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(54) **Cutter bit for use in drilling operations**

Bohrmeissel für Bohrvorgänge

Outil de coupe pour opérations de forage

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## Description

**[0001]** This invention relates to drilling bits for use in drilling operations, such as in the oil and gas industry and, in particular, to a bit suitable for alleviating problems associated with running of the drilling bit into a well hole and pulling of the cutter bit from the hole.

**[0002]** Conventional drilling bits comprise a generally tubular drilling bit body provided at the bottom end thereof with a plurality of cutters for cutting the well formation. Normally, the drilling bit is forged and provided at its bottom end with three legs having attached to their bottom portions, known as shirt tails, mounting pins for securing cone cutter elements made of a durable material. These cutter elements may be conical and are provided with hard cutting teeth, made, for example, from tungsten carbide, for cutting a formation. Through the centre of the drilling bit body is usually provided a bore through which drilling fluids are delivered at high velocity via three conduits to areas adjacent to the cutters to assist in cutting and cuttings removal. However, the central bore is not itself directly open to the cutting face and, for this reason, a number of problems can arise when a drilling bit is being run into the hole, pulled from the hole or simply being used in cutting operations.

**[0003]** Firstly, it is to be appreciated that the drilling bit body will be in gauge with the walls of the hole and, therefore, as the drilling bit is run into the hole it acts as a piston which compresses material below the bottom end of the drilling bit body. The only relief from the increasing pressures is leakage through zones where the drilling bit body has lesser diameter than the gauge of the hole. However, as these zones only have very small area for flow of cuttings and fluids, the flow is substantially restricted and little pressure relief is obtained. The consequence of such increasing pressures is "surge" or the generation of stresses on the rock formations along the open hole section below the drilling bit. It is known in the oil and gas industry that these stresses or surge pressures cause major damage to weak formations and, more importantly, to productive reservoir sands. In particular, the formation may be damaged by fracturing of the formation beneath the cutter bit during running into the hole. This problem is worsened by increasing running speeds and higher viscosity drilling fluids that cause higher pressure drop across the drilling bit. Clearly, damage to the formation, with consequential reductions in oil and gas recovery, is unacceptable to the industry for cost reasons.

**[0004]** Secondly, upon pulling of the drilling bit from the hole a reverse problem known to the industry as "swabbing" occurs. In the worst cases, swabbing, which results from fluid flow into the reduced pressure area caused by pulling of the drilling bit and drillstring from the hole can cause blowouts which are extremely hazardous. In addition, swabbing may result in contamination of the drilling fluids by formation fluids necessitating costly treatment processes and/or increased drilling fluid cost. Swabbing is most pronounced when the drilling bit or drilling stabilisers are encrusted or packed with formation cuttings. In these cases, it becomes increasingly more difficult to maintain an even hydrostatic pressure on both sides of the cutter bit because the already restricted fluid flow area past the outer circumference of the cutter bit is restricted even further. Other factors that contribute to swabbing include variable viscosity drilling fluids and variation in hole diameter.

**[0005]** A yet further problem with conventional cutters is poor hole cleaning due to a poor efficiency of cuttings removal from the centre of the cutting area at the bottom of the hole. Conventional drilling bits rely on the delivery of drilling fluid to the bottom of the hole for effective hole cleaning. In a typical design, as discussed above, there are three cone cutters and, therefore, three nozzles, each adjacent to each cutter cone, are provided for the jetting of cooling and cleaning fluid to the bottom of the hole. Jetting occurs at high velocity with fluid impacting the bottom of the hole at or near its outer edges close to the hole walls. This action effectively washes the outer zone of the hole to remove cuttings. However, cleaning from the centre of the hole is much less efficient because cuttings become trapped in recesses between the cutters and the bottom end of the drilling bit body. In conventional bits, cutting accumulation in this area can create what is called in the industry bit balling, where the trapped cuttings restrict the rotation of the cutting cones. Bit balling has been a major problem in the industry. Thus the overall cleaning and cutting efficiency of the drilling bit is reduced.

**[0006]** The present invention provides a drilling bit comprising:

(a) a body adapted to be connected to a tubular drill string and being rotatable about its axis, said body having a full diameter portion and an upper portion which has at least a circumferential segment which is positioned radially inwardly with respect to the axis of the full diameter portion;

(b) a plurality of leg members extending downwardly from the body and defining a zone therebetween and below the body;

(c) cutting means mounted on each leg member and extending inwardly into the zone for cutting a formation; and

(d) a return passage extending upwardly through the body from said zone and exiting at the upper portion opposite the circumferential segment whereby a portion at least of the fluid delivered from the tubular drill string to said zone, i.e. to the cutting face, flows from said zone through the return passage in the body, bypassing the full diameter portion of the body.

**[0007]** The return passage provides a route for cuttings to escape to the surface of the hole.

**[0008]** Conveniently, the return passage exists the body of the drilling bit at an opening which extends in a plane substantially normal to a central axis extending in the same direction as the tubular drill string. In addition, it may be found desirable for the return passage to communicate with at least one further passage which bypasses the full diameter portion of the body such that the aforesaid portion at least of the fluid exits from the body through a number of openings. The openings to the further passages need not be located at the same level and can be orientated at a variety of different angles corresponding to the trajectory of the first or further passages which ranges between 0° and 90° to the central axis of the cutter bit body, that is the return passage exits from said body at an opening which extends in a plane having an axis extending at an angle not being perpendicular to the central axis of said body.

