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(54) DOWN-THE-HOLE DRILL HAMMER

IMLOCHBOHRHAMMER

MARTEAU PERFORATEUR POUR FONDS DE TROU

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Description

BACKGROUND OF THE INVENTION

[0001] THIS invention relates to down-the-hole drills and particularly to a hammer arrangement therefor.

[0002] Down-the-hole (DTH) drilling is carried out with a drill-string-mounted hammer into which a bit is fitted. Compressed air is fed to a drill rig and passed through a rotating head through a number of hollow drill pipes connected end to end, with the hammer being connected to the final drill pipe, hence the term downhole hammer. A piston in the hammer reciprocates, striking the bit and imparting percussive energy thereto, typically at between 15 to 30 times per second. A hammer of this type is disclosed in EP 0 978 625 A, while a reversable, self propelled soil penetrating machine is known from US 5 467 831 A.

[0003] Until recently, down-the-hole drilling has been utilised for drilling holes larger than 70mm in diameter (for example, 76mm). For various reasons, it would be desirable to use down-the-hole drills to drill smaller diameter holes which up until now have mainly been drilled using top-hammer arrangements. However, as the hammer is made smaller in diameter, its manufacture becomes more difficult, and the power available from the hammer reduces, being related to the square of the piston diameter.

[0004] It is an object of the invention to provide a down-the-hole drill arrangement which can be adapted to the drilling of relatively small holes.

SUMMARY OF THE INVENTION

[0005] According to the invention there is provided a down-the-hole drill hammer according to claim 1.

[0006] In one embodiment, said at least one rib in the sleeve is formed integrally with the sleeve, with said at least one conduit comprising a bore drilled in the sleeve.

[0007] The sleeve and the ribs thereof may be formed by machining or extrusion.

[0008] In other embodiments, the sleeve comprises an inner sleeve defining the cylinder within which the hammer is reciprocable, and an outer sleeve defining said at least one axially extending rib on the outer surface thereof, with said at least one conduit being defined between the inner and outer sleeves.

[0009] The inner sleeve may be formed from tubing or pipe, with the outer sleeve defining hollow axially extending ribs and being fitted about the inner sleeve.

[0010] The ribs may be defined by ridges or corrugations in the outer sleeve.

[0011] Alternatively, the outer sleeve defining the ribs may comprise a relatively thick-walled cylinder having axially extending slots formed in its inner surface adjacent the ribs, the inner sleeve fitting snugly within the outer sleeve to close off the slots, thereby to define the conduits.

[0012] The slots may be formed by machining or extrusion.

[0013] The drill hammer may include a shank reciprocable axially relative to the sleeve and having a first end within the sleeve engagable by the piston, and a second end extending beyond the sleeve and adapted to receive a bit.

[0014] The second end of the shank is preferably threaded to permit a bit to be screwed into position thereon.

[0015] The portion of the shank extending beyond the sleeve preferably has a diameter greater than the internal diameter of the sleeve, and preferably substantially equal to the maximum outer diameter of the sleeve.

[0016] In a variation of the invention, one or more of the conduits in the sleeve are designed to carry a flow of fluid to the bottom of the hole being drilled, said one or more conduits extending to the lower end of the wearsleeve and being ported to the exterior of the sleeve.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017]

Figure 1	is a sectional view of a down-the-hole drill hammer according to the invention;
Figure 2	is a partial sectional view of the hammer of Figure 1, showing the porting arrangements thereof in greater detail;
Figures 3 to 6	are cross sections through four different embodiments of wearsleeves of the hammer assembly illustrated in Figures 1 and 2;
Figure 7	is a partial longitudinal section on the line 7-7 in Figure 3;
Figures 8a to 8d	are sectional views corresponding to Figure 1, showing the operating cycle of the hammer assembly; and
Figure 9	is a partial longitudinal section of the bottom end of the hammer assembly, showing the chuck thereof in greater detail.

DESCRIPTION OF EMBODIMENTS

[0018] Figure 1 shows a hammer assembly of a down-the-hole drill arrangement in longitudinal section. The hammer assembly comprises a hollow, generally cylindrical wearsleeve 10 within which is mounted a generally cylindrical piston 12. The piston 12 is reciprocable axially within the wearsleeve 10, and has a central axial through-bore 14.

