United States Patent [19]

McLain

[11] **3,918,626**

[45] **Nov. 11, 1975**

[54] **METHOD OF FABRICATING PATTERNED TUBING FROM METALLIC STRIP**

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[73] Assignee: **Olin Corporation,** New Haven, Conn.

[22] Filed: **May 10, 1973**

[21] Appl. No.: **359,019**

Related U.S. Application Data

[63] Continuation-in-part of Ser. Nos. 214,034, Dec. 30, 1971, abandoned, and Ser. No. 218,422, Jan. 17, 1972, abandoned.

[52] **U.S. Cl.** **228/147;** 228/152; 219/67; 72/196; 72/368

[51] **Int. Cl.**[2] **B21C 37/08**

[58] **Field of Search** ..... 29/477.7, 477, 157.3 R; 219/8.5, 67; 72/196, 366–368; 228/144, 146, 147, 17.5, 152

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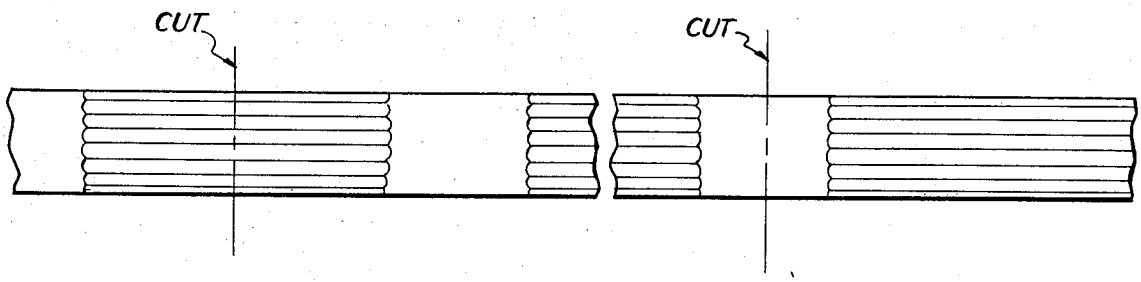
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Attorney, Agent, or Firm—Robert H. Bachman

[57] **ABSTRACT**

A method of fabricating tubing having formed patterns in or upon the tubing wall where the formed pattern is interrupted by contiguous wall sections or segments which are free of said formed pattern facilitating the manufacture of discrete tube lengths having smooth or patterned wall structure in any desired continuity or configuration.

