Sept. 20, 1966 W. J. DE GAIN 3,273,601

STAMPED TUBULAR PRODUCT AND METHOD OF MAKING THE SAME

Filed April 4, 1963

Fig. 1A

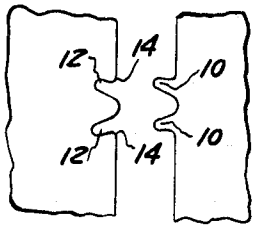


Fig. 1B

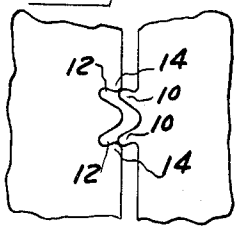


Fig. 1C

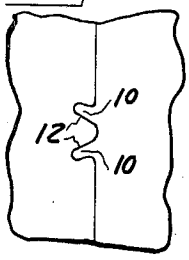


Fig. 6

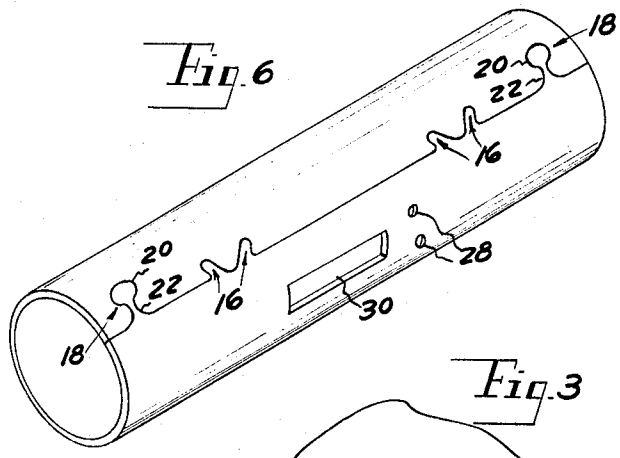


Fig. 3

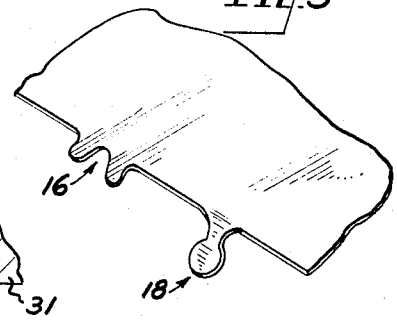


Fig. 4

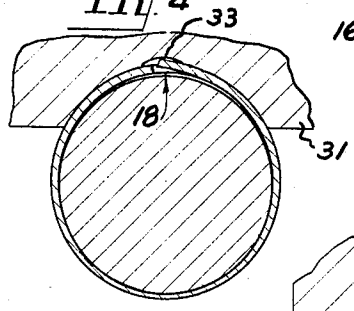
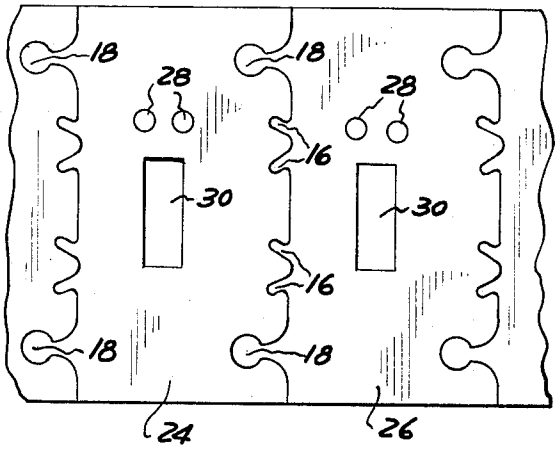


Fig. 2



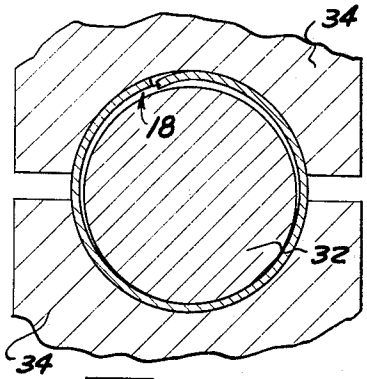


Fig. 5

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STAMPED TUBULAR PRODUCT AND METHOD OF MAKING THE SAME

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This invention relates to tubular parts made from flat stock by a series of press operations and to be novel pressing processes themselves.