[0019] The hammer assembly has a first, bottom end 16 and a second, top end 18. The terms "top" and "bottom" are used because, conventionally, down-the-hole drilling is carried out downwardly from the surface, so that the end of the hammer assembly which carries the bit will normally be lowermost. However, it should be appreciated that this is not necessarily the case.

[0020] At the bottom end 16 of the wearsleeve, a cylindrical shaft or shank 20 which is also reciprocable axially relative to the wearsleeve is provided. As best seen in Figure 9, a first end 22 of the shank 20 is received within a chuck 64 at the bottom end of the wearsleeve and engages the lower end of the piston 12 in use. The shank has a second end 24 which is threaded or otherwise formed to engage a bit 26, and has an intermediate portion 28 with a diameter which is larger than the internal diameter of the wearsleeve 10, so that the bottom portion of the shank cannot retract into the wearsleeve.

[0021] The chuck 64 comprises a short length of pipe or tube of the same external diameter as the wearsleeve 10, which is welded to the bottom end of the wearsleeve 10 itself at 66. This is in contrast to conventional methods of threading the wearsleeve and the chuck and screwing them together, which weakens the walls of the chuck and wearsleeve in this region. This issue becomes critical with small diameter hammers, particularly those less than 40mm in diameter. (Conventionally, the backhead 36 is also screwed into place at the top end of the wearsleeve, and welding can also be used here, with similar advantages.)

[0022] The welding of the components may be carried out by electron beam, TIG (Tungsten Inert Gas), MIG (Metal Inert Gas) or friction welding, for example.

[0023] The chuck 64 is formed with several axially extending splines 68 on its inner surface which engage complemental axial splines 70 on the outer surface of the shank 20. The inner end 22 of the shank is enlarged slightly relative to the splined portion thereof, and is fitted with a retaining ring 72 which holds the shank in the wearsleeve.

[0024] The shank 20 also has a central, axially extending through-bore 30 aligned with the bore 14 in the piston. A blower tube 32 extends from the upper end of the shank concentrically with the bores 30 and 14 and is received within the lower end of the bore 14 when the piston 12 approaches the shank 20. The bit 26 has a central, axial bore 34 aligned with the bore 30 in the shank 20.

[0025] Referring now to Figure 2, at the top end of the hammer assembly is a backhead 36 which is connected in use to the bottom end of the lowermost drill pipe (not shown). The backhead 36 defines a central, axial conduit 38 which feeds compressed air via a check valve 40 and an air distributor assembly 42 into axially extending conduits in the wearsleeve 10 (see below). The respective conduits terminate in ports within the wearsleeve which are located so that the piston alternately opens and closes the respective ports as it reciprocates. The operating cycle of the hammer assembly is illustrated in Figures 8a to 8d. (This aspect of the operation of the hammer assembly is generally conventional and is therefore not discussed in greater detail).

[0026] Referring now to Figures 3 to 6, four possible configurations of the wearsleeve 10 and the conduits therein are shown. In Figure 3, the wearsleeve 10 is formed by milling hollow steel bar and has five equispaced axially extending ribs 44 on its outer surface. The ribs 44 define axially extending channels or valleys 46 between them through which material loosened by the bit 26 can be flushed upwardly, away from the bottom of the hole, by compressed air which is exhausted through the hole 34 in the bit. The outer diameter of the wearsleeve defined by the outer surfaces of the ribs 44 corresponds to, and is slightly less than, the diameter of the hole created by the bit 26.

[0027] Three of the ribs 44 each have three axially extending holes 48 drilled in them to define conduits for the compressed air provided by the distributor 42, and each set of holes 48 terminates in a respective port 50 located to be exposed when the piston is either uppermost or lowermost in its cycle, as the case may be. The sectional view of Figure 7 illustrates the relative arrangement of a conduit defined by the holes 48 and its respective ports 50, and a further port 62.

[0028] Alternative arrangements of the wearsleeve 10 are shown in Figures 4, 5 and 6. In Figure 4, the wearsleeve is also milled from hollow bar to define the ribs 44, but its wall thickness is generally constant. An inner sleeve 52 which is relatively thin-walled is fixed in position within the outer sleeve 54, and channels or slots 56 milled into the inside of each of the ribs 44 are sealed off by the inner sleeve 52 to define the conduits. The ports 50 are formed by drilling holes into the inner sleeve 52 as required, prior to insertion thereof into the outer sleeve.

