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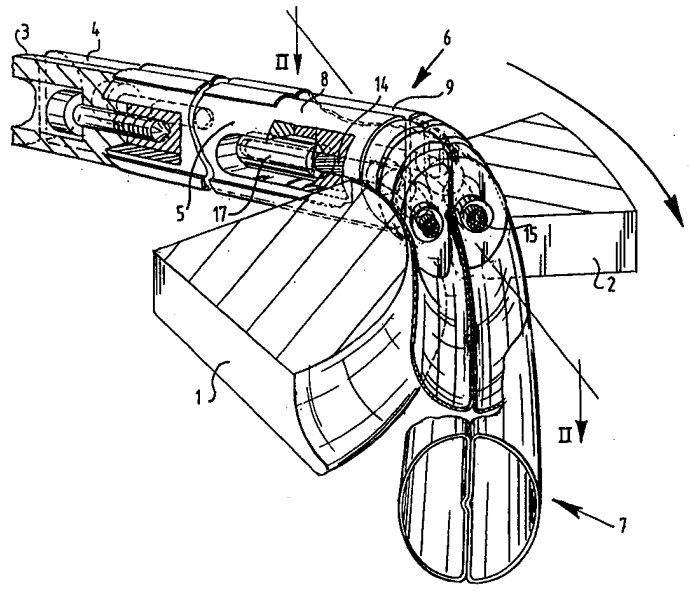
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(57) Abstract

The invention relates to a bending mandrel (5, 6) for bending tubes, comprising a main part (8, 9) movable at most in the axial direction of the tubes and an element (12) connected to the main part for pivoting in at least one plane, wherein the element is connected to the main part for pivoting in two mutually perpendicular planes. As a result of these measures the bending mandrel is not only bendable in the direction of the bend for bending but also in other directions so that, also during bending of bends connecting directly onto each other and not located in the same plane and the bending of composite tubes with an interface not extending perpendicularly of the bending direction, the advantage of an articulated bending mandrel are also obtained.

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BENDING MANDREL

The present invention relates to a bending mandrel for bending tubes, comprising a main part movable at most in the axial direction of the tube and an element connected to the main part for pivoting in at least one plane.

Such a bending mandrel is known from EP-A-0 406 969.

This known bending mandrel is used for bending pipes, wherein the presence of the bending mandrel prevents the outer wall of the pipe for bending being distorted inward during the bending. The presence of the bending mandrel prevents the outer wall of the pipe being subjected to bending from displacing inward. The outer wall is stretched by the bending so that it will tend to displace inward.

On the inside the effect is the reverse; the material is buckled so that it tends to displace inward as a result of the excess of material.

These problems are obviated by the use of a bending mandrel, in particular a pivotable bending mandrel.

This bending mandrel of the prior art operates well in the bending of tubes in a single direction; that is, when bending tubes with the bend located in only a single plane. However, when tubes must be bent with two bends connecting directly onto each other and located in different planes, the problem occurs that the bending mandrel cannot extend as far as wished into the pipe, so that the advantages of the bending mandrel are not fully utilized.

In the bending of composite tubes, for instance tubes with a DD section, the same problem occurs when the separating plane of the two tube chambers does not extend perpendicularly of the direction of the bend.

In such a configuration it is in any case not possible to make use of the bending mandrel of the prior art.

The object of the present invention is to provide a bending mandrel with which the above stated drawbacks are avoided.

This object is achieved in that the element is connected to the main part for pivoting in two mutually perpendicular planes.

As a result of these measures the bending mandrel is not only bendable in the direction of the bend for bending but also in other directions so that, also during bending of bends connecting directly onto each other and not located in the same plane and the bending of composite tubes with a boundary plane not extending perpendicularly of the bending direction, the advantages of an articulated bending mandrel are also obtained.

According to a first preferred embodiment the element is separated from the main part by means of an at least partially spherical body. This results in a simple, attractive construction.

The same advantage also applies when the at least partially spherical body is fixedly connected to the main part or to the element.

