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(54) **DEVICE BY A RETRIEVABLE BRIDGE PLUG**

VORRICHTUNG ZUM EINSATZ MIT PROVISORISCHEN STOPFEN

DISPOSITIF A UTILISER AVEC UN BOUCHON PROVISOIRE

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(56) References cited:  
**EP-A- 0 460 993**                      **US-A- 4 554 973**  
**US-A- 4 588 029**

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## Description

**[0001]** The present invention concerns generally retrievable bridge plugs, but more specifically a drawable mechanical barrier having a packer element, according to the introductory part of patent claim 1.

**[0002]** Among other things, bridge plugs are used for oil- and gas wells. Such bridge plugs (see for example US-A-4 554 973 have a packer element which seals against fluid and pressure. The packer element is comprised mainly of an elastic rubber body sealing against the pressure, and mechanical barriers preventing extrusion of the rubber at pressure load. In oil and gas wells the bridge plug will, in many cases, have to pass restrictions such as, for example, valves and nipples, for subsequent location in a larger diameter. Known retrievable bridge plugs have a limited degree of expansion at a high pressure and a high temperature. The limitation in the degree of expansion is mainly caused by the construction of the drawable mechanical barrier.

**[0003]** It is thus an object with present invention to provide a drawable mechanical barrier, which stabilizes and prevents extrusion of the packer elements at high pressure/temperature and has a large degree of expansion.

**[0004]** The object of the invention is achieved by a device having features as stated in the characterizing part of patent claim 1. Further features are stated in the dependent claims.

**[0005]** According to the invention, a mechanical barrier is developed, which through an axial movement is expanded and then drawn through an opposite movement.

**[0006]** In some oil and gas wells it is desirable that the bridge plug changes pressure direction from one side to the other side. In this case, two packer elements are installed, having a mechanical barrier inbetween. When the packer elements are expanded, the rubber will be forced out radially along the mechanical barrier, and up against the casing. In expanded position, the mechanical barrier has a wedge shape up against the casing. By applying pressure, the packer element will creep into the radial wedge shape, and seal. This wedge shape also has a positive effect to the sealing property of the packer element at increasing pressure load. If the bridge plug should seal against differential pressure from one side, a mechanical barrier with a packer element is installed at the pressure side.

**[0007]** Upon expansion of two packer elements with a mechanical barrier inbetween, a fluid volume will form between the packer elements. When one of the packer elements is pressurized, it will move and cause a pressure build-up on the enclosed volume. This pressure build-up will again cause a movement of the packer element at the non-pressure side. This involves an extra strain on the packer element at the non-pressure side, and is unfortunate, however. This is solved by draining unwanted fluid volume causing pressure build-up.

Drainage is performed by way of U-shaped packers installed in a packer bracket at the non-pressure side. These U-shaped packers act as check valves, and are described below.

**[0008]** When setting the bridge plug in horizontal oil and gas wells, the mechanical barrier positions the mechanical bridge plug in the centre, and thus avoids the extra strain on the packer element from the bridge plug's own weight.

**[0009]** When drawing the bridge plug from the well, the mechanical barrier according to the present invention has a construction whereby it is possible to be actively drawn when running into restrictions. This is performed when the mechanical barrier is subjected to tension, which then leads to the chain pairs rotating around their belonging bolts, thus forcing them against the centre of the bridge plug.

**[0010]** According to the present invention, the mechanical barrier has a construction making it functionally reliable during the aggregation of sand above the bridge plug. The mechanical barrier being situated between two packer elements is advantageous in this respect.

**[0011]** In the following, the invention will be explained further by means of examples of embodiments and with reference to the accompanying drawings, where

Fig. 1 shows a sketch of a retrievable bridge plug with packer elements having a mechanical barrier according to present invention,

Fig. 2 shows a partly sectioned view of packer elements with a mechanical barrier according to present invention, in drawn (not expanded) condition,

Fig. 3 shows packer elements with the mechanical barrier in Fig. 2 in expanded condition,

Fig. 3a shows a detail of the packer element in Fig. 3,

Fig. 4 shows a section of the mechanical barrier in Fig. 3, viewed along the line X-X, and

Fig. 5 shows a perspective view of a chain pair located by the mechanical barrier in Fig. 3.

