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(71) Applicant: **KABUSHIKI KAISHA OPTON**
Aichi 489-8645 (JP)

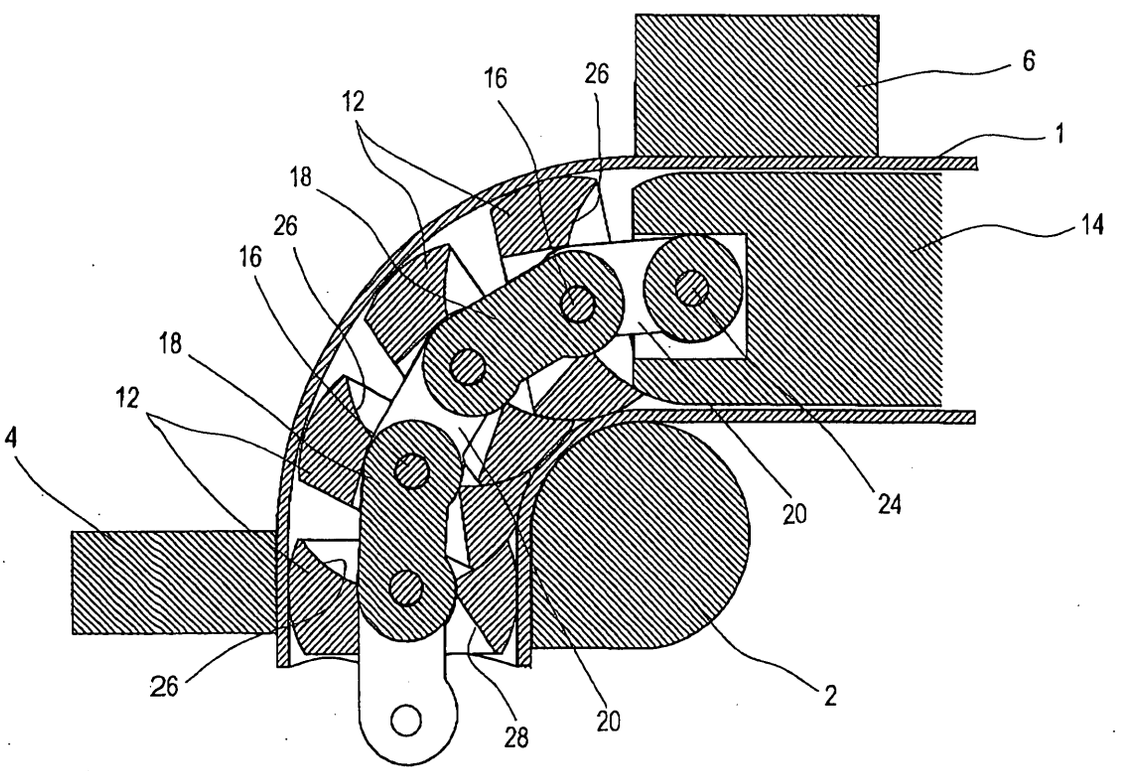
(72) Inventor: **Yogo, Teruaki,**
c/o Kabushiki Kaisha Opton
Seto-shi, Aichi 489-8645 (JP)

(74) Representative: **Liesegang, Roland, Dr.-Ing. et al**
FORRESTER & BOEHMERT
Pettenkoferstrasse 20-22
80336 München (DE)

(54) Mandrel for bending

(57) A mandrel for bending of simple construction and sufficient rigidity is obtained. The mandrel comprises a plurality of plugs (12). Each plug is provided with a spherical outer peripheral surface. A fulcrum pin (16) is fitted through the plug. The first and second link members (18,20,22) are rotatably attached to the fulcrum pins of the neighboring plugs so as to connect the neighboring plugs. The plug is also provided with a spherical depression which the adjoining plug can enter during the bending. The plugs are connected to the shank (14) via the second link members.

FIG.3



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Description

FIELD OF THE INVENTION

[0001] This invention relates to a mandrel for bending which inhibits formation of irregularities at a bending part of a pipe during the bending process.

