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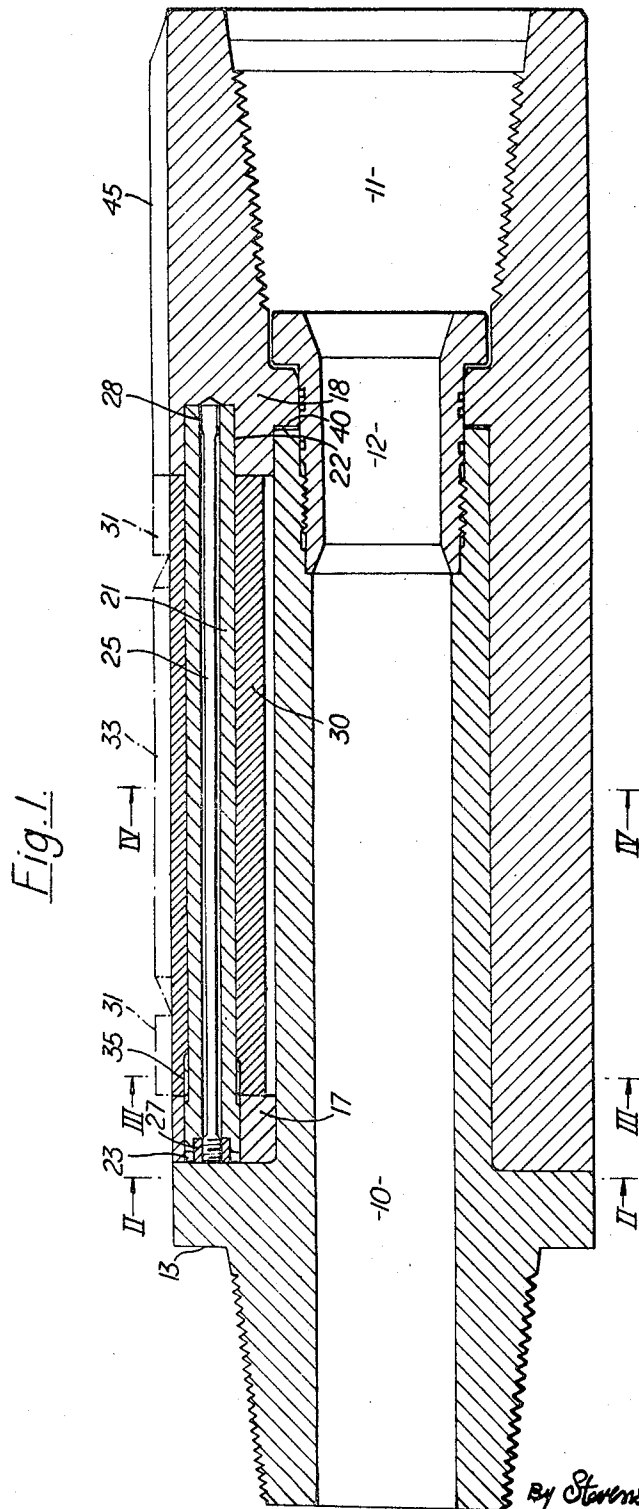
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STABILISERS FOR BOREHOLE DRILLING