**[0012]** Fig. 1 shows a sketch of a retrievable bridge plug, generally denoted 30, set in a casing 31 in a horizontal well. The bridge plug 30 comprises an anchoring part 32 and a mechanical barrier 1 with packer elements, which are expanded against the casing 31.

**[0013]** Fig. 2 illustrates a device according to the present invention, in the form of a mechanical barrier 1 having two packer elements 3, 11 which are arranged at the bridge plug (not shown in Fig. 2), in order to be inserted in, and expanded in the casing (not shown in Fig. 2). The device includes a through axle 15 with an external upper packer bracket 2, connecting the upper end (not shown) with upper packer element 3. The upper packer element 3 is connected through an upper clamping section 4 via first pin 5 to an upper chain 6. The upper chain 6 is rotatably connected with lower chain 8 by a

second pin 7. The lower chain 8 is connected to a lower clamping section 10 by a third pin 9. Lower clamping section 10 is connected with the lower packer element 11 that is then connected with the lower end of the bridge plug, through a lower packer clamp 12. Within upper

clamping section 4 is connected a thin, flexible pipe 18, which forms an expandable cover over the rotatable chain pairs 6 and 8, and is the connected to lower clamping section 10.

**[0014]** In Fig. 2, the device according to the present invention is shown with the mechanical barrier 1 and the packer elements 3, 11 in drawn (not expanded) condition. An angle  $\alpha$  is formed through the longitudinal axis of the bridge plug and a line extending between first pin 5 and second pin 7. The angle  $\alpha$  is larger than zero, and preferably less than  $45^\circ$  when the mechanical barrier is in this drawn condition.

**[0015]** In Fig. 3, the device is shown in expanded position, where upper packer bracket 2 is forced against lower packer bracket 12 with the result that upper packer element 3 is compressed and expanded radially. The axial force propagates further down to the upper chain 6 that due to the angle of departure  $\alpha$  (Fig. 2) will rotate around the pin 5 and tip out radially. This will cause the split pipe 18 to bend outwards and be formed around the periphery of the chain pairs 6 and 8. When upper chain 6 and lower chain 8 are compressed, the lower clamping section 10 will compress the packer element 11 which then will expand radially.

**[0016]** An upper U-shaped packer 13 is installed in the upper clamping section 2 and a lower U-shaped packer 14 is installed in the lower clamping section 12. Upper U-shaped packer 13 has the function of sealing when the packer element 3 is pressurized, and to drain an enclosed volume C when the packer element 3 is pressurized. Lower U-shaped packer 14 is shown in detail in Fig. 3a.

**[0017]** Fig. 4 shows a section view of the mechanical barrier 1 in expanded condition. The pipe 18 is split in a number corresponding to the number of rotatable chain pairs 6 and 8. The pipe 18 is oriented in relation to chain pairs 6 and 8, so that each axial split of the pipe 18 is situated above the middle of each chain pair 6 and 8. In expanded condition, the split pipe 18 is supported by the chain pairs 6, 8, so that the mechanical barrier in expanded condition forms a completely sealed barrier.

**[0018]** Fig. 5 shows a chain pair comprising rotatable chain 6 and rotatable chain 8. The chain pair 6, 8 is shown in expanded condition, and without belonging pins. Each of the chains 6, 8 is comprised an arm section 19a, 19b with belonging holes 20a, 20b for first and third pin 5 and 9, respectively. The arm sections 19a, 19b are rigidly connected to head section 21a, 21b. The head sections 21a, 21b are at their upper end, formed so that the chains 6, 8 can engage each other, as the second pin (not shown) is brought through hole 25 at the upper end. The head sections 21a, 21b have profiled support surfaces 22a, 22b that are rounded in the axial direction

of mechanical barrier 1. The support surfaces 22a, 22b recede into inclined covering surfaces 23, which again recede into inclined end surfaces 24a, 24b.

**[0019]** The chains 6, 8 are constructed so that they, in expanded condition, shall form as large an external supporting surface as possible, in order to give the best possible support for the split pipe 18. Thus, the chains 6, 8 and the split pipe 18 form a complete barrier against the packer elements 3, 11. The optimum width of the chain pairs 6, 8 is the length of the cord belonging to the arc calculated from the circumference of unexpanded bridge plug divided by the number of chain pairs 6, 8. Where the width is the distance between the two external limitations of the chains 6, 8, consisting of the points where the inclined cover surface 23 recedes to inclined end surfaces 24a, 24b. The desired expansion height of a chain pair 6, 8, corresponding to the radial distance between the unexpanded bridge plug 30 and the inner wall of the casing 31, determines the height of the head sections 21a, 21b.

