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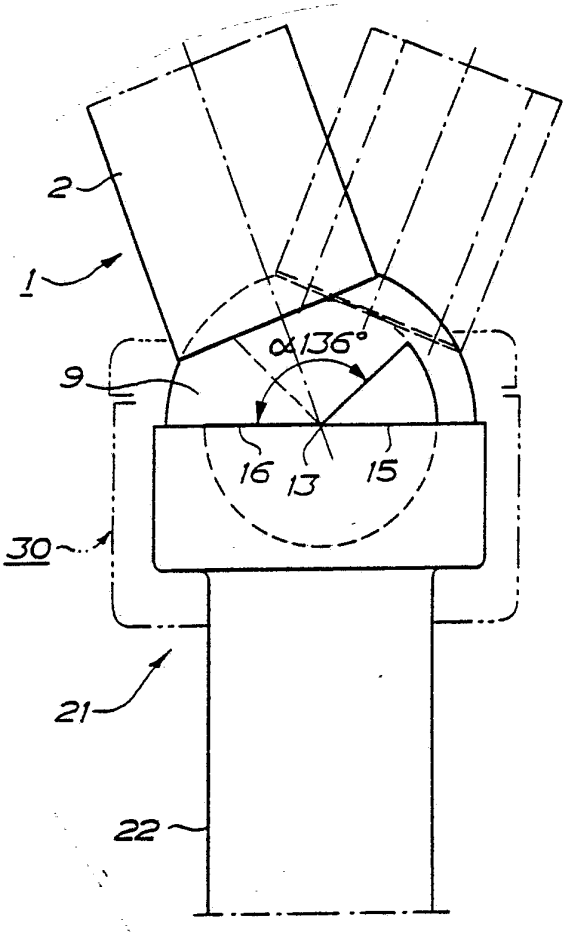
(57) Abstract

A flexible pipe joint of the ball and socket type, comprising a ball member (1) with a through central opening, a socket member (21) with a through central opening, and connecting means (30) pivotally interconnecting the ball member and the socket member. The pivoting of the ball member in the socket member is positively restrained to a single pivot axis by flat surfaces on the ball and socket members engaging each other.



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FLEXIBLE PIPE JOINT

The present invention relates to a flexible pipe joint of the ball and socket type, comprising a ball member with a through central opening, and connecting means pivotally interconnecting the ball member and the socket member.

A pipe joint of this type is disclosed in DE-A-1 650 030. The ball member of this prior art flexible pipe joint has an internally threaded neck portion for connecting one of the pipes to be interconnected by means of the flexible pipe joint. The socket member is arranged in a similar manner with an internally threaded neck portion for connecting the other one of said pipes. The ball member is pivotally mounted in the socket member by said connecting means comprising a ring nut screwed onto the socket member, and is sealed by means of sealing rings. The flexible pipe joint allows one pipe to be swung universally over a limited angle in relation to the other pipe.

DE-C-504 792 discloses a flexible pipe joint of the ball and socket type wherein pivotal movement of the ball member in the socket member is restrained to a single pivot axis extending through the center of the ball member, by pins screwed into the socket member, which are displaceably received by axial grooves in the spherical surface of the ball member. These pins limit the pivoted movement about said axis to a predetermined angle by engagement with the end surfaces of the grooves. This prior art device necessitates a complicated manufacturing process: the pins necessarily have to be mounted in the socket as separate elements, and the grooves require delicate machining. Moreover, this device cannot take up heavy load at angling or internal pressure, and

the function thereof may be impaired by extraneous matter penetrating into the grooves.

The primary object of the invention is to provide a flexible pipe joint of the type referred to above, which is of a strong and yet simple construction and which is particularly well suited for permanent installation as a pipe line connector which can stand high differential pressures and allows the pipe line to be laid directly on broken or irregular sea bottom surfaces in deep water without using support legs for the pipe line and without requiring an evened sea bed, due to the fact that the connector flexes as the pipe line is installed to conform to the bed conditions.

A further object of the invention is to provide a flexible pipe line connector by means of which the pipe can be guided while being laid in the sea from a vessel, so that the pipe laying will be easier and less stress arises in the pipe line from the laying operation.

Another object of the invention is to provide a flexible pipe joint which is well suited for interconnecting tubular drilling bars for rotory drilling with improved possibilities of driving a bore vertically into the rock in deep drilling.

A still further object of the invention is to provide a flexible joint of the kind referred to above, wherein the forces applied between the ball and socket members by tightening the connecting means are taken up by mutually engaging bearing portions of the ball and socket members relieving heavy pressure between the spherical surfaces of said members. Said surfaces may be arranged without mutual contact metal to metal.

