Oct. 23, 1962 R. H. HART ETAL 3,059,319

METHOD FOR MAKING FLEXIBLE TUBULAR MEMBERS

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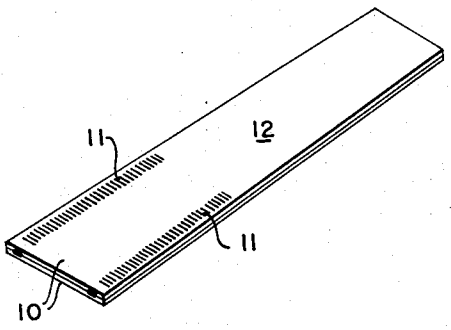


FIG. 1.

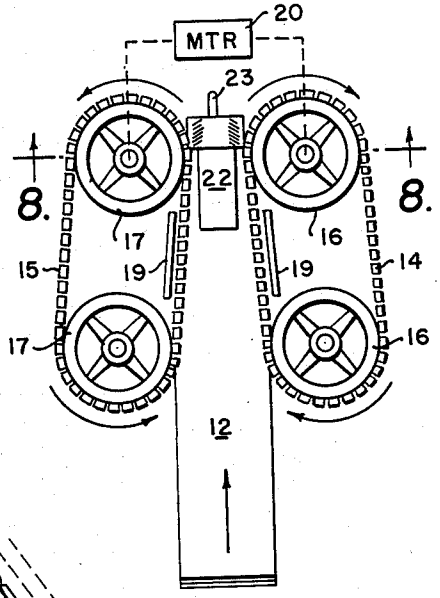


FIG. 3.

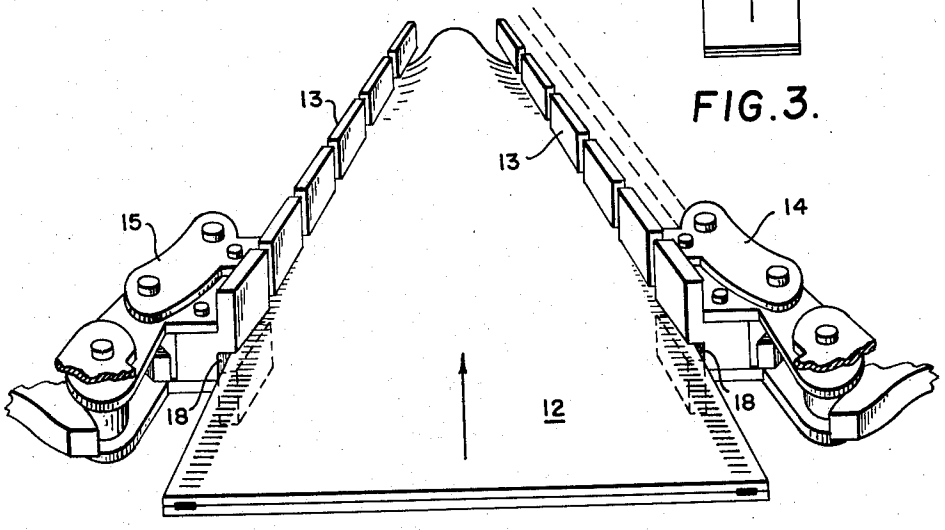


FIG. 2.

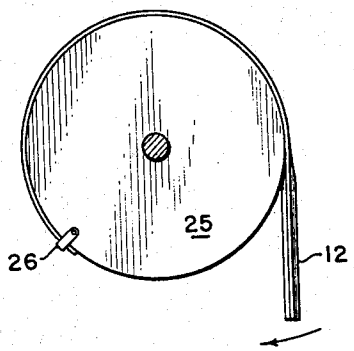


FIG. 9.

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METHOD FOR MAKING FLEXIBLE TUBULAR MEMBERS

Filed March 31, 1960 2 Sheets-Sheet 2

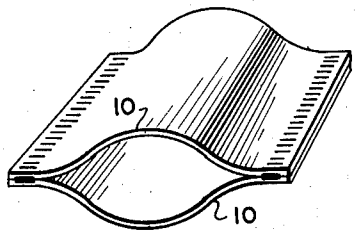


FIG. 4.

