Nov. 7, 1967 G. F. GROSCHKE 3,350,751

ERECTILE MEMBER

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Fig. 1

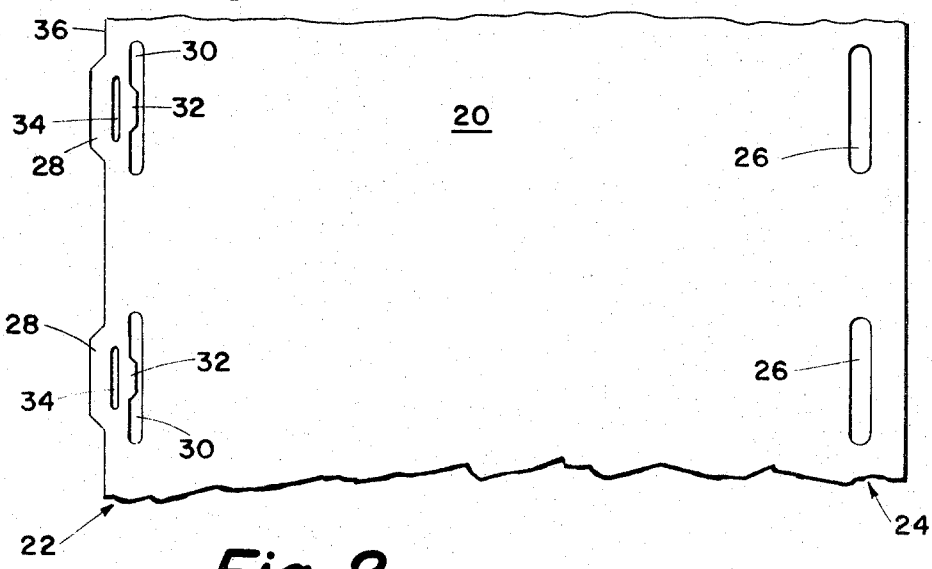


Fig. 2

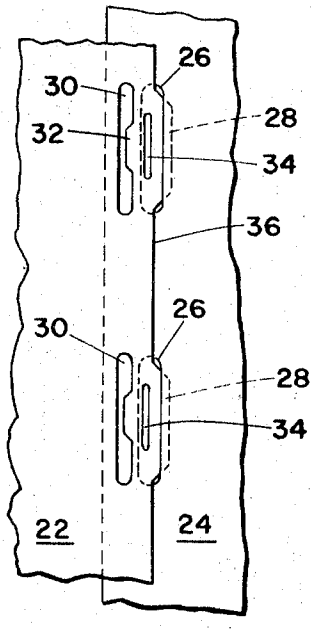


Fig. 4

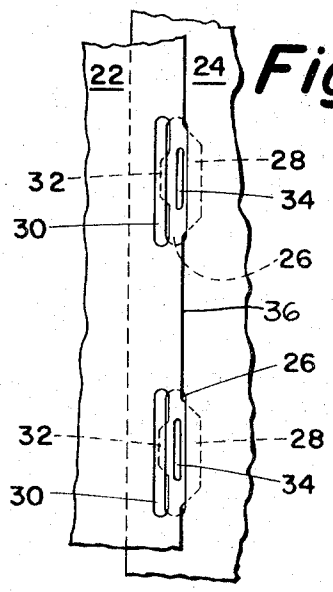


Fig. 3

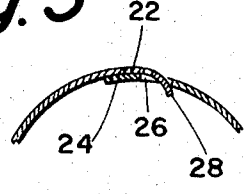
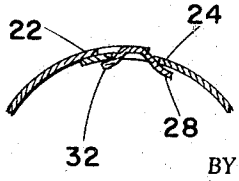