8 Claims, 12 Drawing Figures



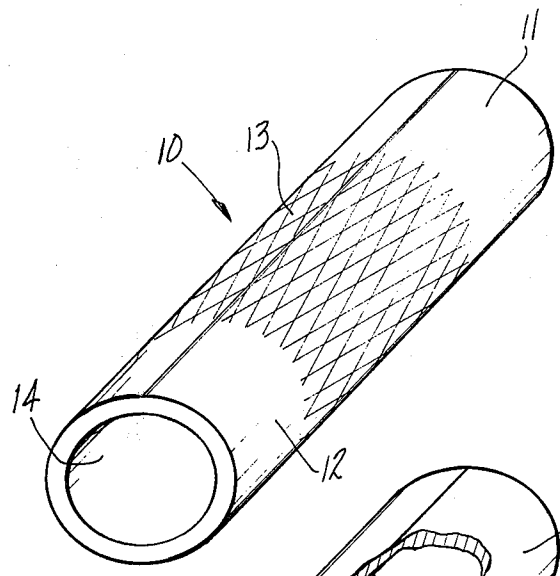


FIG-1

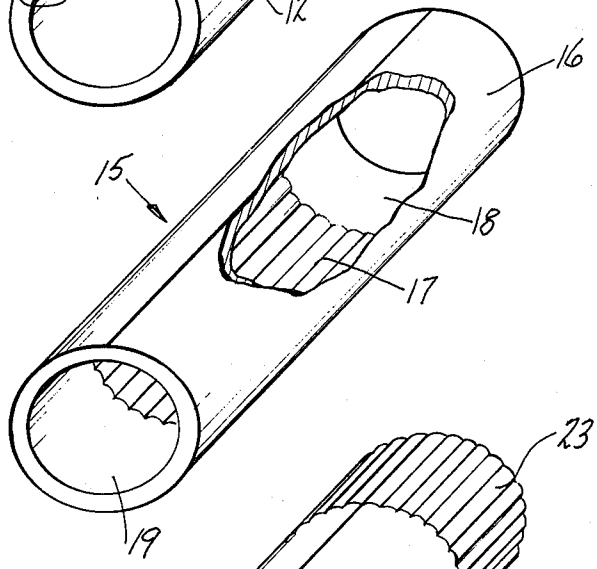


FIG-2

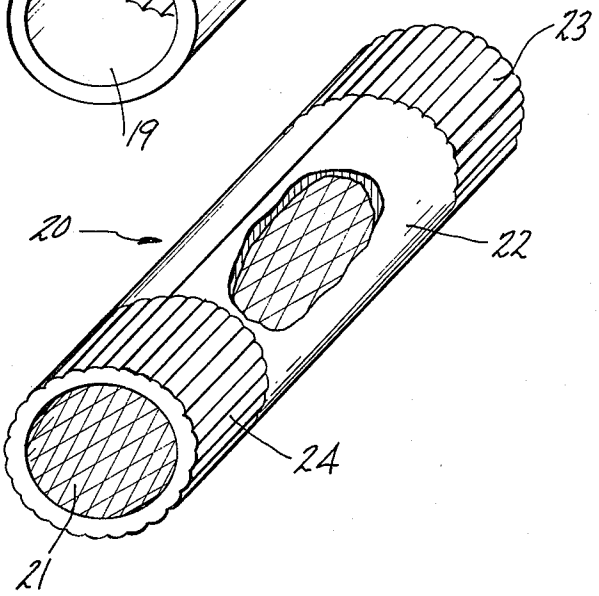