**[0009]** Preferably, flow of cutting through the return passage is assisted by jetting drilling fluid through at least one nozzle communicating a drilling fluid supply and the return passage, and having a trajectory the same as the return passage. The same applies to the further passage. Further, the drilling bit body may be provided with one or more supply passages communicating a drilling fluid supply with an opening or openings of the cutter bit body located adjacent to the cutting means for supply of drilling fluids, such as cooling and cleaning fluids, thereto.

**[0010]** Preferably, the first passage opening in the bottom portion of the cutter bit body is located in a recess defined by a plurality of cutting means to readily allow transfer of cuttings and fluids from the recess to the second zone of the hole.

**[0011]** In a particularly advantageous embodiment of the invention at least one said nozzle is located at a point adjacent and above the uppermost point of the path of rotation of said cutting means, said nozzle having a trajectory the same as said return passage. In one arrangement a second passage and nozzle communicates a filling fluid supply for the cutter bit with the first passage. Preferably, at least one said nozzle is located at a point adjacent and above the uppermost point of the path of rotation of said cutting means, said nozzle having a trajectory approximately tangential to the path of rotation of said cutting means.

**[0012]** For a better understanding of the invention, and to show how the same may be carried into effect, reference will now be made, by way of example, to the accompanying drawings, in which:-

Figure 1 is a sectional view of a drilling bit made in accordance with a first embodiment of the invention;

Figure 2 is a sectional view of a drilling bit made in accordance with a second embodiment of the invention; and

Figure 3 is a sectional view of a drilling bit made in accordance with a third embodiment of the invention.

Figure 4 is a sectional view of a drilling bit made in accordance with a fourth embodiment of the invention.

Figure 5 is a sectional view of a drilling bit made in accordance with a fifth embodiment of the invention.

**[0013]** As can be seen from Figure 1 of the drawings, a drilling bit 10 embodying the invention for use in drilling operations comprises a body 10 having a top portion 11 and a bottom portion 12, the bottom portion 12 being provided with cutting means (not shown) for cutting a formation to which the cutter bit is exposed. Within an outer circumference 13 of the bottom portion 12 of the body 10, there is provided a first opening 14 to a first passage 15 through the body 10 to communicate a first zone 20 of a hole located below the bottom portion 12 of the body with a second zone 21 of the hole located above the bottom portion 12 of the body. In this way, cuttings and fluids located below the bottom portion of the cutter bit can be transferred from the first zone 20 to the second zone 21.

**[0014]** The drilling bit body 10 above described could be a three cone drilling bit familiar to the drilling industry with the additional provision of the first passage 15. The body 10 is connected to the rest of a drillstring run into the hole by a connecting thread portion 16 provided on the top portion 11 of the body 10. However, other connecting means may also be used.

**[0015]** The body 10 is constructed of a suitable durable material such as steel and the cutting means is comprised, for example, of three rotatable conical cutting elements which are rotatably secured by bearings on pins 30 located on leg members 31 of the drilling bit 1, two of which are shown in Figure 1. Though not necessary for the practice of the invention, the cutting elements may be fabricated from a hard material such as steel or tungsten carbide and be provided with teeth of the same material to provide a cutting action. The cutting elements are rotatable in response to the revolution of the drillstring and lubricated by oil or grease supplied through port 46, one of which is shown in each of Figures 1 to 4.

**[0016]** It may also be readily seen from Figure 1 that a recess 26 is definable by the cutter elements. During use of the drilling bit 1, cuttings accumulate therein, in the absence of the first passage 15, reducing both the hole cleaning and cutting efficiency of the drilling bit 1. It will also be apparent that if the first passage 15 is not present, the drilling bit 1 will be an almost solid structure acting as a piston with little pressure relief and increasing the problems of surge and swab. These problems are alleviated to an appreciable extent by provision of the first passage 15. It is also desirable, for the purposes of avoiding plugging of the passage 15 with cuttings, to coat the passage 15 with a non-stick material such as Teflon (Registered Trade Mark).

**[0017]** The trajectory of the passage 15 may also be a matter of some importance in practice. The opening 24 through which cuttings and fluids exit the first passage 15 and enter the second zone 21 may be either parallel or perpendicular to a central axis 23 of the central bore 25 of the drilling bit 1. However, it will be appreciated that if the first passage 15 and its opening 24 to the second zone 21 are perpendicular to the central axis 23, erosion of the hole walls may occur, where jetting of drilling fluids is conducted in accordance with the embodiment described with reference to Figure 3. This would be undesirable.

**[0018]** However, the trajectory of the first passage 15 is not critical to the drilling bit in its broadest aspect and it is therefore to be understood that the first passage 15 may be oriented at any angle in the range 0° to 90° to the central axis 23, i.e. not have its axis perpendicular to the central axis of the body 10. In the embodiments shown, the passage opening 24 is parallel to the central axis 23.

**[0019]** The first passage 15 is separated by wall 27 from the central bore 25 through which drilling fluids travel via conduit 36 and nozzle 37 to a location adjacent the cutting elements.

**[0020]** In the embodiment shown, only one such conduit and nozzle arrangement is shown. However, in a conventional three cone bit it will be understood that there are present three such arrangements. In this way drilling fluids are jetted at high velocity to the cutting face where they assist with cutting operations by cooling and cleaning of the drilling bit 1.