BACKGROUND OF THE INVENTION

[0002] Unexamined Japanese Utility Model Publication No. 6-41921 and Unexamined Japanese Patent Publication No. 7-290156 disclose a known conventional mandrel for bending comprising a plurality of plugs coupled in series onto an end of a shank. As can be seen in Fig. 4, the outer peripheral surface of each plug 50 is formed to be spherical and a connection shaft 52 is inserted through the center of the plug 50. The connection shaft 52 is provided with a spherical part 54 at one end and a spherical depression 56 at the other end.

[0003] The spherical part 54 of the connection shaft 52 is fitted into the spherical depression 56 of another connection shaft 52, which thus constitutes an adjustable joint. In this manner, a plurality of plugs 50 are connected in series. Moreover, the shank 58 is provided with a spherical depression 60 which is identical to the spherical depression 56. The spherical part 54 of the terminal connection shaft 52 is fitted into the depression 60 so that all the plugs 50 are connected to the shank 58.

[0004] When bending is performed, the plugs 50 are inserted into a pipe 62 to be arranged at the bending part. While the bending is performed, the spherical parts 54 rotate within the spherical depressions 56, 60 and the plugs 50 are waggled along the bending direction. As a result, spaces between the respective plugs 50 are narrowed and the outer peripheral surfaces of the plugs 50 are abutted to the inner wall of the pipe 62 in a concentrated manner on the inside of the bend. Thus, formation of irregularities, such as wrinkles, on the inside of the bend is inhibited.

SUMMARY OF THE INVENTION

[0005] However, as shown in Fig. 4, in the case of bending using the conventional mandrel as above, it is necessary to create the spherical part 54 at one end and the spherical depression 56 at the other end of the connection shaft 52. Such construction is complex and is not easy to produce. Moreover, the plug 50 has to be fixed to the connection shaft 52. There is a problem that sufficient rigidity may not possibly be obtained.

[0006] One object of the present invention is to provide a mandrel for bending having simple construction and sufficient rigidity.

[0007] To attain this and other objects, the present invention provides a mandrel for bending which inhibits formation of irregularities of a pipe by arranging plugs at a bending part within the pipe. The mandrel comprises a plurality of plugs. Each plug is provided with a spherical outer peripheral surface. A fulcrum pin is fitted through the plug. A link mechanism is rotatably attached to the fulcrum pins of neighboring plugs for connection therebetween. Each plug is provided with a depression which the adjoining plug can enter during the bending process.

[0008] The mandrel for bending constituted as above is simple in construction and can achieve high rigidity.

[0009] The plugs may be connected to a shank via the link mechanism. The depressions may be formed to be spherical.

BRIEF DESCRIPTION OF THE DRAWING FIGURES

[0010] The invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Fig. 1 is a cross-sectional view of a mandrel for bending according to an embodiment of the present invention before bending;
Fig. 2 is a cross-sectional view taken along the line II-II in Fig. 1;
Fig. 3 is a cross-sectional view of the mandrel for bending according to the embodiment after bending; and
Fig. 4 is a cross-sectional view of a conventional mandrel for bending after bending.

DETAILED DESCRIPTION OF THE INVENTION

[0011] As shown in Fig. 1, a pipe 1 is arranged to be brought into contact with the outer periphery of a bend die 2 which is designed to bend the pipe 1 at a desired angle. Facing to the bend die 2, a clamp die 4 is provided so that the pipe 1 is held between the bend die 2 and the clamp die 4. While the bending is performed, the bend die 2 rotates and the clamp die 4 moves around the bend die 2. A pressure die 6 is also provided in line with the clamp die 4. The pressure die 6 receives bending reaction force induced while the pipe 1 is being bent.

[0012] A mandrel 10 for bending is inserted into the pipe 1. The mandrel 10 is composed of a plurality of plugs 12 and a shank 14. Each plug 12 is provided with an outer peripheral surface formed to be spherical. A fulcrum pin 16 is piercingly fitted into the plug 12 through the center of the spherical outer peripheral surface of the plug 12.

