

[54] TUBULAR ARTICLES AND METHOD OF MAKING SAME

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[57]

ABSTRACT

A perforate, thin-walled, tube structure of surprisingly high strength, having a tightly-clenched lock seam and generally helical wall corrugations, manufactured by a generally continuous rolling process in which the stock is first put through a piercing and corrugating stage and is then fed through a number of complementary-shaped pairs of rollers which progressively change the shape of the stock from basically flat to generally circular in cross-section and with a progressively-formed lock seam joining the edges of the stock in a tightly clenched manner, by use of an arbor extending inside the tubular stock and having a roller which bears against the inside of the lock seam to provide for tight clenching of the latter by an external roller and, at the same time, helping pull the stock through the various roller stages, through all of which the initially-formed wall corrugations are maintained intact in an unflattened condition.

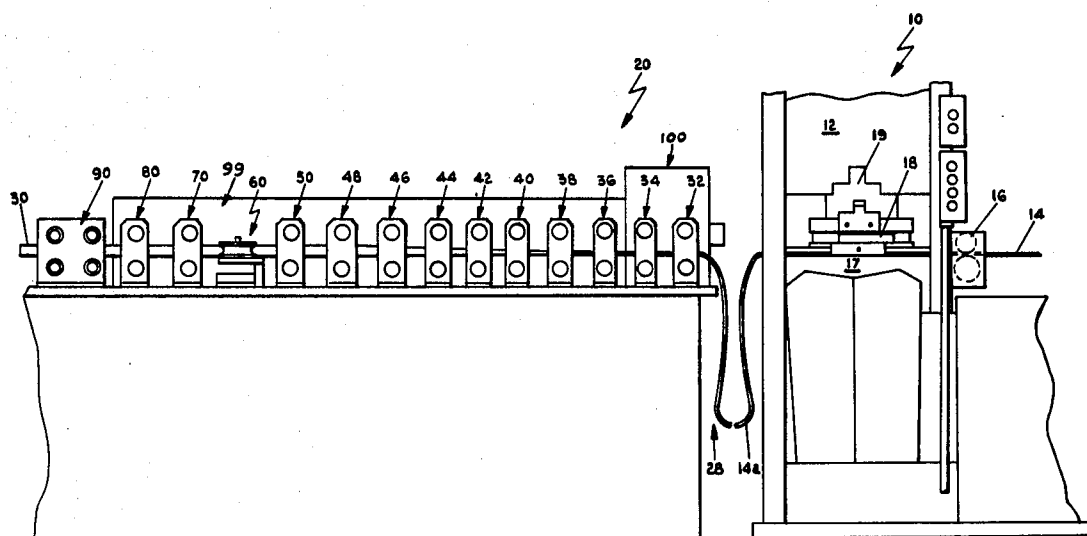
23 Claims, 22 Drawing Figures

Fig. 1

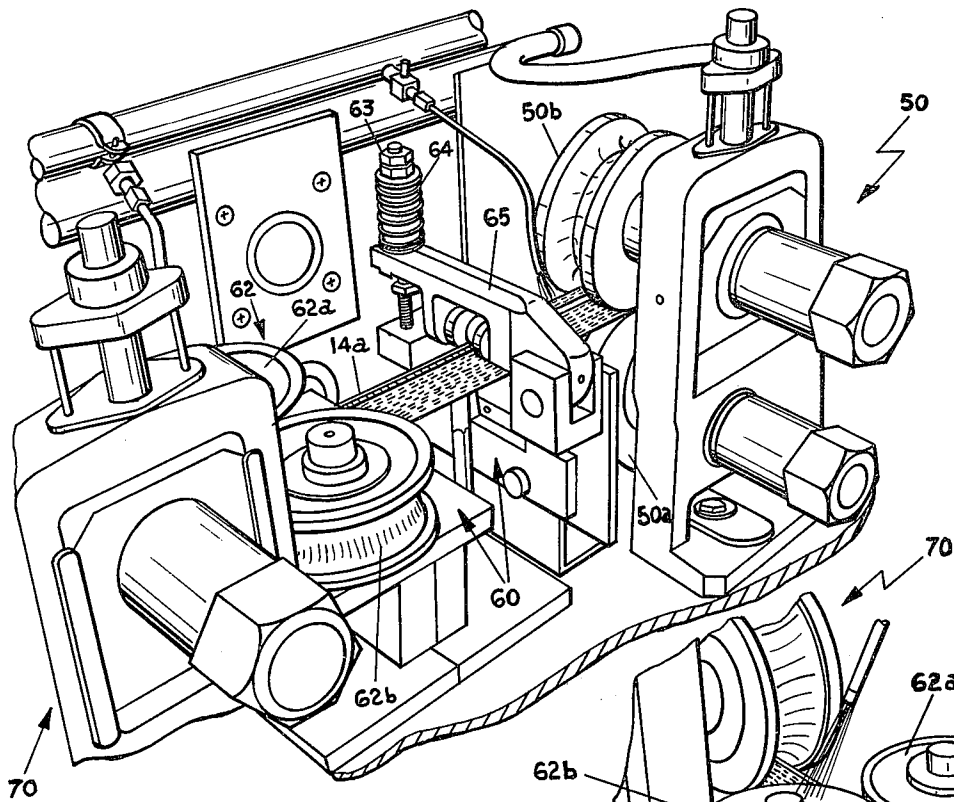


FIG. 2

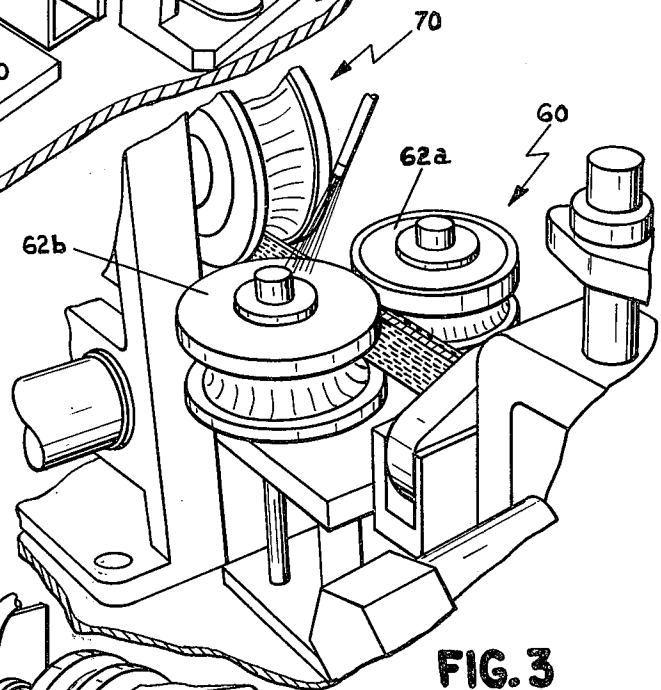


FIG. 3

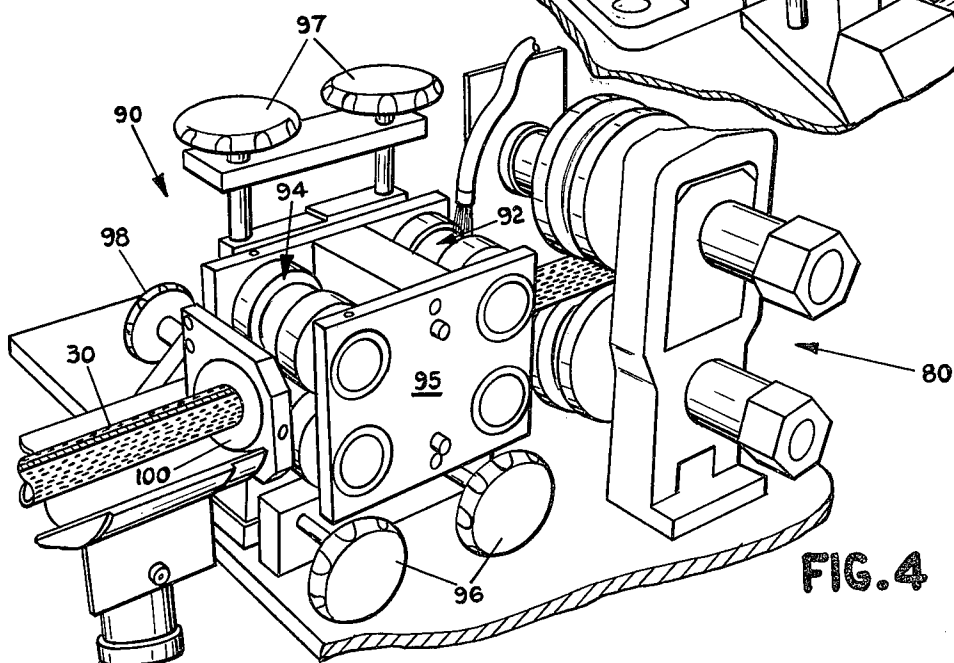


FIG. 4

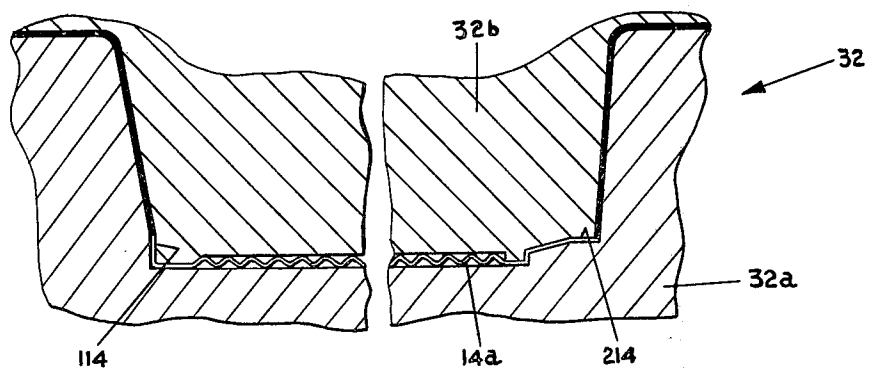


FIG. 5

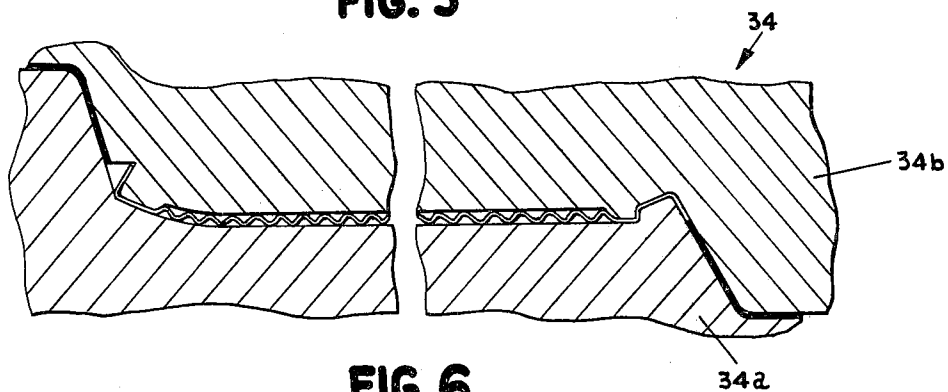


FIG. 6

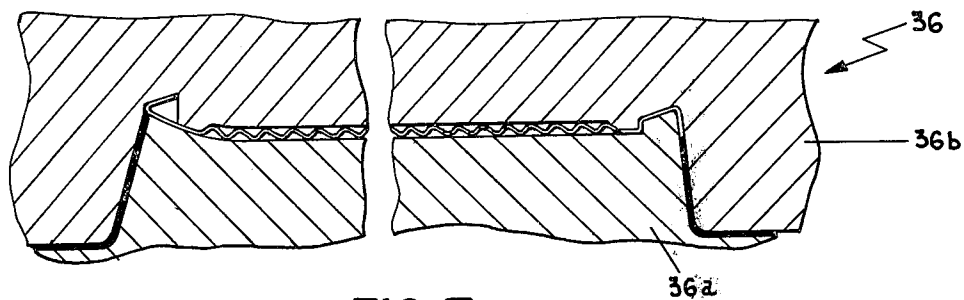


FIG. 7

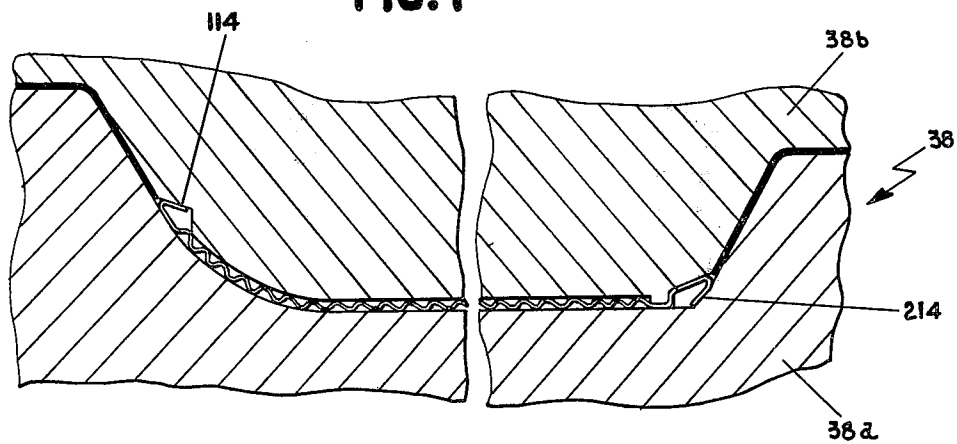


FIG. 8

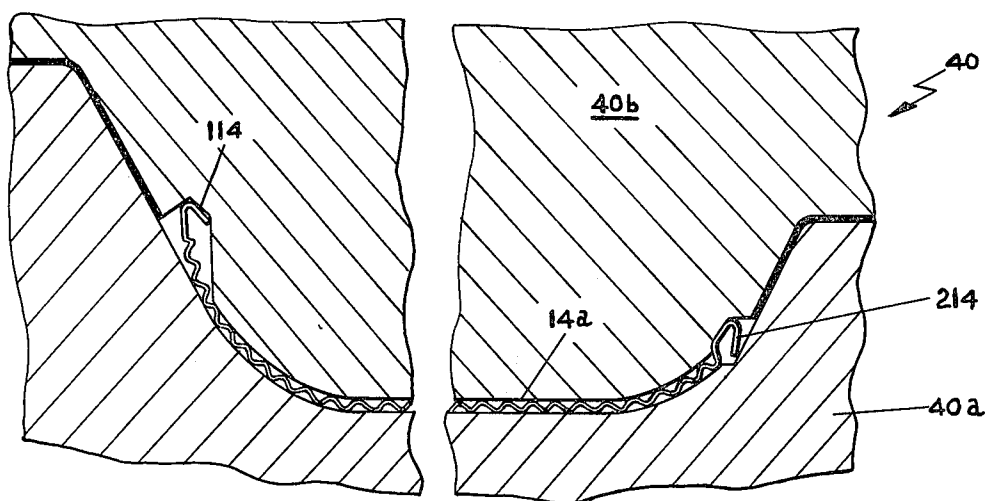


FIG. 9

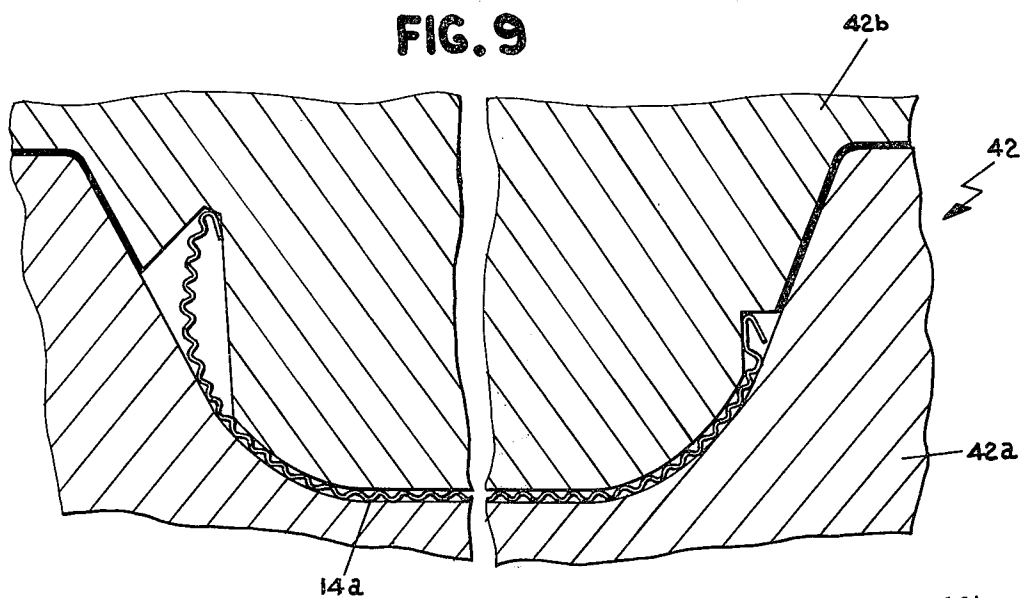


FIG. 10

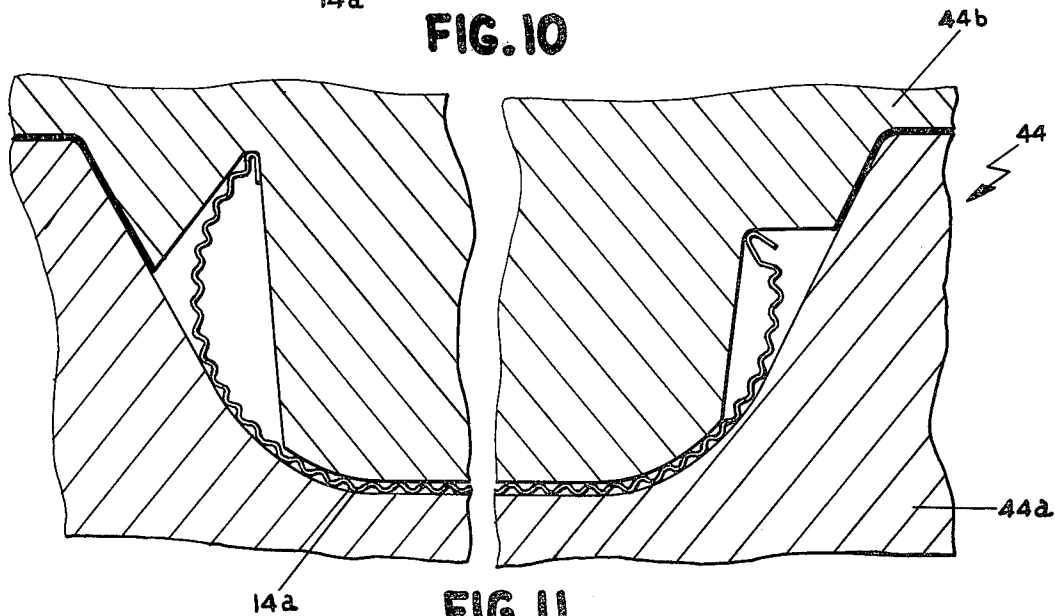


FIG. 11

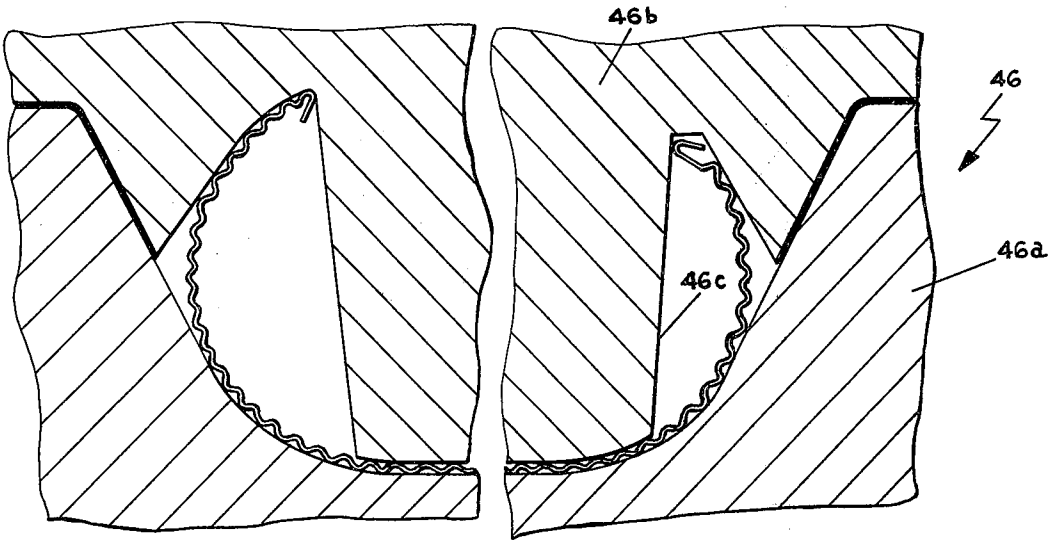


FIG. 12

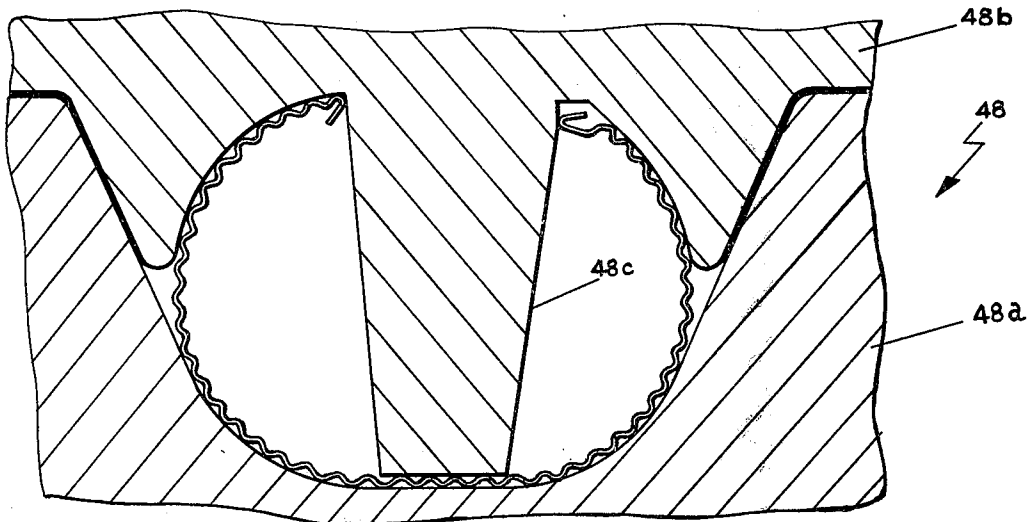


FIG. 13

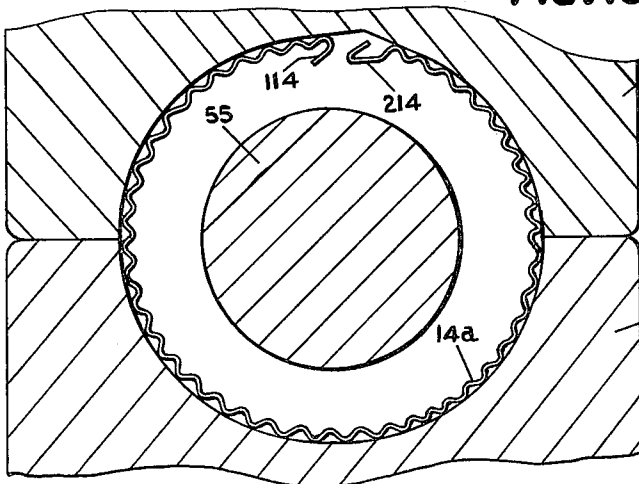


FIG. 14

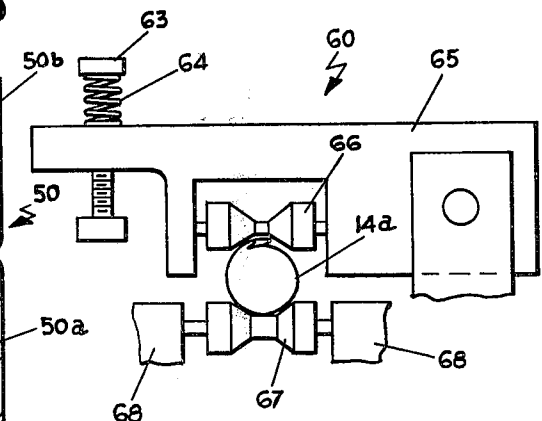


FIG. 14a

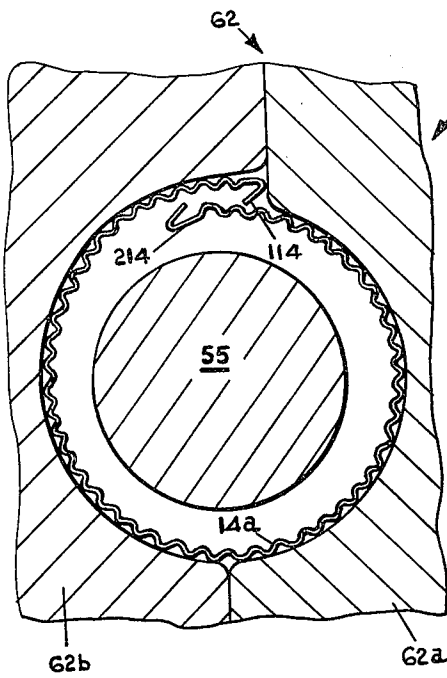


FIG. 15

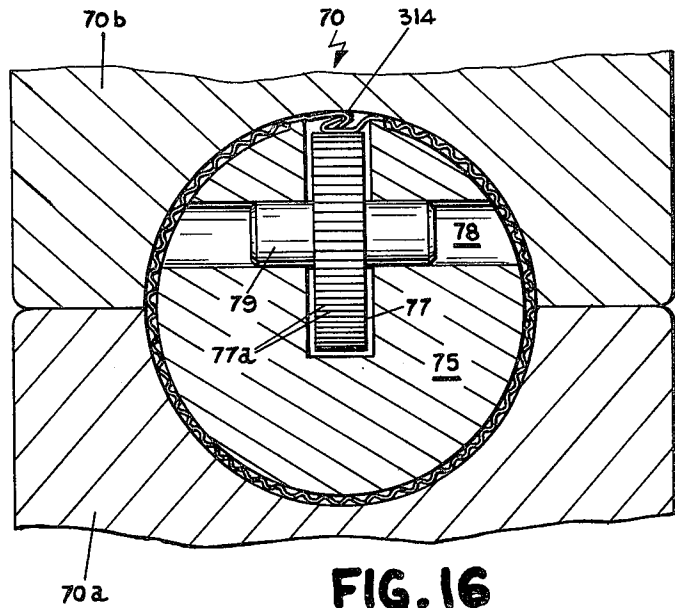


FIG. 16

