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(54) **PIPE CUTTER**

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Description

This invention relates to a pipe cutter, and more particularly to a pipe cutter suitable for cutting the casing of a well bore or the like.

The use of pipe cutting tools for cutting the casing of a well bore, for example an oil or gas well bore, is well known. Such tools typically comprise a body which is run into the casing on a pipe string so that the body can be rotated by the pipe string. A multiplicity of knives are provided on the body and means are provided for forcing the knives outwardly into engagement with the casing as the tool is rotated to effect a cut radially outwardly through the casing.

In order to allow the tool to pass freely through the casing as it travels to the position at which the cut is required it is common to design the body such that the knives can be located within slots provided in the body in a storage configuration in which the knives do not project beyond the radially outer surface of the body. Such an arrangement ensures that the knives are not accidentally damaged as the tool is run into the bore and also ensures that the knives do not catch on discontinuities in the bore and thereby prevent downward movement of the tool.

Heretofore, it has been known to restrain the knives in the storage configuration by the use of banding or by use of shear pins. If such arrangements are used the banding/shear pins are broken when the tool is used thereby allowing the knives to move outwardly into their use configuration under the influence of appropriate power means provided within the tool. Typically, the power means is a hydraulic piston which applies an appropriate force to the knives under the influence of fluid pressure within the drill string.

If the tool is intended to make a single cut before being retrieved to the surface the above arrangements are satisfactory. Under these circumstances, after the cut has been made fluid pressure is relieved from the actuating piston and the tool string withdrawn from the well whereby the knives are cammed inwardly by the lower edge of the cut section of casing and substantially re-enter the slots provided in the body. The knives may not fully re-enter the slots, but since the point of pivotal connection of the knives to the body is located above the free ends of the knives, the knives will under these circumstances merely trail against the interior of the casing as the tool is withdrawn without causing any difficulties.

It will be appreciated, however, that if it is desired to make a second cut of the casing lower than the first cut the fact that the knives of prior art tools do not fully re-enter the slots in the body can be a considerable problem. In particular, under these circumstances if the knives partially, but not completely, re-enter the slots the free ends of the knives will tend to form latch surfaces extending generally perpendicular to the axis of the drill string and such latch surfaces may catch on discontinuities within the casing resulting in difficulty in lowering

the tool through the casing. Further, if the drill string is travelling at significant speed when one of the knives strikes discontinuity substantial damage to the knife or other components of the tool may be caused.

5 The tendency of the knives not to re-enter the slots provided in the body arises in part from an inherent lack of any force tending to move the knives back into the slots, and partly from forces tending to keep the knives at least partially projecting from the slots. These latter
10 forces include dynamic forces due to fluid flow past the tool as the tool is lowered through the casing, and gravitational forces acting on the knives. In relation to gravitational forces it should be noted that the centre of gravity of the knives tends to be located radially inboard of
15 the axis of pivotal connection of the knives to the body, when the knives are fully housed within the body slots. In the circumstances, the knives tend to hang in a manner which leads to projection of at least the corner of the knives from the body, once the banding/shear pins have
20 been broken by the first use of the tool. With a view to overcoming the problems referred to above US-A-3073389 proposes a pipe cutter in which a return spring is used to bias the knives into a retracted position in which they lie wholly within pockets in the tool. However,
25 in the structure of US-A-3073389 the return member which acts on the knives to return them to the pockets, and the piston which is used to drive the knives out of the pockets are part of an integral structure. A disadvantage of this arrangement is that the groove provided in
30 the piston structure for accommodating the inwardly extending fingers of the knives must, of necessity, be over-size relative to the knives so that in certain configurations of the tool, for example as illustrated in Figure 2 of US-A-3073389 the position of the knives is not completely controlled by the combination of the piston and
35 spring. It would be appreciated that with the components in the configuration of Figure 2 of US-A-3073389 a downward loading on the tool string will cause the blades to flip up to a position in which they extend upwardly from their respective pivot axes. This can result in jamming of the blades.

