Jan. 8, 1957 L. E. ZERLAUT 2,776,697

FLEXIBLE MANDREL

Filed March 24, 1955

FIG_1

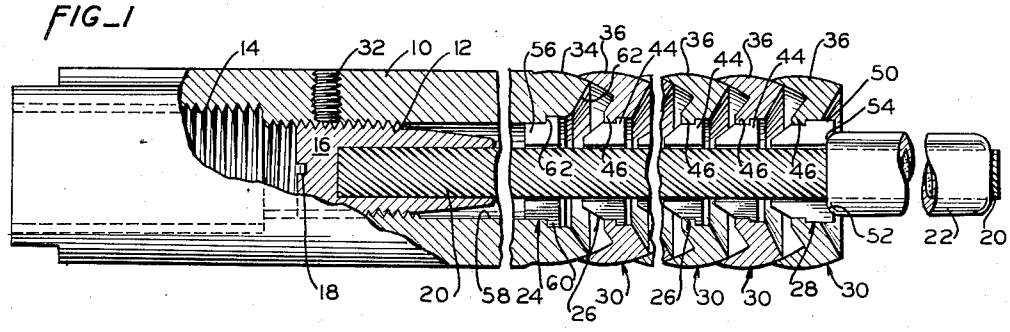


FIG_2

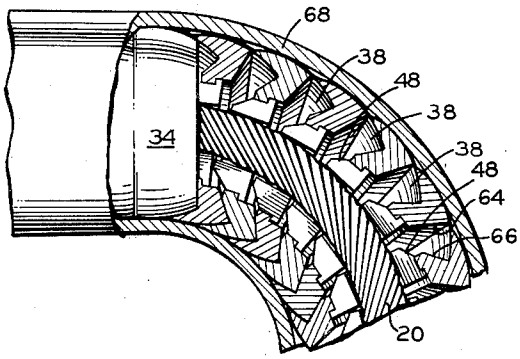


FIG_3

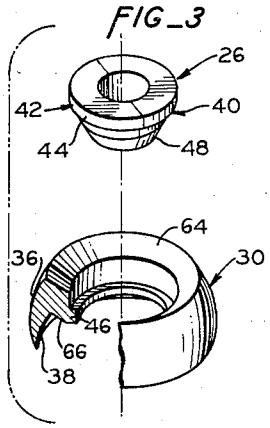
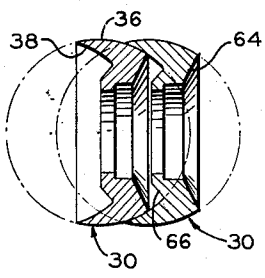


FIG_4



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FLEXIBLE MANDREL

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6 Claims. (Cl. 153—63)

This invention relates to flexible mandrels, and more particularly to an improved flexible mandrel adapted to be inserted within tubes and pipes to enable the bending thereof while preventing any objectionable deformation, such as kinking, of the tube or pipe.

The invention relates to a flexible mandrel of the general type shown in the patent to Stjarnstrom 1,856,597, i. e. a mandrel comprising a non-flexible portion adapted to be attached to a tube bending machine, a flexible portion comprising a cable and a plurality of complementary shaped spherical rings disposed thereon, an outer member fixedly attached to one end of the cable and serving as a retainer member for said rings, and means comprising a plug attached to the other end of the cable threadably engageable with said non-flexible portion.

The improvements over the mandrel of the mentioned patent comprise: the provision of cable-bearing inserts for the spherical rings adapted to center said rings on the cable and to cause said rings to efficiently articulate with respect to each other in response to bending movement of the cable; and the provision of means comprising split cable-bearing inserts enabling ready addition of spherical rings to the cable or removal therefrom, or the replacement of said rings with rings of different size, without the necessity of disassembling the cable assembly or of even disattaching said assembly from the non-flexible portion of the mandrel.

Various other objects and advantages of the invention will be apparent from the following description taken in conjunction with the drawing forming part of this specification, and in which:

Figure 1 is a view in diametral section of the improved mandrel of the invention;

Figure 2 is a view in diametral section of a portion of the mandrel, the same being shown within a bent tube;

Figure 3 is an attenuated view in perspective showing one of the spherical segments, which has been broken away for clarity of detail, and a split insert therefor; and

Figure 4 is a view in diametral section showing the complemental relationship of a pair of spherical semments.

With reference to the drawing, the mandrel comprises a non-flexible cylindrical portion **10** having a partially internally threaded bore **12** and an internally threaded counterbore **14**, the latter being adapted to be secured to an externally threaded spindle of tube bending apparatus, not shown, an externally threaded plug **16** adjustably disposed within bore **12** and having a cross slot **18** in the end thereof whereby said plug may be positionally adjusted rotatably by a screw driver, a flexible cable **20** having an end thereof fixedly secured within plug **16** and having fixedly secured to the other end thereof a cylindrical retainer member **22**, inserts indicated generally at **24**, **26** and **28** disposed in sleeved relation to cable **20**, and a plurality of spherical rings **30** sleeved on inserts **26** and **28**. The mandrel is further provided with a set screw **32** carried by the cylindrical portion **10** and adapted

to secure plug **16** against rotation when the latter has been adjusted to a desired position.

The end surface **34** of the cylindrical portion **10** and the external surfaces **36** of the rings **30** are spherical segments in form, as are the inner rearwardly directed surfaces **38** of the rings, with said surfaces being complemental to each other, as indicated in Figure 4.