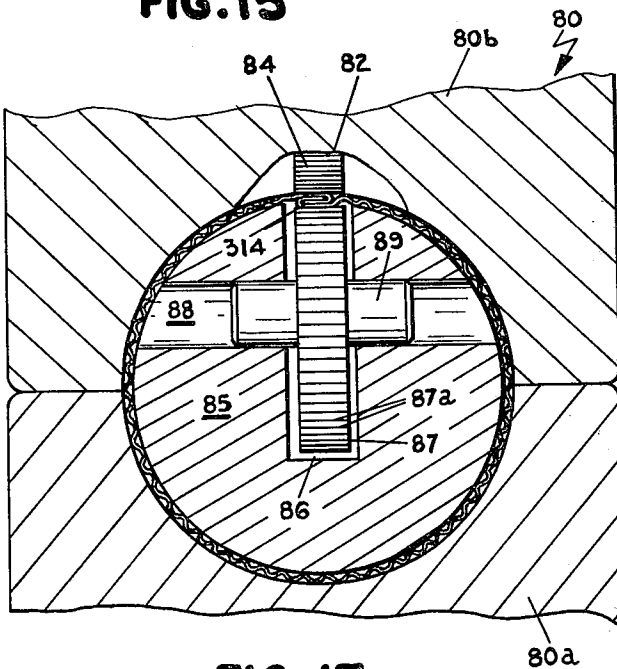


FIG. 17

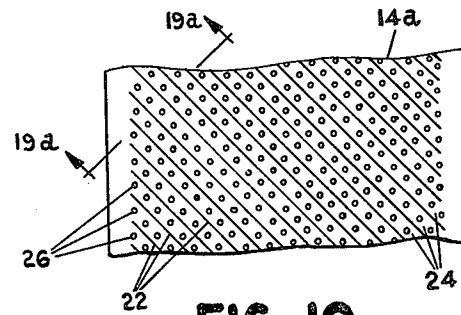


FIG. 19

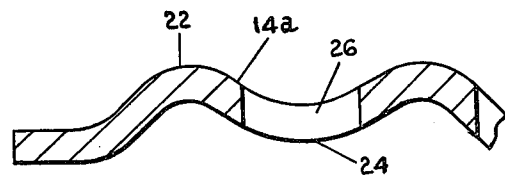


FIG. 19a

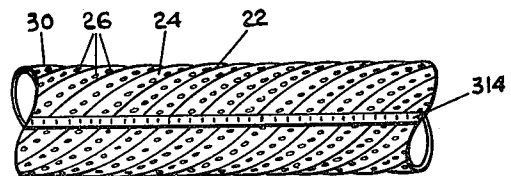


FIG. 20

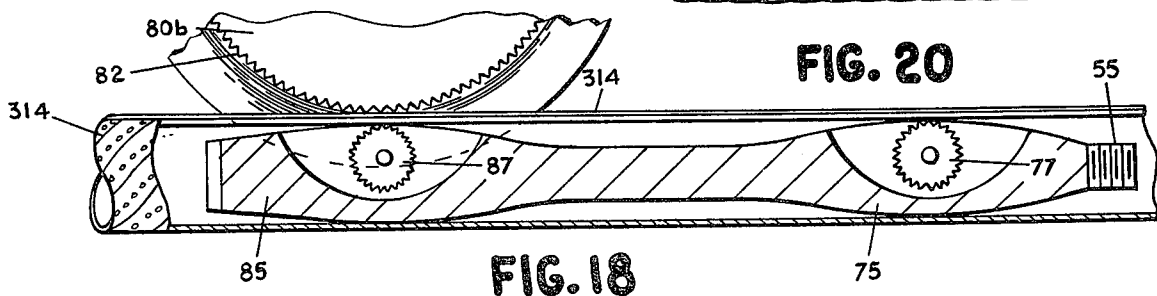


FIG. 18

TUBULAR ARTICLES AND METHOD OF MAKING SAME

BACKGROUND OF THE INVENTION

This invention relates to the roll-forming of sheet stock, typically metal, into tubular form and, in particular, to the formation in such manner of perforated thin-wall tubing having a tightly clenched lock seam and wall corrugations for added strength.

Perforated tubes, usable for example as filter cores, as well as in many other ways, have been manufactured in the past and sold on a commercial basis but the kinds of such tubing heretofore available have been typically characterized by rather low wall strength (in compression and bending), as well as by loose seams or joints. This has particularly been true in the case of thin-walled tubing, which has not even been manufactured on an extensive basis by many manufacturers, and when manufactured has heretofore been done primarily on special machines, in short lengths, where it was still characterized by the aforementioned problems of wall strength and loose seams. Primarily, this is because the thin-walled stock (for example, stainless steel on the order of 0.010 inch - 0.015 inch wall thickness) is clearly of a highly flexible nature, and this is particularly true when, to be used as filter core, the stock must be highly perforate in nature, having a great number of holes punched or otherwise formed in it.

Consequently, it has sometimes heretofore been attempted to form annular corrugations in the walls of the stock in an effort to strengthen it; however, such corrugations are basically inimical to roll-forming techniques and, therefore, tubing of this type is generally limited to manufacture on special-purpose machines, on which only short lengths can be made; furthermore, such corrugations do not really provide as much strength as is desired, particularly in thin-walled stock of the type mentioned above.

