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BENDABLE TUBING

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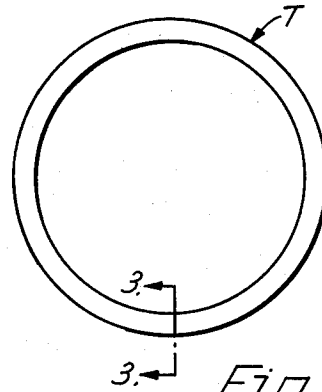
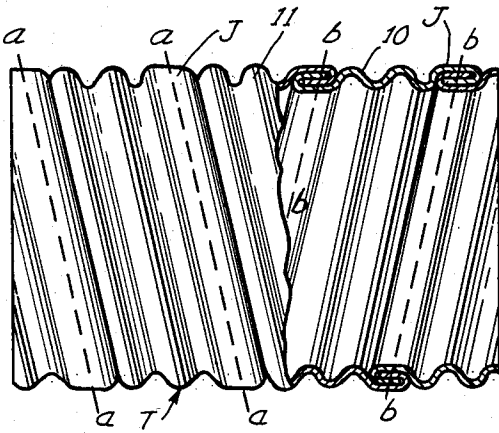


Fig. 1.

Fig. 2.

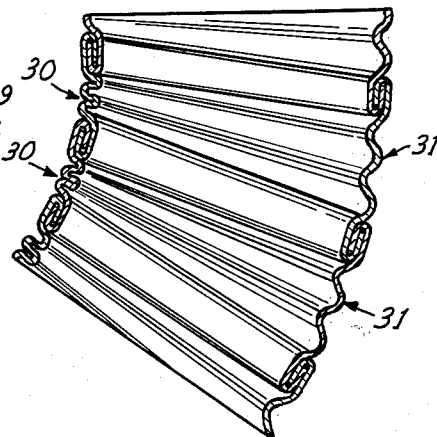
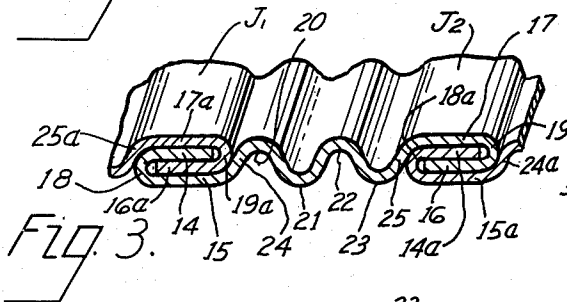


Fig. 3.

Fig. 4.

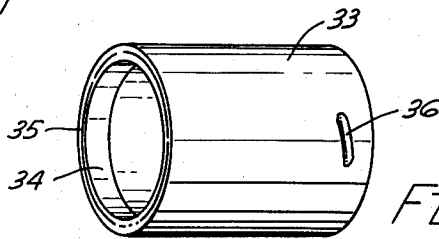


Fig. 5.

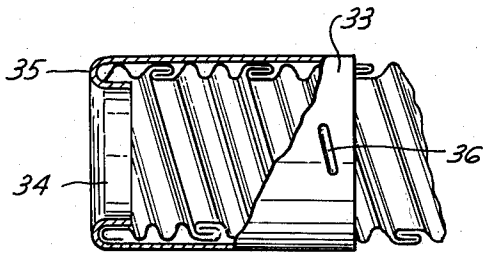


Fig. 6.

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BENDABLE TUBING

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This invention relates to bendable tubing and in particular to bendable tubing formed of a helically wound strip of material and with convolutions thereof interengaged and locked against relative movement.

One of the objects of my invention is to provide tubing that is substantially rigid but bendable. Another object is to provide tubing which is advantageously adapted to be formed in straight sections and which may be readily bent in any direction so that its axis departs from a straight line to assume and remain in a smooth curvilinear path and which has sufficient rigidity in both straight and/or bent form to support itself without sagging when supported only at widely spaced points along its length. Still another object of my invention is to provide such tubing that may be formed in a straight section and curved or bent therefrom through curves or turns of 360° or more and of relatively short radius without substantially changing its circular cross section or radially collapsing the tubing walls. Still another object is to provide such tubing from a relatively narrow and long strip of helically wound formable material. Another object is to provide tubing formed of a helically wound strip of formable material so that the marginal portions of adjacent convolutions of the tubing are overlappingly interengaged and secured against relative movement through the cooperation of such adjacent convolutions and without the use of auxiliary means. Yet another object is to provide means for sealing the joint between such interengaged adjacent convolutions against high fluid pressures. Still another object of my invention is to provide a simple self-securing terminating and finishing means or end ferrule for use with such helically wound tubing.