The inserts **26** for the rings **30** are comprised of two half sections **40** and **42**, as shown in Figure 3, and said inserts are provided with flanges **44** at one end adapted to seat against inwardly directed annular shoulders **46** formed on the rings **30**. The rearwardly directed ends of the inserts **26** and the insert **28** are tapered, as indicated at **48**. Insert **28**, which, like the inserts **26**, is formed of two half sections, is provided with a flanged end **50** which is deeper than the flanges **44** of inserts **26**, with said flanged end **50** being provided in its forward face with an annular concavity **52** adapted to seat the annular convex peripheral end portion **54** of retainer member **22**. Insert **24**, likewise formed of two half sections, has a non-tapered rearward end **56** adapted to fit within the outer and non-threaded end portion **58** of bore **12** and has a flange **60** adapted to engage shoulder **62** formed in the cylindrical portion **10** of the mandrel.

The end surface **62** of the cylindrical portion **10** of the mandrel and the end surfaces **64** of the rings **30** are dished inwardly, while the ring are also provided with complemental dished surfaces **66**. When the surfaces **64** are all brought into contact with their associated surfaces **66** along lines of mutual engagement, as shown in the underside of Figure 2, wherein the mandrel is disposed within a tube **68** which has been bent, the mandrel is locked against further bending in the same direction and in the same plane, i. e. the plane mutually occupied by all of the lines of engagement of surfaces **64** and **66**. It will be appreciated that the mandrel, as shown in Figure 2, is universally movable in every direction but further straight downwardly.

In effect, the inserts, and particularly the inserts **26** and **28**, which move with the cable, constitute the centering means and the means for movably attaching the discs to the backbone, i. e. the rings **30** to the cable **20**, for ready and efficient vertebral movement.

Rings **30** can be added to or removed from the mandrel, or rings of one size can be substituted for another, by the simple expedient of rotating the plug **16** to move it toward the forward end of the cylindrical portion **10**, without moving the plug out of threaded engagement with bore **12**. For example, to remove the leading ring, it is only necessary to loosen the ring assembly in this manner a sufficient degree to enable the removal from between said ring and the retainer member **22** of the two half sections of the insert **28**. The leading ring is then slipped over the member **22**, since the rings have a larger internal diameter than the outside diameter of the retainer member. The two half sections of the first of the inserts **26** are then removed and replaced with the half sections of an end insert **28**, and the plug **16** is then threaded inwardly of mandrel portion **10** to bring the ring assembly to the end-wise tightened condition of Figure 1, in which condition the rings will readily slide over each other in a vertebral action upon a bending of the cable.

It will be appreciated that the bending of the cable causes the flanges **44** and **50** of the inserts **26** and **28** to positively pivot the rings relative to each other, while the rings remain individually centered with respect to the cable, by the engagement between said flanges **44** and **50** and the internal shoulders **46** of the rings.

What is claimed is:

1. A device of the class described comprising a flexible cable, a plurality of rings disposed on said cable, said

rings having spherical convex outside and spherical concave inside surface portions whereby said rings may be disposed in partially overlapping relation for vertebral movement on said cable and means for maintaining said rings in firm endwise engagement without inhibiting said vertebral movement comprising: an elongated member having a threaded bore, a plug secured to the inner end of said cable and adjustably disposed in threaded relation within said bore, a retainer member secured to the outer end of said cable, and a sleeve-like insert for each ring disposed concentrically of each ring in closely embracing relation with said cable, with each ring and insert therefor having complemental flange and shoulder means adapted to impart a positive vertebral movement to said rings upon flexure of said cable.

2. The device as set forth in claim 1, said retainer member having a maximum transverse dimension less than the minimum internal diametral dimension of said rings, and said inserts being each formed of two complemental half sections, whereby said rings may be removed from said cable by adjusting said plug within said bore to provide a degree of looseness between said rings sufficient to enable the removal from said cable of said inserts.

3. The device as set forth in claim 1, said rings having annular dished surface portions at their forward ends and surface portions at their rearward ends complemental to said dished surface portions.

4. The device as set forth in claim 3, said retainer member having a maximum transverse dimension less than the minimum internal diametral dimension of said rings, and said inserts being each formed of two complemental half sections, whereby said rings may be removed from said cable by adjusting said plug within said bore to provide a degree of looseness between said rings sufficient to enable the removal from said cable of said inserts.

5. In a device of the class described including a flexible cable, a plurality of alike rings on said cable having spherical convex outside and spherical concave inside surface portions whereby said rings may be disposed in partially overlapping relation for vertebral movement on said cable, an externally threaded plug fixed on one end of said cable, a retainer member for said rings secured to the other end of said cable, and holder means for threadably receiving said plug to place said cable under tension; the provision of sleeve-like inserts for said rings disposed concentrically of said rings in closely embracing relation with said cable, said inserts having radially projecting flanges at their forward ends seated on annular shoulders formed on said rings, with the insert disposed adjacent said retainer member being in reacting engagement with the rearward end thereof.

6. In a device of the class described as set forth in claim 5, said rings being adapted to be passed over said retainer member, and said inserts being formed of two complemental half sections for placement on and removal from said cable without necessitating the removal of said plug or said retainer member from said cable.

References Cited in the file of this patent

UNITED STATES PATENTS

174,609	Wright	Mar. 7, 1876
279,573	Leaycraft	June 19, 1883
650,049	Lynch	May 22, 1900
1,683,573	Mueller et al.	Sept. 4, 1928
1,748,158	Walp	Feb. 25, 1930
1,856,597	Stjarnstrom	May 3, 1932
2,425,298	Attridge et al.	Aug. 12, 1947
2,451,717	Check	Oct. 19, 1948
2,453,531	Meyers	Nov. 9, 1948