SUMMARY OF THE INVENTION

The present invention provides a new process for the manufacture of lock-seam tubing, particularly advantageous for manufacturing such tubing from extremely thin-walled stock, and for the manufacture of such tubing in long lengths and, in fact, practically unlimited lengths. Furthermore, the process of the invention is basically of a continuous nature, and is extremely rapid when compared to other specialized manufacturing processes for thin-walled tubing, which are also limited in length, with manufacturing speeds as much as ten to twenty times the speed of the special processes just mentioned.

Additionally, the invention provides, as an article of manufacture, new and superior thin-walled tubing products, in particular, thin-walled tubing having highly perforate walls, and yet of exceeding strength, particularly in lateral loading situations (i.e., crushing). Still further, the tubing provided by the invention has an extremely tightly-clenched lock seam which, with a novel wall configuration also provided, contributes to the structural strength of the tubing and, at the same time, adds great reliability to the product.

The foregoing major objectives and advantages of the invention, as well as numerous other objects and advantages thereof, will become more apparent upon consideration of the attached drawings and the following specification.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a fragmentary, side elevational view showing the overall apparatus used in the invention;

FIG. 2 is an enlarged, fragmentary, side perspective view showing certain details of the apparatus of FIG. 1;

FIG. 3 is an enlarged, fragmentary, side perspective view showing certain other details of the apparatus used;

FIG. 4 is an enlarged, fragmentary, side perspective view showing further details of the apparatus used;