**[0020]** The chains 6, 8 are constructed for achieve a large mechanical strength, so that they can bear the influence from the pressure forces that can occur. In order to achieve an optimum combination of mechanical strength and size of the supporting surface, the end surfaces 24a, 24b are shaped with an inclination as described above.

## 30 Claims

1. Device for use with a retrievable bridge plug (30) comprising a through axle (15), with an external upper packer bracket (2) that is connected with an upper packer element (3), and with an external lower packer bracket (12) that is connected with a lower packer element (11), **characterized in that**
  - the upper packer element (3) is connected through an upper clamping section (4) to a chain (6), said upper chain (6) being rotatably connected with the upper clamping section (4) by a first pin (5),
  - the upper chain (6) is rotatably connected to a lower chain (8) by a second pin (7), and lower chain (8) is rotatably connected to a lower clamping section (10) by a third pin (9), so that an angle ( $\alpha$ ) is formed between the longitudinal axis of the bridge plug and a line extending through the first pin (5) and the second pin (7), and correspondingly through the second pin (7) and the third pin (9) which is greater than zero when upper chain (6) and lower chain (8) is drawn, whereas upper chain (6) and lower chain (8) are arranged for, at setting, to expand radially by compression of the upper packer bracket (3) against lower packer bracket (12), for forming a mechanical barrier for upper packer element (3) and lower packer element (11).
2. Device according to Claim 1,

**characterized in that** upper chain (6) and lower chain (8) are covered by a flexible split pipe (18), that in expanded condition together with the chain pairs (6, 8) forms a mechanical barrier that forms a sealed wall between a casing (31) and the bridge plug (30).

3. Device according to either of claims 1 or 2, **characterized by** a plurality of chain pairs (6, 8), preferably two, three, four, five or six, being arranged around the circumference of axle (15).
4. Device according to any one of claims 1 to 3, **characterized in that** an upper U-shaped packer (13) is installed in upper clamping section (2) and lower U-shaped packer (14) is installed in lower clamping section (12), wherein upper U-shaped packer (13) is arranged for sealing when the packer element (3) is pressurized, and draining an enclosed volume (C) at the chain pairs (6, 8) when the packer element (11) is pressurized, and lower U-shaped packer (14) is arranged for sealing when the packer element (3) is pressurized, and draining a volume (C) when the packer element (3) is pressurized.

#### Patentansprüche

1. Vorrichtung zur Verwendung mit einem provisorischen Brückenstopfen (30) mit einer Durchgangsschse (15) mit einer äußeren oberen Packerstütze (2), die mit einem oberen Packerelement (3) verbunden ist, und mit einer äußeren unteren Packerstütze (12), die mit einem unteren Packerelement (11) verbunden ist, **dadurch gekennzeichnet, daß** das obere Packerelement (3) durch einen oberen Klemmabschnitt (4) mit einem Kettenglied (6) verbunden ist, wobei das obere Kettenglied (6) mit dem oberen Klemmabschnitt (4) durch einen ersten Stift (5) drehbar verbunden ist, das obere Kettenglied (6) mit einem unteren Kettenglied (8) durch einen zweiten Stift (7) drehbar verbunden ist und das untere Kettenglied (8) mit einem unteren Klemmabschnitt (10) durch einen dritten Stift (9) drehbar verbunden ist, so daß ein Winkel ( $\alpha$ ) zwischen der Längsachse des Brückenstopfens und einer Linie gebildet wird, die durch den ersten Stift (5) und den zweiten Stift (7) und entsprechend durch den zweiten Stift (7) und den dritten Stift (9) verläuft, welcher größer als Null ist, wenn das obere Kettenglied (6) und untere Kettenglied (8) gezogen sind, während das obere Kettenglied (6) und untere Kettenglied (8) beim Einsetzen so angeordnet sind, daß sie sich durch Druck der oberen Packerstütze (3) gegen die untere Packerstütze (12) radial ausdehnen, um ein mechanisches Sperrglied für das obere Packerelement (3) und un-

tere Packerelement (11) zu bilden.