[0029] In the arrangement of Figure 5, the wearsleeve 10 comprises a relatively thick-walled inner sleeve 58 of uniform thickness, with a relatively thin-walled outer sleeve 60 fixed around it, with the ribs 44 being formed as "corrugations" of generally rectangular section in the sleeve 60 to define the conduits. The outer sleeve can be formed as an extrusion, or its "corrugations" could be formed in sheet metal which is then folded and welded into a tube. Again, the ports 50 are defined by drilling or cutting apertures into the inner sleeve 58 as required.

[0030] The arrangement of Figure 6 is similar to that of Figure 5, except that both the inner sleeve 58 and the outer sleeve 60 are formed of relatively thin walled material of uniform and generally equal thickness.

[0031] It will be appreciated that the above described embodiments of the wearsleeve 10 are purely exemplary, and that other embodiments are possible. What the embodiments have in common, however, is that they define a cylinder within which the piston 12 can reciprocate, with conduits for compressed air or other pressurised operating fluid being formed in axially extending ribs or ridges, on an outer surface of the wearsleeve.

[0032] In a variation of the invention, one or more of the conduits in the wearsleeve can be designed to carry a flow of fluid, typically water, to the bottom of the hole being drilled. This fluid suppresses dust from the drilling and in sufficient quantity can act as a flushing fluid to assist in carrying material loosened by the bit up the hole, in the valleys or channels between the ribs. In this embodiment, the relevant conduit(s) will not terminate in ports in the cylinder, but will extend to the lower end of the wearsleeve and be ported to the exterior of the wearsleeve.

[0033] By locating the conduits in the ribs, which serve the additional purpose of defining passages between them for the flushing of drilled material, the effective diameter of the hammer as a percentage of the bit diameter and thus the hole diameter is maximised. Conventional thinking has been limited to making the hammer diameter a fixed percentage of the hole diameter, for example 90% in the case of large hammers of greater than 200mm diameter, and 80% to 85% of the hole diameter in relatively small hammers. Preliminary tests suggest that an increase in power of between 10% and 20%, typically in the region of 18%, is available from hammers designed using the principles of the invention.

[0034] A further advantage of the described hammer assembly is that by providing a shank 20 which receives the bit 26 but which is a part of the hammer assembly itself and does not need to be replaced each time the bit is replaced, the size and therefore the cost of the consumable bit is substantially reduced, with a corresponding reduction in drilling costs.

Claims

1. A down-the-hole drill hammer comprising:

a sleeve (10) defining a cylinder;

a piston (12) reciprocable within the cylinder and arranged to operate a bit (26) percussively;

a shank (20) reciprocable axially relative to the sleeve (10) and having a first end (22) within the sleeve engagable by the piston, and a second end (24) extending beyond the sleeve and adapted to receive the bit;

the down-the-hole drill hammer being **characterised in that** the sleeve further defines a plurality of axially extending ribs (44) on the outer surface thereof, the ribs defining passages between them for the flushing of drilled material and

at least one conduit (48, 56) being formed in said ribs of the sleeve for conveying a drive fluid to one or more ports defined in the sleeve to operate the piston.

2. A down-the-hole drill hammer according to claim 1 wherein said ribs in the sleeve are formed integrally with the sleeve, with said at least one conduit comprising a bore drilled in the sleeve.

3. A down-the-hole drill hammer according to claim 2 wherein the sleeve (10) and the ribs (44) thereof are formed by machining or extrusion.

4. A down-the-hole drill hammer according to claim 1 wherein the sleeve comprises an inner sleeve (52) defining the cylinder within which the hammer is reciprocable, and an outer sleeve (54) defining said axially extending ribs on the outer surface thereof, with said at least one conduit being defined between the inner and outer sleeves.

5. A down-the-hole drill hammer according to claim 4 wherein the inner sleeve (52) is formed from tubing or pipe, with the outer sleeve (54) defining hollow axially extending ribs and being fitted about the inner sleeve.

6. A down-the-hole drill hammer according to claim 5 wherein the ribs (44) are defined by ridges or corrugations in the outer sleeve.

7. A down-the-hole drill hammer according to claim 6 wherein the outer sleeve (46) defining the ribs (44) comprises a relatively thick-walled cylinder having axially extending slots (56) formed in its inner surface adjacent the ribs, the inner sleeve fitting snugly within the outer sleeve to close off the slots, thereby to define the conduits.