Briefly, I accomplish the foregoing objects of my invention by passing a relatively narrow and long flat strip of formable material such as sheet steel through a series of rolls to transform the flat strip into a preformed strip of material of predetermined lateral cross section in a manner well known in this art. The strip of material having the desired preformed cross section is then helically wound on a revolving mandrel against which it is pressed and further worked by a plurality of grooves rollers between which the mandrel revolves. This mode of making a helically wound tube of formable material and the apparatus by which it is effected are well known and forms no part of this invention which consists essentially in the particular configuration which is given to the preformed strip before it is wound on the mandrel and to the relationship of adjacent convolutions of the tube after coming off the revolving mandrel.

A specific embodiment of my invention and several modifications thereof are described below in connection with the accompanying drawings in which:

FIGURE 1 is a side elevational view of a length of helically wound bendable metal tubing constructed in accordance with my invention and partially sectioned in the plane of the axis of the tubing to show the interior thereof and sections through the walls;

FIGURE 2 is an end elevational view of the tubing section of FIGURE 1;

FIGURE 3 is a sectional view in perspective and in enlarged scale of a small portion of the tube section taken in the plane of line 3—3 in FIGURE 2;

FIGURE 4 illustrates a length of the tubing formed in a smooth bend and sectioned in the plane of the axis

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of the tubing to show the formation of the cross section of the walls thereof on the outside and the inside of the bend;

FIGURE 5 is a perspective view of the ferrule I prefer to employ in terminating or trimming the end of the tube of my invention; and

FIGURE 6 is a side elevational view of a section through the plane of the axis of a length of helically wound tubing with the ferrule of FIGURE 5 mounted thereon.

I will describe and illustrate my invention in terms of a specific embodiment of the invention, but not as a limitation thereof. The specific embodiment is adapted for use as an automobile exhaust system tail pipe and is formed of a strip of soft cold rolled steel having a good coat of galvanizing on both sides thereof and having a gauge thickness of approximately .022 inch and a width of 1 inch. I have made tubes from strip of the above specifications having outside diameters of 1½ inch to 3½ inches specifically for use as tail pipes though tubes of larger or smaller diameters may be made.

While tubing embodying my invention has many and various uses, it may be advantageously used for tail pipes in exhaust systems of automotive vehicles because of its ability to be formed into the wide variety and variations of curves and shapes required in this service and because of its ability to retain the shape desired while permitting some small adjustments therein when the tail pipe is installed beneath the automobile. When such tubing is employed as tail pipe, the end ferrule of my invention in combination with helically wound tubing provides an easily installed and attractive termination for the outward end of the tail pipe.

The tubing of my invention is not limited for use only as tail pipe nor to the particular material mentioned above and, alternatively, may be formed of other cold formable metallic strip of ferrous or non-ferrous materials or even of non-metallic formable strip.

Referring now to the drawings, the length of tubing T seen in side elevation in FIGURE 1 and in end elevation in FIGURE 2 is of circular cross section and made up of a preformed narrow metal strip having parallel edge portions helically wound about the axis of the tubing. In FIGURE 1, one convolution of the preformed strip as it appears on the exterior of tubing T is indicated generally by the pair of parallel broken lines a—*a* and another convolution as it appears on the inside of tubing T by the pair of parallel broken lines b—*b*. The marginal portions of adjacent convolutions are formed together into a joint J as between adjacent convolutions 10 and 11, for example.

The shape of the preformed strips making up the convolutions of the tubing and the detail of the locked joint between adjacent convolutions can best be seen in the enlarged sectional portion shown in FIGURE 3. Each convolution is made up with its lateral marginal portions folded back in opposite directions overlying that portion of the tube adjacent the marginal portion. As seen in FIGURE 3, marginal portion 14 is folded back so as to overlie the inner surface of the adjacent portion 15 of the strip and marginal portion 16 is folded back so as to overlie the outer surface of adjacent portion 17. The folded marginal portions 14 and 16 form a rolled edge on the strip at the crease or junctures 18 and 19 of their folds, respectively. Being helically wound, the adjacent edges of adjacent convolutions are folded in opposite directions to form an interfolded and interengaged joint. Thus, marginal portion 14 and its underlying adjacent portion 15 interfold and interengage marginal portion 16a and underlying adjacent portion 17a of the adjacent convolution. In like manner, the folded marginal portion 16 and underlying adjacent portion 17 interfold and

interengage folded marginal portion 14a and underlying adjacent portion 15a of the adjacent convolution.