It will be apparent that the bending mandrel can be inserted further into the pipe for bending and can thus provide support over a larger part of the area when the bending mandrel comprises more than one element and each of the elements is connected to the preceding element for pivoting in two mutually perpendicular planes.

According to yet another preferred embodiment the elements are connected mutually and to the main part by means of an elongate, flexible body, for instance a steel cable.

Other attractive preferred embodiments are stated in the remaining sub-claims.

The present invention will be elucidated hereinbelow with reference to the annexed drawings, in which:

figure 1 shows a partly broken away, schematic perspective view of a bending machine provided with a bending mandrel according to the present invention;

figure 2 shows a section along the arrow II in figure 1; and

figure 3 shows a partly broken away perspective view of a second embodiment of a bending mandrel according to the invention.

Shown schematically in figure 1 is a bending machine in the form of a bending mould 1, only the lower half of which is shown, and a pressure piece 2, of which likewise only the lower half is shown. In the present case the bending machine further comprises two rods 3,4 which on their severed ends (not shown) are connected to the bending machine and which are connected on their shown ends to two bending mandrels 5,6 according to the present invention.

The embodiment shown in this drawing is suitable for bending a composite tube with a DD configuration. Such a tube finds application for instance as exhaust for motor vehicles, wherein the ducts connected to the emission ports of different cylinders must be separated over the greatest possible distance to prevent feedback of exhaust gases.

As also shown in figure 2, each of the bending mandrels 5,6 is formed by a main body 8 respectively 9 which is connected by means of balls 10 respectively 11 to loose elements 12 respectively 13. The loose elements 12 and 13 are also mutually connected by balls 10 and 11. Due to the presence of the balls it is possible for the elements 12 to pivot in two directions relative to each other and relative to main part 8. The same applies for elements 13 relative to main part 9.

It will be apparent that it is possible to replace the balls 10 by bodies fixedly mounted on elements 12 or on main body 8. It is important herein that the elements are separated mutually and from the main body by surfaces enabling rotation in two directions, thus preferably spherical surfaces; it will be apparent that other constructions are also possible, for instance hinges with two different rotation shafts.

Since the balls cannot absorb tensile forces, separate measures must be taken for this purpose.

In the embodiment shown in figures 1 and 2 these measures consist of arranging a cable 14 respectively 15 which are provided on one end with a collar 16 and which at the other end run out into a compression body 17 received in main part 8 respectively 9.

In the embodiment shown in figures 1 and 2 there is only one cable 14 respectively 15 extending through each of the elements 12 respectively 13 and each of the balls 10 respectively 11.

It is however also possible to make use of an embodiment as shown in figure 3, wherein the cable is placed in a loop and thus extends twice through each of the elements 12 respectively 13. Both outer ends are connected on one side of the loop by means of a collar 18.

CLAIMS

1. Bending mandrel for bending tubes, comprising a main part movable at most in the axial direction of the tube and an element connected to the main part for pivoting in at least one plane, **characterized in that** the element is connected to the main part for pivoting in two mutually perpendicular planes.

2. Bending mandrel as claimed in claim 1, **characterized in that** the element is separated from the main part by means of an at least partially spherical body.

3. Bending mandrel as claimed in claim 2, **characterized in that** the at least partially spherical body is fixedly connected to the main part or to the element.

4. Bending mandrel as claimed in claim 1, 2 or 3, **characterized in that** the bending mandrel comprises more than one element and that each of the elements is connected to the preceding element for pivoting in two mutually perpendicular planes.

5. Bending mandrel as claimed in any of the foregoing claims, **characterized in that** the elements are connected mutually and to the main part by means of an elongate, flexible body, for instance a steel cable.

6. Bending mandrel as claimed in claim 5, **characterized in that** the elongate, flexible body extends through all elements and the main part.

7. Bending mandrel as claimed in claim 5 or 6, **characterized in that** the flexible body extends through the spherical bodies.

8. Bending mandrel as claimed in claim 5 or 6, **characterized in that** the flexible body extends adjacently of the spherical bodies.