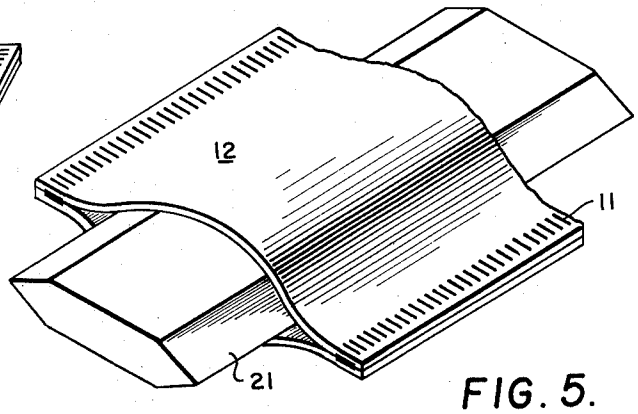


FIG. 5.

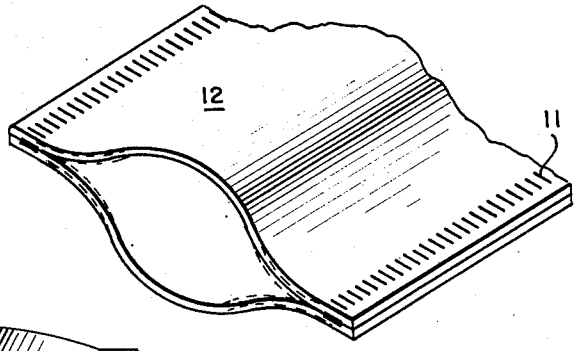


FIG. 6.

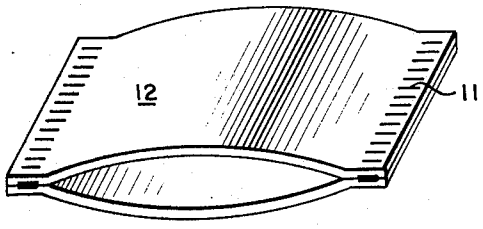


FIG. 7.

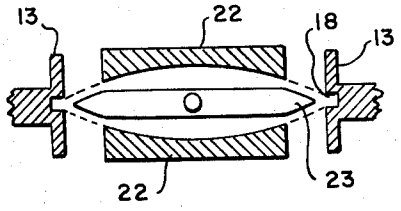


FIG. 8.

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3,059,319
METHOD FOR MAKING FLEXIBLE TUBULAR MEMBERS

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Filed Mar. 31, 1960, Ser. No. 19,133
3 Claims. (Cl. 29—155)

The present invention relates to a process for making tubular support members and more particularly for expanding tubular support members composed of two superposed flat strips of metal bonded along their margins and containing an unbounded potential tubular central portion. More specifically, the present invention is directed to the production of flexible support members of the type comprising the subject matter of patent application Serial No. 848,879 filed 26 October 1959, now Patent No. 3,032,151, granted May 1, 1962 to Robert L. Allen and Robert H. Hart, said Hart being one of the present joint inventors.

As described in said patent application, a support member which is transversely rigid, torsion resistant and has an inherent tendency to assume a rectilinear state comprises an elongated tubular member of lenticular cross section having integral fins extending laterally in the plane of its longitudinal edges and being constructed of thin spring material. Such a member when constrained in a coil stores spring energy which is available to uncoil the member to straight form when the constraint is relaxed.

An object of the present invention is to provide a simple effective method for expanding into tubular form a blank composed of two superposed flat strips of sheet spring material joined along their margins.