**[0021]** Additionally, it will be seen that, in contrast to the situation where the first passage 15 is absent, the flow of drilling fluids passes through the recess 26 and into the first passage 15 thereby enhancing cuttings removal and hole cleaning. In addition, the restricted flow area of the conventional drilling bit has been increased by the flow area of the first passage 15 thereby increasing pressure relief and allowing a reduction in surge and swab pressures on running into the hole or pulling from the hole of the drilling bit and drillstring.

**[0022]** Figure 2 shows a further embodiment of the invention in which the flow area for communication between the first zone 20 and the second zone 21 of the hole is increased still further by the provision of a plurality of openings, two of which openings 24 and 24a are shown. However, any desired number of openings can be employed. Opening 24a communicates with first passage 15 through a further passage 33. This arrangement, by increasing the flow area and improving the distribution of drilling fluid flow into the annulus between the drilling bit body 10 and the hole walls, gives additional assistance in relieving the surge and swab pressure problems. The further passage 33 may likewise be coated with Teflon to improve flow properties and reduce the risk of plugging with cuttings. There is no requirement that openings 24 and 24a be at the same level of the drilling bit body 10 or at the same trajectory as each other, though this may be found convenient for the purposes of manufacture and uniform flow distribution.

**[0023]** Figure 3 shows a further embodiment of the invention in which the flow of cuttings through first passage 15 is enhanced by jetting of drilling fluids upward through the first passage 15 to create a venturi effect that further assists in cuttings removal from the first zone 20. In this embodiment, the conduit 36 communicates through conduit 41 and nozzle 42 with the first passage 15 thereby ensuring flow of drilling fluids into the first passage. Control over jetting velocity can be obtained by suitable sizing of the conduit 41 and nozzle 42. The trajectory of the jet is preferably angularly upward and in the embodiment shown is at 75° to the central axis 23 of the central bore 25 of the drilling bit 1. Although in the embodiment described only one such jet has been provided there could be provided a plurality of such jets to further enhance cuttings removal and hole cleaning.

**[0024]** It is of some importance in this embodiment that the first passage 15 be designed to avoid erosion damage caused by impingement of high velocity drilling fluids on the walls 15a of the passage. With this end in view, hard facing of a portion of the first passage 15 may be required.

**[0025]** Figure 4 shows a still further embodiment of the invention which is identical in many respects to that of Figure 3 described above. However, in this embodiment, the nozzle 37 is absent with conduit 36 being blanked off by blank 47 at the position previously occupied by nozzle 37. Therefore, a jet of higher pressure through conduit 41 and nozzle 42 can be achieved. This facilitates removal of cuttings through the first passage 15 to the surface of the hole.

**[0026]** Figure 5 shows a still further embodiment in which conduit 36 extends downwardly a sufficient distance that the nozzle 42 is located to cause a jet of drilling fluid above and adjacent, preferably immediately adjacent, the uppermost point, A, of the path of rotation, B, of each cutter element (not shown). The jet is directed along the trajectory of the first passage 15 to obtain the above described advantages.

**[0027]** There are also additional advantages to the arrangement shown in Figure 5. Firstly, by extending the nozzles of the bit closer to the bottom of the hole and orientating the jets across the recess 26, jetting of the drilling fluid achieves a valuable cleaning effect which assists in the alleviation of balling-up or accumulation of cuttings between the cone teeth or inserts of the cutter elements.

**[0028]** Secondly, and importantly the location of nozzle 42 is in close proximity to a cutting face to which the drilling bit is exposed. As the jet of drilling fluid is directed along passage 15 or approximately tangential to the path of rotation, A, a venturi effect is obtained, creating a suction pressure at the cutting face which greatly assists hole cleaning.

**[0029]** Using one, two or three such jets at the above described position and orientation will create a reduced bottom hole pressure under the bit. This jetting action produces a venturi effect under the bit such that the reduced bottom hole pressures allow formation of an artificial drilling break.

**[0030]** Lower pressures at the bottom of the hole are desirable in that hole pore pressures and bottom hole pressure become equalised which is desirable at the bit tooth and rock contact. Consequently, the "chip hold down" which is always greater when drilling with heavier mud weights can also be reduced allowing for an equally substantial increase in the rate of penetration.

**[0031]** It is to be understood that the invention is in no way limited by the foregoing description and different means of effecting the invention may be apparent to those skilled in the art who have read the above description. For example, the invention is not limited in its application to three cone cutter bits. Such differences, however, do not depart from the scope of the invention.

## Claims

**1.** A drilling bit comprising:

(a) a body adapted to be connected to a tubular drill string and being rotatable about its axis, said body having a full diameter portion and an upper portion which has at least a circumferential segment which is positioned radially inwardly with respect to the axis of the full diameter portion;
(b) a plurality of leg members extending downwardly from the body and defining a zone therebetween and below the body;
(c) cutting means mounted on each leg member and extending inwardly into the zone for cutting a formation; and
(d) a return passage extending upwardly through the body from said zone and exiting at the upper portion opposite the circumferential segment whereby a portion at least of the fluid delivered from the tubular drill string to said zone, i.e. to the cutting face, flows from said zone through the return passage in the body, bypassing the full diameter portion of the body.

**2.** A drilling bit as according to claim 1 wherein said return passage exits from said body at an opening which extends in a plane substantially normal to a central axis extending in the same direction as said tubular drill string.

**3.** A drilling bit as according to claim 1 wherein said return passage communicates with at least one further passage bypassing the full diameter portion of the body such that said portion at least of the fluid exits from said body through a plurality of openings.