Fig. 5



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Fig. 6

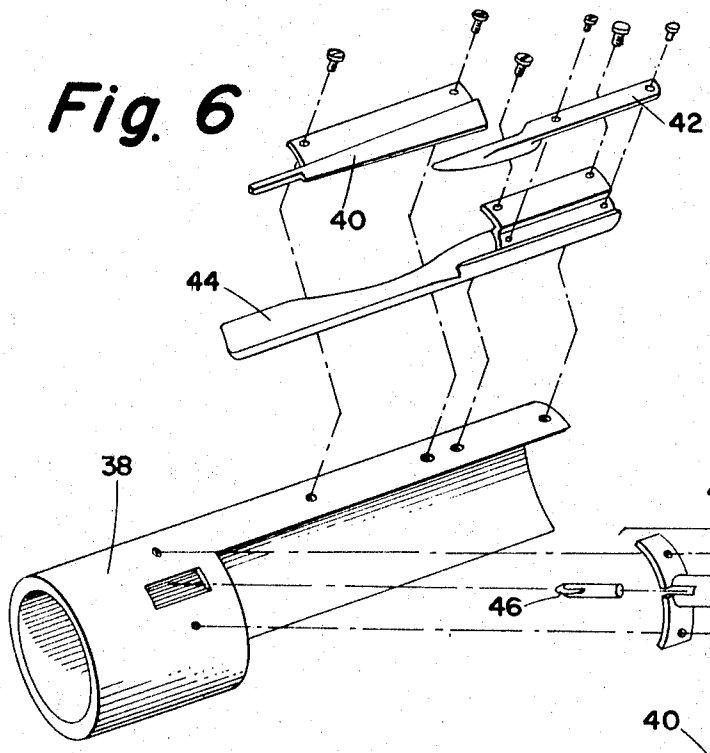


Fig. 7

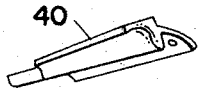


Fig. 8

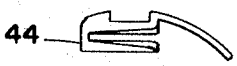


Fig. 9

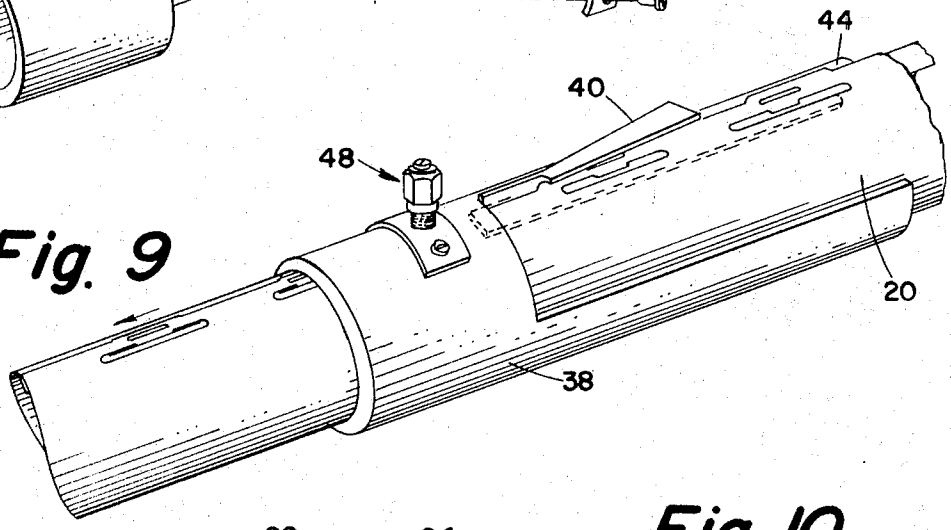
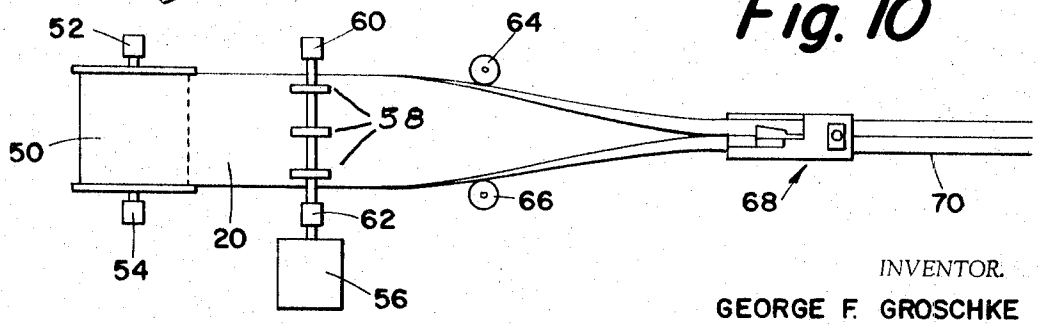


Fig. 10



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6 Claims. (Cl. 24—201)

ABSTRACT OF THE DISCLOSURE

Flexible strip is provided on one edge with a sequence of slots parallel to edge and on other edge with protruding tongues relieved in back to produce backward-extending tabs. Strip is formed into tube by tucking tongue into slot, locking it in position with tab.