[0013] To the fulcrum pin 16, a link mechanism including a first link member 18 and a pair of second link members 20, 22 is rotatably attached. Both the first and second link members are formed into a plate. In the present embodiment, one end of the first link member 18 is rotatably attached to the fulcrum pin 16 of the plug 12 and the other end of the first link member 18 is rotatably attached to the fulcrum pin 16 of the adjoining plug 12 for connecting the two neighboring plugs 12.

[0014] As can be seen in Fig. 2, one ends of the second link members 20, 22 are rotatably attached to the same fulcrum pin 16 to which the other end of the first link member 18 is attached. The other ends of the second link members 20, 22 are rotatably attached to the fulcrum pin 16 piercing the adjoining plug 12, to which one end of another first link member 18 is rotatably attached. In other words, between the one ends of the second link members 20, 22, the other end of the first link member 18 is held, and between the other ends of the second link members 20, 22, the one end of the another first link member 18 are held, so that the two neighboring plugs 12 connected via the first link member 18 are coupled with another two neighboring plugs 12, connected in the same manner, via a pair of second link members 20, 22.

[0015] The other end of this another first link member 18 is rotatably attached to the fulcrum pin 16 of the further adjoining plug 12. By repetition of the above, a plurality of plugs 12, that is, four in the present embodiment, are connected to each other via the first link members 18 and the second link members 20, 22. Also, a fulcrum pin 24 similar to the fulcrum pin 16 is fitted through the shank 14. One ends of the second link members 20, 22 which are connected to the terminal plug 12 at the other ends are rotatably attached to the shank via the fulcrum pin 24.

[0016] Each plug 12 is provided with a spherical depression 26 which the adjoining plug 12 can enter. The spherical depression 26 is formed a little larger than the spherical outer peripheral surface of the plug 12. In the present embodiment, the distance between the fulcrum pins 16 of two neighboring plugs 12 is substantially equal to or a little larger than the radius of the spherical outer peripheral surface of the plug 12.

[0017] Accordingly, the center of the spherical depression 26 and the center of the spherical outer peripheral surface of the adjoining plug 12 are almost the same. Additionally, the shank 14 is also provided with a spherical outer peripheral surface which is identical to the outer peripheral surface of the plug 12, on the side where there is the plug 12.

[0018] The diameter of the outer peripheral surface of the plug 12 is a little smaller than the internal diameter of the pipe 1 so that the plug 12 can be inserted into the pipe 1. The plug 12 is formed by cutting a sphere at both ends, leaving a central portion having a thickness substantially equal to the radius of the sphere. A plurality of plugs 12 are arranged with a little space therebetween in the thickness direction.

[0019] On the side of the plug 12 opposite to the side where there is the spherical depression 26, a cut-off depression 28 is formed in such a manner that the plug 12, the first link member 18, and the second link members 20, 22 can together rotate on the fulcrum pin 16. In the present embodiment, the cut-off depression 28 is designed to allow rotation to only one direction.

[0020] Now, operation of the mandrel 10 for bending of the present invention will be explained.

[0021] Firstly, as shown in Fig. 1, a pipe 1 is held between the bend die 2 and the clamp die 4. The pressure die 6 is abutted to the pipe 1. Next, the mandrel 10 for bending comprising a plurality of plugs 12 is inserted into the pipe 1. At the time of the insertion, each plug 12 is disposed in such a manner that the side with the cut-off depression 28 faces to the inside of the bend.

[0022] While the bend die 2 is rotated on its axis, the clamp die 4 is rotated around the bend die 2. As a result, the pipe 1 is wound around the bend die 2, resulting in that the outside of the bend is stretched and the inside of the bend is compressed at the bending part of the pipe 1.

[0023] As shown in Fig. 3, in the mandrel 10 for bending, the plugs 12, the first link members 18, and the second link members 20, 22 together rotate on the respective fulcrum pins 16. The spaces between the plugs 12 are expanded on the outside of the bend and are narrowed on the inside of the bend. As a result, on the inside of the bend, the outer peripheral surface of the plug 12 moves into the depression 26 of the adjoining plug 12 and the plugs 12 are closely abutted to each other so that no space is left between the neighboring plugs 12. Accordingly, even if the pipe 1 is compressed on the inside of the bend during the bending, formation of irregularities like formation of wrinkles cannot be promoted.