FIGS. 5-17 inclusive constitute a series of enlarged, fragmentary, sectional end elevations, each taken through a succeeding one of the roller stages illustrated generally in FIG. 1, showing the progression in cross-sectional shape of the stock from substantially flat to substantially circular;

FIG. 14a is a fragmentary side elevational view on a reduced scale, showing details of the apparatus used between the roller stages of FIGS. 14 and 15, respectively;

FIG. 18 is a fragmentary, sectional side elevational view showing further details of the apparatus of FIGS. 16 and 17, shown on a reduced scale;

FIG. 19 is an enlarged, fragmentary, top plan view showing the nature of the stock after piercing and corrugating but prior to the roll-forming operations;

FIG. 19a is an enlarged, fragmentary cross-sectional view of the stock shown in FIG. 19; and

FIG. 20 is an enlarged, fragmentary, overhead plan view showing the nature of the tubular product made by using the method and apparatus of the invention.

DESCRIPTION OF A PREFERRED EMBODIMENT

Although the concepts of the invention are undoubtedly susceptible to implementation in at least several somewhat varying embodiments, one preferred embodiment is illustrated in the drawings, from FIG. 1 of which it can be seen that apparatus for the practice of the invention may include a first stage 10 which may be described as a stock-conditioning stage, and a multi-part, composite second stage 20, constituting a progressive series of different shaping steps. Basically, the first stage 10 illustrated in the drawings makes use of a punch-press apparatus 12, which may be basically of a conventional nature, to which flat stock 14 from an appropriate supply, as for example a long length of sheet metal wound on a roll and having the requisite width, is fed through a guiding pair of rollers seen at 16, over a platen 17, which carries half of a mating die set which is complementary to another half die 18 