2. Vorrichtung nach Anspruch 1, **dadurch gekennzeichnet, daß** das obere Kettenglied (6) und untere Kettenglied (8) durch einen flexiblen gespalteten Schlauch (18) bedeckt sind, der im expandierten Zustand zusammen mit dem Kettengliedpaar (6, 8) ein mechanisches Sperrglied bildet, das eine Abdichtungswand zwischen einem Futterrohr (31) und dem Brückenstopfen (30) bildet.
3. Vorrichtung nach Anspruch 1 oder 2, **dadurch gekennzeichnet, daß** rings um den Umfang der Achse (15) eine Mehrzahl von Kettengliedpaaren (6, 8), vorzugsweise zwei, drei, vier, fünf oder sechs angeordnet sind.
4. Vorrichtung nach einem der Ansprüche 1 bis 3, **dadurch gekennzeichnet, daß** ein oberer U-förmiger Packer (13) im oberen Klemmabschnitt (2) und ein unterer U-förmiger Packer (14) im unteren Klemmabschnitt (12) eingesetzt sind, wobei der obere U-förmige Packer (13) so angeordnet und ausgebildet ist, daß er abdichtet, wenn das Packerelement (3) unter Druck gesetzt ist, und ein am Kettengliedpaar (6, 8) eingeschlossenes Volumen (C) ablaufen läßt, wenn das Packerelement (11) unter Druck gesetzt ist, und ein unterer U-förmiger Packer (14) so ausgebildet und angeordnet ist, daß er abdichtet, wenn das Packerelement (3) unter Druck gesetzt ist, und ein Volumen (C) ablaufen läßt, wenn das Packerelement (3) unter Druck steht.

#### Revendications

1. Dispositif destiné à être utilisé avec un bouchon de support récupérable (30) comportant un axe traversant (15), avec une console extérieure supérieure (2) de packer qui est reliée à un élément supérieur (3) de packer, et une console extérieure inférieure (12) de packer qui est reliée à un élément inférieur (11) de packer, **caractérisé en ce que** l'élément supérieur (3) de packer est relié par une section supérieure (4) de serrage à une chaîne (6), ladite chaîne supérieure (6) étant reliée de façon à pouvoir tourner à la section supérieure (4) de serrage par une première broche (5), la chaîne supérieure (6) étant reliée de façon à pouvoir tourner à une chaîne inférieure (8) par une seconde broche (7), et la chaîne inférieure (8) est reliée de façon à pouvoir tourner à une section inférieure (10) de serrage par une troisième broche (9), afin qu'un angle ( $\alpha$ ) soit formé entre l'axe longitudinal du bouchon de support et une ligne passant par le premier axe (5) et le deuxième axe (7) et, de façon correspondante, par le deuxième axe (7) et le troisième axe

(9), lequel est supérieur à zéro lorsque la chaîne supérieure (6) et la chaîne inférieure (8) sont tirées, alors que la chaîne supérieure (6) et la chaîne inférieure (8) sont agencées, lors de la mise en place, pour s'expanser radialement par compression de la console supérieure (3) de packer contre la console inférieure (12) de packer, pour former une barrière mécanique pour l'élément supérieur (3) de packer et l'élément inférieur (11) de packer.

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2. Dispositif selon la revendication 1,

**caractérisé en ce que** la chaîne supérieure (6) et la chaîne inférieure (8) sont recouvertes d'un tube fendu flexible (18), qui, dans un état expansé forme, avec les paires de chaînes (6, 8), une barrière mécanique qui forme une paroi étanche entre un tubage (31) et le bouchon de support (30).

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3. Dispositif selon l'une des revendications 1 ou 2,

**caractérisé par** plusieurs paires de chaînes (6, 8), avantageusement deux, trois, quatre, cinq ou six, agencées autour de la circonférence de l'axe (15).

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4. Dispositif selon l'une quelconque des revendications 1 à 3,

**caractérisé en ce qu'un** packer supérieur (13) en forme de U est installé dans la section supérieure (2) de serrage et un packer inférieur (14) en forme de U est installé dans la section inférieure (12) de serrage, dans lequel le packer supérieur (13) en forme de U est agencé de façon à réaliser une obturation lorsque l'élément de packer (3) est mis sous pression, et à vidanger un volume fermé (C) au niveau des paires de chaînes (6, 8) lorsque l'élément de packer (11) est mis sous pression, et le packer inférieur (14) en forme de U est agencé de façon à réaliser une obturation lorsque l'élément de packer (3) est mis sous pression, et à vidanger un volume (C) lorsque l'élément de packer (3) est mis sous pression.