**4.** A drilling bit as according to claim 1 wherein said return passage exits from said body at an opening which extends in a plane having an axis extending at an angle not being perpendicular to a central axis of said body.

**5.** A drilling bit according to claim 1 wherein flow of cuttings through said return passage is assisted by jetting drilling fluid through at least one nozzle communicating a drilling fluid supply and the return passage, and having a trajectory the same as the return passage.

**6.** A drilling bit according to claim 3 wherein flow of cuttings through at least one said further passage is assisted by jetting drilling fluid through a nozzle communicating a drilling fluid supply and said further passage and having a trajectory the same as said further passage.

**7.** A drilling bit according to claim 5 or 6 wherein at least one said nozzle is located at a point adjacent and above the uppermost point of the path of rotation of said cutting means, said nozzle having a trajectory the same as said return passage.

**8.** A drilling bit according to claim 5 or 6 wherein at least one said nozzle is located at a point adjacent and above the uppermost point of the path of rotation of said cutting means, said nozzle having a trajectory approximately tangential to the path of rotation of said cutting means.

## Patentansprüche

**1.** Bohrmeißel, enthaltend

a) einen Korpus, der für ein Verbinden mit einem rohrförmigen Bohrgestänge geeignet und um seine Achse drehbar ist, wobei der Korpus einen Volldurchmesserbereich und einen oberen Bereich mit mindestens einem Umfangssegment aufweist, welches radial einwärts in bezug auf die Achse des Volldurchmesserbereiches angeordnet ist;

b) eine Vielzahl von Beinteilen, die sich vom Korpus abwärts erstrecken und zwischen sich und unterhalb des Korpus eine Zone definieren;

c) Schneidmittel, die an jedem Beinteil befestigt sind und sich einwärts in die Zone erstrecken, um eine Formation zu schneiden; und

d) einen Rückführungsdurchlaß, der sich aufwärts durch den Korpus erstreckt und im oberen Bereich gegenüber dem Umfangssegment austritt, wobei zumindest ein Teil der von dem rohrförmigen Bohrgestänge zu der Zone, d. h. zu der Schneidfläche herbeigeführten Flüssigkeit aus der Zone durch den Rückführungsdurchlaß in den Korpus fließt und den Volldurchmesserbereich des Korpus umgeht.

**2.** Bohrmeißel nach Anspruch 1, wobei der Rückführungsdurchlaß über eine Öffnung aus dem Korpus austritt, die sich in einer Ebene im wesentlichen senkrecht zu einer zentralen Achse erstreckt, welche in gleicher Richtung wie das rohrförmige Bohrgestänge verläuft.

**3.** Bohrmeißel nach Anspruch 1, wobei der Rückführungsdurchlaß mit mindestens einem weiteren den Volldurchmesserbereich des Korpus umgehenden Durchlaß kommuniziert, so daß mindestens der Teil der Flüssigkeit aus dem Korpus durch eine Vielzahl von Öffnungen austritt.

**4.** Bohrmeißel nach Anspruch 1, wobei der Rückführungsdurchlaß über eine Öffnung aus dem Korpus austritt, die sich in einer Ebene mit sich unter einem nicht rechtwinkligen Winkel zu einer zentralen Achse des Korpus verlaufenden Achse erstreckt.

**5.** Bohrmeißel nach Anspruch 1, wobei der Fluß an Bohrmehl durch den Rückführungsdurchlaß mittels Ausspritzen von Bohrflüssigkeit aus mindestens einer Düse unterstützt wird, die mit einer Bohrflüssigkeitszuführung und dem Rückführungsdurchlaß kommuniziert und eine gleiche Trajektorie wie der Rückführungsdurchlaß aufweist.

**6.** Bohrmeißel nach Anspruch 3, wobei der Fluß an Bohrmehl durch mindestens einen weiteren Durchlaß mittels Ausspritzen von Bohrflüssigkeit aus einer mit einer Bohrflüssigkeitszuführung kommunizierenden Düse unterstützt wird und der weitere Durchlaß die gleiche Trajektorie wie der Rückführungsdurchlaß aufweist.

**7.** Bohrmeißel nach Anspruch 5 oder 6, wobei mindestens eine der Düsen an einem Punkt benachbart und oberhalb des höchsten Punktes des Rotationsweges der Schneidmittel angeordnet ist und die Düse die gleiche Trajektorie wie der Rückführungsdurchlaß aufweist.

**8.** Bohrmeißel nach Anspruch 5 oder 6, wobei mindestens eine der Düsen an einem Punkt benachbart und oberhalb des höchsten Punktes des Rotationsweges der Schneidmittel angeordnet ist und die Düse eine annähernd tangentiale Trajektorie zum Rotationsweg der Schneidmittel aufweist.

## Revendications

**1.** Trépan comprenant :

a)un corps apte à être raccordé à une colonne de forage tubulaire et pivotant autour de son axe, ledit corps présentant une portion de diamètre plein et une portion supérieure comportant au moins un segment circonférentiel qui est positionné radialement vers l'intérieur par rapport à l'axe de la portion de diamètre plein ;
b)une pluralité de bras s'étendant vers le bas à partir du corps et définissant, entre eux et sous le corps, une zone ;
c) des moyens de coupe montés sur chaque bras et s'étendant vers l'intérieur, dans la zone, pour couper une formation ; et
d)un passage de retour traversant le corps vers le haut depuis ladite zone et débouchant au niveau de la portion supérieure à l'opposé du segment circonférentiel, une partie au moins de la boue délivrée depuis la colonne de forage tubulaire vers ladite zone, c'est-à-dire la face de coupe, s'écoulant depuis ladite zone à travers le passage de retour ménagé dans le corps, en dérivation avec la portion de diamètre plein du corps.