[0024] Moreover, the respective plugs 12 are connected via the fulcrum pins 16, the first link members 18, and the second link members 20, 22. Therefore, the construction is simple. Even if large external force is applied to the respective plugs 12, the plugs 12 are supported by the fulcrum pins 16, the first link members 18, and the second link members 20, 22. Accordingly, the rigidity is high enough to be capable of inhibiting damages.

[0025] The present invention is not limited to the above embodiment, and other modifications and variations are possible within the scope of the present invention.

[0026] The features disclosed in the foregoing description, in the claims and/or in the accompanying drawings may, both separately and in any combination thereof, be material for realising the invention in diverse forms thereof.

Claims

1. A mandrel for bending a pipe, comprising

a plurality of plugs, each plug being provided with a spherical outer peripheral surface,
a fulcrum pin being fitted through the plug, and
a link mechanism being rotatably attached to the fulcrum pins of the neighboring plugs so as to connect the neighboring plugs,

wherein each plug is provided with a depression which the adjoining plug can enter during the bending process.

2. The mandrel for bending as set forth in claim 1, wherein said plugs are connected to a shank via the link mechanism.

3. The mandrel for bending as set forth in claim 1, wherein said depression is spherical.

4. The mandrel for bending as set forth in claim 1, wherein said link mechanism comprises

a plate-like first link member which connects two neighboring plugs, and
a plate-like second link member which connects one of said two neighboring plugs with another plug which adjoins said one of two neighboring plugs.

5. The mandrel for bending as set forth in claim 4, wherein said second link members are provided in pairs and the first link member is arranged to be held therebetween.

6. The mandrel for bending as set forth in claim 4, wherein said plug is provided with a rotation restriction mechanism which restricts the rotation of the first link member around the fulcrum pin of the plug to regulate a bending direction of the mandrel during the bending process.