These and other objects and advantages of the

invention are achieved in accordance with the purpose of the invention by a flexible pipe joint of the type referred to above, which is characterized in that the ball member has two flat surfaces forming planings of the spherical surface of the ball member, which are parallel to an axial plane and are located symmetrically one at each side of this plane, and which guidingly engage flat surfaces of the socket member, forming planings of the socket member in the socket thereof, and located one at each side of the ball member received therein, to limit the pivotal movement of the ball member in the socket member to a single pivot axis extending perpendicularly to said axial plane.

A flexible pipe joint in accordance with the invention is also well suited for use in pipe lines on land, in raisers for production platforms and for drill rigs, and in all other pipe connections particularly for oil and gas production off shore as well as on land.

The accompanying drawings which are incorporated in and constitute a part of this specification illustrate embodiments of the invention and together with the description serve to explain the principles of the invention.

In the drawings

FIG. 1 is a side view showing the main parts of the flexible pipe joint in one embodiment thereof with the ball resting in the socket;

FIG. 2 is an axial cross-sectional view of the flexible pipe joint shown in FIG. 1;

FIG. 3 is a side view of the ball member;

FIG. 4 is a view of the ball as seen in the direction of the arrows IV-IV in FIG. 3;

FIG. 5 is a view of the socket as seen in the

direction of the arrows V-V in FIG. 6;
FIG. 6 is an axial cross-sectional view of the socket shown in FIG. 5;
FIG. 7 is a perspective view showing a complete flexible pipe joint with the ball and socket pivotally interconnected by means of connecting screw means;
FIG. 8 is an axial cross-sectional view of the flexible pipe joint in another embodiment thereof;
and
FIG. 9 is a view similar to that in FIG. 8 taken perpendicularly to the view of FIG. 8.

With reference to the drawings and particularly to FIGS. 1 - 4 therein the ball member designated generally 1 has a cylindrical neck portion 2, a ball 3 and a through central circular opening 4. This opening is flared from the transition 5 between the neck portion 2 and the ball 3 in a first axial plane 6 (FIG. 4) to have in the mouth 7 at the perifery of the ball a width which is double the width of the opening in the neck portion. However, in a second axial plane 8 which is perpendicular to said first axial plane 6 the width of the flared opening through the ball equals the width (diameter) of the opening 4 in the neck portion 2.

The ball 3 forms two flat surfaces 9 and 10 which are parallel to said first axial plane 6 and are positioned symmetrically one at each side of this plane. These surfaces are formed by planings of the spherical surface of the ball 3. The ball also forms shoulder portions 11 and 12 projecting from the surfaces 9 and 10, respectively. Each of these shoulder portions forms a rounded edge 13 and 14, respectively, which is positioned substantially on

a diameter extending through the center of the ball 3 perpendicularly to said first axial plane 6. Two sloping abutment surfaces 15, 16 and 17, 18 extend in opposite directions from the related edge 13 or 14, respectively.

Referring to FIGS. 1, 2, 5, and 6 the socket member is generally designated 21 therein and forms a cylindrical neck portion 22, a socket 23 and a through central circular opening 24. As will be seen from FIGS. 5 and 6 the socket 23 forms a semi--spherical recess 25 with two opposite flat side surfaces 26' and 27', which are parallel to each other and are formed by two semi-spherical segments 26 and 27, arranged symmetrically in reversed positions, which terminate in the diameter plane of the socket 23 at plane circular segments 28 and 29. The flat side surfaces 26' and 27' are planings of the socket member, bounding the semi-spherical recess 25. The segments 26 and 27 form bearings for pivotal mounting of the ball 3 in the plane-parallel recess 25 in the socket 23 in co-operation with the shoulder portions 11 and 12 abutting the circular segments at the edges 13 and 14 thereof. Then, the surfaces 9 and 10 on the ball 3 form guide surfaces for pivotal movement of the ball member in the socket member about a single axis, viz. the axis extending through the center of the ball 3 perpendicularly to said first axial plane 6.

As will be most clearly seen from FIG. 1 the size of the angle α included by the abutment surfaces 15 and 16 will define the range of pivoting the ball member and the socket member in relation to each other. Considering the flow and the design the maximum pivot angle in each direction from the zero position as defined by the axis of the socket member

23, preferably should be about 44°, i.e. the angle α included by the abutment surfaces 15, 16 and 17, 18, FIG. 4, should be about 136°.