FIG-3

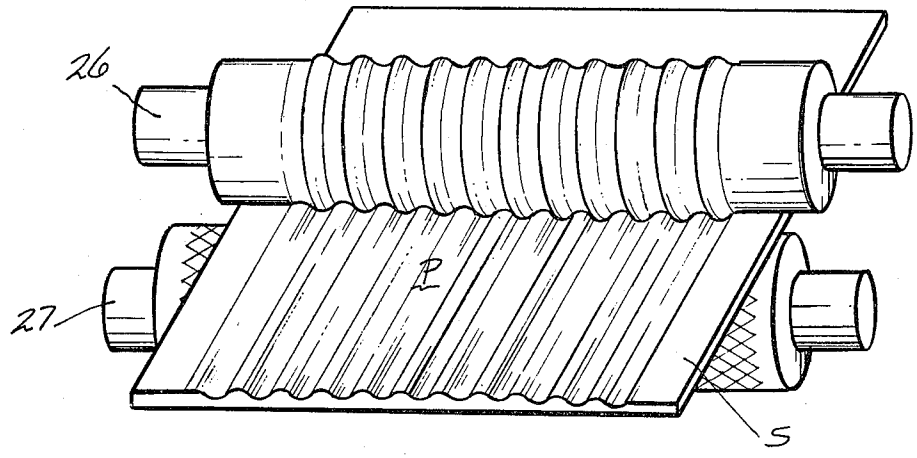


FIG-4

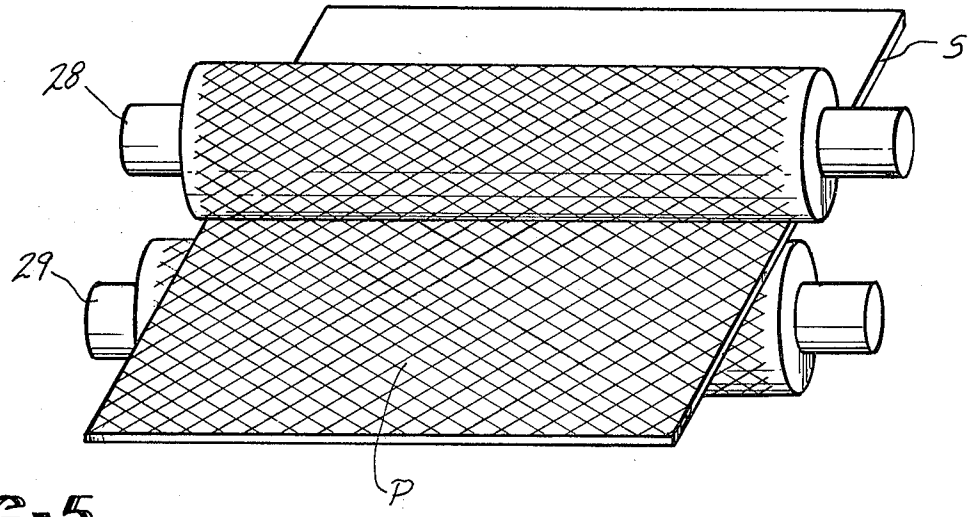


FIG-5

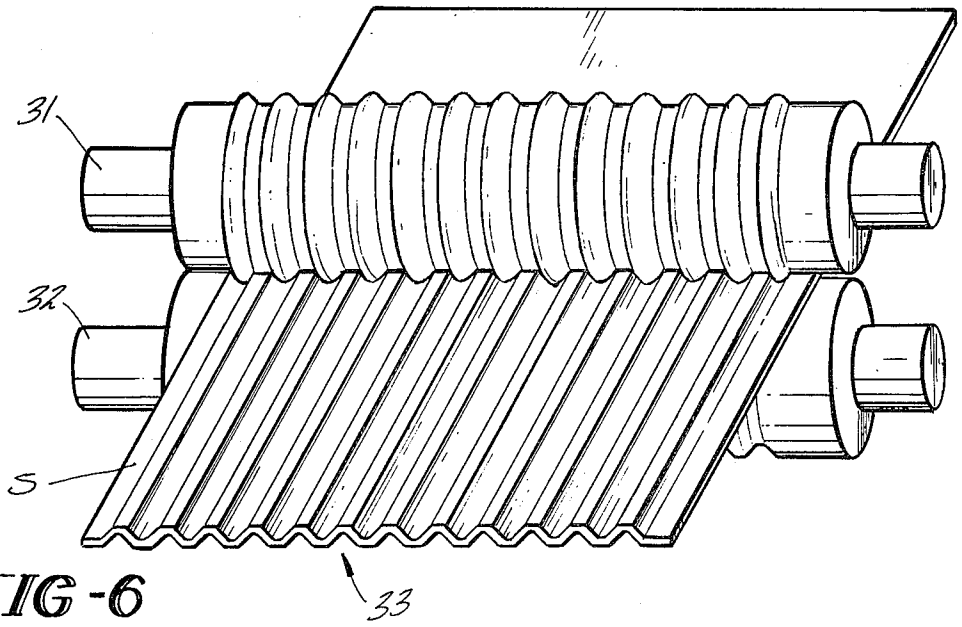