In practicing the invention, two flats strips of spring tempered metal or equivalent material are superposed and bonded as by welding along their margins. It is important that the breadth dimension between the welded margins be constant along the length of the strips. It is also important that the welded strips be flat and if the welding operation shortens the margins the welded strips should be rolled in such a manner that the rolling action on these margins returns them to the length of the unwelded portion of the strips. If the material in the welded area elongates during welding then the rolling action will be applied to increase the length of the unwelded portion. In either event the rolling operation should result in a welded blank which will lay flat without distortion. Since in most metals the welding action will cause shortening, a suitable countermeasure consists in mechanically compressing the strips at the weld area prior to welding whereby the welding will shrink this area to the desired length. The result of the above operation is a flat ribbon composed of a pair of mated strips of spring tempered metal bonded along their longitudinal margins and containing a longitudinally extending unbonded potential tubular intermarginal portion. This flat ribbon is then subjected to a shaping operation which includes progressively decreasing the breadth dimension in such a manner as to expand the unbonded portion outwardly and obtain opposing camber.

Other objects and advantages of the invention will become apparent from the following description when read in connection with the accompanying drawings in which:

FIG. 1 is a view in perspective of bonded strips formed preliminary to the expanding operation;

FIG. 2 is a fragmentary view in perspective showing a preferred form of an apparatus for practicing the invention;

FIG. 3 is a plan view of the apparatus of FIG. 2;

FIG. 4 is a perspective view of a segment of a tubular member as expanded by the apparatus of FIG. 2;

FIG. 5 illustrates a method of increasing the camber of the expanded tube of FIG. 4;

FIG. 6 illustrates the tube resulting from the operation shown in FIG. 5;

FIG. 7 illustrates the preferred shape of an expanded tubular member;

FIG. 8 is a partial sectional view of the apparatus of FIG. 3 taken at the section 8—8; and

FIG. 9 illustrates a method of removing excess camber of the expanded tube of FIG. 6.

In practicing the invention two flat strips **10** of spring tempered material, preferably spring steel, are superposed and bonded along their longitudinal margins **11** as by welding, care being taken that the resulting composite ribbon **12** remains flat or if needed is flattened by suitable rolling action after the welding step. The unbonded center portion of the composite ribbon **12** constitutes a potential tubular portion which according to the invention is expanded by progressively subjecting the outer edges of the ribbon **12** to sufficient pressure to decrease its breadth dimension in such a manner that the unbonded central portion of the upper and lower strips **10** part in the center and obtain opposing camber as shown in FIG. 4. An apparatus for accomplishing this expanding operation is shown in FIGS. 2 and 3 as comprising a plurality of shoes **13** mounted along the outer periphery of endless roller chains **14** and **15** trained over pairs of sprocket wheels **16** and **17**, respectively. The shoes **13** are provided with slots **18** alined parallel with the chains **14** and being just wide enough to receive the margins of the ribbon **12**. The pairs of sprockets **16** and **17** are arranged so that the slotted shoes **13** at what is to be the entrance end is slightly greater than the width of the ribbon **12** and at the exit end is less than the width of the ribbon **12** by an amount sufficient to expand the two strips **10** to the separation desired. Both chains **14** and **15**, preferably backed by tracks **19**, are moved in the direction of travel of the ribbon **12** by their respective sprockets **16** and **17** at the exit end, which sprockets are driven in synchronism by a suitable motor **20**. Upon insertion of one end of the flat ribbon **12** in the slots **18** at the entrance end of the shoes **13**, the sides of the ribbon **12** are gripped by the slotted shoes **13** and moved through the exit end during which time the edges are forced toward each other causing the unbonded portion of the ribbon **12** to separate and obtain permanent deformation with opposing cambers as shown in FIG. 4. The shoes **13** thus constitute a forming matrix.