**2.** Trépan selon la revendication 1, caractérisé en ce que ledit passage de retour débouche dudit corps au niveau d'un orifice qui s'étend dans un plan sensiblement normal à un axe central parallèle à ladite colonne de forage tubulaire.

**3.** Trépan selon la revendication 1, caractérisé en ce que ledit passage de retour communique avec au moins un autre passage en dérivation avec la portion de diamètre plein du corps, de telle sorte que cette partie au moins du fluide ressort dudit corps par une pluralité d'orifices.

**4.** Trépan selon la revendication 1, caractérisé en ce que ledit passage de retour débouche dudit corps au niveau d'un orifice qui s'étend dans un plan dont un axe forme un angle non perpendiculaire avec un axe central dudit corps

**5.** Trépan selon la revendication 1, caractérisé en ce que l'écoulement de déblais à travers ledit passage de retour est assisté par l'injection de boue de forage via au moins une buse qui communique avec une source de boue de forage et le passage de retour et dont la trajectoire est identique à celle du passage de retour.

**6.** Trépan selon la revendication 3, caractérisé en ce que l'écoulement de déblais à travers le ou lesdits autres passages est assisté par l'injection de boue de forage via une buse qui communique avec une source de boue de forage et ledit autre passage de retour et dont la trajectoire est identique à celle dudit autre passage.

**7.** Trépan selon la revendication 5 ou 6, caractérisé en ce que la ou lesdites buses sont situées à proximité et au-dessus du sommet de la trajectoire de rotation desdits moyens de coupe, la ou lesdites buses ayant une trajectoire identique à celle dudit passage de retour.

**8.** Trépan selon la revendication 5 ou 6, caractérisé en ce que ladite ou lesdites buses sont situées à proximité et au-dessus du sommet de la trajectoire de rotation desdits moyens de coupe, ladite buse ayant une trajectoire sensiblement tangentielle à la trajectoire de rotation desdits moyens de coupe.

Fig 1.

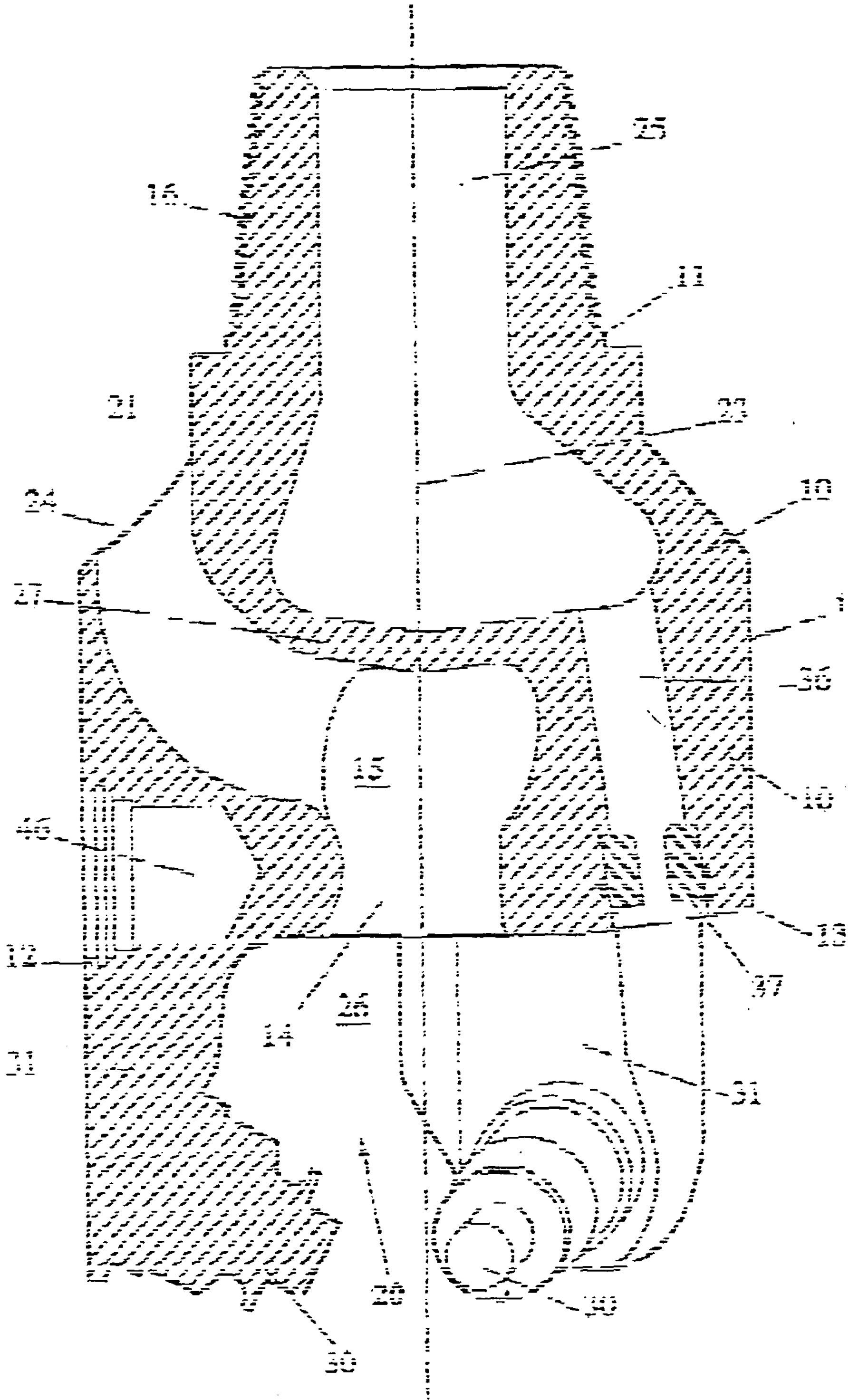

Fig 2.