This invention pertains to the formation of circular tubes or other structures by the interlocking of the edges of sheets of thin flexible material; and to apparatus for the ready interlocking or unlocking of such edges; also generally to interlocking fastenings.

There are many uses for elongated structures having the general characteristics of masts or spars; and for many such uses it is convenient (or essential) that such masts (to standardize a convenient term) be capable of collapse into small volume and later erection into mast form. If great strength or rigidity are not required, it is feasible to utilize the elasticity of thin metal or plastic materials which have a permanent set in the shape of elongated "wraparound" tubes, formed with overlap but no edge fastening; where rigidity may be negligible even a partial wrap (as in self-extending measuring tapes) will suffice. The overlapping metal tube has been produced for use as an extensible spar or mast for use as an antenna or for stabilizing spacecraft by the gradient of gravity. Such elastic permanently set members may be collapsed by forcibly rolling them around their shorter axes and restraining them in such rolled condition until their erection is again desirable, in which case they may be unrolled and will extend themselves. However, such permanently set structures have the disadvantage that, because of the absence of edge bonding, they can deflect rather readily. Also, to provide an extended piece with a particular permanent set complicates the supply problem; the permanent set must be imparted in some factory or equivalent, and the product issued therefrom is devoted to a particular use; it is no longer interchangeable with other strip stock of the same material.

I have invented a simple way of forming a mast of flexible strip material which requires only a simple punching at both edges to permit the fastening of opposite edges of the strip to form a rigid tube, without protruding edges. The manner of edge fastening is such that the strip may be rolled and edge-fastened by passage through a simple former-fastener; and it may be unfastened and restored to its flat strip condition by movement in reverse through the former-fastener. The particular manner of edge fastening is not limited to fastening opposite edges of the same sheet, but may be used to fasten different pieces of material. Neither tension nor compression nor alternation of both will loosen the fastening.

Thus it is generally my object to teach the formation of a rigid tubular structure from a flexible strip and, as part of such disclosure, to teach a convenient and inexpensive way of releasably but reliably fastening the edges of a flexible sheet material to another material. Accomplishment of these objectives achieves economy, lightness, compactness, and similar ancillary objects which those skilled in the art will appreciate without recital.

For the better understanding of my invention I have provided figures of drawing in which:

FIG. 1 represents a strip of material edge-punched according to my invention;

FIG. 2 represents edges of material according to FIG. 1 partially joined;

FIG. 3 represents an end view of FIG. 2;

FIG. 4 represents edges of material according to FIG. 1 completely joined;

FIG. 5 represents an end view of FIG. 4;

FIG. 6 represents an exploded view of a former-fastener according to my invention;

FIG. 7 represents an alternate view of a forming guide according to my invention;

FIG. 8 represents an end view of an edge guide according to my invention;

FIG. 9 represents an assembled former-fastener according to my invention operating upon material according to FIG. 1;

FIG. 10 represents a mode of application of a structure according to my invention.

FIG. 1 represents a portion of a strip **20** having generally two parallel edge regions **22** and **24**. In the region **24** there are oval perforations **26** which, in a successful embodiment, were one inch long, spaced one inch between ends of successive perforations, were $\frac{7}{32}$ inch wide and were spaced one-fourth inch from the nearer edge of strip **20**. The region **22** is somewhat more elaborately punched and trimmed. From the edge of region **22** there protrude trapezoidal tongues **28** which, in a successful embodiment were three-fourths inch long at the base, $\frac{9}{16}$ inch wide at the top, and $\frac{7}{64}$ inch high. Oval slots **30**, in the same embodiment, were one inch long, $\frac{7}{64}$ inch wide, and had reentrant trapezoidal tongues **32** of base dimensions $\frac{5}{16}$ inch, top dimension one-fourth inch, and height $\frac{3}{64}$ inch. All the tongues and slots thus far recited perform topological functions in edge fastening. Oval slots **34**, on the other hand, which in the embodiment cited were one-half inch long and $\frac{1}{16}$ inch wide, are provided only to modify the stiffness of the strip in their vicinity; they do not receive locking tongues. For reasons which will appear in the consideration of FIG. 2, tongues **28** and **32**, and slots **30** and **34** are located symmetrically around axes of symmetry of oval slots **26**. In the embodiment cited, the sides of slots **30** nearest edge **36** of the strip were $\frac{11}{64}$ inch distant from edge **36**, and the sides of slots **34** nearest slots **30** were $\frac{1}{16}$ inch distant therefrom.