The passage of the ribbon **12** through the apparatus of FIGS. 2 and 3 without restraining the thickness dimension to which the ribbon **12** expands results in the strips **10** being sharply curved in the center and rapidly decreasing in curvature out toward the margins as indicated in FIG. 4. When the expanded ribbon **12** is to be used as a flexible support member, it is desirable to move more material away from the neutral axis such as results when the strips **10** have a substantially uniform curvature throughout their width dimension as illustrated in FIG. 7. One method of accomplishing this result is to insert a mandrel such as a hexagonal bar **21** in the void of the expanded ribbon **12** as shown in FIG. 5 and rerunning this assembly through the forming apparatus of FIGS. 2 and 3 which causes bending to occur on both strips **10** parallel to and adjacent to the felded margins **11** which places more material away from the neutral axis and increases the second moment of area of the section as indicated in FIG. 6. The strip **12** in this condition (FIG. 6) now probably has more camber than may be retained after the member has been flattened. The excess camber is removed by bending the expanded ribbon **12** alternately in

both directions around a drum **25** (FIG. 9) having a radius small enough to cause the strips **10** to flatten against each other thereby removing equal amounts of camber from both the strips **10** and resulting in a flexible tubular support member **12** having the sectional configuration substantially as shown in FIG. 7. The drum **25** may be provided with a clip **26** under which one end of the tube **12** is inserted to facilitate the bending operation.

The desired sectional configuration shown in FIG. 7 may be directly obtained in a single forming operation by providing suitable fixed opposed platens **22** having their facing surfaces shaped and spaced to conform to the desired sectional configuration and arranged between the slotted shoes **13** and extending from the exit end thereof toward the entrance end a sufficient distance to insure that when the ribbon **12** reaches the leading edges of the platens **22** its expanded dimension will be less than the distance separating the opposed platens **22**. The facing surfaces of the platens **22** may be shaped and spaced to produce other sectional configurations of the expanded ribbon **12**; however, the configuration substantially as illustrated in FIGS. 7 and 8 is preferred for providing flexible support members of the type comprising the subject matter of the above identified patent application filed by Robert L. Allen and Robert H. Hart. This sectional configuration may also be directly obtained by positioning a shaping mandrel **23** within the expanding ribbon **12** and in contact only with the noncentral areas thereof to force more bending adjacent the bonded margins **11** and thus overcome the tendency of the central portion of the ribbon **12** to become too sharply curved.

When the apparatus of FIG. 3 utilizes both the restraining platens **22** and the shaping mandrel **23** it may be desirable to mount the platens **22** and the mandrel **23** so that they yield to a certain pressure to the end that some variation in the dimension of the fabricated composite ribbon **12** may be readily tolerated.

While for the purpose of disclosing the invention the preferred embodiments thereof have been described in detail to enable those skilled in the art to practice the invention it will be evident in view of the above disclosure that various modifications may be made therein without departing from the intended scope of the invention as set forth in the appended claims.

What is claimed is:

1. The method of making an elongated hollow flexible support member of uniform lenticular cross section with integral fins extending laterally in the plane of its longitudinal edges which includes bonding together the longitudinal margins of two superposed flat rectangular strips of spring tempered metal to provide a flat bonded blank containing an unbonded potential tubular portion, longitudinally advancing the bonded blank while subjecting the same to pressure from opposite edges thereof to progressively decrease its breadth dimension and to expand the unbonded portion outwardly in permanent deformation with opposing cambers, and during such expansion restraining only the outermost expanded surface portions to cause additional expansion of the unbonded portion adjacent the bonded margins.

2. The method of expanding a tubular support member composed of two superposed flat rectangular strips of metal bonded along their margins and containing an unbonded potential tubular portion therebetween, comprising longitudinally advancing said member while subjecting the same to pressure from opposite edges thereof to decrease its breadth dimension and to expand the unbonded portion outwardly in permanent deformation with opposing cambers, inserting a bar mandrel into the expanded portion to increase its breadth dimension, and while said mandrel is so inserted again subjecting said member to pressure from opposite edges thereof to decrease its breadth dimension to expand the unbonded portions adjacent the bonded margins.

3. The method according to claim 2 including the step of alternately bending in opposite directions the expanded member around a drum having a diameter just small enough to cause the strips to flatten against each other and thereby remove any excess camber.

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