Tubing is normally formed by various extrusion techniques which produce a seamless product or by rolling strip stock and then welding the seam. Such processes form tubes of a high quality having strong resistance to radial forces. However, these processes are expensive and difficulty is encountered in forming holes, slots, and other apertures in the tubing. It is also possible to form short lengths of tubing from flat stock by pressing techniques. Any required apertures may be formed in the flat stock prior to the formation of the tubing. The seams in such tubing may be joined by interlocking tabs. In applications where the product is not subjected to forces which act directly upon the seam, tubes produced in this manner provide adequate performance at a much lower cost than similar parts produced by the other processes. For example, automotive steering columns may be produced by pressing techniques from flat stock much more economically than by other processes.

The interlocking tabs which join the seam of such tubular parts may be divided into two classes. The first type or "planar" locking tab may be formed by sliding the two edges of the metal toward each other in the plane of the material. Such locks are easy to form since it is not necessary to utilize a mandrel to support the tube, but they offer a low resistance to forces which tend to pull the edges away from each other. The second type of interlocking tab may be termed "perpendicular" because the tab configuration is such that the two edges must be brought together by a motion perpendicular to the plane of the part in the maner of pieces of jig-saw puzzle. Such tabs offer a higher resistance to forces which tend to separate the edges of the seam, but an interior mandrel must be utilized in forming them and the time required to insert and retract the mandrel from a tube slows the production rate so as to add appreciably to the part cost.

The present invention comprises a tube formed by pressing techniques which utilizes a planar form of tab formed at spaced points along the tube to close the seam and perpendicular tabs adjacent each end of the tube. Use of perpendicular tabs only at the end provides a very short path for the mandrel and the time required by the operation is therefore negligible; yet it provides a high resistance to forces tending to separate the tube at the seam. The invention further lies in the use of a unique type of planar tab which provides appreciable resistance to seam separation although it is formed simply by bringing the two sections together in the plane of the metal at the seam line. This planar tab is non-reversible and the force utilized to push the parts together bends the tabs so as to form an interference fit which resists a greater force pulling them apart.

Because planar and perpendicular tabs are formed with different motions and the entire seam must be brought together at the same time to prevent distortion of the tube, it is not apparent how both types of tabs may be formed adjacent one another along the same tubing. Another object of the present invention is to provide a unique method of forming such diverse tabs in the same tube.

In the preferred embodiment of the invention, which will subsequently be described in detail, the method consists of forming tube from a sheet which has a developed length slightly greater than the circumference of the finished tube. The male members of the perpendicular tabs are then bent down out of the plane of the tubing. The sheet is then bent in a circle with closed ends so that the planar tabs close and the male members of the perpendicular tabs are disposed within the tubing wall. As a coordinate step, mandrel stubs are inserted in each end of the tubing and external forming dies press the tubing to its final size and simultaneously push the perpendicular tabs into locked position.

It is therefore seen to be an object to provide a press formed tube having a seam formed with center tabs which may be joined by a planar motion and end tabs which are joined by a perpendicular motion so as to provide a greater seam strength.

Another object is to provide a method of forming such a tube wherein the developed length of the blank is oversize for the tube to be formed; the male members of the perpendicular tabs are first bent out of the plane of the sheet; the tubing is then formed bringing the two edges together and locking the planar tabs; and finally the tube is reduced over mandrels inserted a teach end so as to form the perpendicular tabs.

Other objects, advantages and applications of the present invention will be made apparent by the following detailed description of the preferred embodiment of the invention. The description makes reference to the accompanying drawings in which:

FIGURES 1A, 1B and 1C illustrate the successive steps involved in the formation of the planar tabs utilized in connection with the present invention;

FIGURE 2 illustrates the method in which successive blanks for forming the preferred embodiment of tube may be cut from a roll of sheet stock without a loss of material;

FIGURE 3 illustrates the first step in the forming process wherein the male members of the perpendicular tabs are bent out of the plane of the material;

FIGURE 4 illustrates the second stage of the process where the tube is formed so that the planar tabs join;

FIGURE 5 illustrates the last stage of the process wherein the tubing is die-formed over mandrels to its final dimension so as to close the perpendicular tab; and

FIGURE 6 illustrates the tube of the present invention formed in accordance with this process.