carried on the ram 19 of the punch press, such that the stock 14 is advanced in step-by-step fashion, indexing beneath the ram 19 so as to be struck between the die parts 17 and 18. As will be understood, such step-by-step operation is generally of a type long known in the art, in which controlled apparatus such as the roller set 16 (which is typically duplicated at the outlet of the punch press by another similar set of rollers located there) operates to advance the stock in synchronism with the cycling operation of the punch press ram.

The first stage 10 of the apparatus functions to condition, or pre-form the stock 14, from a basically flat ribbon-like sheet in which it is supplied from its roll or other such source to the form illustrated in FIGS. 18 and 18a; that is, the stock is deformed into an undulating or corrugated shaped 14a, in which the stock re-

mains basically flat at the edge extremities but has alternating peaks and valleys 22, 24 disposed angularly across its width, and with a great plurality of holes 26 extending through the stock. The peaks and valleys 22, 24 actually comprise elongated groove-deformations, the axes of which are oriented at an acute angle with respect to the longitudinal axis of the stock 14, most preferably, an angle of 45°. In the context used in this specification, the term "groove-like" is intended to mean a single such deformation, for example an elongate peak 22, while "corrugation-like" is intended to connote the undulating, reversely complimentary nature of adjacent peaks and valleys. The term "longitudinally-extending" used relative to the deformations just mentioned is, in its broadest implications, intended to mean that the undulations or corrugations are at least somewhat longitudinal and not perpendicular to the longitudinal axis of the stock, i.e., that they are either angled acutely across the latter or, in an extreme, parallel to such axis, but do not extend perpendicularly across the same.