The ball member 1 and the socket member 21 are mounted together by a connecting means 30 comprising a lock ring 31 forming an annular end flange 32 which engages a bottom shoulder 33 on the socket member 21, and a screw ring 34 which is screwed into the lock ring 31 and engages the outside speherical surface of the ball 3. The screw ring 34 is screwed into the lock ring 31 and can be tightened as desired. Sealing rings 35 are arranged in annular grooves in the screw ring and the ball, and sealing rings 36 are arranged between the flange 32 and the shoulder 33 to provide secondary sealing between the socket member and the lock ring 31.

In the flexible pipe joint of the invention the spherical surface of the ball 3 forms a small gap with the spherically curved surface of the semi--spherically recess 25, no contact metal to metal being provided between said surfaces. When the screw ring 34 is tightened the sealing rings 35 will be compressed against the spherical surface of the ball 3 and the sealing rings 36 will be compressed against the shoulder 33. Initially, no contact metal to metal will be obtained between the screw ring and the spherical surface or between the flange 32 of the lock ring 31 and the shoulder 33. The pressure of the screw ring against the ball will be taken up by the shoulder portions 11 and 12 bearing at the edges 13 and 14 on the surfaces 28 and 29. When the joint is used as a pipe line connector the joint should be in this condition when the pipe line is being laid down so as to allow the pipe line to adjust itself to irregularities of the surface supporting the pipe

line, by flexing of the pipe joint. When the pipe line has been laid the screw ring 34 will be tightened further to completely compress the sealing rings 35 so as to bring the screw ring 34 into contact metal to metal with the ball 3, and to completely compress the sealing rings 36 so as to bring the flange 32 into contact metal to metal with the shoulder 33.

In this condition the ball and socket members are locked to prevent flexing of the pipe joint which accordingly functions as a rigid pipe joint.

As will be seen from FIG. 7 the lock ring 32 and the screw ring 34 are provided with projections 37 for engagement with tools for manipulating the rings.

As mentioned above the positively guided flexibility of the pipe joint of the invention, limiting relative angular movement of the two pipes interconnected by the joint, to a single plane offers great advantages when laying down oil or gas pipe lines on the sea bottom or on land due to the fact that the handling of the pipe lines will be greatly facilitated. In this connection it should be mentioned that the pipes can be welded to the neck portions of the flexible pipe joint on land, leaving just mechanical assembling to be done off shore. This enables installation time to be substantially reduced. The flexible joint will be stronger than the pipe itself in all positions, and the joint has a smooth outer surface which facilitates handling of the pipe line. The joint flexes when the pipe line is being laid, and then when the pipe line has been laid, the joint is fixed in its final position by tightening the connection means.

The flexible pipe joint of the invention can also be used for interconnecting tubular drill bars in deep hole boring. When the lock ring 31 and the screw

ring 34 are tightened there will be no play between the individual drill bars interconnected by means of the joint. Due to the fact that the flexibility is positively limited to one plane only, the risk of the rotating composite drill bar causing drift of the drill bit will be substantially reduced. Another advantage provided by the pipe joint of the invention is the possibility of reversing the rotational direction, if the drill bit has been stuck in the bore. A composite drill bar wherein the individual drill bars are interconnected in the conventional manner by being screwed together, does not provide this possibility.

A further advantage of using the flexible pipe joint of the invention for interconnecting tubular drill bars is that the drill bit together with the composite drill bar comprising sealingly interconnected individual tubular drill bars, after a successful drilling may be left in the bore and may be used for conveying the oil or gas.

In the embodiment described the center of the ball 3 and the center of the semi-spherical socket recess 25 coincide and the pivot axis of the flexible pipe joint extends substantially through said center. However, it is possible and may be preferred considering the flow pattern in the joint, to position the center of the ball and the recess and the center of pivoting displaced axially in relation to each other, the center of pivoting being positioned below the center of the ball and recess as seen in FIGS. 1 and 2. In that case the socket member should have the surfaces 28 and 29 positioned below the center of the recess 25, the edges 10 and 11 bearing on said surfaces defining the center of pivoting.

Referring now to FIGS. 8 and 9 disclosing another

embodiment of the flexible pipe joint of the invention the pipe joint disclosed therein comprises a ball member 1 having a ball 3 and a neck portion 2, and a socket member 21 having a socket 23 and a neck portion 22 as in the embodiment previously described. However, in this case the bearing arrangement is modified. The socket member 21 is provided with elements 40 which are arranged at diametrically opposite sides. Each element 40 is fixedly secured to or forms an integral part of the socket 23 and projects from the end surface 41 thereof. The element 40 is received by a V-shaped recess 42 in the ball 3, and the element 40 and the ball 3 form flat surfaces engaging each other at 43. They also form circularly curved surfaces which bear against each other at 44. By this arrangement the angular relative movement of the ball and socket members is restrained in the same manner as in the embodiment first described, to a single cross axis indicated at 45 in FIG. 9, which extends through the ball center and through the center of the circularly curved surfaces. The angular movement is limited by surfaces 46 in the recess 42 abutting the element 40 and preferably the ball and socket members can be swung in relation to each other over a maximum angle of 20^{o} towards each side of the zero position shown in FIGS. 8 and 9. However, the recess 42 may also be made unsymmetric so as to allow the ball and socket members to be swung towards one side only from the zero position.