The present invention, starting from the precharacterising portion of claim 1, is characterised in that the biasing means which applies a bias force to the knives
40 tending to return them to their storage configuration includes a first sleeve, the upper end of which engages the first cam faces of each knife. The operating means includes a second sleeve the lower end of which engages the second cam face of each knife. The first and second
45 sleeves are separate members the opposite ends of which are spaced apart by the portions of the knives defining the cam faces. This arrangement not only provides better control for the position of the knives, but also allows the axial zone of the tool which, in the case
50 of US-A-3073389 is occupied by a portion which connects the piston to the return member, to be used for fluid flow.

In the preferred embodiment of the invention the bi-

asing means comprises a biasing spring. Preferably, a single biasing spring acts to spring bias all the knives into the storage configuration. In the preferred embodiment the biasing spring acts on the knives via a first sleeve which is slidably mounted within the bore of the body. The first sleeve is biased longitudinally of the tool by the biasing spring and engages a first cam face on each knife to exert a force on the knife tending to rotate the knife into the storage configuration. The first sleeve preferably includes a longitudinal bore which is open to allow fluid flow through the first sleeve.

Preferably, means are provided to maintain the biasing means in a pre-stressed condition whilst one or more knives is removed from the tool. By this means, the knives may be changed without disassembling the biasing means. In a particularly preferred embodiment of the invention means are provided for maintaining the biasing means in a pre-loaded condition in which the biasing means do not apply any force to the knives. Such an arrangement particularly facilitates changing of the knives.

Preferably, the means for maintaining the biasing means in a pre-loaded condition comprises one or more stop members which may be selectively positioned to prevent movement of the sleeve beyond a predetermined position in the direction of relaxation of the biasing means. Accordingly, in order to change the knives force may be applied to the second sleeve to bias the knives out of their storage configuration and compress the spring of the biasing means. The or each stop may then be positioned and the force previously applied to the second sleeve may be relieved to allow the first sleeve to move into engagement with the stops. This configuration will occur before the knives have been fully retracted. Accordingly, with the first sleeve held by the stop means the knives may readily be removed and replaced. After the knives have been replaced forces again applied to the second sleeve to drive the knives further from their storage configuration allowing removal of the temporary stop. The force may then be removed from the second sleeve and the knives will be returned to the storage configuration by the biasing means.

The invention will be better understood from the following description of a preferred embodiment thereof, given by way of example only, reference being had to the accompanying drawings wherein:

Figure 1 illustrates schematically in half-section a portion of an embodiment of the invention;
Figure 2 is a view corresponding to Figure 1 illustrating the components in a configuration facilitating removal of the knife; and
Figure 3 illustrates the components in an alternative configuration and shows the use of a service tool to assist in removal of the knives.

Referring firstly to Figures 1 and 2 there is shown a pipe cutting tool 1 suitable for use downhole to cut the

casing of a well bore. As will be understood by those skilled in the art the tool will, in general, have screw-threaded connections at the upper and lower ends thereof enabling connection of the tool to other components of a drill string. In the interests of clarity, these connections have been omitted from Figures 1 and 2.

The tool 1 comprises a body 2 having a multiplicity of slots 3 each of which houses a knife 4 which is pivotally connected to the body 2 by means of a pivot pin 5. Typically, the tool 1 may incorporate three knives 4 but other arrangements are possible.

The knife 4 illustrated in Figures 1 and 2 has been broken away to illustrate a feature of the design which would otherwise be obscured by the blade 4. It should be appreciated, however, that the blades 4 are unitary structures typically comprising a body of steel having a hard facing of, for example, tungsten carbide so as to increase the cutting efficiency and prolong the service life of the knives.

An operating piston 6 is, in conventional manner, mounted within the body and is movable in response to fluid pressure within the drill string above the tool 1 to apply a downward force onto a sleeve 6A which is slidably mounted in the tool and the lower face of which engages cam faces on the upper ends 7 of the knives 4. This downward force produces a couple about the pivot pin 5 of each knife to rotate the knife anti-clockwise to bring the free end of the knives into engagement with the casing to be cut. The tool is rotated to effect cutting of the casing whilst continued pressure on the ends 7 by the sleeve 6A maintains the knives in cutting engagement with the casing. Suitable means may be provided for indicating when the knives 4 are at their outermost position, thereby indicating that the cutting of the casing has been completed.