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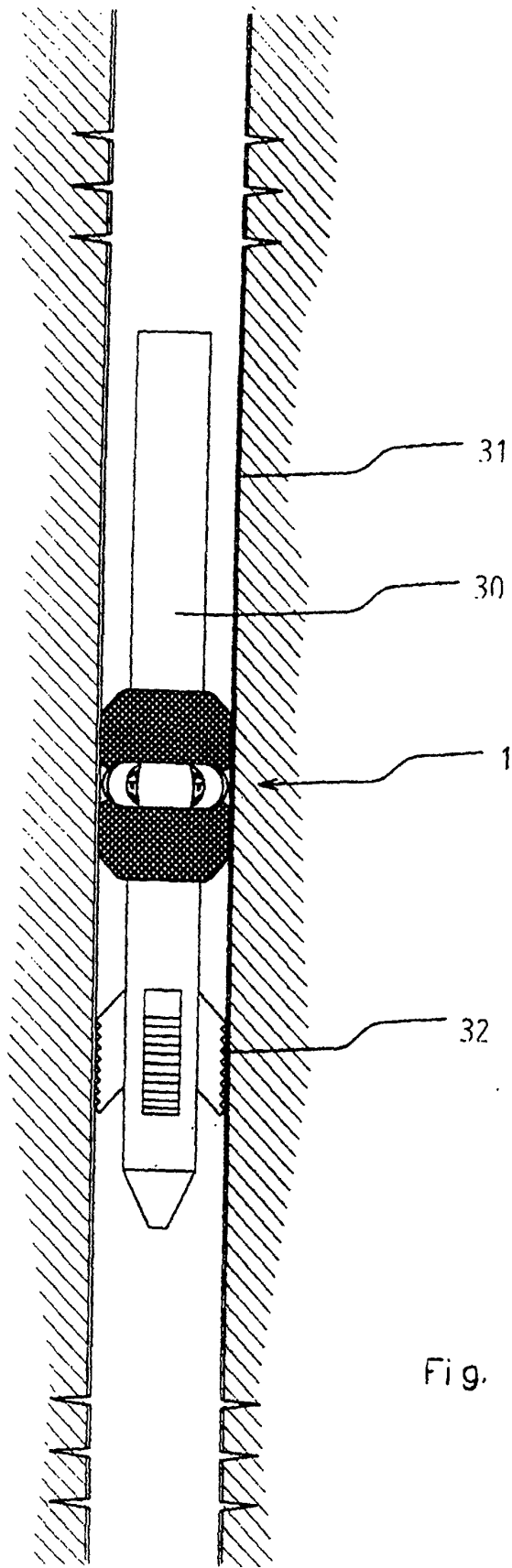