8. A down-the-hole drill hammer according to claim 7 wherein the slots (56) are formed by machining or extrusion.

9. A down-the-hole drill hammer according to any one of claims 1 to 8 wherein the second end (24) of the shank is threaded to permit a bit to be screwed into position thereon.

10. A down-the-hole drill hammer according to claim 8 wherein the portion of the shank (20) extending beyond the sleeve has a diameter greater than the internal diameter of the sleeve.

11. A down-the-hole drill hammer according to claim 10 wherein the portion of the shank (20) extending beyond the sleeve has a diameter substantially equal to the maximum outer diameter of the sleeve.

12. A down-the-hole drill hammer according to any one of claims 1 to 11 wherein one or more of the conduits (48, 56) in the sleeve are designed to carry a flow of fluid to the bottom of the hole being drilled, said one or more conduits extending to the lower end of the sleeve and being ported to the exterior of the sleeve.

Patentansprüche

1. Imloch-Bohrhammer mit:

einer Hülse (10), welche einen Zylinder definiert;

einem Kolben (12), welcher innerhalb des Zylinders bin- und herbewegbar ist und welcher ausgestaltet ist, um einen Bohrkopf (26) im Schlagbohrbetrieb zu betreiben,

einem Schaft (20), welcher axial relativ zu der Hülse (10) hin- und herbewegbar ist und welcher ein erstes Ende (22) innerhalb der Hülse aufweist, welches von dem Kolben ergriffen werden kann, und ein zweites Ende (24), welches sich über die Hülse hinaus erstreckt und welches ausgestaltet ist, um den Bohrkopf aufzunehmen;

wobei der Imloch-Bohrhammer **dadurch gekennzeichnet ist, dass** die Hülse weiterhin eine Mehrzahl von sich axial erstreckenden Rippen (44) auf ihrer äußeren Oberfläche aufweist, wobei die Rippen dazwischen liegende Passagen zum Ausspülen von ausgebohrtem Material aufweisen; und
mindestens einem Kanal (48, 56), welcher in den Rippen der Hülse ausgebildet ist, um eine Antriebsflüssigkeit zu einer oder mehreren Öffnungen in der Hülse zu befördern, um den Kolben anzutreiben.

2. Imloch-Bohrhammer gemäß Anspruch 1, wobei die Rippen in der Hülse einstuckig in der Hülse ausgebildet sind, wobei der mindestens eine Kanal eine in die Hülse gebohrte Bohrung umfasst.

3. Imloch-Bohrhammer gemäß Anspruch 2, wobei die Hülse (10) und die Rippen (44) derselben durch spanabhebende Bearbeitung oder Extrusion hergestellt sind.

4. Imloch-Bohrhammer gemäß Anspruch 1, wobei die Hülse eine innere Hülse (52) umfasst, welche den Zylinder bildet, innerhalb dessen der Hammer hin- und herbewegbar ist, und eine äußere Hülse (54), welche die sich an ihrer Aussenseite axial erstreckenden Rippen definiert, wobei der mindestens eine Kanal zwischen der inneren und der äußeren Hülse ausgebildet ist.

5. Imloch-Bohrhammer gemäß Anspruch 4, wobei die innere Hülse (52) aus einem Schlauch oder Rohr gebildet ist, wobei die äußere Hülse (54) hohle, sich axial erstreckende Rippen definiert und um die innere Hülse herum angepasst ist.

6. Imloch-Bohrhammer gemäß Anspruch 5, wobei die Rippen (44) durch Grate oder Rillen in der äußeren Hülse definiert sind.

7. Imloch-Bohrhammer gemäß Anspruch 6, wobei die äußere Hülse (46), welche die Rippen (44) definiert, einen vergleichsweise dickwandigen Zylinder umfasst, welcher sich axial erstreckende Schlitze (56) aufweist, die in seiner inneren Oberfläche neben den Rippen ausgebildet sind, wobei die innere Hülse eng in die äußere Hülse eingepasst ist, um die Schlitze zu verschließan, wodurch die Kanäle gebildet werden.

8. Imloch-Bohrhammer gemäß Anspruch 7, wobei die Schlitze (56) durch spanabhebende Bearbehung oder Extrusion gebildet sind.