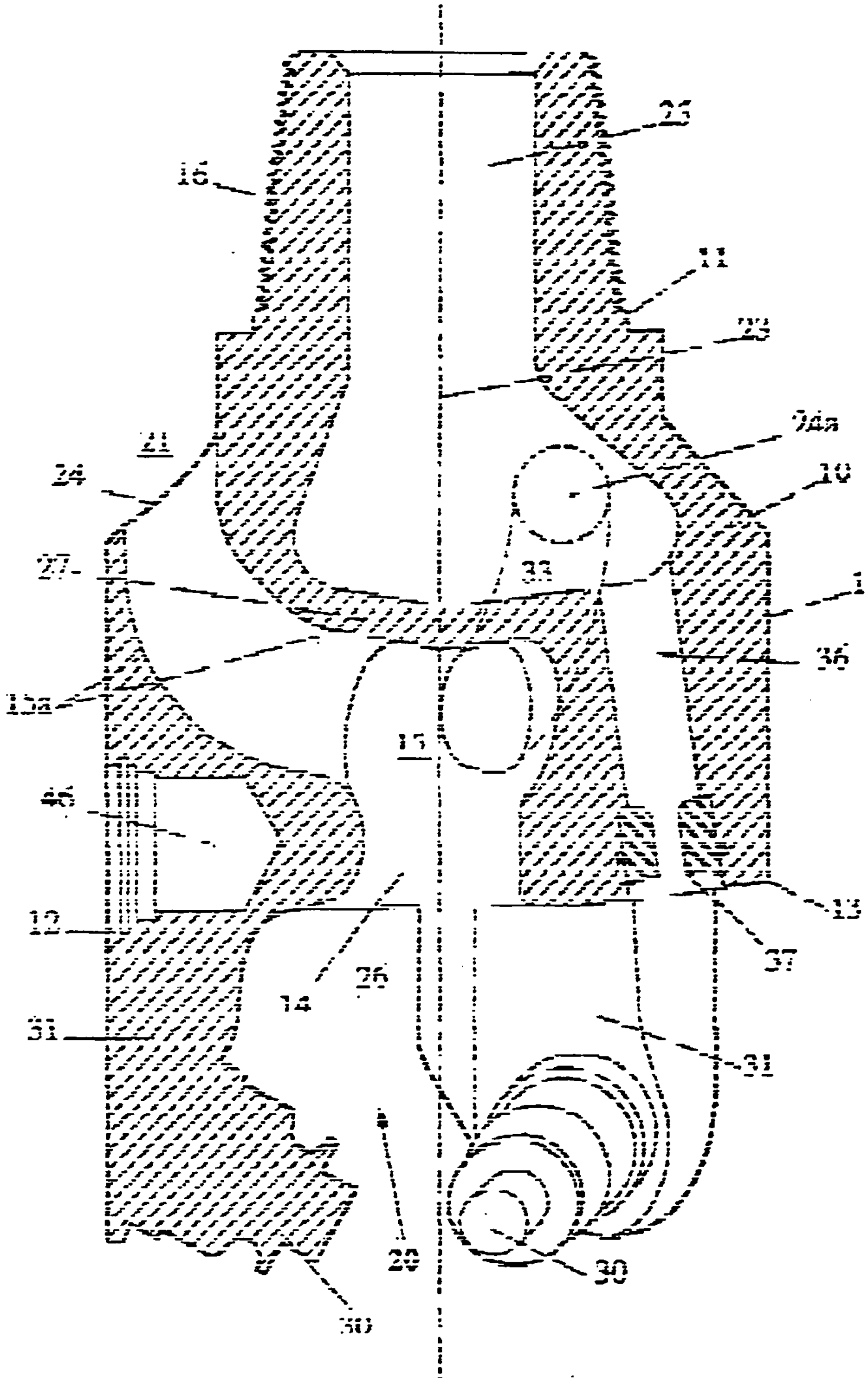

Fig 3.