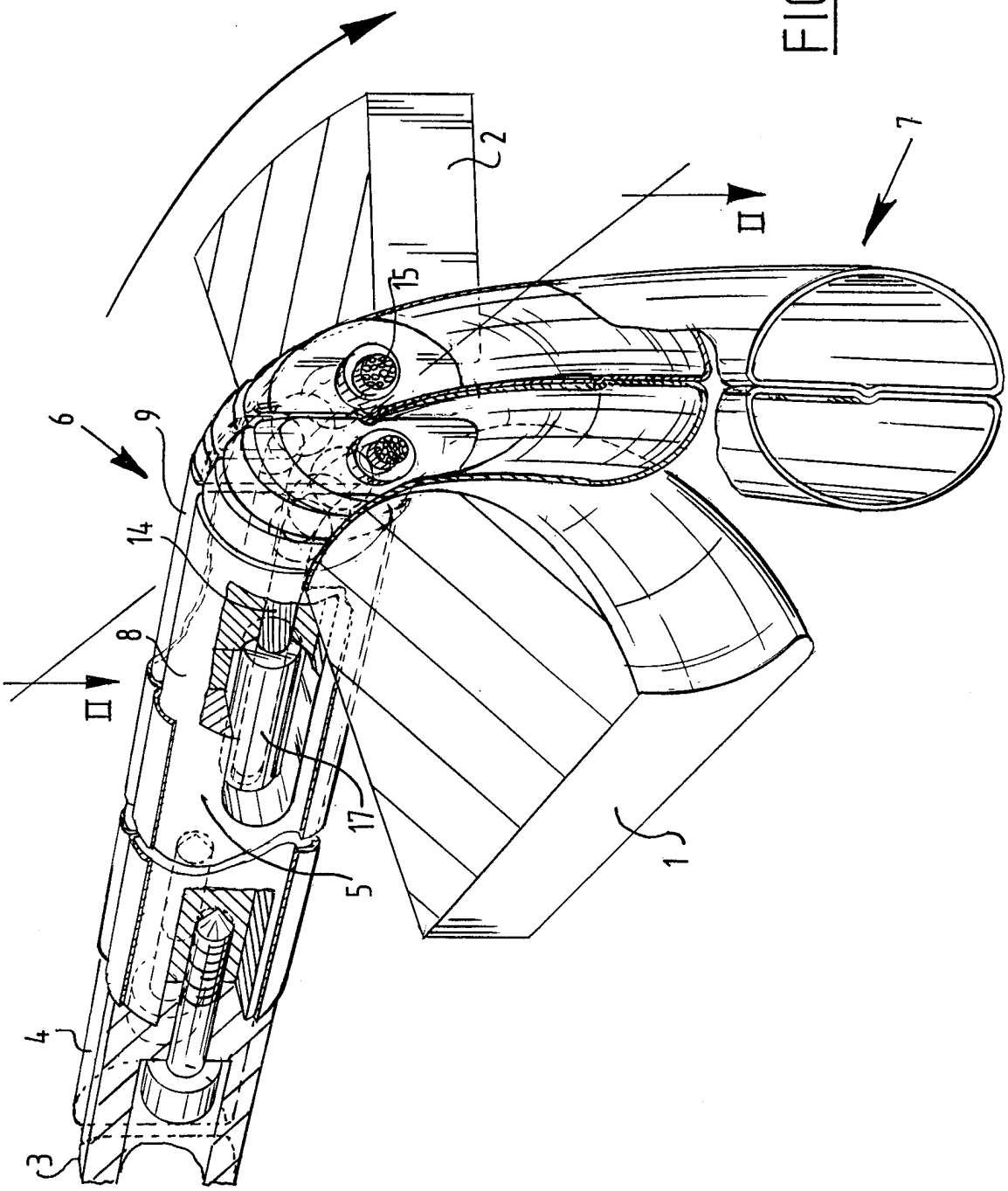
9. Bending mandrel as claimed in claim 8, **characterized in that** the flexible body has the configuration of a loop and extends on either side of the spherical bodies.