FIG-6

FIG-7

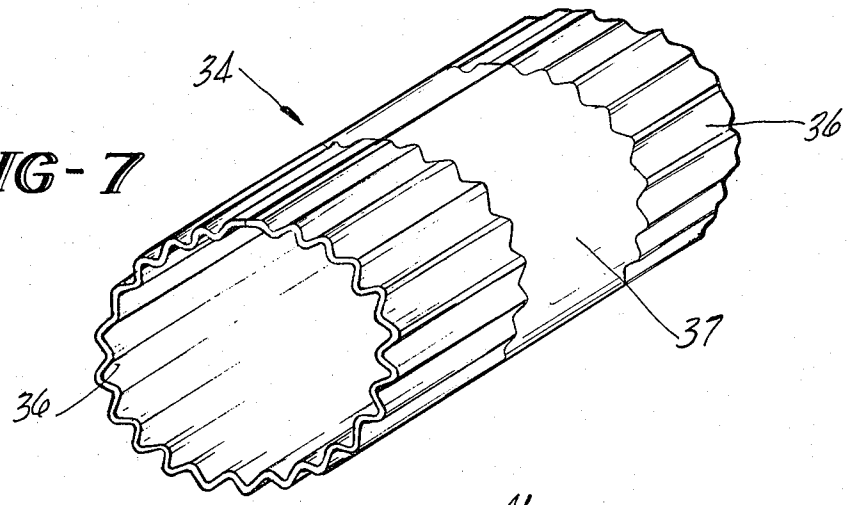


FIG-8

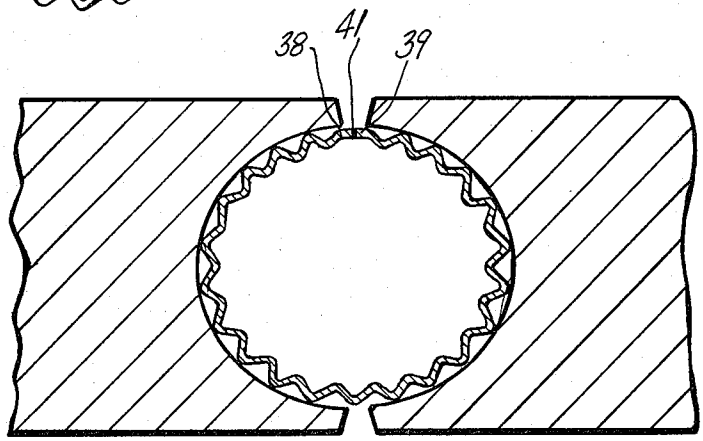
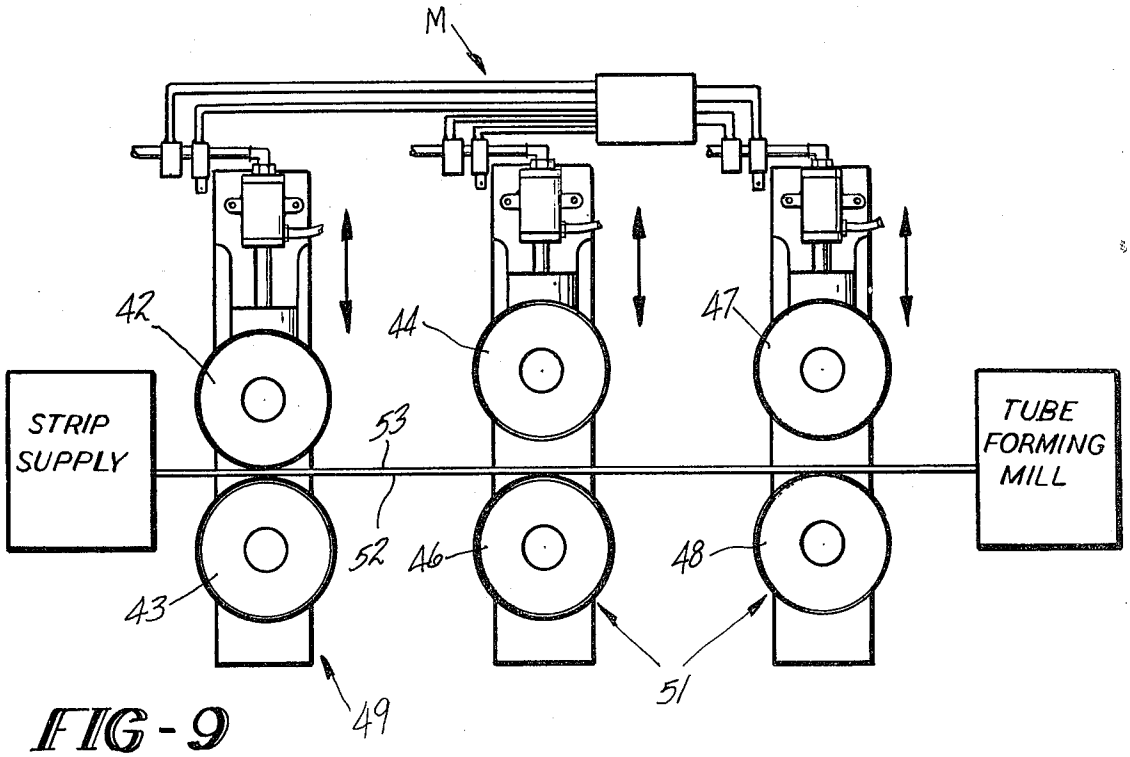