Fig. 1

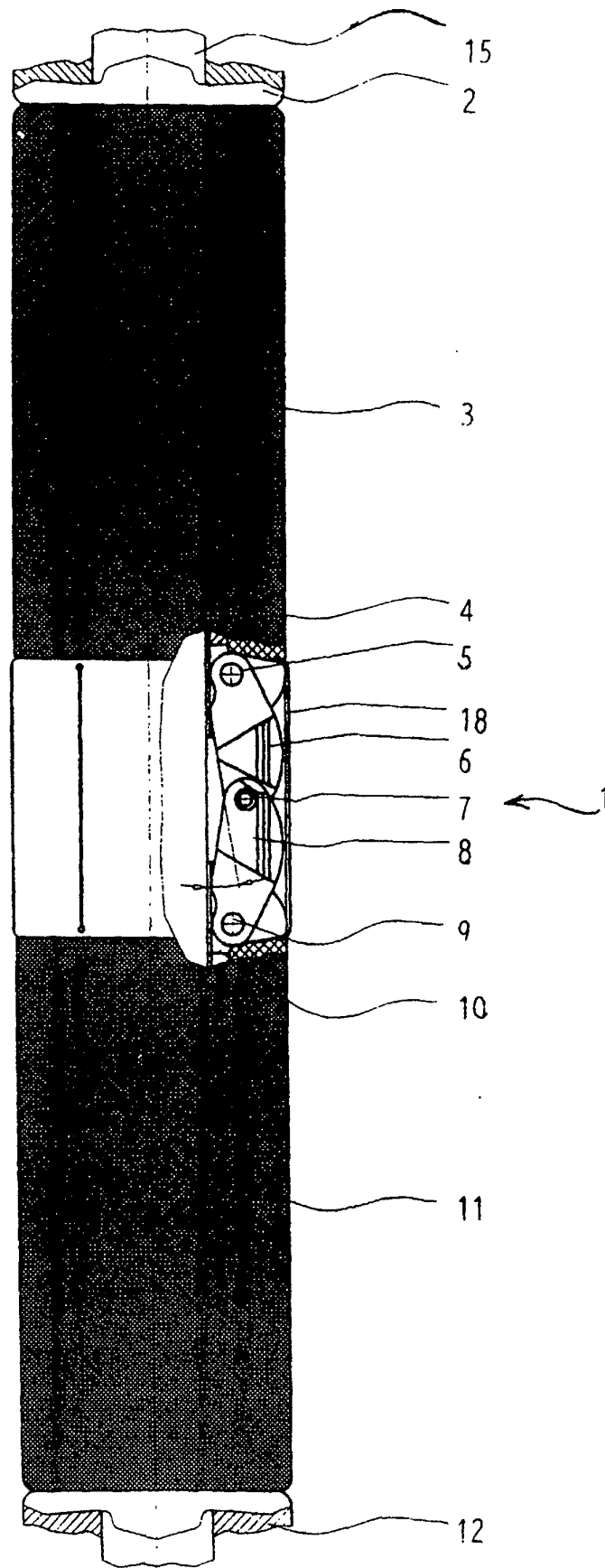
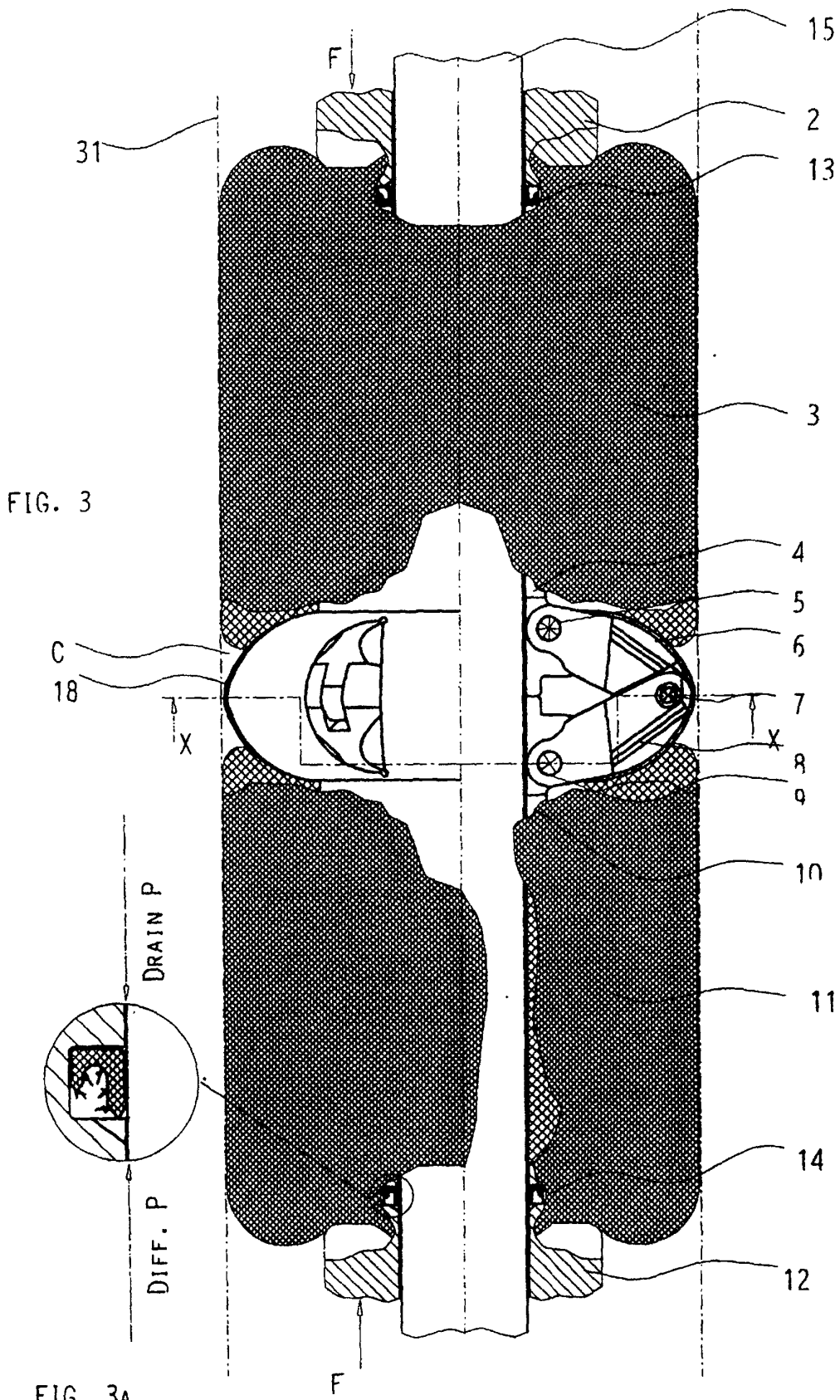