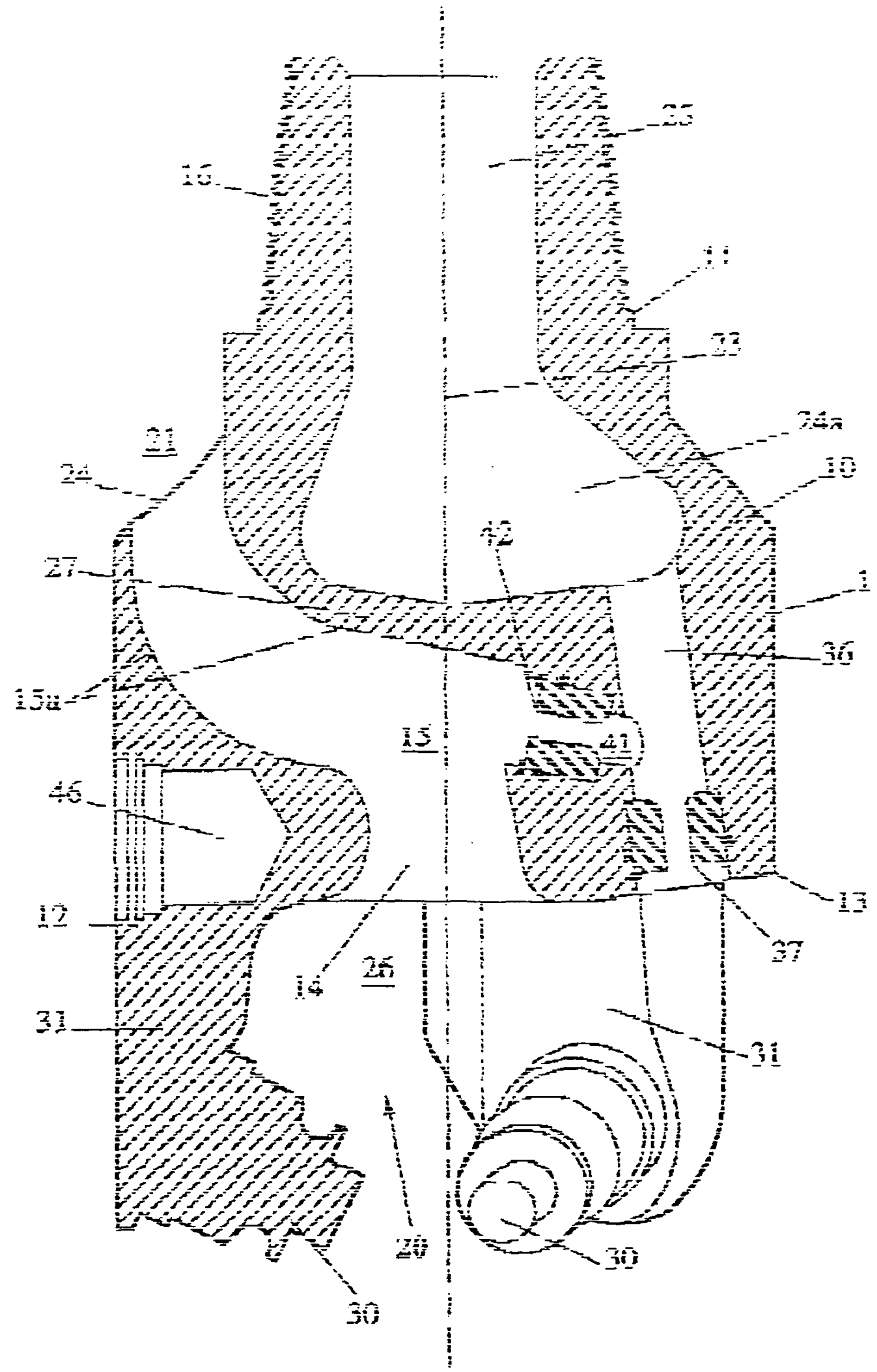
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Fig 4.