9. Imloch-Bohrhammer gemäß einem der Ansprüche 1 bis 8, wobei das zweite Ende (24) des Schafts ein Gewinde aufweist, um zu ermöglichen, dass ein Bohrkopf darauf angeschraubt wird.

10. Imloch-Bohrhammer gemäß Anspruch 8, wobei der Abschnitt des Schafts (20), welcher sich über die Hülse hinaus erstreckt, einen größeren Durchmesser als den Innendurchmesser der Hülse aufweist.

11. Imloch-Bohrhammer gemäß Anspruch 10, wobei der Abschnitt des Schafts (20), welcher sich über die Hülse hinaus erstreckt, im Wesentlichen den gleichen Durchmesser aufweist wie der maximale Außendurchmesser der Hülse.

12. Imloch-Bohrhammer gemäß einem der Ansprüche 1 bis 11, wobei einer oder mehrere der Kanäle (48, 56) in der Hülse ausgebildet sind, um einen Strom einer Flüssigkeit zu dem Ende des Lochs, welches gebohrt wird, zu leiten, wobei einer oder mehrere Kanäle sich bis zum, unteren Ende der Hülse erstrecken und eine Öffnung zur Außenseite der Hülse aufweisen.

Revendications

1. Marteau perforateur de puits, comprenant :

un manchon (10) définissant un cylindre ;
un piston (12) mobile à va-et-vient à l'intérieur du cylindre et agencé pour mettre en oeuvre une mèche (26) de manière percutante ;
une tige (20) mobile à va-et-vient axialement par rapport au manchon (10) et comportant une première extrémité (22), située à l'intérieur du manchon, pouvant être engagée par le piston, et une seconde extrémité (24) s'étendant au-delà du manchon et apte à recevoir la mèche ;
le marteau perforateur de puits étant **caractérisé en ce que** le manchon définit en outre une pluralité de nervures (44) s'étendant axialement sur sa surface extérieure, les nervures définissant des passages entre elles destinés à l'évacuation du matériau perforé ; et
au moins un conduit (48, 56) étant formé dans lesdites nervures du manchon servant à transporter un fluide d'entraînement vers un ou plusieurs orifices définis dans le manchon dans le but de mettre en oeuvre le piston.

2. Marteau perforateur de puits selon la revendication 1, dans lequel lesdites nervures situées dans le manchon sont formées intégrées au manchon, ledit au moins un conduit comprenant un alésage percé dans le manchon.

3. Marteau perforateur de puits selon la revendication 2, dans lequel le manchon (10) et ses nervures (44) sont formés par usinage ou par extrusion.

4. Marteau perforateur de puits selon la revendication 1, dans lequel le manchon comprend un manchon intérieur (52) définissant le cylindre à l'intérieur duquel le marteau est mobile à va-et-vient, et un manchon extérieur (54) définissant lesdites nervures s'étendant axialement sur sa surface extérieure, ledit au moins un conduit étant défini entre les manchons intérieur et extérieur.

5. Marteau perforateur de puits selon la revendication 4, dans lequel le manchon intérieur (52) est formé à partir d'un tube ou d'un tuyau, le manchon extérieur (54) définissant des nervures creuses s'étendant axialement et s'ajustant autour du manchon intérieur.

6. Marteau perforateur de puits selon la revendication 5, dans lequel les nervures (44) sont définies par des cannelures ou des sillons réalisés dans le manchon extérieur.

7. Marteau perforateur de puits selon la revendication 6, dans lequel le manchon extérieur (46) définissant les nervures (44) comprend un cylindre à paroi relativement épaisse comportant des fentes s'étendant axialement formées dans sa surface intérieure adjacente aux nervures, le manchon intérieur s'ajustant étroitement à l'intérieur du manchon extérieur pour fermer les fentes, pour définir ainsi les conduits.

8. Marteau perforateur de puits selon la revendication 7, dans lequel les fentes (56) sont formées par usinage ou par extrusion.

9. Marteau perforateur de puits selon l'une quelconque des revendications 1 à 8, dans lequel la seconde extrémité (24) de la tige est filetée pour permettre de visser une mèche en position sur celle-ci.

10. Marteau perforateur de puits selon la revendication 8, dans lequel la partie de la tige (20) s'étendant au-delà du manchon a un diamètre plus grand que le diamètre intérieur du manchon.