FIG.1

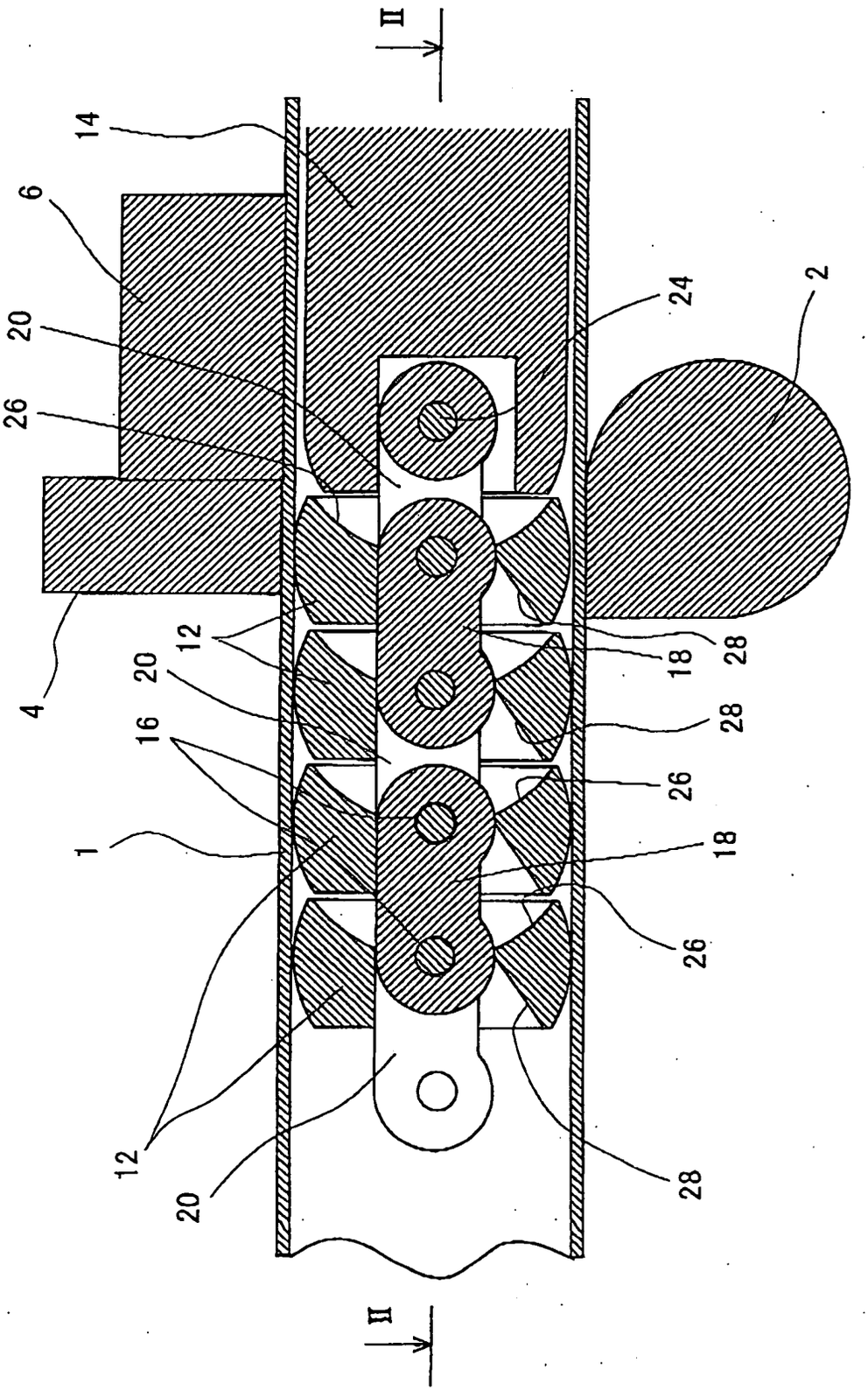


FIG.2

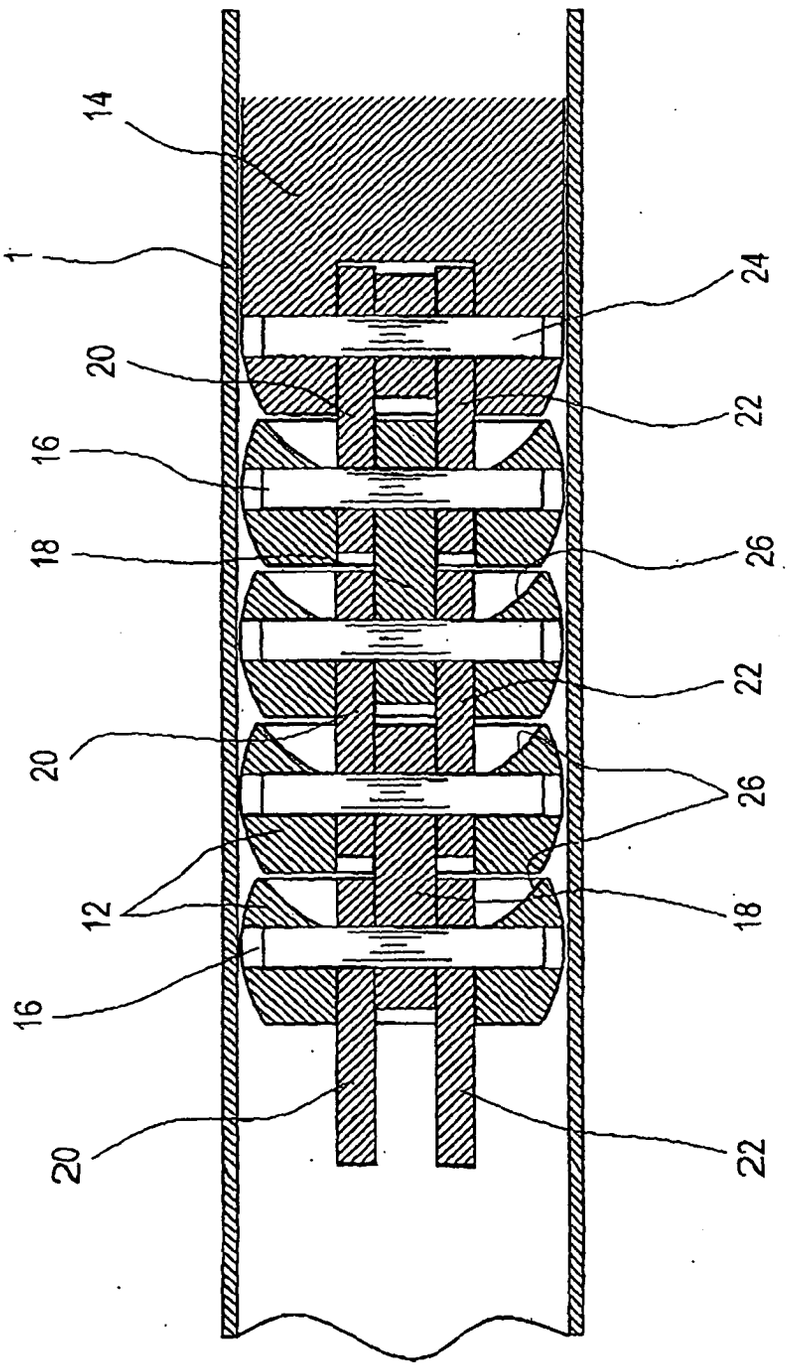


FIG.3

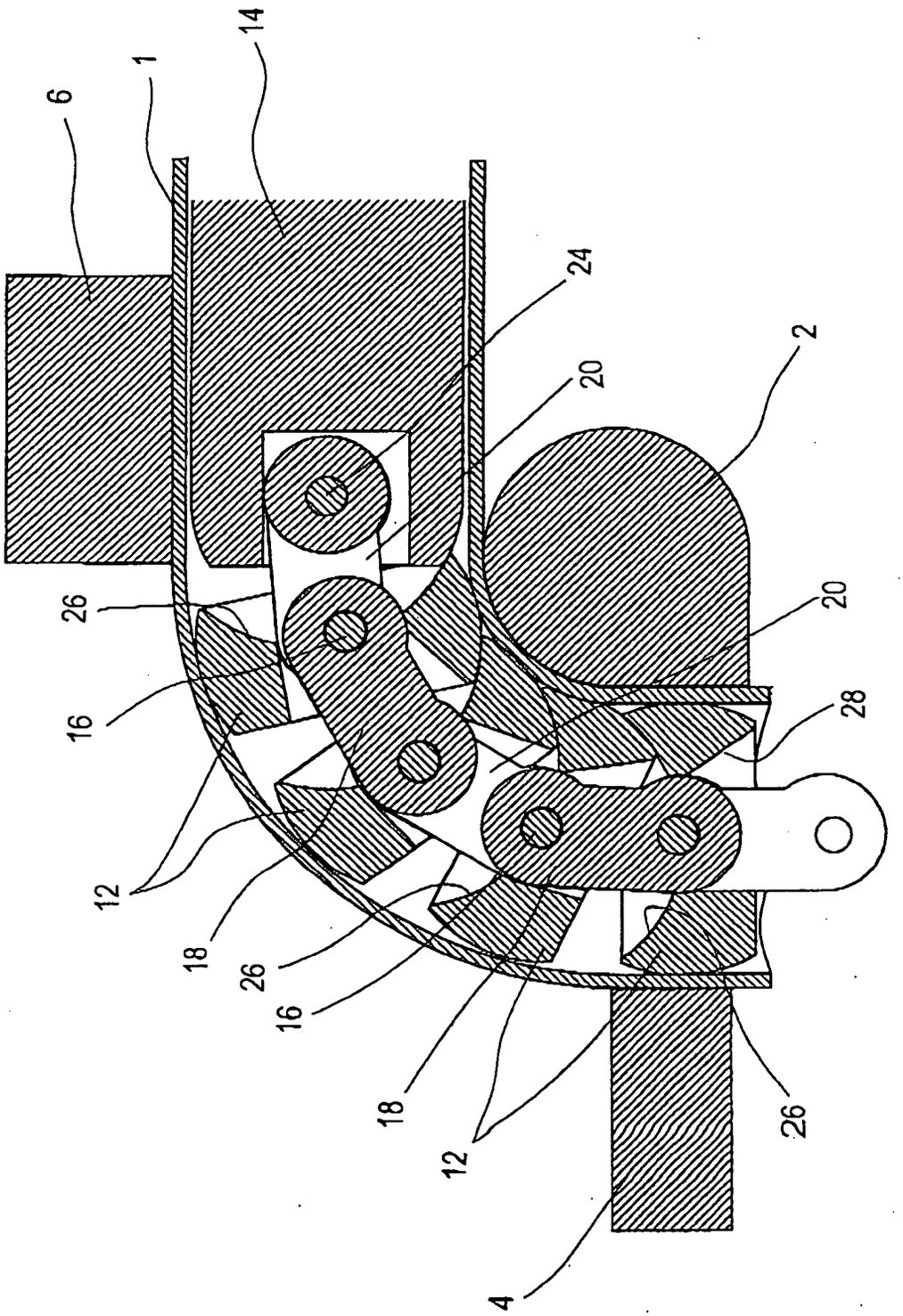
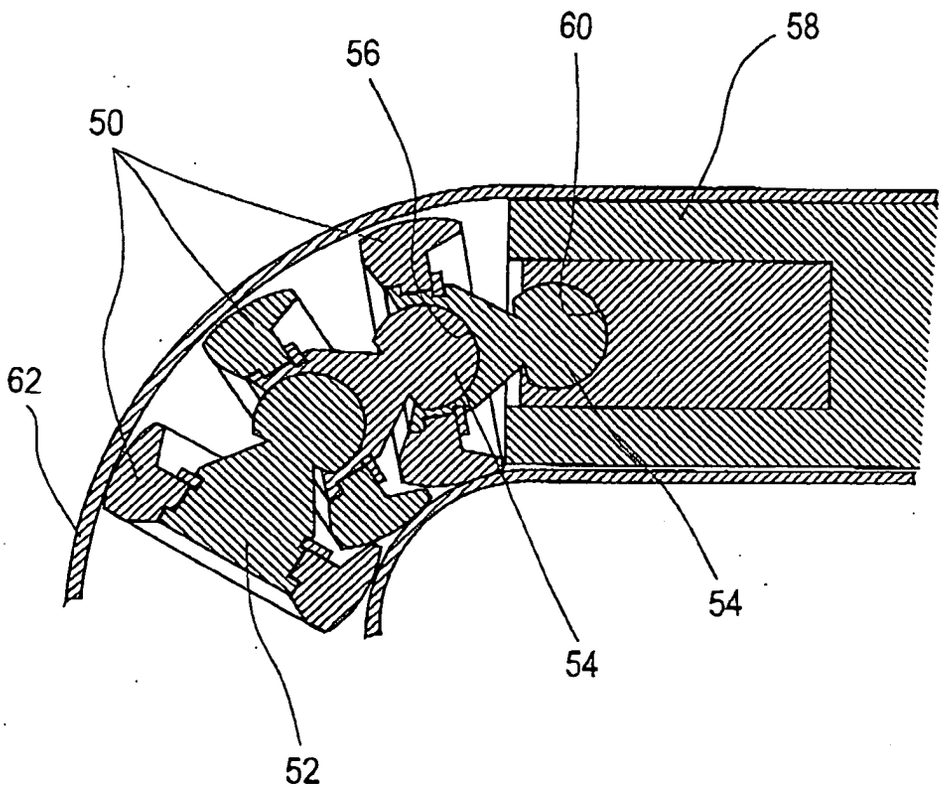


FIG.4



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EUROPEAN SEARCH REPORT

Application Number
EP 04 01 4189

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	FR 2 248 683 A (IND MECCA BREV PEDRAZZOLI) 16 May 1975 (1975-05-16) * the whole document *	1-6	B21D9/03
A,D	PATENT ABSTRACTS OF JAPAN vol. 1996, no. 03, 29 March 1996 (1996-03-29) -& JP 07 290156 A (SEKISUI CHEM CO LTD), 7 November 1995 (1995-11-07) * abstract *	1-3	

TECHNICAL FIELDS SEARCHED (Int.Cl.7)

B21D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	10 August 2004	Meritano, L

CATEGORY OF CITED DOCUMENTS

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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10-08-2004

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82