In the embodiment of FIGS. 8 and 9 the ball and socket members are interconnected by means of a screw ring 47 which engages a threaded portion 48 of the socket member 21. Primary sealing rings 35 are arranged between the ball 3 and the screw ring 47 while secondary sealing rings are provided between the out-

-side cylindrical surface of the socket member 21 and the screw ring 47.

The function and advantages of the embodiment described with reference to FIGS. 8 and 9 are the same as those provided by the embodiment first described. The two embodiments described herein are commensurate and can be used as alternative to each other.

CLAIMS

1. A flexible pipe joint of the ball and socket type, comprising a ball member with a through central opening, a socket member with a through central opening, and connecting means pivotally interconnecting the ball member and the socket member, c h a r a c t e r i z e d in that the ball member has two flat surfaces forming planings of the spherical surface of the ball member, which are parallel to an axial plane and are located symmetrically one at each side of this plane and which guidingly engage flat surfaces of the socket member, forming planings of the socket member in the socket thereof and located one at each side of the ball member received therein, to limit the pivotal movement of the ball member in the socket member to a single pivot axis extending perpendicularly to said axial plane.

2. A flexible pipe joint as claimed in claim 1, c h a r a c t e r i z e d in that the ball member is supported on the socket member by bearings at diametrically opposite sides, the pivot axis being defined by said bearings.

3. A flexible pipe joint as claimed in claim 2, c h a r a c t e r i z e d in that said bearings comprise edges at diametrically opposite sides, said pivot axis extending substantially along said edges.

4. A flexible pipe joint as claimed in claim 3, c h a r a c t e r i z e d in that the edges are formed by the ball member and that the ball member forms abutment surfaces at each side of each edge, limiting pivotal movement of the ball member by engagement with the socket member.

5. A flexible pipe joint as claimed in claim 4, c h a r a c t e r i z e d in that each edge is formed

by shoulder portions projecting one from each flat surface of the ball member, said abutment surfaces being formed by said projection and diverging from said edge.

6. A flexible pipe joint as claimed in claim 5, c h a r a c t e r i z e d in that each edge bears against the end surface of the socket member at the opening of the socket formed therein.

7. A flexible pipe joint as claimed in claim 2, c h a r a c t e r i z e d in that said bearings comprise projections on the socket member, projecting from the end surface thereof at diametrically opposite sides of the opening of the socket formed therein.

8. A flexible pipe joint as claimed in claim 7, c h a r a c t e r i z e d in that the ball member forms recesses at opposite sides thereof, each recess receiving one of said projections, diverging bounding surfaces of each recess forming abutment surfaces at each side of the projection received therein, limiting pivotal movement of the ball member by engagement with the projection.

9. A flexible pipe joint as claimed in claim 8, c h a r a c t e r i z e d in that the projections and recesses form said guide surfaces on the ball member and the socket member, respectively.

10. A flexible joint as claimed in claim 8 or 9, c h a r a c t e r i z e d in that the ball member is supported on the projections at circularly curved bearing surfaces on the ball member and the projections, respectively, the center of said surfaces laying on said pivot axis.