Filed Jan. 18, 1968

3 Sheets-Sheet 1



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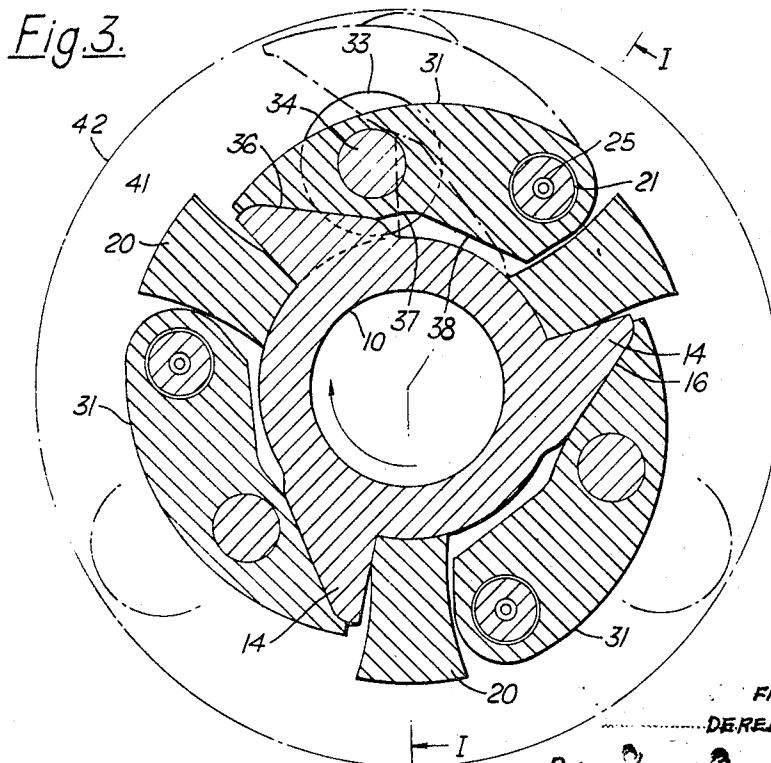
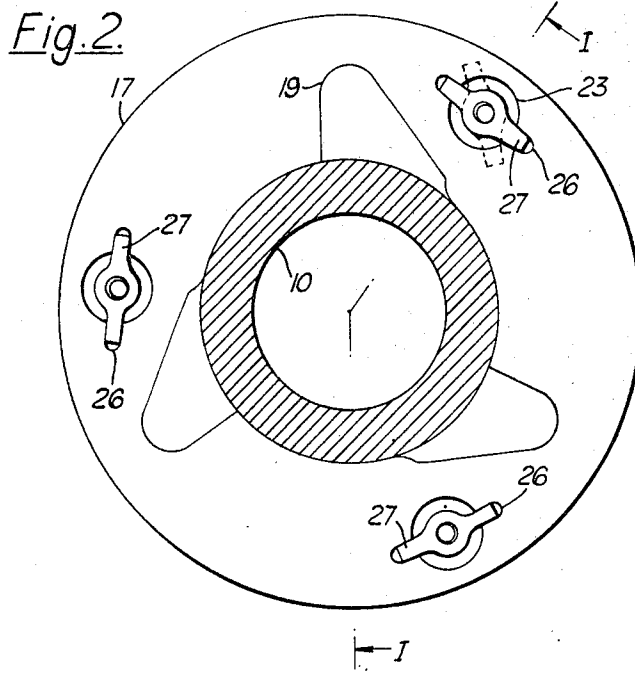
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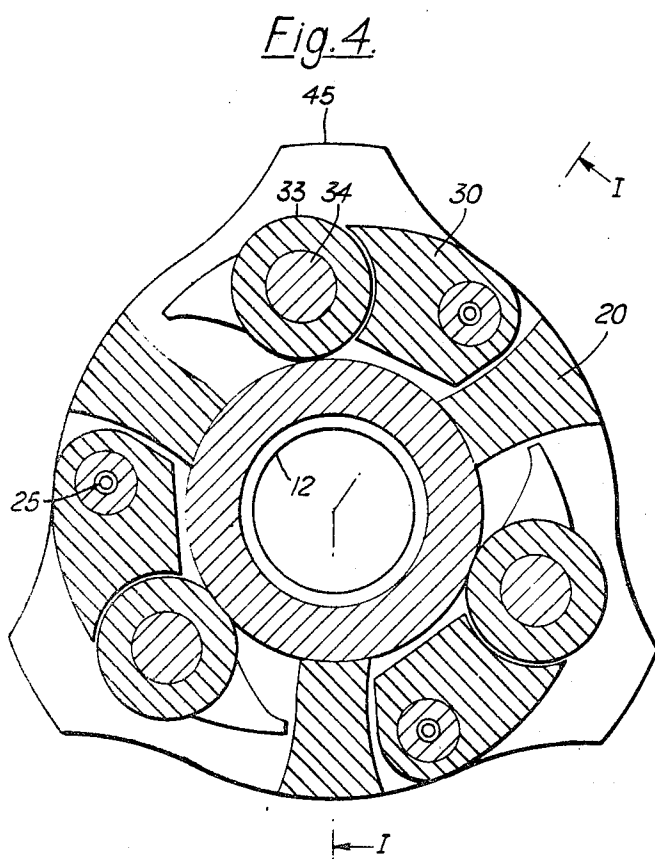


Fig. 5.