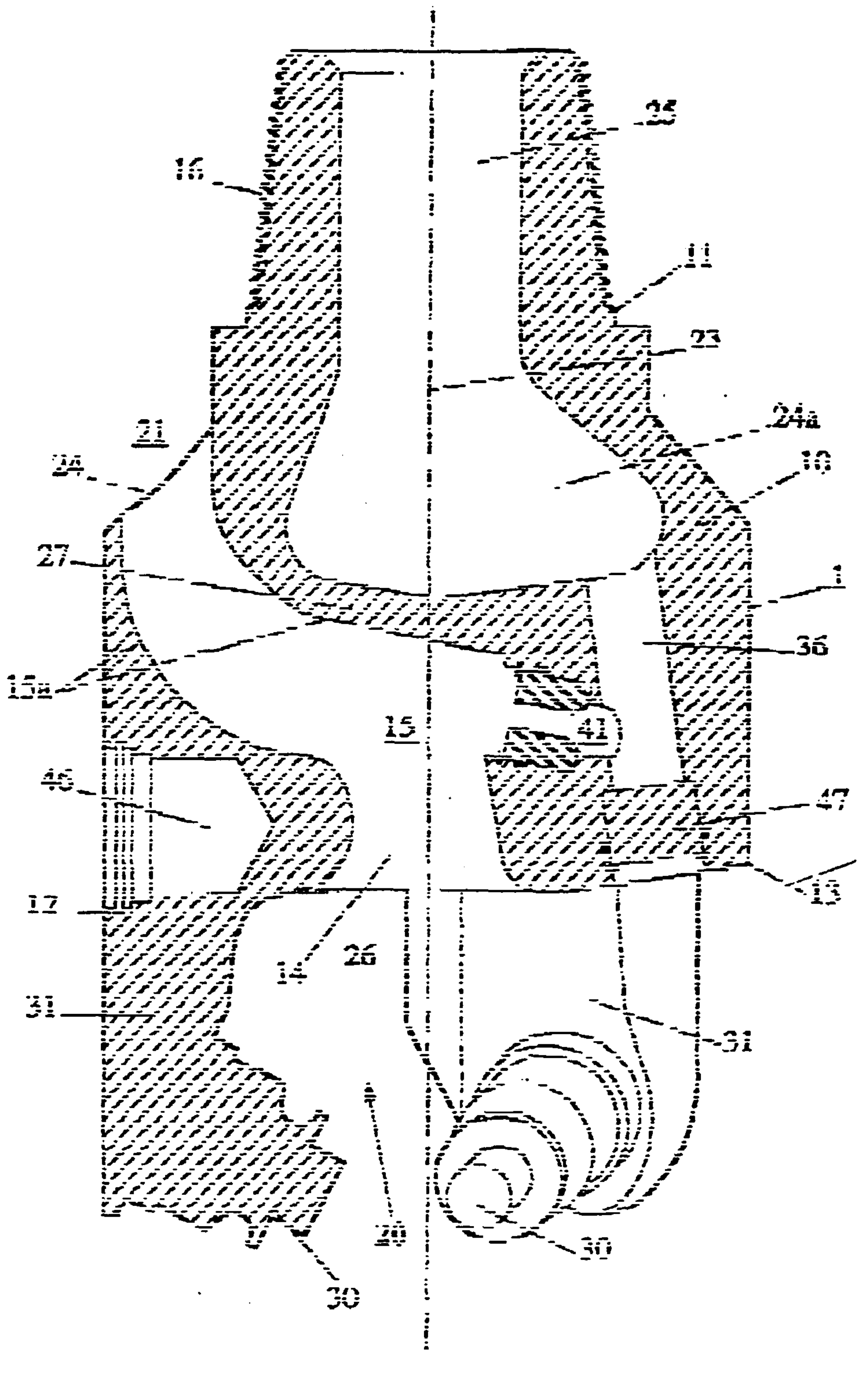
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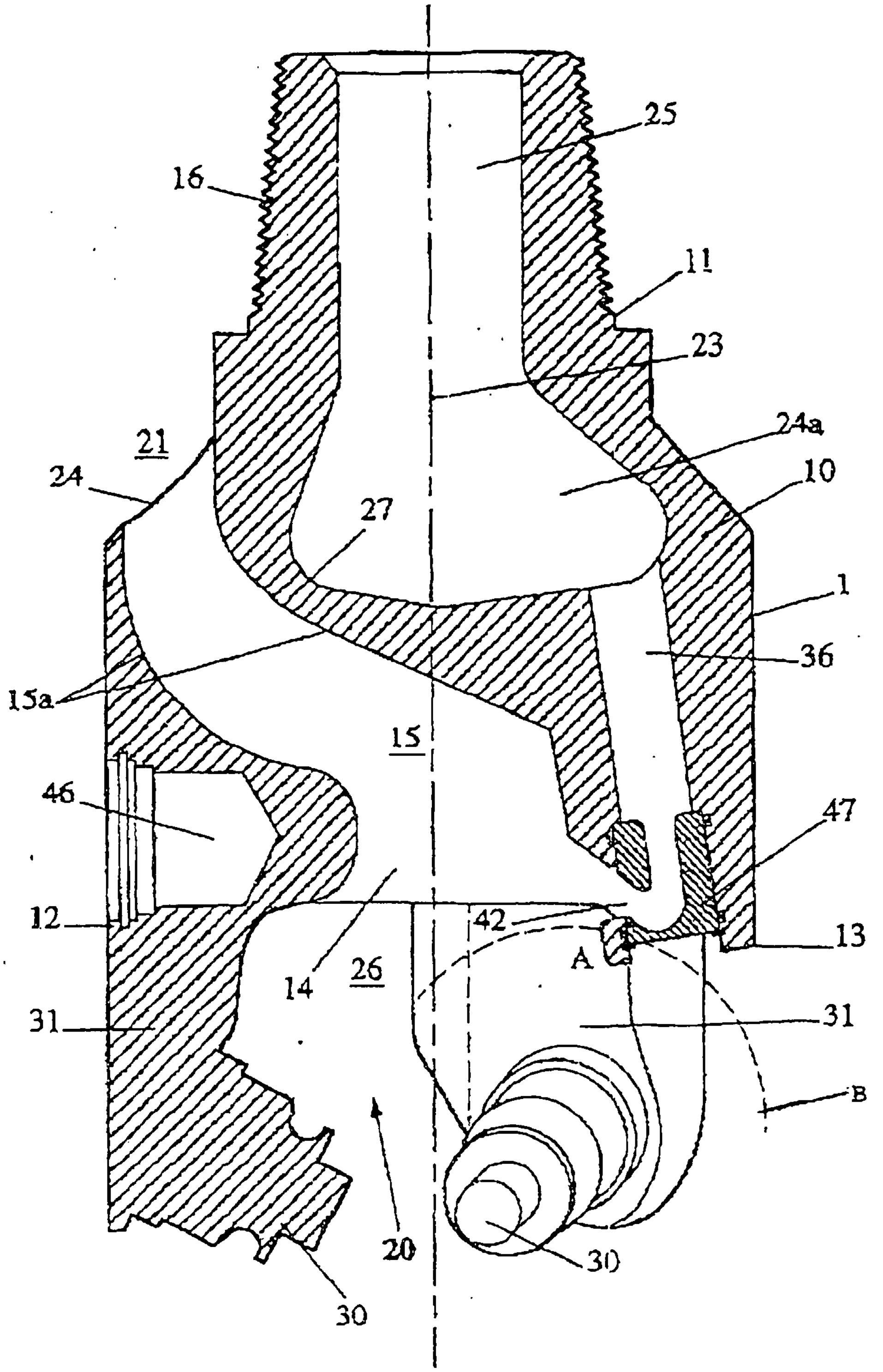
Fig 5.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