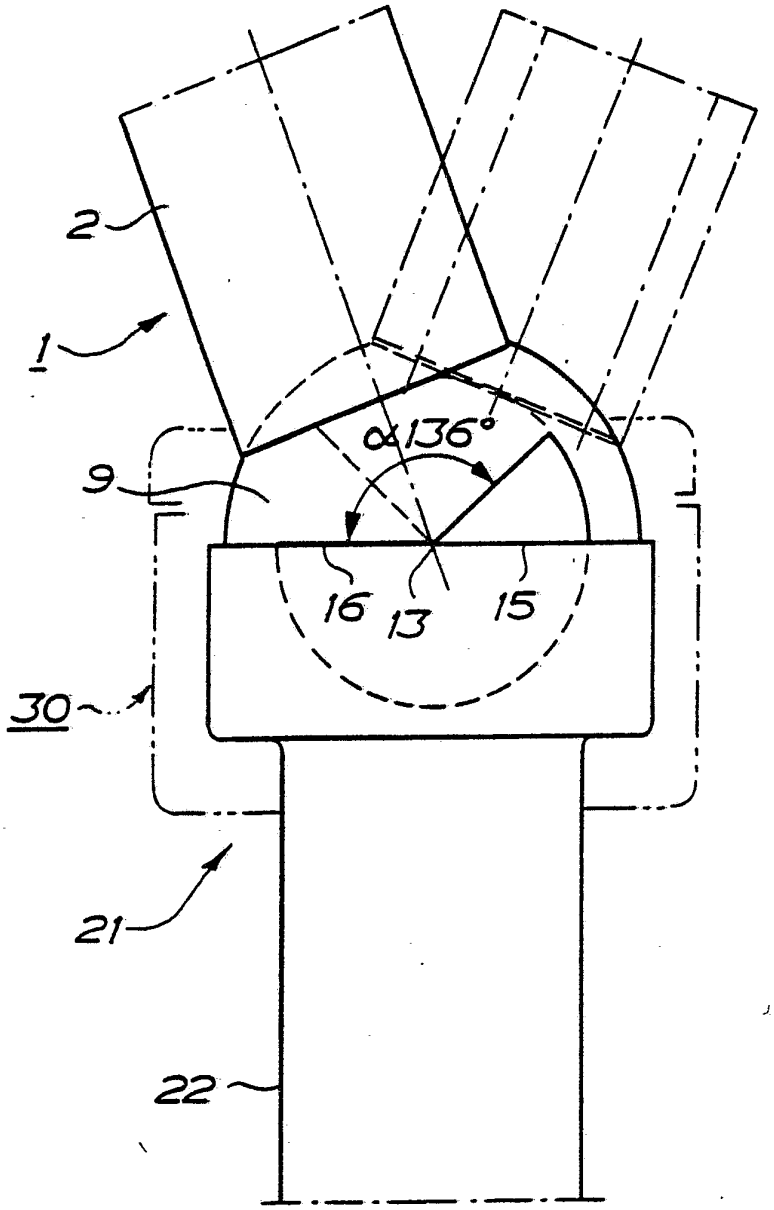

FIG. 1

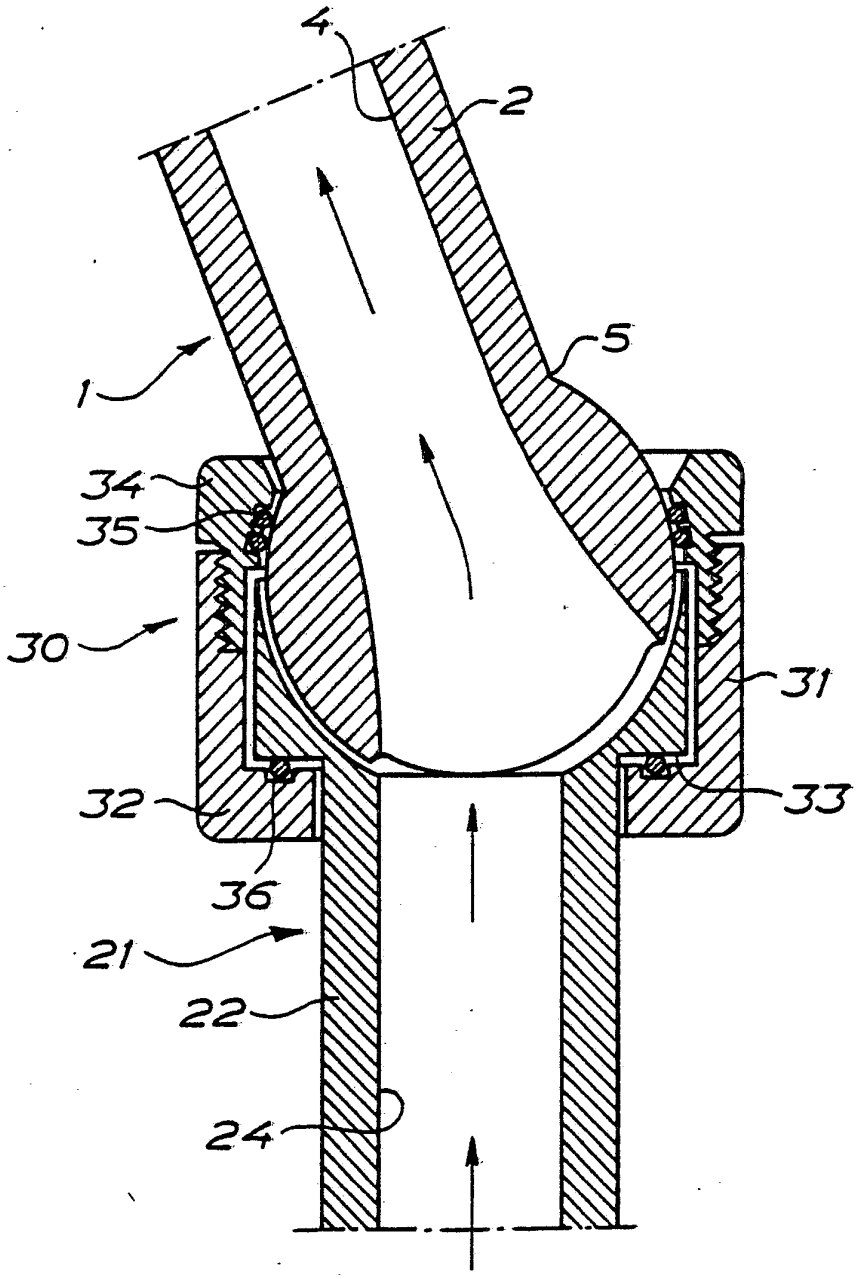

FIG. 2

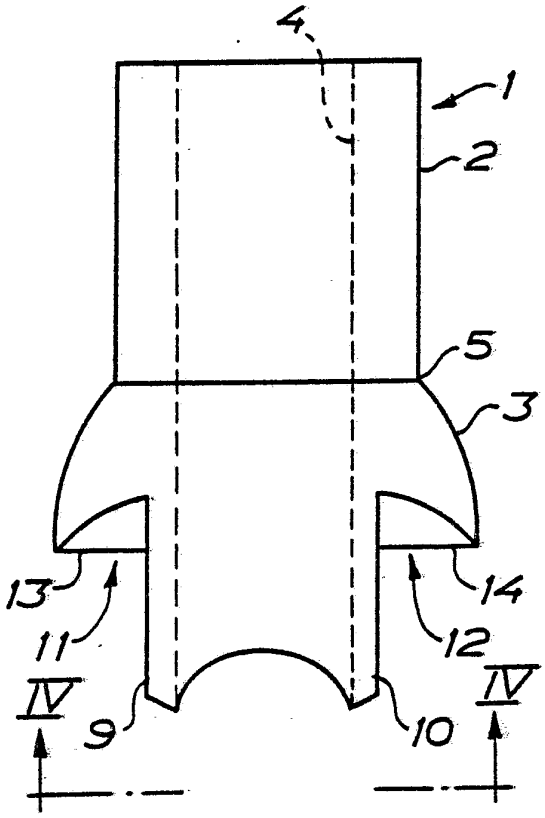

FIG. 3

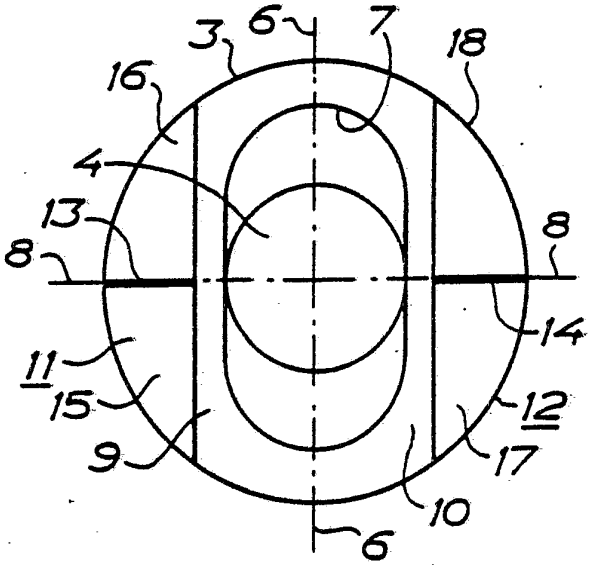

FIG. 4

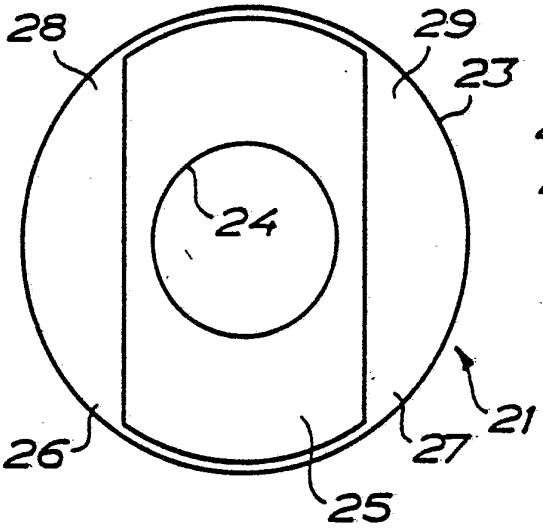

FIG. 5

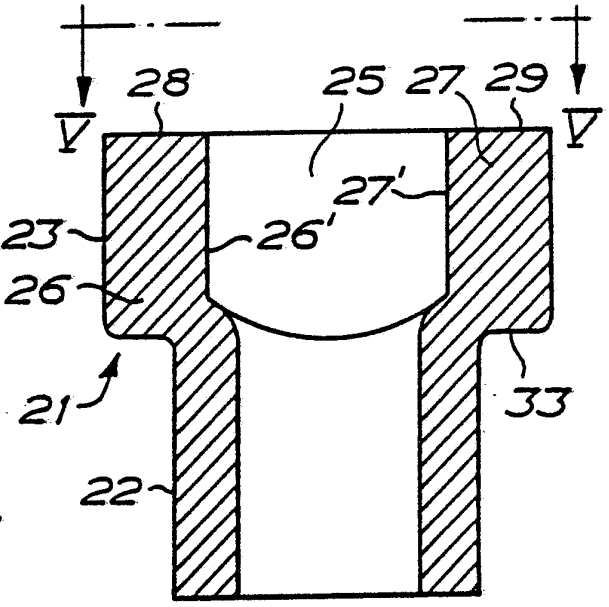

FIG. 6

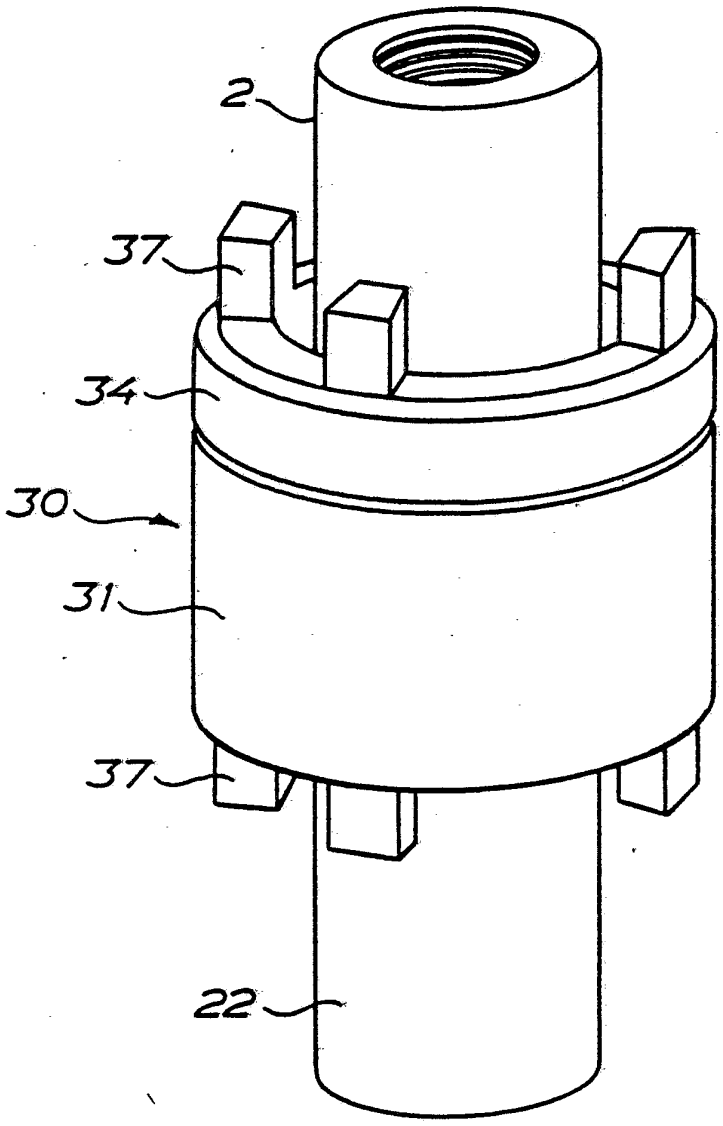

FIG. 7

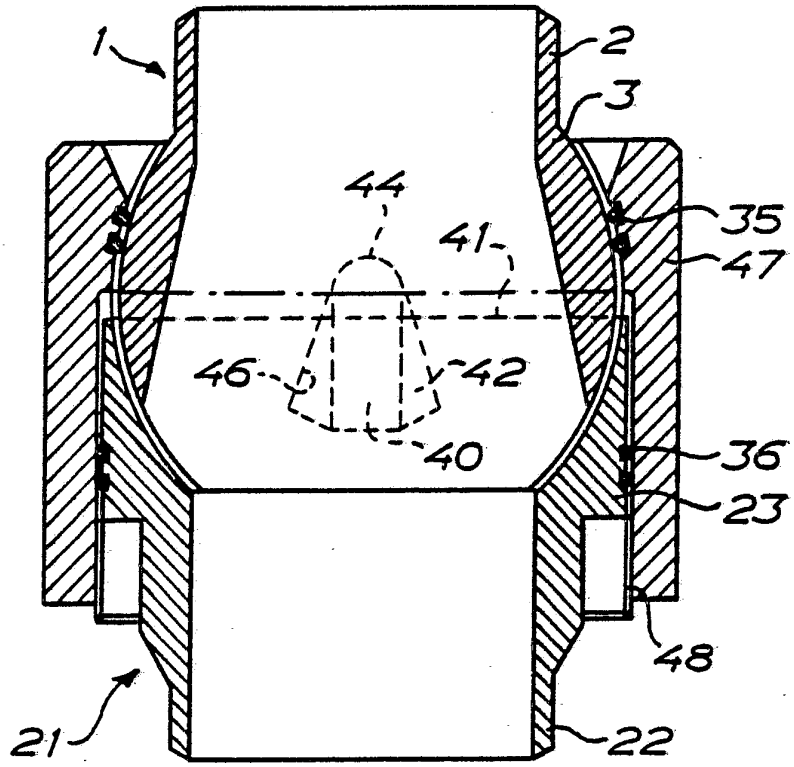

FIG. 8