FIG-9



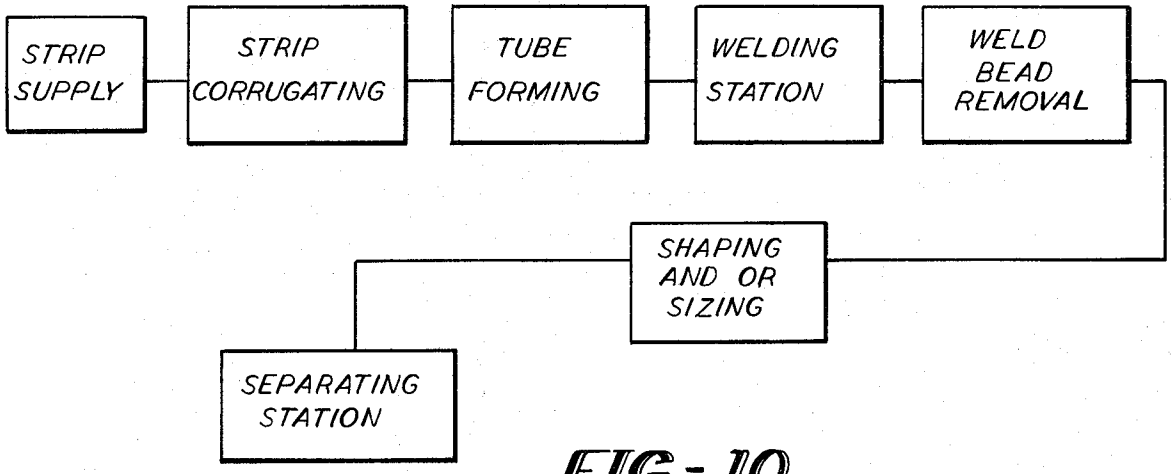


FIG - 10

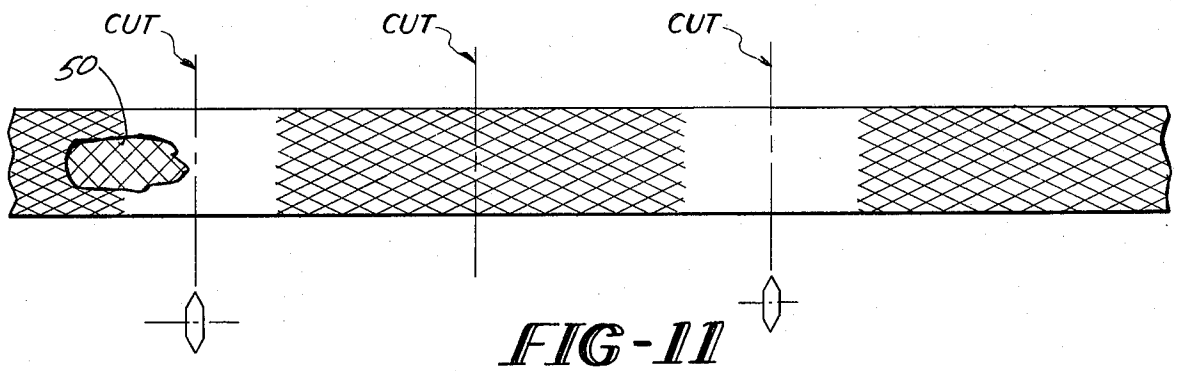


FIG - 11

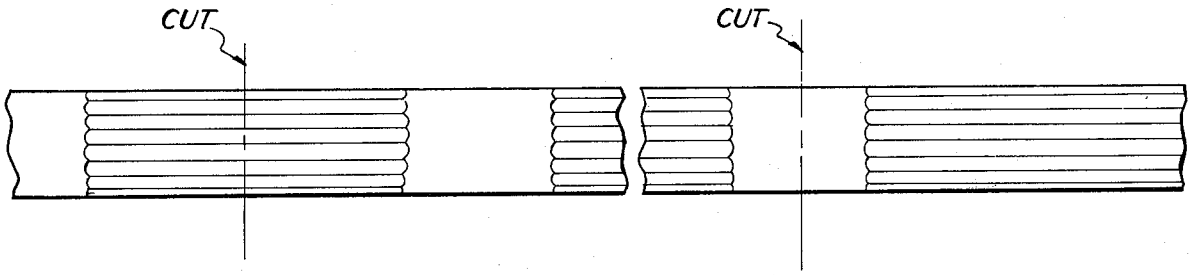


FIG - 12

METHOD OF FABRICATING PATTERNED TUBING FROM METALLIC STRIP

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a Continuation-In-Part of co-pending applications Ser. No. **214,034**, filed Dec. **30, 1971**, and Ser. No. **218,422**, filed Jan. **17, 1972**, by Charles D. McLain, both now abandoned.

BACKGROUND OF THE INVENTION

This invention relates to the continuous fabrication of tubing using metallic strip as a starting material.

For example, metallic strip of predetermined width and indefinite length having side edges is advanced continuously through a tube forming mill to curl the strip into a tube with the side edges abutting one another to form a longitudinal seam. The seam is continuously closed by welding or other suitable operation to produce a fluid-tight endless tube.

The cited co-pending applications are directed to tube forming processes which include continuously embossing one or more surfaces of the strip in accordance with any desired pattern prior to entry into the tube mill so that the tubing ultimately formed has an embossed surface on the interior or the exterior or both surfaces of the tube wall as desired. Obviously, the pattern structure is a matter of choice consistent with the ultimate use of the tubing.

The co-pending applications are also directed to physically and continuously deforming the strip, prior to entry into the tube mill, by generating longitudinal, spiral or transverse striations, grooves or channels in the strip. Thus, the tube ultimately fabricated from deformed strip has a wall structure which has been physically shaped in one fashion or another in contrast to tube wall structure developed from embossed strip. Here again, the pattern generated by deforming the strip is a matter of choice governed by ultimate tube use.

Accordingly, the co-pending applications deal with tubing made from strip formed with a pattern by embossing, etching or similar surface treatment or with tubing made from strip formed with a pattern by corrugating, crimping or other metal formimg process.

The co-pending applications also disclose that in the case of strip surface treatment a pattern may be generated on one or more sides of the strip so that the wall of the tube ultimately formed may carry a pattern on the internal wall surface or the external wall surface or on both wall surfaces, as desired.

Obviously, if the pattern is generated by deforming the strip, it will appear on the interior as well as the exterior of the tube wall.

For purposes of claiming the present invention surface treatments on one or more sides of the strip or deformation of the strip, which generate discernable surface indicia or which generate deformed wall structure in the tubing, are all referred to as "formed pattern," "pattern forming," or "pattern."

The method of developing the pattern by surface treatment or the method of developing the pattern by deforming the strip are a matter of choice and are not critical to the principles of the present invention.

Therefore, it is to be understood that the language "pattern," "formed pattern," or "pattern forming" as applied to the metallic strip is intended to include any process or operation which removes metal from any surface of the strip or which physically deforms the strip prior to entry into the tube mill.