The intermediate or central portion of the strip is provided with longitudinally extending corrugations 20 through 23 as can be seen most clearly in FIGURE 3. The bottom of corrugation 20 faces outwardly of the tube wall and thus oppositely of the direction in which its adjacent marginal portion 14 is folded. In like manner, the bottom of corrugation 23 faces interiorly of the tube wall and thus oppositely from the direction that its adjacent marginal portion 16 is folded. Side wall 24 of corrugation 20 is pressed or formed into tight engagement with the exterior of juncture 19a of the folded edge of the adjacent convolution of the tubing. In like manner, side wall 25 of corrugation 23 forms a shoulder snugly pressing against juncture 18a of the folded margin of its adjacent convolution of the tubing. With side wall 24 of corrugation 20 bearing against juncture 19a and the free edge of the folded marginal portion 14 bearing against the interior of juncture 19a, the interfolded and interengaged joint J₁ locks together and restrains adjacent convolutions against relative movement. In like manner, joint J₂ locks together and restrains adjacent convolutions of the tubing against relative movement by the engagement of side wall 25 of corrugation 23 bearing against the exterior of juncture 18a and the free edge of folded marginal portion 16 bearing against the interior side of juncture 18a.

Joint J₁ further locks together and restrains adjacent convolutions against relative movement because side wall 25a of an adjacent convolution bears against the outer surface of juncture 18 and the free edge of folded marginal edge portion 16a bears against the interior of juncture 18. In like fashion, joint J₂ further locks together and restrains its adjacent convolutions against relative movement because side wall 24a bears against the exterior of juncture 19 and the free edge of folded marginal portion 14 bears against the interior of juncture 19.

Thus each joint and the adjacent convolutions comprising it may be furnished, in effect, with a double lock and restraint against relative movement when the folded marginal portions of adjacent convolutions are turned back an equal amount. For example, in joint J₁, folded marginal portion 14 is turned back from juncture 18 an amount equal to that of interengaged folded marginal portion 16a. In this manner, the free edges of the interengaged marginal portions 14 and 16a both extend and firmly engage the bottom of junctures 19a and 18, respectively, of joint J₁.

It will be apparent that only one interlock between a free edge of a marginal folded portion and a side wall or shoulder of an adjacent corrugation in the intermediate portion of the strip need be employed to insure against relative movement at the joint and thus it is not necessary that both marginal portions of the strip forming the tubing be folded back equal distances. The interfolded and interengaged joints further restrain adjacent convolutions against relative movement therebetween and seal them together because they are pressed radially under substantial pressure against the rotating mandrel during the tube forming operation.

The joints may be provided with an additional sealing means by incorporating a sealing member in one or both of the junctures of the interfolded parts of the joint. For example, I have successfully employed a continuous length of asbestos yarn as a sealing means by laying it in the juncture of one or both of the folded parts of the joint so that it is compressed between and held tightly in engagement with adjacent surfaces by the free ends of the folded marginal portions entering the interior of their respective junctures. As seen in FIGURE 3, the sealing means might be incorporated in the interior of juncture 18a and compressed and held in place by a free edge of folded marginal portion 16. It would also appear in the interior of juncture 18 and be compressed between

and held in place by the free edge of folded marginal portion 16a. Tubing formed according to the teachings in this invention of one inch strip gauging .022 inch and employing a continuous asbestos yarn in one of the two junctures of each joint has been tested to over 600 pounds per square inch.

In the specific embodiment shown in the drawings and especially in FIGURE 3, the intermediate portion of the strip making up the tubing is provided with four corrugations. I prefer to form these corrugations with semi-circular bottoms alternately facing inwardly and outwardly of the tubing wall. The number of corrugations into which the intermediate portion of the strip is formed can be more or less than four, it being important only that the two corrugations adjacent the marginal portions of each strip have bottoms facing in opposite directions and in the proper relationship with the adjacent folded marginal portions so that the side walls of these corrugations cooperate with the interfolded joint to provide the locking and restraining means against relative movement between adjacent convolutions. I prefer that the overall height of two adjacent and oppositely facing corrugations be substantially the same as the radial thickness of the interfolded joints in the tubing though my invention is not limited to such a proportion between the depth of the corrugations and the thickness of the joint.