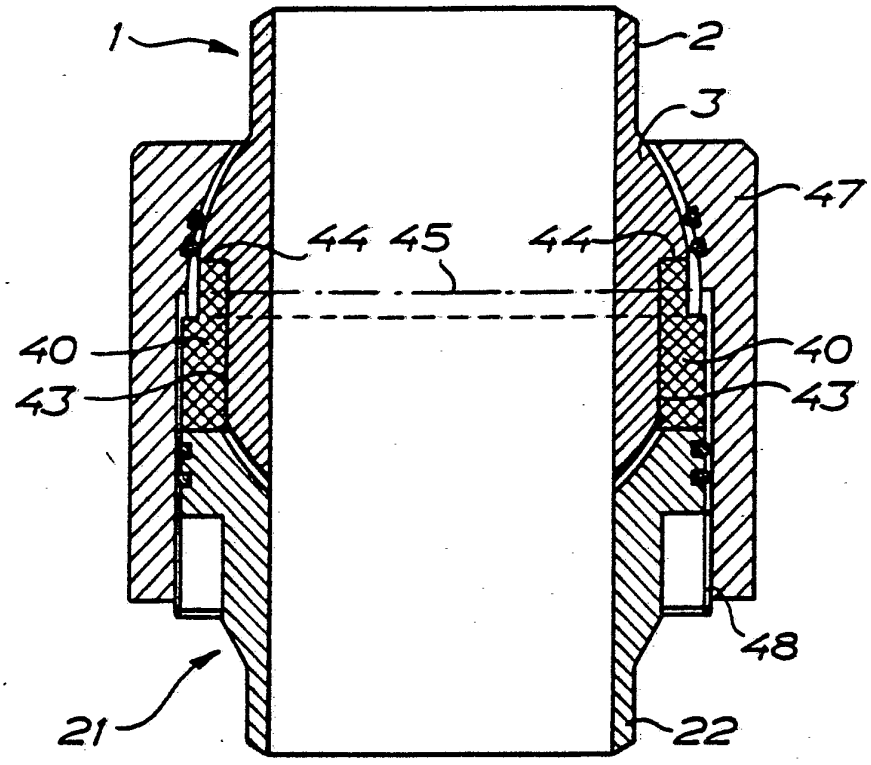

FIG. 9

INTERNATIONAL SEARCH REPORT

International Application No PCT/SE84/00044

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC 3

F 16 L 27/04

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
IPC 3	F 16 L 27/00-27/06
National Cl	47b: 13; 47f: 13
US Cl	285: 135, 160, 166, 184, 185, 261-282

Documentation Searched other than Minimum Documentation to the Extent that such Documents are included in the Fields Searched [5]

SE, NO, DK, FI classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category *	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
A	DE, C, 504 792 (ALOIS SIEBECK) 24 July 1930	
A	DE, B, 1 135 248 (A EHRENREICH & CIE) 23 August 1962	
A	CH, A, 192 639 (HUGO DROTSCHMANN) 1 November 1937	
A	US, A, 1 614 667 (L H GILLICK) 18 January 1927	

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IV. CERTIFICATION

Date of the Actual Completion of the International Search [2]	Date of Mailing of this International Search Report [2]
1984-04-25	11 MAY 84
International Searching Authority [1]	**Signature of Authorized Officer** [10]
Swedish Patent Office	Axel Lindhult K.L.

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