with the tool 3 and as a result of the orbiting and simultaneous longitudinal advancement of the tube 1 friction between the surface of the tube 1 and inner surface of the sleeve 87 will of course also cause the development of heat. This, however, is uniformly distributed over the surfaces of the tube 1 and of the sleeve 87 so that no difficulties have been encountered as a result of local overheating at low and medium operating speeds.

If, however,the operating speed is to be extremely high, heat which does develop as a result of such frictional contact could rise to an unacceptable level. To avoid this we have provided the embodiment illustrated in FIG. 3 which corresponds to the one in FIG. 2 except that the guide sleeve 87 is replaced with rollers 88 which are journalled turnably about their respective longitudinal axes in projections of a counterweight 10 which orbits with the tool 3. The rollers 88 of course again engage the tube at a side opposite that at which

the tube is engaged by the pressure rolls **86** of the respective tool **3**. Another difference of FIG. **3** with respect to FIG. **2** is that only two pressure rolls **86** have been illustrated, as opposed to the three which have been shown in FIG. **2**. At least two will be required, of course,but more can also be provided.

It has been found particularly advantageous if the rollers **88** of FIG. **3** are configurated as illustrated in FIG. **4**, that is if they are substantially barrel-shaped bodies of rotation.

The present invention assures that the frictional heating between the surface of the tube and the respective tool of the grooving unit is negligible over the entire range of applicability of the apparatus. Furthermore, forces acting both on the tube and on the tools are correspondingly reduced so that the apparatus can be used with tubes of greater wall thickness than before as well as with tubes which are made of difficult to deform materials; moreover the apparatus can also be used with tubes having particularly small wall thicknesses or being made of materials which are particularly susceptible to pressures or heating or indeed with any combination of factors. In addition, the lifetime of the tools themselves and the reliability of the apparatus are substantially improved, and the operating and production speed is increased whereas the quantity of lubricant needed is substantially decreased.

It will be understood that each of the elements described above or two or more together may also find a useful application in other types of constructions differing from the types described above.

While the invention has been illustrated and described as embodied in a tube corrugating apparatus, it is not intended to be limited to the details shown since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without futher analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be protected by Letters Patent is set forth in the appended claims.

We claim:

1. Apparatus for forming corrugations or similar grooves in tubes of ductile material, particularly in tubular sheaths for electrical cables, comprising advancing means for advancing an internally unsupported tube longitudinally in a predetermined path; a pair of universally movable bearing means spaced along and each surrounding a portion of said path, said bearing means having respective passages for the advancing tube so that a section of the same between said bearing means can flex transversely of said path without appreciable stretching of its ductile material; and a grooving unit located between said bearing means and including a support arranged to orbit about said path, holder means pivoted in said support for rotation about an axis which is at least substantially normal to said path, a plurality of grooving tools supported by said holder means for movement therewith, each of said tools comprising at least two pressure rolls located sufficiently close to said path to flex and simultaneously groove said section of said tube, and said holder means being arranged to travel about said axis at a rate of speed such that said section is contacted by one tool at a time, and a guide element mounted for orbiting about said path in synchronism with said support and comprising at least two guide rollers arranged substantially opposite said pressure rolls across said tube section and adapted for engaging the latter and limiting the extent of flexing thereof.

2. Apparatus as defined in claim **1**, wherein said pressure rolls are of chromium steel.

3. Apparatus as defined in claim **1**, wherein said guide rollers are configurated as substantially barrel-shaped bodies of rotation.

4. Apparatus as defined in claim **1**, wherein said pressure rolls are mounted for rotation about their respective axes.

5. Apparatus as defined in claim **1**, wherein said guide element is of substantially C-shaped cross-section and partially embraces a portion of said tube section.

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