In order to maintain the knives 4 wholly within the slots 3 as the tool is initially run into the well and to return the knives 4 to the slots 3 after each cut is made biasing means are adapted to apply a force to a cam surface 8 of each knife 4 thereby producing a couple on the knife directed clockwise about the pivot pin 5. In the illustrated embodiment of the invention the biasing means comprises a sleeve 9 slidably mounted within the bore 10 of the tool and a biasing spring 11 which acts between a shoulder 12 provided in the tool bore and the lower end 13 of the sleeve 9. As illustrated in Figure 1 the blade 4 is in the storage position and is so maintained by the force applied by the upper end surface 14 of the sleeve 9 on the cam surface 8 of the knife.

Preferably, suitable means are provided for preventing rotation of the sleeve 9 relative to the body 1. Such means may conveniently comprise a slot 15 provided in the body for receipt of a suitable key provided on the sleeve 9.

Preferably, axial movement of the sleeve 9 is limited by a key 16 which is located in a bore 17 provided in the body and retained in position by a screw 18. In the normal use configuration of the components, as illustrated

in Figure 1, the lower surface of the key 16 is close to but spaced from the lower edge 19 of a groove 20 machined in the outer surface of the sleeve 9. Hence, the key 16 does not in this configuration limit upward movement of the sleeve 9 (as viewed in Figure 1), but rather upward movement of the sleeve is limited by the engagement of the sleeve surface 14 with the cam surface 8. Thus, in the normal configuration of the components as illustrated in Figure 1 there is a permanent bias applied to the knives maintaining them in the fully seated position within the slots 3.

In use, the tool 1 is run into a well on a tubing string and, when at the correct level, the tubing string is rotated and pressurized to drive the piston 6 and sleeve 6A downwardly and thereby pivot the knives 4 outwardly into engagement with the casing wall. When the required cutting operation has been completed pressure within the tubing string is allowed to decay and the force applied to the knives by the biasing spring 11 will overcome the force applied by the piston 6 resulting in rotation of the knives into the storage configuration illustrated.

If desired, a separate return spring may be provided for returning the piston 6 to its initial configuration. It will be understood, however, that the provision of a return spring for the piston 6 alone is not sufficient to return the knives 4 to the storage configuration illustrated for the reasons set out above. It will be noted, however, that even in the absence of a piston return spring the surfaces 7 of the knives, acting via the lower surface of the sleeve 6A, will return the piston to its initial position as the knives themselves are returned to their initial position by the biasing means.

It will be noted that there is no connection provided, within the bore of the tool, between the sleeve 6A of the operating mechanism and the sleeve 9 of the biasing means. In use, downward movement of the sleeve 9 of the biasing means is effected as a result of engagement of the upper end of the sleeve by the cam surfaces 8 as the knives are rotated out of their storage configuration by the operating mechanism. Accordingly, the zone of the bore located between the upper end of the biasing means sleeve 9 and the lower end of the operating mechanism sleeve 6A is occupied only by the portions of the knives which define the cam surfaces. Accordingly, this zone of the bore is free for the passage of fluid. This fact, combined with the fact that the longitudinal bores of the sleeves 6A and 9 are both open permits flow of fluid through the bore of the tool. The design of the piston 6 is also such as to provide an open bore and accordingly fluid may be circulated through the entire length of the tool in use.