Obviously, the term "pattern" is intended to define the result of such metal removal or metal deformation.

SUMMARY OF THE INVENTION

It is a principal object of the present invention to provide a process for fabricating discrete lengths of tubing having wall segments or sections defining formed patterns interruped by contiguous wall segments which are smooth or free of said formed pattern.

It is an additional object of the present invention to provide an improved process for continuously fabricating tubing from metallic strip where discrete lengths of tubing are formed with discontinuous patterns in various combinations and permutations and the discontinuities are exemplified by intervening and contiguous tube segments which are smooth or free of a pattern.

It is a further object of the invention to provide an improved continuous process for generating tubing from metallic strip where the tubing fabricated has a wall formed with a pattern interrupted by contiguous wall segments which are smooth or free of a formed pattern, giving one the option to separate the tubing into discrete lengths in the region of a pattern or in the region of a smooth segment.

A process embracing certain principles of the present invention may comprise the steps of: providing a strip of metal of predetermined width, indefinite lengths and side edges; continuously advancing the strip; continuously forming patterns on at least one surface of the strip during the course of advance; intermittently interrupting the pattern forming step to break the continuity of the formed pattern and to create intervening smooth segments in said surface defining a discontinuous pattern; continuously forming said strip into a tube by abutting the side edges to create a seam; continuously closing the seam to create a fluid-tight seal; and thereafter continuously separting the tubing into discrete lengths, said separating step occurring in the regions of the tube defined by said smooth segments.

Other features and advantages of the present invention will become more apparent from an examination of the succeeding specification when read in conjunction with the appended drawings, in which:

BRIEF DESCRIPTION OF DRAWINGS

FIGS. **1, 2** and **3** are representative examples of discrete lengths of tubing illustrating contiguous smooth and patterned wall segments or sections;

FIGS. **4** and **5** show typical mill rolls for generating patterns on the strip surface;

FIG. **6** shows a typical pair of mill rolls operative to generate a pattern by deforming the strip;

FIG. **7** shows a finished segment of tubing where the pattern is interrupted by a smooth wall;

FIG. **8** shows a typical tube forming die;

FIG. **9** is a side view of a mill arrangement operative to generate patterns on the strip in discontinuous fashion;

FIG. **10** shows, schematically, a typical tube forming operation starting with the strip supply and ending with tube cutting or separation;

FIGS. **11** and **12** illustrate points at which the tube may be separated or cut into discrete lengths.

Referring now to FIGS. 1, 2 and 3, the reference numeral 10 designates a finished length of tubing having smooth ends 11 and 12 and an intermediate patterned segment 13. In this case, the internal surface of the tube 14 is smooth throughout.

FIG. 2 shows a length of tubing 15 having a smooth external surface 16 throughout its length with an interior patterned surface 17 terminating in smooth ends 18 and 19.

FIG. 3 shows a still further variation in that tube 20 is formed with a pattern 21 throughout its interior and the exterior surface is smooth as at 22 and patterned at each end as indicated by the reference numerals 23 and 24.

FIGS. 4 and 5 each illustrate a pair of cooperating mill rolls, 26–27 and 28–29 operative to form a pattern "P" on one or both surfaces of strip "S" as disclosed in said co-pending applications.

FIG. 6 shows mill rolls 31–32 operative to physically deform strip S by generating striations or corrugations indicated by the reference numeral 33, also disclosed and described in the co-pending applications.

In FIG. 7, a discrete length of tubing 34 is formed with a pattern 36—36 interruped by contiguous smooth segment 37.

In FIG. 8, the strip of FIG. 6, is shown in the course of tube forming wherein end edges 38 and 39 abut one another to generate a longitudinal seam 41 as disclosed and described in said co-pending applications.