FIG. 2 represents the first stage in the engagement of the joint between edge regions **22** and **24**. The strip **20** is formed into a circular cylinder and edge region **22** is bent downward at a greater angle with the horizontal than edge region **24**, so that tongues **28** enter slots **26**. An end view of this engagement is represented by FIG. 3. It is evident from the figures that there is nothing to prevent tongues **28** from slipping backward out of slots **26**. However, this initial step of inserting tongues **28** into slots **26** is important because (a) it is readily effected by pressing edge regions **22** and **24** together in proper angular relationship; and (b) when accomplished, it prepares the way for the tucking in of tabs **32**, as represented in FIGS. 4 and 5, to form a rigidly interlocked connection.

FIG. 6 represents an exploded view of a former-fastener comprising a sleeve **38**, an engaging or forming guide **40**, a separator **42**, a tube or edge guide **44**, and a beveled locking or tucking roller **46** which is supported by locking roller mounting assembly **48**. FIG. 7 shows a pictorial view of the underside of engaging guide **40**, revealing how it is rounded so that when an edge portion **22** is forced against the underside of **40**, the tongues **28** will be pointed downward as indicated in FIG. 3, so that tongues **28** enter slots **26**. FIG. 8 is an end view of tube guide **44**. It shows that, in addition to an upper

slot for receiving separator 42, tube guide 44 has a horizontal lower slot. This slot is for receiving the edge portion 26 of the strip material 20. FIG. 9 represents the former-fastener assembled with strip material 20 in place. In such case the edge portion 26 of strip 20 is in the horizontal slot of tube guide 44; and the remainder of strip 20 extends in a counter-clockwise direction around the inside of sleeve 38, extending up over separator 42 with edge portion 22 coming against the underside of the curved portion of engaging guide 40, so that tongues 28 are pointed down toward slots 26. Edge portion 22 extends above separator 42 and tube guide 44. As strip 20 is advanced in the direction indicated by the arrow, the taper of engaging guide 40 causes tongues 28 to be inserted in slots 26, as represented in FIG. 2. Further advance causes the thus inserted tongues 28 to pass in the vicinity of locking roller 46. Locking roller 46 is so located that it bears upon tabs 32 as they pass beneath it, tucking tabs 32 beneath the edge of slot 26, as represented in FIG. 4. Thus by feeding the strip 20 in the direction shown by the arrow of FIG. 9, the strip is edge joined to form a tubular structure. If the motion of the strip is reversed, separator 42 releases the joints of tongues 28 and 32 with slots 26, snapping the tongues out past the edges of slots 26 (somewhat as an inserted index finger peels an orange) and returning the strip to its original flat condition.

For use with the dimensions given for the embodiment found satisfactory, sleeve 38 was two inches in outside diameter with a wall ⅛ inch thick and was about six and one-half inches long. Locking wheel 46 was beveled to a sharp edge and was about three-eighths inch in diameter.

It is apparent that the particular mode of edge fastening is not confined to formation of cylinders from a single piece, but could also be used to fasten two different pieces appropriately punched and trimmed. In such case, since it is necessary to provide a force tending to cause tongues 28 to slip into slots 26, and, at least initially, to secure proper registry between slots 26 and the tongues 28 and 32, it would be feasible and desirable to feed the respective punched and trimmed parts by means of sprockets having suitable protrusions to engage slots 26, for the one edge, and slots 30 or 34, for the other. From my disclosure it should be apparent that, while it is convenient to have perforations 26 collinear, that is, with their corresponding long edges in line and to have tongues 28 similarly collinear lengthwise, it is not necessary for the use of the fastening configuration I disclose that this be true. So long as suitable relative motion of the material portion bearing the first perforations 26 and of the material portion bearing the tongues 28 and 32 will permit tongues 28 to enter perforations 26 and tongues 32 to be tucked in also, perforations 26 may have arbitrary orientation. Thus, it is not even strictly necessary that the perforations be located at the edge of the sheet, although for use of an automatic former-fastener such as I have described, it is highly desirable.