In order to assemble the illustrated tool the spring 11 is first run into the bore 10 until it seats on the shoulder 12 and thereafter the sleeve 9 is inserted through the bore from above so that the end of the sleeve 13 contacts the spring 11 and the key provided on the sleeve engages the slot 15 provided in the body. There-

after, force is applied by suitable means to the upper end of the sleeve to compress the sleeve sufficiently to enable a stop member such as a full diameter key 16A to be inserted through the bore 17 and temporarily locked in position by means of the screw 18 (Fig 2). The means compressing the spring 11 are then released to bring the shoulder 19 of the groove 20 into contact with the key 16A. Because the key 16A has a relatively larger size than the service key 16 as illustrated in Figure 1 the effect of introducing the key 16A will be to detain the sleeve 9 in a position in which the spring 11 is slightly more compressed than normally would be the case in the use configuration of the components illustrated in Figure 1. By restraining the sleeve in this manner the knives 4 can readily be positioned within the slots and the pivot pins 5 inserted. This will produce the configuration illustrated in Figure 2 in which a small clearance space will exist between the upper edge 14 of the sleeve 9 and the cam surface 8 of the knives 4. The sleeve 6A and piston 6 will then be inserted and an appropriate force applied to the piston to rotate the knives 4 outwardly to an intermediate position and partly compressed spring 11. With the components in this intermediate position the screw 18 and key 16A can be removed, the service key 16 inserted, and the screw 18 replaced. Upon release of the force from the piston the components will then be returned to the working configuration illustrated in Figure 1. The piston 6 and sleeve 6A may be integral.

Suitable means for applying a force to the piston are illustrated in Figure 3. To this end, a service tool 21 comprises a sleeve 22 which, in the use position illustrated in Figure 3, is screw-threadedly engaged with the screw-threads 23 provided on the upper end of the body 2. A jack 24 is in turn in screw-threaded engagement with threads 25 provided on the interior bore of the sleeve 22. By rotating the jack 24 by means of handle 26 the lower end of the jack can be engaged with the piston and used to force the piston downwardly as illustrated in Figure 3 to compress the spring 11 as described above. It will be appreciated that if, after assembly of the components, it is desired to change one or more of the knives 4 the service tool 21 may be used to facilitate compression of the spring 11 thereby allowing the key 16A to be reinserted in the bore 17 whereupon the jack may be released to return the components to the configuration illustrated in Figure 2 thereby enabling ready replacement of the knives.

Claims

1. A pipe cutter (1) for cutting the casing of a well bore comprising: a body (2); a plurality of knives (4) pivotally mounted on the body and each rotatable between a storage position in which the knife does not extend radially outwardly of the body (2) and a use position in which the knife extends radially outward-

ly of the body (2) to engage a pipe to be cut; operating means (6,6A) selectively operable to move the knives (4) from the storage position to the use position; and biasing means (9,11) biasing the knives into the storage position whereby when said operating means is not in use the blades adopt the storage position under the influence of the biasing means, characterised in that the biasing means includes a first sleeve (9) the upper end of which engages first cam faces (8) of each knife and the operating means includes a second sleeve (6A) the lower end of which engages second cam faces of each knife, the first and second sleeves being separate members with the opposing ends of the first and second sleeves spaced apart by the portions of the knives defining the cam faces.

2. A pipe cutter according to claim 1 wherein the biasing means comprises a single biasing spring (11) which acts on the first sleeve (9) to spring bias all the knives into the storage position.
3. A pipe cutter according to claim 3 wherein the first sleeve (9) includes a longitudinal bore which is open to allow fluid flow through the first sleeve.
4. A pipe cutter according to any preceding claim wherein the second sleeve (6A) includes a longitudinal bore which is open to allow fluid flow through the second sleeve.
5. A pipe cutter according to any preceding claim including means for maintaining the biasing mean (9, 11) in a prestressed condition whilst one or more knives (4) is removed from the tool.
6. A pipe cutter according to claim 5 wherein the means for maintaining the biasing means in a prestressed condition comprises one or more stop member (16A) which may be selectively positioned to prevent movement of the sleeve beyond a predetermined position in the direction of relaxation of the biasing means (9, 11).