It may be noted that the holes 26 are all disposed within aligned columns or ranks located in the valleys 22, and this is the preferred form, although in certain instances the apertures can also appear in the peaks. If, in the practice of the invention, a first stage 10 is used such as the punch press herein illustrated and described, the intermittent step-by-step operation thereof will make advisable the presence of a loop or bight 28 of preformed stock between the first and second stages, to ensure a continuous supply of the preformed stock for the second stage, which is basically of a continuous nature. In this regard, however, other types of apparatus may readily be used as the first stage, e.g., complementary rollers or a mangle or the like incorporating the required groove-forming configurations, with the piercing or other such forming of the apertures 26 occurring either as a part of such operation, or at some other time. In any event, the pre-forming of the first stage may occur either as a generally continuous process, or in the step-by-step manner illustrated in the preferred embodiment.

As illustrated in FIG. 1, the preformed stock 14a moves as a generally continuous ribbon from the loop 28 at the inlet of the second stage to the opposite end of the latter, at which the stock has been transformed into the tubular shape 30 indicated in FIG. 1. In undergoing this change, the stock is first passed through a first series of rollers which, in the preferred embodiment illustrated, may include 10 different and distinct individual sets of rollers 32-50, inclusive, which basically serve to bend the stock into designated requisite circular cross-sectional shape. The formed stock then passes through some intermediate roller stages 60 (illustrated in more detail in FIGS. 2-4) serving to interengage the formed edges of the tube constituting the lock seam portions, and then passes through forming and clenching rollers 70 and 80, and finally, through straightening apparatus 90 illustrated in more detail in FIG. 4. Each of the roller sets 32-50 and 80-90 may be rotatably driven by a direct mechanical connection (for example, a geared connection which is selectively engageable) to a drive train 99 (FIG. 1), typically embodying a long splined or other such drive shaft, which is rotatably driven by a motor 100. As noted below, however, not all of the roller sets are in fact so driven, in particular modes of operation.

Although the basic nature of the roller mill machine constituting the entire second forming stage 20 is of a known commercial nature, the particular roller sets and other apparatus used, as well as the manner in which the same are used, constitute a decided departure which enables the manufacture of structurally superior thin-walled perforated lock seam tubing and accomplishes the same at a great increase in speed.

More particularly, as may be seen by reference to FIGS. 5-17, the incoming stock 14a first passes between a pair of rollers 32a, 32b (FIG. 5) which, while primarily contacting the stock along flat opposite edges nonetheless have edge extremities which angularly configure (i.e., bend) the uncorrugated edges of the stock in the manner illustrated. This bending, or configuring, of the edge extremities of the stock continues through mating rollers 34, 36, 38 and 40, (FIGS. 6-9) through all of which the stock remains in basically flat condition although progressively becoming somewhat broadly U-shaped, but with the edge extremities 114, 214 of the stock progressively being shaped so that edge 114 is reversely bent into a hooking flange oriented toward the interior of the troughed stock and edge 214 being oppositely-configured into a hooking flange oriented toward the exterior of the curved or troughed stock. Throughout this entire time, the complementary rollers in all or a selected lesser number of each set thereof can exert a reasonable pulling force on the stock, since the latter stays basically flat, although the clearance between the two rollers in each set always carefully maintained such that the corrugations in the stock are never flattened. As will be understood, the two rollers in each set are both basically cylindrical elements with a uniform cross section around their entire periphery, and with axial pins or journals (note FIGS. 2, 3 and 4) extending laterally from each opposite side on the axis of rotation thereof, the fragmentary showing of FIGS. 5-17 being limited in most cases to the area of complementary contact between rollers and stock for purposes of simplicity, inasmuch as this area is the one of chief importance.

Following formation of the hooking flanges 114 and 214 as mentioned above, the succeeding roller sets 42, 44, 46, 48 and 50 (see FIGS. 10-14 inclusive) gradually bring the stock 14a from a primarily flat (i.e., less than semi-circular) shape to essentially a fully circular shape, although still slightly open at the top, as illustrated in FIG. 14. The change in complementary shapes of the rollers in each of these sets is fully illustrated in the figures, from which the progression in shape may be readily seen. As will be observed, a radially-extending central part of each roller (for instance, part 48c of roller set 48 in FIG. 13) protrudes inside the increasingly-circular trough shape of the stock, so as to keep a diminishing-width part of the stock in lightly pinched contact between parts of the upper and lower roller in each set, which are disposed directly opposite one another with the stock between. This pinched contact helps pull the stock through the roller mill, along with other forces to be described subsequently. At the stage 50, however, this aspect of the complementary rollers ceases, and the stock is brought very nearly into circularly closed condition by rollers 50a, 50b which each basically comprise a semi-circularly-grooved pulley-like roller wheel (FIG. 14).

Although the progression and shape of the roller sets 32-50 just noted is certainly important to the process of the invention, the intermediate rollers 60 and the

first and second forming and clenching rollers 70 and 80 have considerable importance to the successful practice of the invention. That is, these elements together with other structure now to be described, act to form the lock seam and give the completed tube its final circular shaping, in order to successfully complete the formation of the tube.

The intermediate or interengaging rollers 60 (FIGS. 2, 3 and 15) actually constitute two different roller sets or component groups. A first set 62 constitutes a pair of rollers similar in general nature to rollers 50 of FIG. 14, described above, but with their rotational axis rotated 90°, so that the two rollers lie in a horizontal plane as opposed to a vertical one. However, roller 62a has a somewhat smaller groove than roller 62b (FIG. 15) and is somewhat asymmetrically disposed with respect thereto, so that this roller causes the formed hooking flange 214 to be resiliently flexed relative to hooking flange 114 (compare FIGS. 14 and 15) and shifted laterally with respect thereto, so as to overshift the two hooking flanges, by, in effect, squeezing one side of the tube.

As will be understood, upon leaving roller set 62, the resiliency of the tube stock would by itself tend to cause the tube to expand diametrically so that hooking flange portions 114 and 214 move back toward one another, and become hooked. This step of the process is facilitated and insured, however, by the use of an elongated, cantilevered mandrel 55 (FIGS. 14, 15 and 18) fixedly mounted on the bed of the roller mill upstream of roller set 50 relative to the direction of motion of the tube stock, and projecting downstream, inside the tube being formed, through the long, narrow, V-shaped opening formed by the hooking flanges 114 and 214 which, at a point upstream from roller set 50, are still moderately spaced apart. While the use of such a mandrel, in its broadest sense, is known heretofore in rolling mill technology, this is not true of the application of this concept to the present process, and such use is an important part of the process.

That is, the aforementioned mandrel 55 projects downstream through the tube being formed at stations 50, 60, 70 and 80 (see FIGS. 14, 15, 16, 17 and 18). At the first two such stages, the mandrel 55 is considerably smaller in diameter than the encircling tubular stock 14a, and merely projects centrally thereof and out of contact therewith. At stage 70, however, (FIG. 16) the mandrel 55 has a first enlargement 75, which may be a concentrically mounted sleeve-like arbor which is fixedly secured on the mandrel as by set screws or the like. Arbor 75 closely approaches in size, but is preferably somewhat smaller in diameter than, the desired inside diameter of the finished tubing; thus, arbor 75 is larger in diameter than the constricted size of the tubular stock at station 60, (shown in FIG. 15). Accordingly, the hooking flanges 114 and 214 are forced together into interengagement downstream of stage 60 not only by the resiliency of the tube stock, but also by being passed over the larger-diameter arbor 75. At the same time, mating rollers 70a and 70b of stage 70 (FIG. 16) are embracing the tubular stock from both opposite sides and, furthermore, a rotatable clenching wheel 77 disposed within a slot in arbor 75 and mounted on an axle 79 fitted into a transverse bore 78 bears against the underside of the hooking flanges as they are brought together. This cooperative action first brings the hooking flanges into tightly hooking engagement with one another, and then substantially closes them

upon one another so that they form a somewhat loose lock seam as the stock is brought into closed tubular form.