Fig. 2





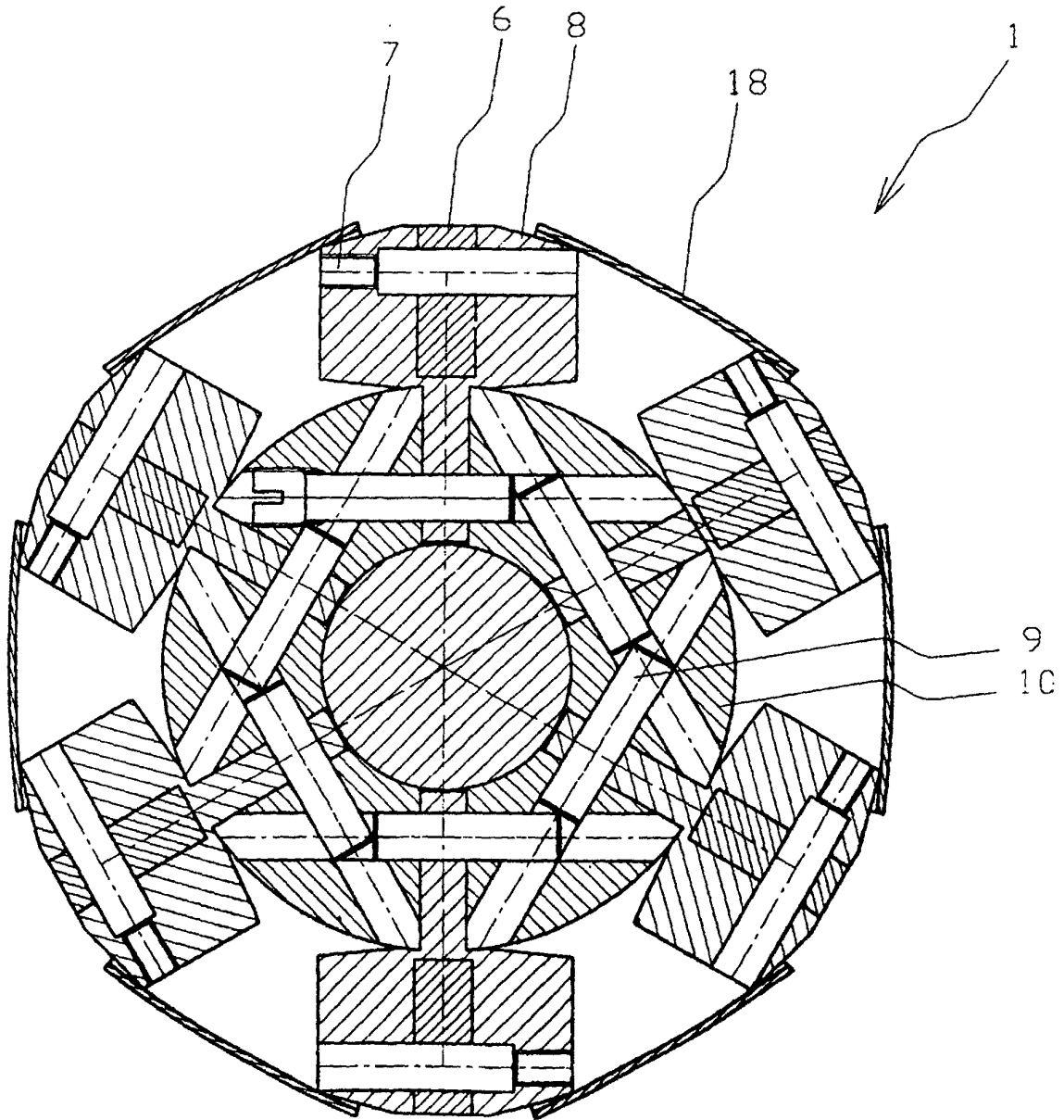