Patentansprüche

1. Schneidvorrichtung für Rohre (1) zum Schneiden der Verkleidung eines Bohrloches, bestehend aus: einem Körper (2); mehreren, schwenkbar auf dem Körper angeordneten Messern (4), von denen jedes zwischen einer Ruheposition, in der das Messer nicht radial aus dem Körper (2) herausragt, und einer Anwendungsposition, in welcher das Messer radial aus dem Körper (2) herausragt, drehbar ist, um so ein zu schneidendes Rohr zu ergreifen; einer selektiv zu betätigenden Betätigungsvorrichtung (6, 6A), welche die Messer (4) aus der Ruheposition in

die Anwendungsposition bringen; und einer Ausrichtevorrichtung (9, 11), welche die Messer (4) schräg in Ruheposition bringt, wobei, wenn besagte Betätigungsvorrichtung nicht verwendet wird, die Schneidmesser unter dem Einfluß der Ausrichtevorrichtung die Ruheposition einnehmen, gekennzeichnet dadurch, daß die Ausrichtevorrichtung aus einer ersten Buchse (9) besteht, deren oberes Ende an erste Nockenflächen (8) eines jeden Messers angreift, und dadurch, daß die Betätigungsvorrichtung aus einer zweiten Buchse (6A) besteht, deren unteres Ende an zweite Nockenflächen eines jeden Messers angreift, wobei die erste und zweite Buchse zwei separate Elemente sind und wobei die gegenüberliegenden Enden der ersten und zweiten Buchse durch die Abschnitte der Messer, welche die Nockenflächen bilden, voneinander getrennt werden.

2. Schneidvorrichtung für Rohre nach Anspruch 1, wobei die Ausrichtevorrichtung aus einer einzigen Ausrichtefeder (11) besteht, die auf die erste Buchse (9) wirkt und alle Messer in ihre Ruheposition bringt.
3. Schneidvorrichtung nach Anspruch 3, wobei die erste Buchse (9) mit einer länglichen Bohrung versehen ist, die offen ist, damit Flüssigkeit durch die erste Buchse fließen kann.
4. Schneidvorrichtung nach jedem der vorhergehenden Ansprüche, wobei die zweite Buchse (6A) mit einer länglichen Bohrung versehen ist, die offen ist, damit Flüssigkeit durch die erste Buchse fließen kann.
5. Schneidvorrichtung nach jedem der vorhergehenden Ansprüche, die mit einer Vorrichtung versehen ist, welche die Ausrichtevorrichtung (9, 11) in einem vorgespannten Zustand hält, während ein oder mehrere Messer (4) aus dem Werkzeug entnommen werden.
6. Schneidvorrichtung nach Anspruch 5, wobei die Vorrichtung, welche die Ausrichtevorrichtung in einem vorgespannten Zustand hält, ein oder mehrere Halteelemente (16A) umfaßt, die selektiv positioniert werden können, um die Bewegung der Buchse über eine vorherbestimmte Position in Richtung der Entspannung der Ausrichtevorrichtung (9, 11) hinaus zu verhindern.

Revendications

1. Coupe-tube (1) pour couper le cuvelage d'un forage de puits comprenant: un corps (2); plusieurs couteaux (4) montés de façon pivotante sur le corps,

- chacun rotatif entre une position de stockage dans laquelle le couteau ne s'étend pas radialement à l'extérieur du corps (2) et une position opérationnelle dans laquelle le couteau s'étend radialement à l'extérieur du corps (2) pour engager un tube devant être coupé; des moyens de commande (6, 6A) sélectivement opérables pour déplacer les couteaux (4) de la position de stockage à la position opérationnelle; et des moyens de polarisation (9, 11) polarisant les couteaux dans la position de stockage par laquelle, quand lesdits moyens de commande ne sont pas utilisés, les lames prennent la position de stockage sous l'influence des moyens de polarisation, dont les caractéristiques sont que les moyens de polarisation comportent un premier manche (9) dont l'extrémité supérieure engage les premières faces à cames (8) de chaque couteau, et que les moyens de commande comportent un deuxième manche (6A) dont l'extrémité inférieure engage les secondes faces à cames de chaque couteau, les premier et second manches étant des membres séparés avec les extrémités opposées des premier et second manches espacés par les parties des couteaux définissant les faces à cames.
2. Coupe-tube selon la revendication 1 dans lequel les moyens de polarisation comprennent un ressort de polarisation unique (11) qui agit sur le premier manche (9) pour monter sur ressorts obliques tous les couteaux en position de stockage.
3. Coupe-tube selon la revendication 3 dans lequel le premier manche (9) comporte un perçage longitudinal, ouvert pour permettre l'écoulement d'eau à travers le premier manche.
4. Coupe-tube selon l'une quelconque des précédentes revendications dans lequel le second manche (6A) comporte un perçage longitudinal, ouvert pour permettre l'écoulement d'eau à travers le second manche.
5. Coupe-tube selon l'une quelconque des précédentes revendications comportant des agents de maintien des moyens de polarisation (9, 11) en condition précontrainte pendant qu'un ou plusieurs couteaux (4) sont retirés de l'outil.
6. Coupe-tube selon la revendication 5 dans lequel les agents de maintien des moyens de polarisation en condition précontrainte comprennent une ou plusieurs barres d'arrêt (16A) pouvant être sélectivement placées pour empêcher le mouvement du manche au-delà d'une position prédéfinie dans le sens de relaxation des moyens de polarisation (9, 11).