Referring now to FIG. 9, the reference letter M designates a pattern forming mill comprising a series of pattern forming rolls 42–43, 44–46 and 47–48 which are operable in timed sequence (in accordance with the length of pattern that one desires to generate) to move from an operative position indicated by the reference numeral 49 to an inoperative position indicated by the reference numeral 51. By appropriate control or programming of the operative and inoperative condition of the various pairs of mill rolls, one can generate a broken or interrupted pattern on the strip in accordance with various combinations or permutations, as desired.

For example, a discontinuity of pattern can be generated on the bottom surface 52 of the strip leaving the top surface 53 smooth, or vice versa.

Obviously, if one surface or the other is intended to be smooth throughout, a smooth roll must be placed in working contact with that surface.

Furthermore, with appropriate programming, the pattern forming mill M can be operated to generate pattern discontinuites in top and bottom surfaces of the strip (interior and exterior surfaces of tubing) which are phased (or displaced) from one another so that a particular tube segment ultimately formed can be smooth (or formed with a pattern) on both surfaces in a particular selected segment or a pattern can be displaced on one surface relative to the pattern on the opposite surface. Thus, smooth and patterned tube segments on the interior and exterior surfaces of a given length of tubing can be phased or displaced as design considerations in the ultimate use of the tube dicatate.

For example, FIG. 3 shows a displaced pattern in that segment 22 on the exterior surface of the tube 20 is smooth, while the interior surface 21 is formed with a pattern throughout without any discontinuity. In contrast, the window 50 in FIG. 11 illustrates a phased pattern.

Frequently it is necessary to size the strip before its entry into the tube mill to insure a neat, uniform longitudinal seam. Typically this involves scarfing, bevelling or shearing the side edges of the strip starting material to create a uniform cross-sectional configuration in the strip before entry into the tube mill.

It is to be understood that the process steps of the present invention can be praticed on virtually any metallic strip which is susceptible of pattern forming.

Furthermore, while one principal use of tubing fabricated in accordance with the principles of the invention involves heat exchanger applications, it is entirely within the scope of the invention to utilize the exterior ornamentation and aesthetic design features of the finished tubing in applications other than in the field of heat exchangers.

It is anticipated that a variety of pattern modifications may be devised as considerations of thermal engineering, construction and ornamentation may dictate without departing from the spirit and scope of the invention.

What is claimed is:

1. A method of continuously fabricating metallic tubing having formed patterns on the tubing wall comprising the steps of:
providing a strip of metal of predetermined width, indefinite length and side edges;
continuously advancing the strip;
continuously forming patterns on at least one surface of the strip during the course of advance;
intermittently interrupting the pattern forming step to break the continuity of the formed pattern and to create intervening smooth segments in said surface transverse to the strip length, each segment being a discontinuity in the pattern across the width of the strip;
continuously forming said strip into a tube by abutting the side edges to create a longitudinal, axially extending, continuous seam;
continuously welding said seam to create a fluid-tight seal;
and thereafter transversely cutting the tubing within smooth segments thereof into discrete tube lengths.

2. The method of fabricating tubing according to claim 1 in which the tube cutting step occurs within segments having a smooth internal surface.

3. The method of fabricating tubing according to claim 1 in which the pattern forming step occurs on opposite surfaces of the strip.

4. The method of fabricating tubing according to claim 1 in which the pattern forming step occurs on opposite surfaces of the strip simultaneously and the interruption step is timed so that the pattern discontinuity on one surface is phased with the corresponding discontinuity on the second surface.

5. The method of fabricating tubing according to claim 1 in which the pattern forming step occurs on opposite surfaces of the strip simultaneously and the interruption step is timed so that the pattern discontinuity on one surface is displaced with respect to the corresponding discontinuity on the second surface.

6. The method of claim 1 wherein the intermittent interruption of the pattern forming step to break continuity of the formed pattern is accomplished by shifting from one pattern configuration to another pattern configuration.

7. A method according to claim 1 in which the pattern forming step comprises forming longitudinally extending corrugations.

8. A method according to claim 1 in which the tube cutting step occurs within segments having a smooth external surface.

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