11. Marteau perforateur de puits selon la revendication 10, dans lequel la partie de la tige (20) s'étendant au-delà du manchon a un diamètre sensiblement égal au diamètre extérieur maximal du manchon.

12. Marteau perforateur de puits selon l'une quelconque des revendications 1 à 11, dans lequel un ou plusieurs des conduits (48, 56) réalisés dans le manchon sont conçus pour transporter un écoulement de fluide vers le fond du trou en cours de forage, lesdits un ou plusieurs conduits s'étendant vers l'extrémité inférieure du manchon et débouchant à l'extérieur du manchon.

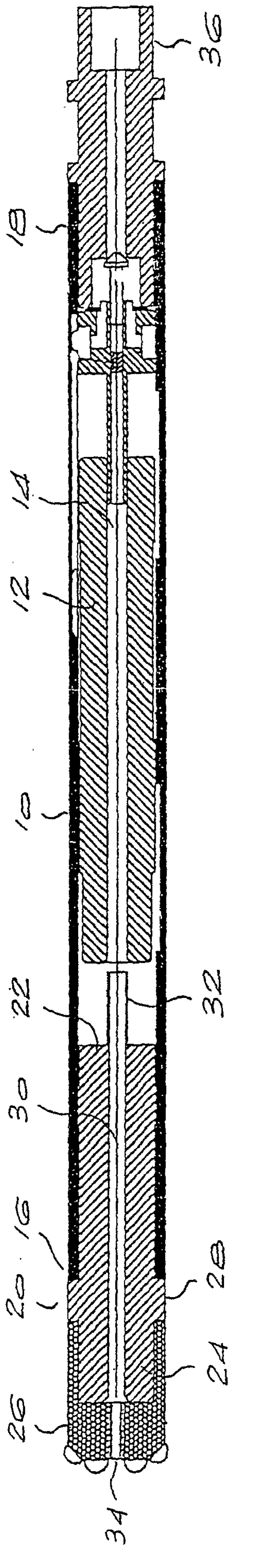


FIG. 1

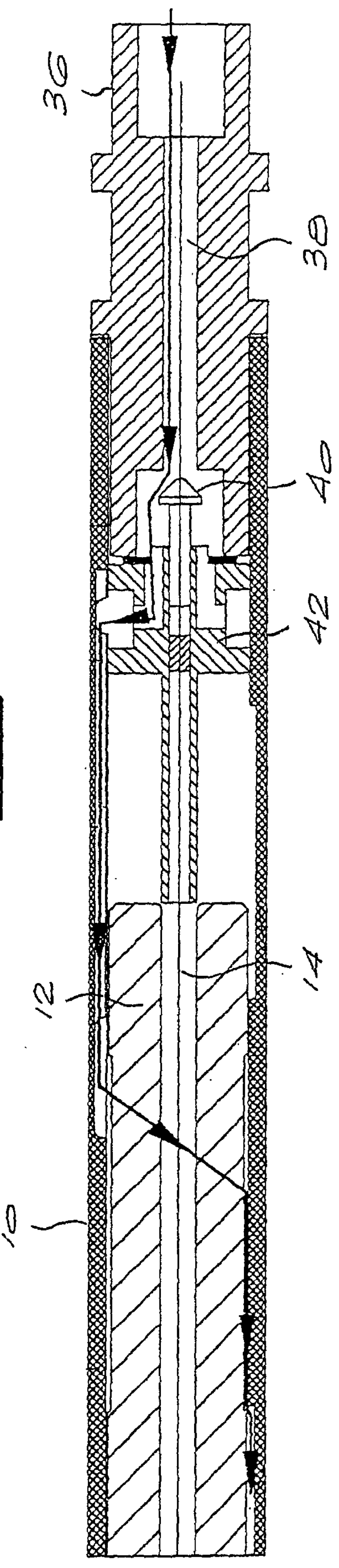


FIG. 2

FIG. 6

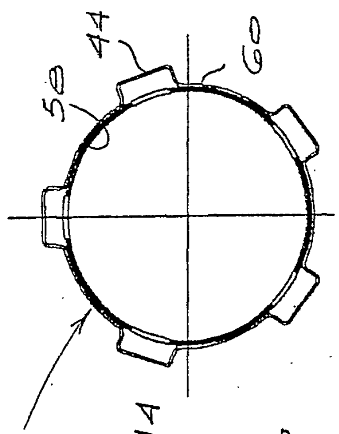


FIG. 5

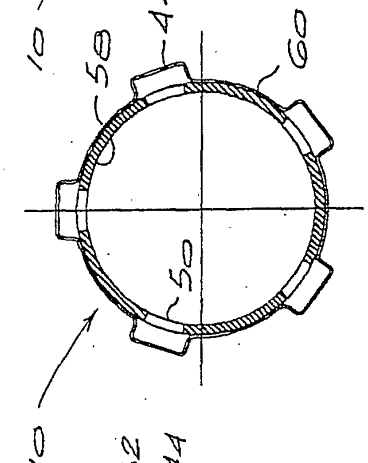


FIG. 4