The form of planar tab used in connection with the preferred embodiment of the invention, as illustrated in FIGURES 1A, B and C, may be formed with a planar motion, yet forms an interference fit so as to resist a motion of the two parts away from the seam. It also utilizes two fully complementary male and female sections so that a male section on one blank and a female section on the next blank may be formed with a single die cut without loss of material. The male portion of the tab takes the form of a pair of truncated oval ears **10** separated from one another and extending from the sheet edge in opposite directions so that their central axes intersect to form an obtuse angle. The female sections **12** are formed identically thereto. The angle of the tabs is such that when the two sections are brought together in a planar direction the male members first contact the points **14** on the female member which form the extreme points of contact with the edge section thereof. As shown in FIGURE 1B a further motion in the planar direction bends the male tabs toward one another until their edges enter the female tabs. A continuation of the planar motion leads the male tabs **10** into the female tabs **12** to complete the junction shown in FIGURE 1C. A force of similar magnitude is required to separate the formed planar tabs.

As disclosed in FIGURE 6, a preferred embodiment of the finished tube utilizes a seam closed by several planar tab sets, generally indicated at **16**, with perpendicular tab sets, generally indicated at **18**, adjacent the two ends of the tubing. In other embodiments only a single perpendicular tab set **18** might be formed at one end of the tubing, depending upon the use to which the article is to be put. The perpendicular tab sets **18** each take the form of a circular section **20** connected to the edge of the sheet by a slot **22** which is narrower than the diameter of the circular section. The male tab and the female tab receiving opening are exactly complementary to one another so that they may also be formed in successive sections of flat stock without any loss of material.

The perpendicular tabs **18** are, of course, joined by a relative motion between the male and female sections in a direction perpendicular to the plane of the material. They exhibit very high resistance to forces tending to separate the two joined sections.

FIGURE 2 illustrates the manner in which several workpiece blanks are formed from a large section of sheet stock of the proper width without any loss of material. A pair of successive blanks **24** and **26** are identical to one another. Each contains a series of holes **28** and a slot **30** which are required in the finished article, as is seen in FIGURE 6. These may easily be formed in the sheet stock by well known metalworking techniques. Their formation in a finished section of tube produced by some other process would be much more difficult.

The developed length of the blank, that is, the dimension between the two lines which are formed at the sides of the seam, is slightly greater than the developed perimeter of the finished tube. (This perimeter is measured at a radius one-third of the metal thickness from the inside diameter of the tubing, in accordance with common metalworking theory and practice. The normal developed length of a blank is equal to the perimeter of the finished tube measured at this radius.) For example, when a tube of 2" O.D. is to be formed from .065 inch stock, a dimension L of 6.125 inches is employed rather than a blank length of 6.00 inches as would be dictated by normal metalworking practice. The reason for this unusual practice will be noted subsequently.

The male members of the planar tab sections **16** and the perpendicular tab sections **18** are formed in one edge of the sheet **26** at the same time as the complementary female formations are produced in the sheet **24** by a single pressing action. Similar formations are produced on the opposite edges of each blank.

A first step in the formation of the closed tube of FIGURE 6 from the blank of FIGURE 2 involves the bending of the male tab members **18** about their line of intersection with the main sheet so that they are inclined by a very few degrees with respect to the main sheet. FIGURE 3 illustrates this desired bend which may be achieved by a wide variety of equipment and may be performed in connection with one of the subsequent operations of the process.

The next step in the process is to form the flat sheet into a tube. The tube thus formed will have an outer diameter slightly in excess of that of the desired finished product in accordance with the oversized developed length employed in forming the blanks. During this operation the planar tabs **16** will be formed in accordance with the sequence disclosed in FIGURES 1A, B and C.

The specific method of round forming the tube does not form a part of the present invention. If the tube is formed with a die **31** as disclosed in FIGURE 4, I have discovered that it is necessary to provide a relief **33** in the die, over the area adjacent to the planar tabs **16**. Otherwise the male members of these tabs have a tendency to snap downwardly, into the tube.

This rotational forming operation is performed in such a direction with respect to the direction of bend of the male tab members **18** that the male tab members are bent down into the finished tube and lie immediately below the normal surface of the tube. This condition is illustrated in FIGURE 4. As has been noted, the operation of bending down the tabs may be performed simultaneously with the press forming of the tube.