10. Bending mandrel as claimed in any of the foregoing claims, **characterized in that** the bending mandrel is

adapted to bend a composite pipe in that the bending mandrel comprises more than one main body and each of the main bodies is connected to at least one element.

11. Bending device for bending pipes, **characterized in that** the bending device comprises at least one bending mandrel as claimed in any of the foregoing claims.

FIG.1



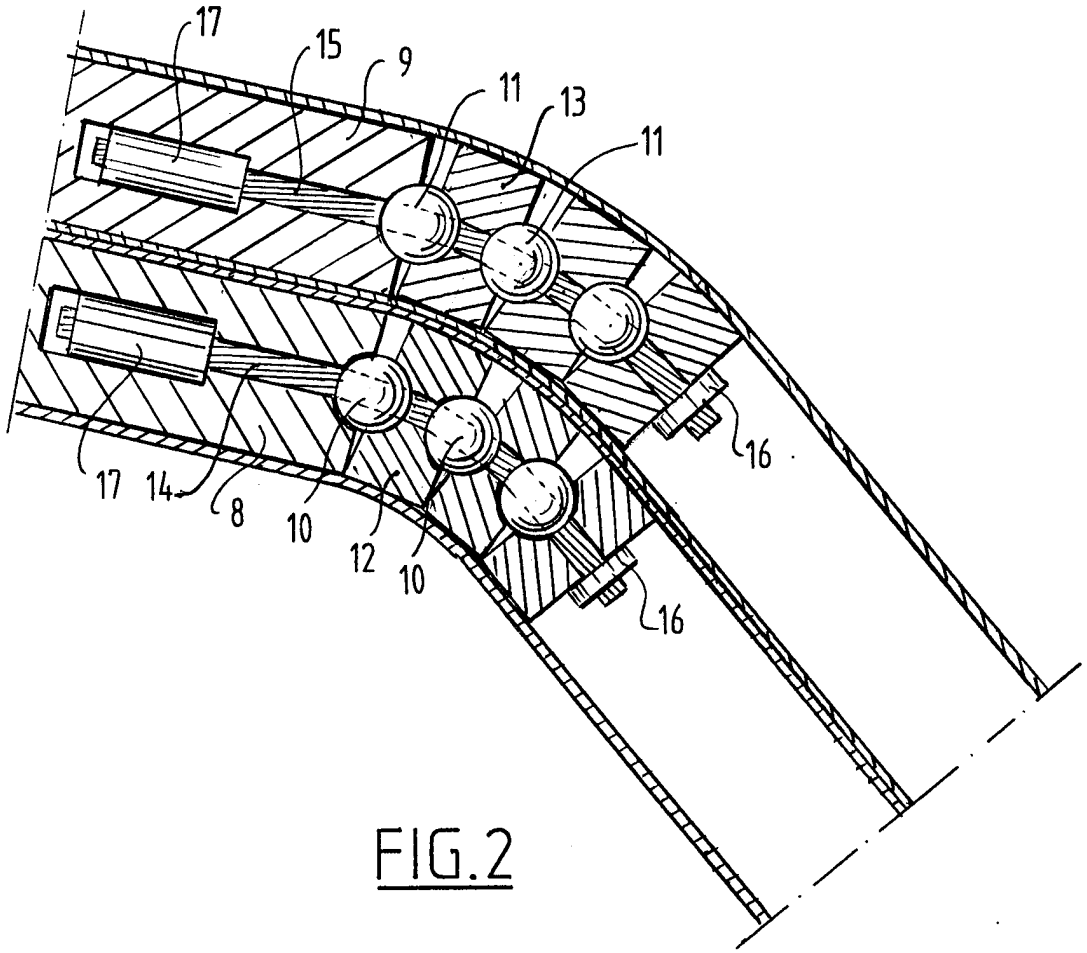


FIG.2

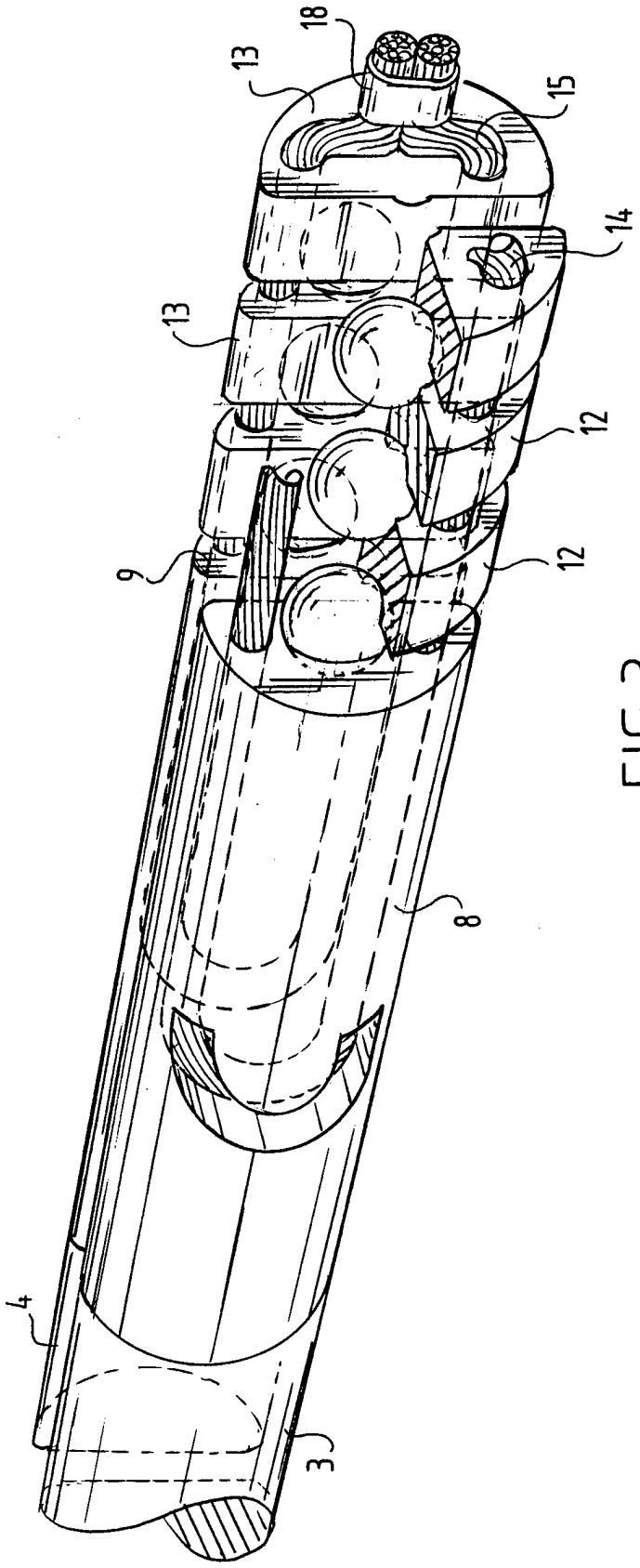


FIG.3

INTERNATIONAL SEARCH REPORT

Inte onal Application No
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A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B21D9/03

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B21D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 30 00 170 A (ECKOLD W AG) 9 July 1981 see figure 2	1,2,4-7, 11
X	US 2 825 386 A (WESTERN ELECTRIC COMP.) 4 March 1958 see the whole document	1-6,8,9, 11
X	GB 2 097 854 A (PRESSBEND LTD) 10 November 1982 see the whole document	1-4,11
X	US 4 671 096 A (CROSBY JR CHARLIE P) 9 June 1987 see the whole document	1,2,4-7, 11

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
19 January 1998	11/03/1998

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	PATENT ABSTRACTS OF JAPAN vol. 018, no. 498 (M-1675), 19 September 1994 -& JP 06 170449 A (FURUKAWA ALUM CO LTD), 21 June 1994, see abstract -----	10

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...formation on patent family members

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