For completeness, FIG. 10 represents schematically an installation for automatically extending and retracting a cylindrical mast or rigid member by my invention. A supply roll 50 running on bearings 52 and 54 carries a supply of strip 20. The punching and trimming of strip 20 is omitted because it has been amply represented elsewhere. A motor 56 drives drive rollers 58, supported by bearings 60 and 62. Idler bearings not visible through strip 20 bear against the part of strip 20 in contact with rollers 58, so that rotation of motor 56 and rollers 58 will advance or retract strip 20. When the strip 20 is advanced, it meets rollers 64 and 66 which, while not essential, are desirable to assist strip 20 in bowing toward cylindrical form so it can enter former-fastener 68 and be edge-fastened into an erected member 70. If the equipment shown in mounted in a space vehicle, member 70 may serve as a gravity-gradient stabilizer. If strip 20 is of an electrically conductive material, such as a springy metal, member 70 may serve as a stub antenna which may be driven by any of the many ways well known in the antenna art. Clearly, there are many uses for mast-like structures.

The material of strip 20 is not critical; paper, plastic, and metal have been found to work satisfactorily. There is no reason why a composite material such as plastic and metal should not function satisfactorily, provided that there is no great disparity between the properties of the edges to be joined. Obviously, a soft paper edge would tear if an attempt were made to join it with a very stiff metal edge with sharp-edged tongues.

The subdivision of claims into subparagraphs is for the purpose of facilitating reading and has no necessary relation to relationship or relative importance of the elements recited therein.

What is claimed is:

1. Fastening means comprising:
female means comprising a first portion of material of given thickness
perforated with first perforations whose length is greater than their width,
both the said length and said width being much larger than the said thickness of the first portion of material;
male means comprising a second portion of material having an edge from which protrude first tapered tongues whose distal end is shorter than the length of the said first perforations
perforated within the region adjacent to the said edge with second perforations having at their edges closer to the said first tongues
second tapered tongues extending into the apertures of the said second perforations in a direction opposite from that in which the said first tongues extend,
the distance between the base of a first tongue and the base of an opposed second tongue being not greater than the width of a first perforation,
the spacing and orientation of the said perforations and tongues being such that
the lengths of the said first and second tongues and the said second perforations are parallel to each other,
a first tongue and a second tongue lie between the lines tangent to the opposite ends of a second perforation and normal to its length, and
the said first tongues may, by relative motion of the said first portion of material and the said second portion of material, be caused to enter into the said first perforations, each of the said second tongues being positioned medially of an associated said second aperture and having a length such as to provide sufficient space thereabove and therebelow to enable use of roller type tongue tucking means therewith.

2. Fastening means as claimed in claim 1, in which
the said first perforations are collinear lengthwise, of equal lengths, and uniformly spaced in the direction of their lengths;
the said first tapered tongues at their bases are collinear lengthwise, of equal lengths.

3. As a new product, a strip of material comprising the fastening means claimed in claim 1.

4. A former-fastener for fastening protruding-tongued and reentrant-tongued strip edges to perforated strip edges, comprising
guide means for guiding the perforated strip edges;
forming means for forming the said strip into an approximately circular shape and to constrict the said tongued edge to cause the therefrom protruding

tongues to enter the perforations of the said perforated edge;

tucking means for tucking the reentrant tongues of the said tongued edge into the perforations of the said perforated edge.

5. A former-fastener as claimed in claim 4 in which a separator extends between the said guide means and the said forming means.

6. The method of forming a rigid tubular collapsible structure which comprises the steps of

providing a supply of flexible strip material perforated and shaped into opposed protruding and reentrant tongues in the vicinity of its edges to permit joining of opposite edges of the said strip by insertion of tongues in perforations;

advancing the said flexible strip material

between forming means to form the said strip into an approximately circular shape and to constrict the said strip to cause some said protruding tongues to enter some first said perforations and then between tucking means to tuck said re-

entrant tongues associated with said some protruding tongues into some first said perforations;

advancing the said flexible material thence to protrude as a rigid tubular structure;

retracting the said flexible strip material over a separating finger to remove said tongues from said first perforations, to collapse said rigid tubular structure, and

returning the said flexible strip material to the said supply.

References Cited

UNITED STATES PATENTS

161,409	3/1875	Hardman	24—20
450,142	4/1891	Davidson et al.	138—199
638,261	12/1899	McCool	138—166
2,025,201	12/1935	Graham	229—21 X
2,698,031	12/1954	Primich	138—167
2,960,561	11/1960	Plummer	138—168 X
3,092,530	6/1963	Plummer	138—166 X
3,250,077	5/1966	Ede	29—429 X

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