Immediately downstream from stage 70, at stage 80, a second arbor or other such enlargement 85 is mounted near the end extremity of mandrel 55 (FIGS. 17 and 18). Arbor 85 is preferably slightly larger in diameter than arbor 75, having exactly (or substantially so) the required inside diameter for the finished tubing. Furthermore, arbor 85 is centrally bifurcated or slotted to form a slot 86 in which a second clenching wheel 87 is disposed, sometimes referred to herein as an anvil, or clenching anvil. That is, arbor 85 has a transverse hole 88 bored therein, in which a pin 89 is press-fitted, such pin constituting the axle for wheel 87 and mounting the same in freely rotatable manner within the slot. As illustrated, the clenching wheel 87 has a series of transverse serrations or tooth-like formations 87a formed thereon for positive engagement with the underside of lock seam 314. Directly above and in the same vertical plane with clenching wheel 87 is a central clenching band 82 which is preferably formed as one piece with roller 80b, extending circumferentially around the latter at the center of its grooved periphery, and constituting a slightly raised annular formation having tooth-like projections 84 thereon like the projections 87a on clenching wheel 87.

The spacing between clenching wheel 87 and clenching band 82 is such that these two components tightly grip the lock seam 314 therebetween, to thereby tightly clench the lock seam together in an extremely secure manner and, at the same time, to exert a positive pulling force on the tubular stock and thereby greatly facilitate the passage thereof through the rolling mill. That is, roller 80a in effect supports the tubular stock from beneath while wrapping it around the underside of arbor 87 and, in effect, supporting the arbor through the interposed tubular stock. At the same time, the tubular stock is forced downwardly and around the top part of the arbor by roller 80b, with the lock seam being tightly clenched. Rollers 80a and 80b are driven rollers, as are other rollers in the preceding stages, except those at the intermediate stage 60 and as noted subsequently. Consequently, each of the driven roller pairs will contribute somewhat to the pulling force required to properly carry out the process and cause the stock to pass through the entire rolling mill; however, the final clenching stage 80 is extremely important in this process, contributing greatly to the pulling force required.

It should be noted that the pulling force just mentioned must be accomplished without flattening the corrugations placed in the stock initially; that is, without substantial or major flattening, since some slight degree (on the order of, for example, 10 or 15 percent or thereabouts) may be unavoidable under some very stringent conditions. Consequently, it is not simply a matter of squeezing the stock tightly between opposing rollers, as would be true if the stock were merely uncorrugated, plain sheet. Indeed, it is this aspect of the process which may in some ways serve to best characterize it and distinguish it from others, i.e., particularly when the process is used with very thin-wall stock, it will be appreciated that the corrugations or other upset formations in the wall section would very easily be deformed and even flattened back out of the stock with any great amount of force applied to the stock by the different rollers in the roller mill. At the same time, however, the rollers must grip the stock with sufficient force to pull

it through the roller mill, otherwise a rolling process is clearly impossible. The requisite balance of forces is accomplished by the gradual roll-forming process, in the progression described above, and using the driven clenching roller arrangement just described. This allows for the use of rigid, accurately-sized steel rollers which will produce the desired accuracy in size and will have the desired durability in use, even though having a relatively low coefficient of friction with the stock, as compared for example to hard foam or other types of rollers which might be used and which would have a higher coefficient of friction against the stock to better pull it through the roller mill, but which would not have the desired accuracy or durability.

The requisite balance, or relative contribution, of pulling forces exerted on the stock by the different roller sets, mentioned above as necessary to move the stock continuously through the rolling mill and accomplish each of the different formative steps, is a very important aspect. It should be noted in this regard that, at least with very thin stock, it is not desirable to have the first few stages or roller sets (e.g., 32 and 34) exert large pulling forces on the stock even though this might otherwise be thought to be advantageous or even essential since the stock is still basically flat at this juncture and thus affords the best opportunity for maximum gripping or pressure by the rollers, especially along the edges, which are as yet still basically flat. However, for this very reason the roller sets downstream from this point exert lesser degrees of pulling force, and if the first few sets of rollers are used to produce large pulling forces they will also exert large pushing forces and may well cause the stock to buckle between them and succeeding downstream rollers. For this reason it is often advantageous, and at times may be essential (especially with very thin stock) to leave the first few roller sets (for example sets 32 and 34) undriven, i.e., not connected to the drive train 99. When this is done, such undriven rollers will exert a drag on the stock at their position, and this may somewhat surprisingly, help to attain the desired distribution or "balance" of pulling and pushing forces on the stock along the progression of rollers.

In bringing the stock to its final circular cross section, and in interengaging the hooking flanges, it may be noted (FIGS. 2 and 14a) that the intermediate interengaging stage 60 includes, in addition to rollers 62a and 62b already discussed, a floating roller set which comprises a pair of spool-like roller elements 66 and 67 (FIG. 14a) having a generally V-shaped annular groove centrally of each which rides upon and guides the stock 14a as it reaches circular engagement. As illustrated, the lower roller spool 67 is journaled in appropriate fixed bearing blocks 68, while upper roller spool 66 is mounted in a pivotal arm 65 having a spring 64 which urges the arm and spool downwardly in a yielding manner while controlling the force with which roller 66 engages the stock. Adjustment nuts 63, in turn, enable adjustment of the force setting of spring 64. As stated earlier, the hooking flanges of the stock are narrowly spaced apart at roller set 50, and are overshifted at roller set 62, with a long, narrow V-shaped space between such roller stages. The roller spools 66, 67 thus support and guide the work stock between these points and have been found to facilitate and help insure the successful joining of the hooking flanges, particularly as a result of the floating, spring-biased engagement of these rollers with the work stock.

Immediately downstream from the final roller stage 80 is the straightening apparatus 90 mentioned previously (FIGS. 1 and 4). Basically, this apparatus comprises two sets 92 and 94 of spool-like rollers similar to rollers 65 and 66 of the intermediate stage 60. Each of these four rollers is permanently journaled between a pair of end plates 95 which are adjustably mounted on the bed of the roller mill, such that by rotating pairs of adjustment handles 96, 97 and 98, the entire apparatus, including the end plates and the two sets of rollers, may be shifted as a unit in these axes relative to the longitudinal axis of the formed tubing, which issues endwise from a bronze bushing 100 or the like held in an appropriate bearing block; that is, by adjustment of one or another of the adjustment handles, the apparatus may be shifted laterally, vertically, or angularly relative to the axis of the emerging tubing. In this manner, the tubing may be slightly cold-worked or stressed so as to straighten it longitudinally and insure that regardless of the length of tubing issuing during any given interval, such tubing will remain axially straight. With respect to tubing length, the apparatus and manufacturing process just described is basically of a continuous nature and can produce straight, long sections of tubing whose length is determined ultimately only by the length of the stock supplied to the apparatus. Of course, finished lengths of tubing of particular dimension, however long, will typically be desired and in order to accomplish this the apparatus may be stopped periodically to cut the emerging tubing at any desired length or, alternatively, any other variety of traveling cutting devices may be used if it is desired to run the apparatus continually.