In addition to the locking or restraining function performed by the side walls of those corrugations adjacent the interfolding and interengaging joints, the corrugations serve at least two other functions. As is shown in the sectioned view of a bent length of tubing in FIGURE 4, the corrugations in the strip permit bending of the tubing by compressing or folding together as at 30 and thereby reducing the length of the tubing on the inside of the bend and/or by tending to straighten or flatten out somewhat as at 31 and thereby increasing the length of the tubing on the outside of the bend.

Whether the tubing is straight or bent, the nature of the joints and their cooperation with the corrugations therebetween is such that adjacent convolutions of the tubing are, at all times, locked and restrained against relative movement. For example, when subjected to tensile stresses, adjacent convolutions are restrained by the joints from moving relative to each other by one or both of the free edges of the folded marginal portions of adjacent convolutions bearing against the interior of its cooperating juncture in the joint. The joints also secure and restrain adjacent convolutions against relative movement when the tubing is subjected to compressive stresses by the side walls of the adjacent corrugations bearing against the exterior of the junctures of the joints. I have found that even in the longer radius side of a bent section of tubing where the corrugations are somewhat flattened that the side walls of those corrugations adjacent the joints tend to remain in relatively unreduced engagement with the exterior of their respective junctures and continue to secure the joint and adjacent convolutions against relative movement under compressive loading.

The joints of the tubing on the inside of a bend also restrain under tension and compression loads the interlocked parts thereof against relative movement by the bottoming of the free edge of the folded marginal portions in the interior or the inner side of the junctures and the squashing of the corrugations between joints into even tighter engagement with the exterior of the junctures than when the tube is formed.

Also, as can be seen in FIGURE 4, the tubing of my invention when bent does not collapse or reduce in diameter as does a conventional plain walled tube when bent. I believe this to be due to the ability of the tube wall to expand and contract in length provided by the corrugations intermediate the joints therein as well as due to the multilayer interfolded and secured joints act-

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ing in the manner of continuous spiralling reinforcement incorporated in the wall of the tubing.

In shaping various sizes of tubing into bends of varying radii, the difference in length between the inside and outside walls produced by the bend is accomplished initially to a large degree by the shortening of the inside wall through the compression of the grooves therein. Even in severe bends, the shortening of the wall on the inside of the bend is usually greater than the lengthening of the outside wall of the bend through straightening or flattening of the grooves therein. This result is highly desirable because it insures that the joints on the outside of the bend will always remain firmly secure and restrain adjacent convolutions against relative movement therebetween by engagement of the side walls of the corrugations adjacent the joint bearing against the exterior of the junctures of the joint.

It should be noted also that the tubing once bent can be straightened and rebent in even the opposite direction a limited number of times without damage thereto and, at all times, maintaining its circular cross section. However, undue flexing of the corrugations of the wall will usually weaken the material comprising the wall and may produce failures therein.

The specific embodiment of my invention described above is particularly well adapted for use in forming exhaust pipes and/or tail pipes in the exhaust systems of automobiles. These pipes are required to follow a tortuous path from the exhaust manifold in the engine to the muffler and from the muffler to the rear end of the automobile in order to avoid and pass around or under or over the chassis, axle and other parts of the vehicle. The conventional manner of providing for these pipes in an exhaust system is to preform a seamless plain walled tube or the like into the predetermined form required for a particular model, make and year of automobile in question. It is characteristic of automobile exhaust systems today that a different shape and/or length and/or diameter of tail pipe is required for almost every model, make and year automobile produced. Thus, each preformed plain walled pipe is useful with only a very limited number of the total vehicles produced each year or in current use. The problem becomes more acute as the number of makes and models is increased.

With the tubing of my invention, an exhaust pipe and/or tail pipe for any make, model and year of automobile can be provided from a very limited stock comprising a few straight sections of pipe of a few different diameters. The bendable tubing of my invention is useful for both original equipment and replacement parts for the exhaust systems of automobiles. It is particularly advantageous in the replacement business from the standpoint of the automobile parts retailer who is able to satisfy the needs of all his potential customers from a small number of bendable tubes rather than having to maintain a large supply of preformed conventional pipes.