The final operation, illustrated in FIGURE 5 consists of pressing or reducing the tube to the finished size and simultaneously closing the perpendicular tab members **18**. In order to accomplish this operation, short mandrels **32** are brought into each side of the tube. The mandrels have outer diameters which are similar to the desired inner diameter of the finished tube. Because the tube formed in the previous stage is slightly oversized, these mandrels clear the male tab sections **18** which project down into the tube. The mandrels **32** project sufficiently into the tube to extend under the location of the perpendicular tab sections **18**.

Following the insertion of the mandrels, a pair of half-cylindrical forming dies **34**, having a cavity similar to the desired outer diameter of the finished tube, are brought over the tube and the mandrels. The tube is thus compressed in a circumferential direction to the smaller final diameter. During this process the male planar tab members are formed into their complementary female openings.

From the review of the process it will be seen that the oversized blank length is necessary so that the planar tab members may be completely closed without reducing the diameter of the tube to a point where it will be impossible to have the mandrels clear the inwardly bent male perpendicular tab members. In practice, the operations are performed in a single die fixture which makes it impossible to bend the tab in an outward direction so as to allow mandrel clearance without providing an elaborate die set-up.

Having thus described my invention, I claim:

1. A tube product comprising: a generally rectangular sheet bent in circular form so that a pair of opposed edges abut one another and form a seam; and a plurality of tab connectors closing the seam, each consisting of a male member extending from the edge forming one side of the seam and a complementary female opening in the edge forming the opposite side of the seam and each being of the type which resists separating motion in a direction parallel to the plane containing the edges of the sheet, a plurality of such tab connectors being of the type which may be closed by bringing the edges of the sheet toward one another in the direction of the plane of the sheet, and at least one tab connector, disposed adjacent to an end of the tube, being of the type which is closed by a motion in a direction perpendicular to the plane of the sheet.

2. The structure of claim **1** wherein tab connectors of the type which is closed by a motion in the direction perpendicular to the plane of a sheet are disposed adjacent to each end of the tube and a plurality of tab connectors of the type which may be closed by bringing the edge of the sheet toward one another in a direction of the plane of the sheet are disposed along the seam intermediate of such end tabs.

3. A tube product comprising: a generally rectangular sheet bent in circular form so that a pair of opposed edges abut one another to form a seam; and a plurality of tab connectors closing the seam, each consisting of a male member extending from an edge forming one side of the seam and a complementary female opening in the edge forming the opposite side of the seam and each being of the type which resists separating motion in a direction parallel to the plane containing the edges of the sheet, a plurality of such tab connectors being of the type wherein the male member consists of a pair of ears extending from the edge of the sheet at equal angles with respect to a line perpendicular to the edge, in directions opposed to one another, whereby the tab may be locked by bringing the edges of the sheet toward one another in the

direction of the plane of the sheet so that the male tab members are bent by the female tab members, first towards one another and then away from one another, and at least one tab connector, disposed adjacent to the end of the tube, is of the type which is closed by a motion in a direction perpendicular to the plane of the sheet.

4. The structure of claim 3 wherein the tab connectors adjacent to each end of the tube are of the type which is closed by a motion in a direction perpendicular to the plane of the sheet and a plurality of the other form of tab members are disposed at regular intervals along the seam intermediate of these end tab connectors.

5. The structure of claim 1 wherein the tab connector of the type which is closed by a motion in a direction perpendicular to the plane of the sheet consists of a male member having a circular end and a link of a width less than the diameter of said circular end connecting the circular end to the edge of the sheet.

6. The structure of claim 3 wherein the tab connector of the type which is closed by a motion in a direction perpendicular to the plane of the sheet employs a male member having a circular end and a link of a width less than the diameter of the circular end connecting such end to the edge of the sheet.

7. A tube product comprising: a generally rectangular sheet bent in circular form so that a pair of opposed edges abut one another and form a seam; and a plurality of tab connectors closing the seam, each consisting of a male tab member extending from the edge forming one side of the seam and an identical female recess in the

edge forming the other side of the seam, each of said tab connectors being of a type which resists separating motion in a direction parallel to the plane containing the edges of the sheet, a plurality of such tab connectors being of the type which may be closed by bringing the edges of the sheet toward one another in the direction of the plane of the sheet and having male tabs consisting of a pair of elongated ears projecting from the seam at inclined angles with respect to one another, and a pair of tab connectors disposed adjacent to the two ends of the tube being of the type which is closed by motion in a direction perpendicular to the plane of the sheet and comprising a tab of a generally circular configuration joined to the seam by a relatively narrow neck.

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