The finished tubing made in accordance with the invention is illustrated in FIG. 20, after completion of the lock seam 314. As illustrated, in its final circularly rolled form, the angular corrugations or groove-like deformations 22 or 24 can be made to align with one another, so as to be generally continuous in nature and thus define generally helical formations, although such term is not intended to mean that such formations are truly helical in a strict sense. In the finished form of the tube the undulating or corrugated wall section adds very high strength to the tubing, especially in the critical area of lateral or crush strength, which is a demanding requirement when the tubing is used for filter cores. As illustrated in FIG. 20, the tightly-crimped lock seam 314 actually becomes marked with a series of transverse impressions formed by the operation of the tooth-like formations 84 and 87a of the clenching band and roller, respectively, and thus serve to demonstrate the high degree of clenching compression imparted to the lock seam. The very tight lock seam construction adds to the strength of the tubing and it helps to ensure the continuing high degree of circularity of the latter, even after extended use, despite the many wall perforations 26 which will permit a high rate of fluid flow through the wall.

It is entirely conceivable that upon examining the foregoing disclosure, those skilled in the art may devise embodiments of the concept involved which differ somewhat from the embodiment shown and described herein, or may make various changes in structural details to the present embodiment. Consequently, all such changed embodiments or variations in structure which utilize the concepts of the invention and clearly incorporate the spirit thereof are to be considered as within the scope of the claims appended herebelow, unless

these claims by their language specifically state otherwise.

The embodiments of the invention in which an exclusive property or privilege is claimed are described as follows:

1. A method of manufacturing thin-walled, lock-seam tubing, comprising the steps: shaping a generally flat sheet of stock by forming generally longitudinally-extending groove-like depressions therein; then moving said stock as so formed lengthwise through successive pairs of mating rollers, having cooperative shapes which progressively change the cross-sectional shape of said stock from generally flat to generally circular; forming oppositely-disposed flange portions along the edges of said stock, and inter-engaging the same to form a loose lock seam closing the circumference of said generally circular cross section and forming a tube thereof; clenching said loose lock seam tight by passing said tube through at least one pair of rollers while extending an arbor means inside the tube and between such pair of rollers, by using an arbor means having an anvil element disposed in contact with the interior part of said lock seam and using a clenching portion on at least one of such rollers to tightly flatten the lock seam between itself and said anvil element; rotatably driving at least certain of said pairs of rollers to exert a pulling force on said stock; and maintaining said groove-like depressions in generally unflattened condition throughout said mating roller steps following formation thereof, so that such depressions are still present in the completed lock seam tube.

2. The method of claim 1, wherein said shaping step comprises embossing said stock to form corrugation-like depressions and ridges therein.

3. The method of claim 1, wherein said shaping step is carried out to form said groove-like depressions at an acute angle with respect to the longitudinal axis of said stock, such that when the stock is rolled into a tube said depressions extend generally helically thereof.

4. The method of claim 3, including the step of forming a plurality of apertures in said stock prior to said clenching step.

5. The method of claim 4 wherein said apertures are formed to lie in lines extending along said groove-like depressions.

6. The method of claim 5, wherein said shaping step comprises embossing said stock to form corrugation-like depressions and ridges therein, said apertures lying within said depressions.

7. The method of claim 1, wherein a plurality of said pairs of mating rollers are driven and used to grip said formed stock between such rollers and exert a pulling force on the stock, to help move the latter through the said roll-forming operation, while maintaining the nature and force of such grip such that the same does not substantially flatten said depressions.

8. The method of claim 1, wherein said flange portions are formed while said stock is still generally flat or semicircular in cross-sectional shape and prior to the time the same closely approaches circularity.

9. The method of claim 1, wherein said depressions are formed prior to any of said roll-forming of said stock into tube form.

10. The method of claim 9, wherein said depressions are formed prior to formation of said flange portions.

11. The method of claim 10, including the step of forming a plurality of apertures in said stock at substan-

tially the same time as when said depressions are formed.

12. The method of claim 1, including the step of using a rollable member as said anvil element of said arbor means.

13. The method of claim 1, including the step of using a sizing member as a part of said arbor means, with the outside diameter of such member being substantially the same as the desired inner diameter of the completed lock seam tube.

14. The method of claim 1, including the steps of using a pair of different arbor elements as said arbor means, by passing the tube over a diameter-sizing element prior to clenching, and clenching by using an inner arbor having a rollable member bearing against the inside of said seam.

15. The method of claim 14, including the step of providing tooth-like serration elements on said clenching roller, on the opposite side of said lock seam from said rollable member of said inner arbor.

16. The method of claim 15, including the step of providing tooth-like serration elements on said rollable member of said inner arbor.

17. The method of claim 1, including the step of using a pair of lateral squeezing elements to interengage said flange portions after said stock has been brought to a substantially full-circle, tubular cross-sectional shape, by pressing the sides of the tubular stock inwardly to in effect reduce the diameter thereof and bring the flange portions over and beyond one another.

18. The method of claim 17, including the step of applying a radially inwardly-directed diameter-maintaining force to said substantially full-circle tubular stock at least slightly prior to said interengaging step.

19. The method of claim 18, wherein said diameter-maintaining force is applied by using undriven, "floating-axis" roller elements at least one of which is resiliently biased toward the other and movable toward and away from the latter.

20. The method of claim 19, including the step of using a diameter-enlarging arbor element inside said tubular stock at a point downstream from that where interengagement of said flange portions takes place.

21. A method of manufacturing thin-walled, longitudinally fluted tubing, comprising the steps: shaping a generally flat sheet of stock by forming generally longitudinally-extending fluted deformations therein; rolling said stock through a plurality of successive pairs of mating rollers to thereby incrementally and progressively change the overall cross-sectional shape of said stock from generally flat to generally circular; closing the circumference of said generally circular cross section and securing the longitudinal edges thereof together to form a tube; rotatably driving selected ones of said rollers during said rolling process including at least certain thereof located where said stock has become generally circular to exert a pulling force on said stock, while leaving other selected rollers undriven including certain thereof located near the beginning of said rolling process where said stock is still generally flat to act as a drag on said stock; and maintaining said fluted deformations in generally unflattened condition throughout the steps following formation thereof, such that the same are still present in the completed tube.

22. The method of claim 21, wherein said undriven rollers comprise a minor proportion of said plurality thereof in said rolling process.

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23. A method of manufacturing thin-walled, seamed tubing comprising the steps: shaping a generally flat sheet of stock by forming depression formations therein between the edges thereof, while providing generally flat axially-extending portions along the edge margins of said stock; then moving said stock as so formed lengthwise through successive pairs of mating rollers having cooperative shapes which progressively change the cross-sectional shape of said stock from generally flat to generally circular; using closely-spaced complementary mating side edge portions on at least certain of said mating rollers to grip said generally flat portions along the edge margins of said stock to help

pull the stock through said successive pairs of rollers while its cross-sectional shape is so changed; forming oppositely-disposed flange portions along the edges of said stock, and interengaging the same to form a seam closing the circumference of said generally circular cross section and forming a tube thereof; rotatably driving at least certain of said pairs of rollers to exert a pulling force on said stock; and maintaining said depression formations generally unflattened and intact throughout said mating roller steps following formation thereof, so that such depressions are still present in the completed lock seam tube.

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