Fig.1.

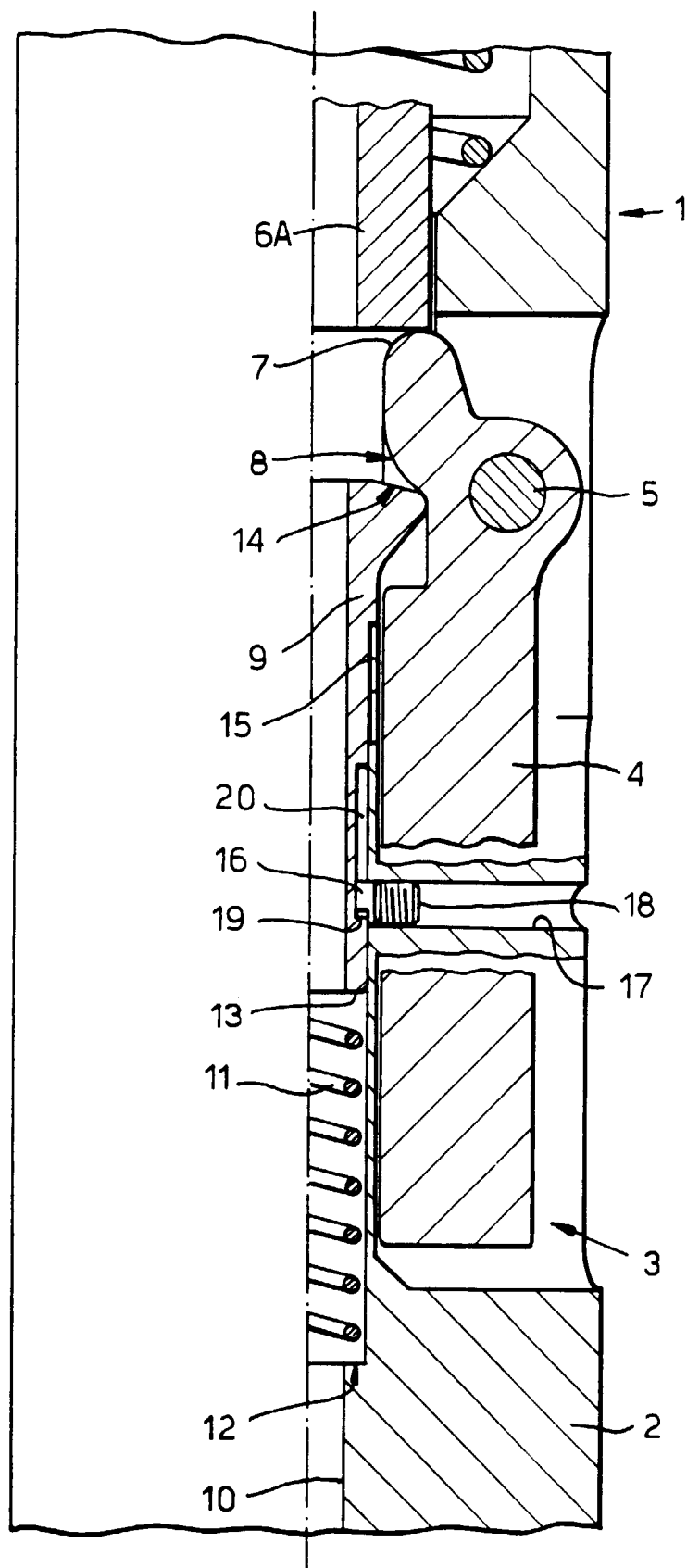