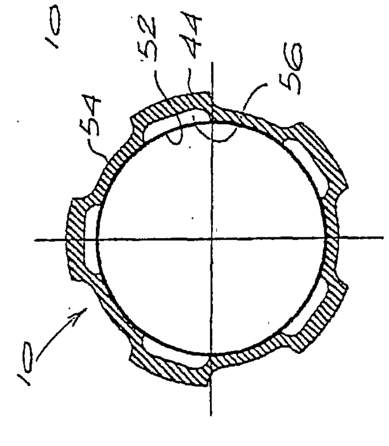


FIG. 3

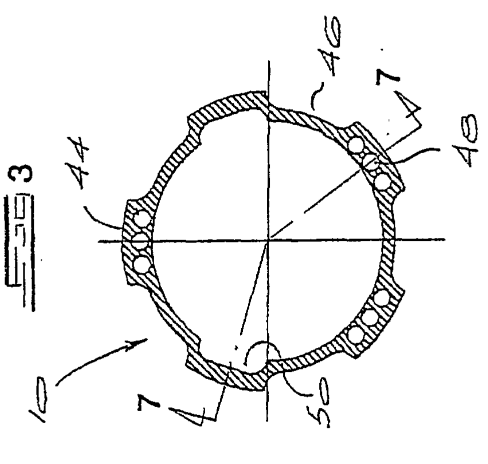


FIG. 7

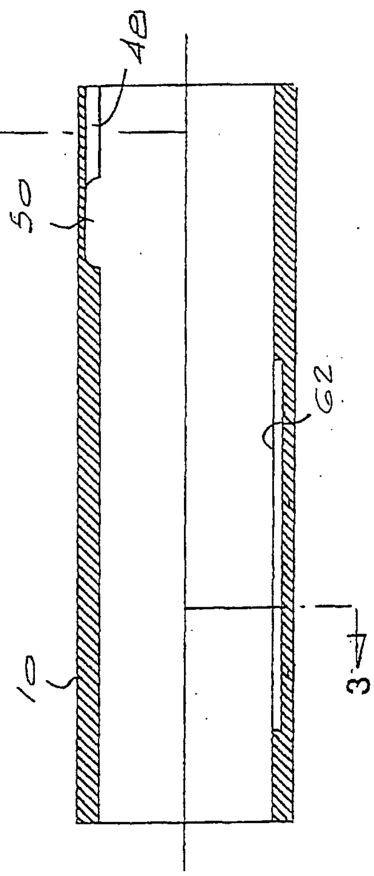


Fig. 8a

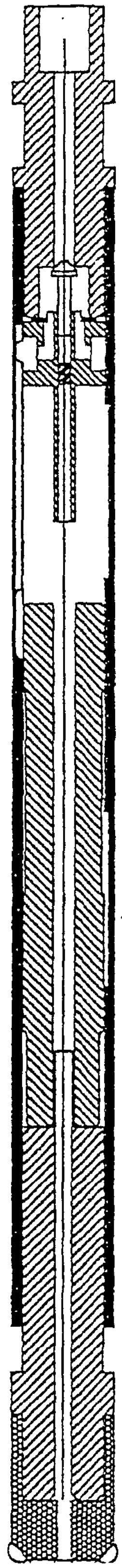


Fig. 8b

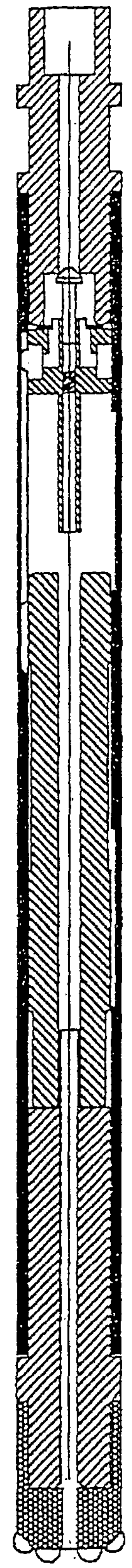


Fig. 8c

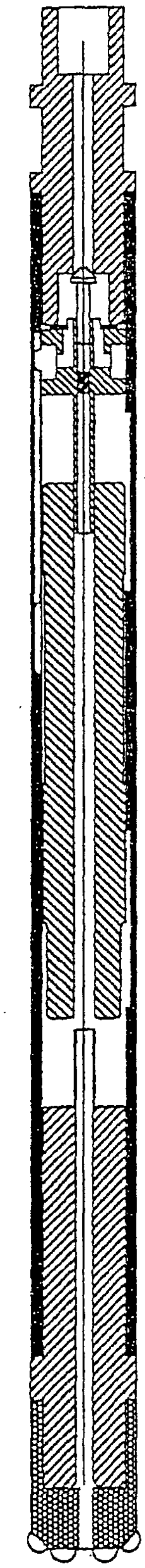
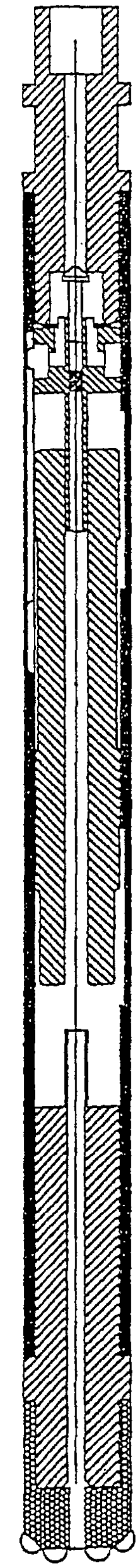


Fig. 8d



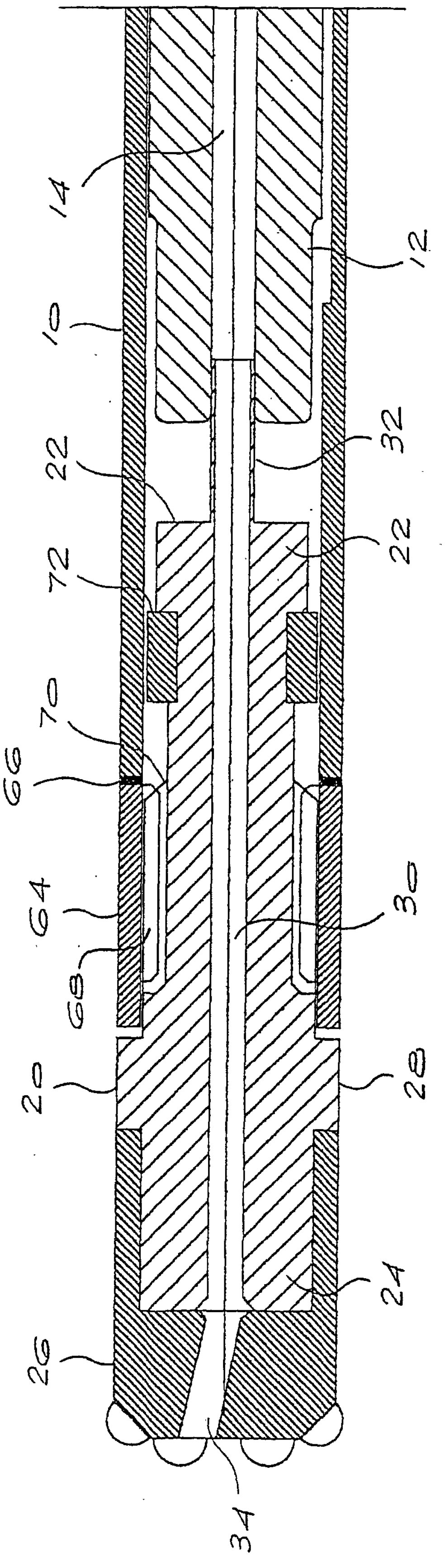


Fig. 9