Fig. 4

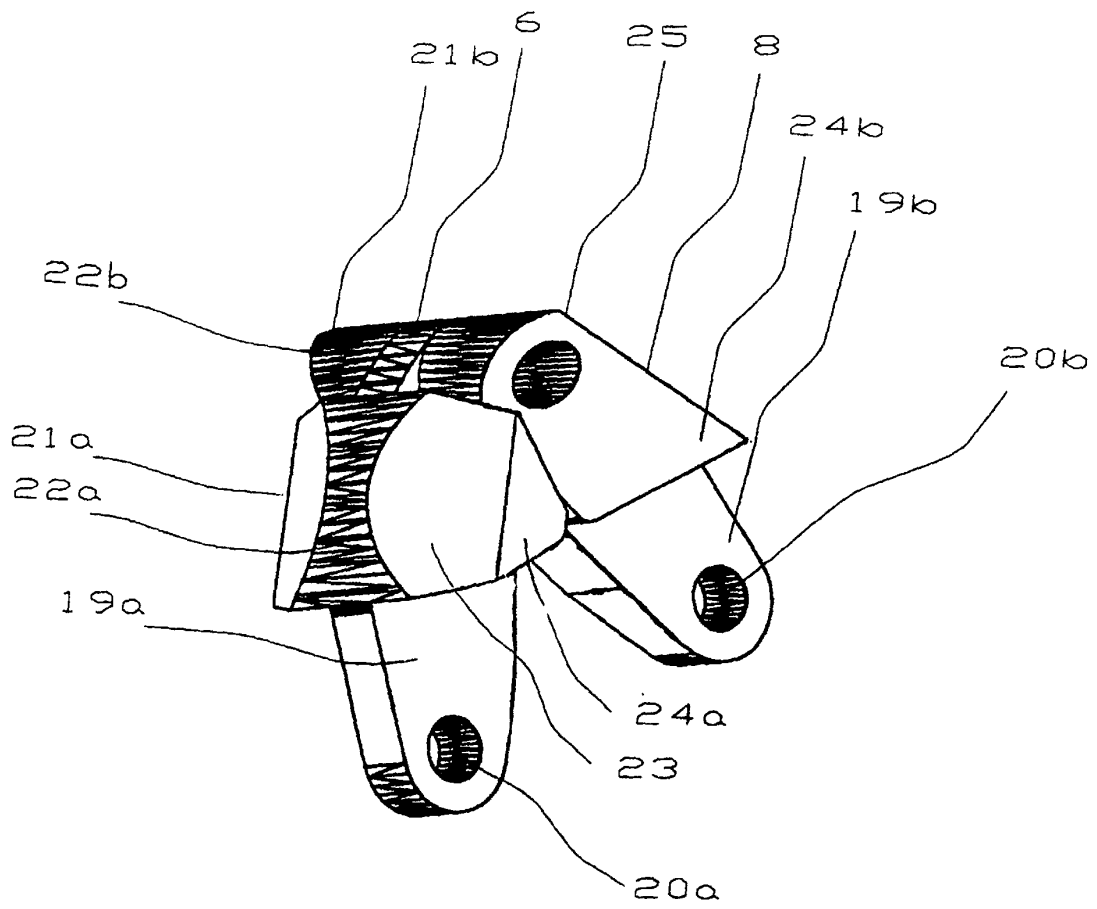


Fig. 5