When the use to which the bendable tubing of my invention is put requires a finished or trim end thereon, I prefer to employ the metal ferrule shown in FIGURES 5 and 6. The ferrule comprises a cylindrical outer portion 33 having an inside diameter adapted to slip easily over the outside of the pipe with which it is used. A shorter and smaller in diameter cylindrical inner portion 34 is located concentrically within and at one end of cylindrical outer portion 33. The adjacent ends of concentric cylindrical portions 33 and 34 are joined by a rolled end wall 35. The short inner cylindrical portion 34 is adapted to be received easily within the inside of the tube with which the ferrule is to be used.

In outer cylindrical portion 33 of the ferrule, I provide one or more elongate dimples or indentations 36 inclined to the axis of the ferrule at a slightly different angle than the inclination of the corrugations of the tubing with which the ferrule is to be used. The ferrule can be easily and

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quickly mounted and secured on and to the end of a length of corrugated tubing by turning the ferrule about the tubing with the indentation engaging one of the outwardly facing grooves or corrugations in the tubing. The ferrule is turned onto the tubing until the free end of the tubing engages and abuts the inside of end wall 35 of the ferrule. The indentation 36 in cylindrical portion 33 will ride in the groove or corrugation with which it is originally engaged drawing the ferrule onto and over the end of the tubing until the free end of the length of tubing engages end wall 35. After engagement of the free end of the tubing with the inside of end wall 35, additional turning of the ferrule on the tubing causes indentation 36 in cylindrical portion 33 to wedgingly bear against the side wall of the corrugation with which it is engaged because of the difference in the angle of inclination of indentation 36 and the cooperating corrugation in the tubing with the coincident axis of the ferrule and tubing. The difference in angle need not be great and provides a simple and effective means for securing the ferrule on the end of a piece of corrugated tubing.

Such a ferrule as I have illustrated in FIGURES 5 and 6 is especially useful in finishing the end of the tail pipes for automobile exhaust systems. The use of such a ferrule for this purpose permits the installer of the bendable tail pipe to completely install the tail pipe and then cut it off with a hack saw at a suitable point with relation to the rear end of the automobile. The installer may then turn the ferrule onto the free end of the pipe to provide an attractive and smooth edged terminating means for the relatively rough sawed end of the pipe. Because of the wedging action of the indentation with the cooperating corrugation in the tubing, the ferrule is self-secured even when subject to continuous and long shock and vibration.

It will be apparent from the foregoing description of my invention that I have provided a bendable tubing formed of a helically wound strip joined along the adjacent margins thereof by interfolded and interengaged joints securing and restraining adjacent convolutions against relative movement. The tubing is substantially rigid but bendable and will retain any particular shape given it. In addition, the tubing embodying my invention resists collapsing or change in its circular cross section at the point of bending. By employing sealing means, the tubing can be made to withstand very substantial internal pressures. I have also provided simple and effective terminating means for use in connection and cooperation with the bendable pipe.

Changes, modifications and improvements may be made to the above-described forms of my invention without departing from the precepts and principles of the invention. Therefore, I do not wish my patent to be limited to any particular form of my invention specifically illustrated and described nor in any manner inconsistent with the extent to which my invention has promoted the art.

I claim:

1. A cylindrical tube comprising a helically wound strip of formable material, said strip having marginal portions turned back into overlying relation to opposite faces of said strip and extending along the longitudinal sides thereof with the free edge of each of said marginal portions received in interfolding engagement with and within the turned back marginal portion of the convolution of the strip contiguous thereto, a shoulder extending longitudinally of said strip adjacent to each of its marginal portions and respectively cooperatively engaging the turned back and interfolded marginal portions of the convolutions thereof contiguous thereto to secure the interlockingly engaged marginal portions against relative movement by bearing engagement between said shoulders and said turned back marginal portions.

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2. The tube described in claim 1 wherein there is provided at least one laterally expansible and compressible corrugation in said strip extending longitudinally thereof intermediate said shoulders for permitting bending of the tube.

3. The tube described in claim 1 wherein at least one of the free edges of the thus interfolded marginal portions of the strip engages the bottom of the inside of the folded back marginal portion of a contiguous convolution of the strip and wherein said longitudinally extending shoulders are substantially radially directed and bear in substantially radial planes against the outside of the marginal portion of the contiguous convolution of the strip.

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