Fig.2.

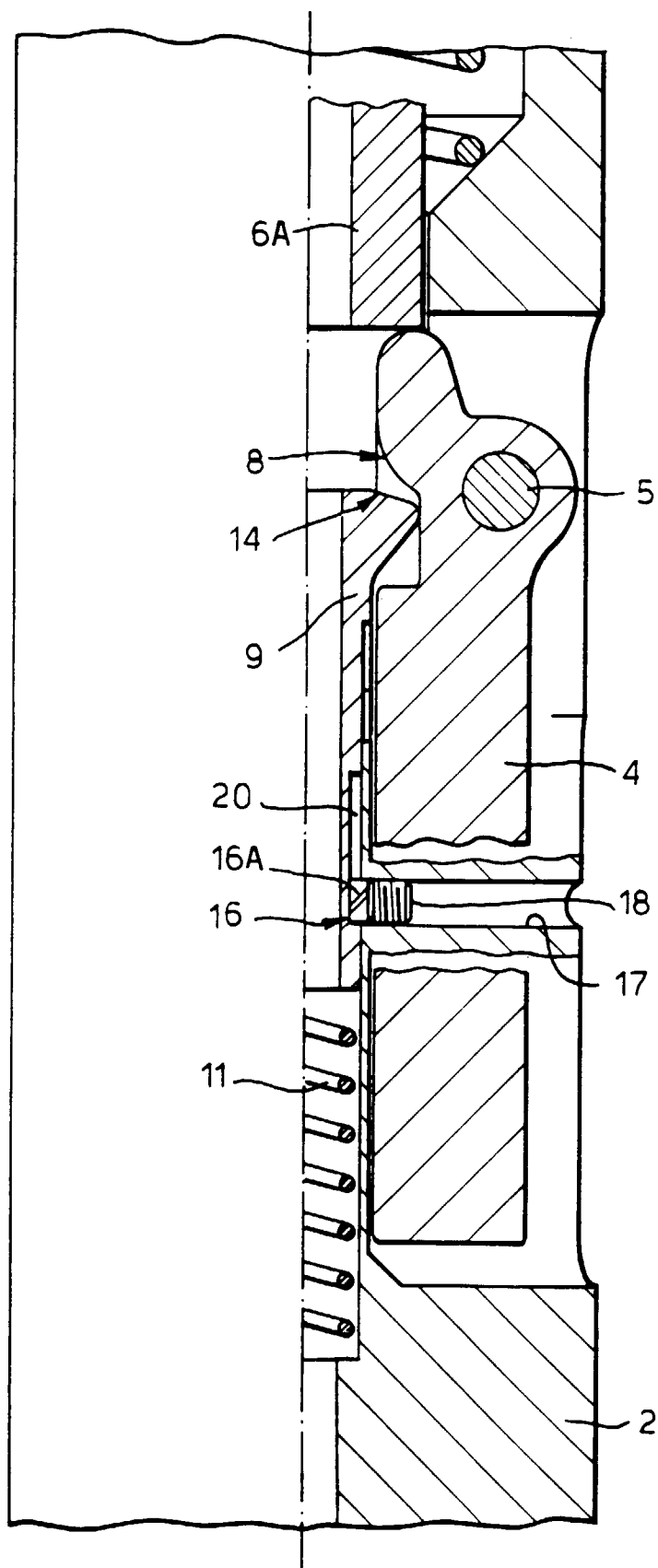


Fig.3.