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1

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STABILISERS FOR BOREHOLE DRILLING

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4 Claims

ABSTRACT OF THE DISCLOSURE

A stabiliser for use in a drill string in borehole drilling comprising two members coupled together with rotary lost motion and respectively connectable to the upper and lower parts of a drill string. One of the members having spacer elements pivotally mounted thereon and the other member having cams whereby rotation of the drill string will cam the spacer elements radially outward from a retracted position to an extended position.

In the drilling of deep boreholes in the ground, a drill bit at the bottom of the hole is connected to equipment at the surface by means of a series of lengths of drill pipe which are joined together and are known as the "drill string." These lengths of drill pipe are of smaller diameter than the drill bit.

A long drill string is relatively flexible and subject to lateral deflection during drilling. Such deflection is undesirable for a variety of reasons and one object of the present invention is to provide a stabiliser for limiting such deflection.

The invention is applicable to rotary drilling in which the whole drill string is rotated by a motor at the surface, and also to drilling with a "down-hole" motor in which only the portion of the drill string below the motor in the borehole is rotated.

There may be one or more such stabilisers.

A stabiliser according to the present invention comprises two members coupled together with rotary lost motion, and capable of connection respectively to an upper and lower part of a drill string, spacer elements carried by one member and movable between radially retracted and extended positions in response to relative rotary motion of the members, and means for transmitting torque from one member to the other when the elements are extended.

Preferably the stabiliser is in a rotary portion of a drill string, and the spacer elements carry rollers to engage the borehole wall.

Preferably means are provided for automatic retraction of the spacer elements which come into operation when the stabiliser is not being driven and the driven member is not under axial compression.

By way of example, one form of the invention will now be described with reference to the accompanying drawings of which:

FIGURE 1 is a longitudinal section through a rotatable portion of a borehole drill string which is provided with a stabiliser, the section being on the line I—I in FIGURES 2, 3 and 4;

FIGURES 2, 3 and 4 are cross-sections taken through the planes II, III and IV respectively of FIGURE 1; and

FIGURE 5 shows an arrangement having two stabilisers.

In the example illustrated the invention is applied to a drill string with a "down-hole" motor of the kind in which the drill bit is rotated by a turbine driven by drilling fluid pumped down inside the drill string. The drill string includes a driving member in the form of a shaft 10 and

2

an overlapping stabiliser body 11 which constitutes a driven member, the tapered upper end of the shaft being externally screw threaded, for attachment to a "turbine output sub" for example, whilst the internally tapered lower end of the stabiliser body is screw threaded, for attachment for example to an "inertia sub" above the drill bit. The stabiliser body is detachably secured to the shaft by a flanged nut 12.

The shaft 10, which is formed adjacent to one end with a radial external flange 13, is also formed with two longitudinally spaced sets of wing-like cams 14 (FIGURE 3). The axial extent of each set matches the arms 31, described below and marked in FIGURE 1. Both sets of cams consist of three equiangularly spaced cams which extend radially outwards. Each cam is of wedge cross-section having a substantially radial surface 15 and a tangential surface 16. The body 11 comprises annular end portions 17, 18 joined together integrally by three pillars 20 which are equiangularly spaced apart and alternate circumferentially with the cams 14. The portion 17 is formed with three access slots 19 (FIGURE 2) through which the sets of cams 14 are passed during assembly of the stabiliser components.

A hollow spindle 21 extends alongside each pillar, one end of each spindle entering a recess 22 formed in the body portion 18 whilst the opposite end enters an axial passage 23 drilled in the body portion 17. Through each spindle extends a torsion bar 25, one end of which carries a torsion lever 27 arranged when preloaded to engage in a retaining slot 26 formed in the body portion 17. The spindle 21 and the torsion bar 25 have interengaging torque-transmission splines 28. The spindle 21 supports the stem of a carrier 30 which includes two longitudinally-spaced radial arms 31, the stem and arms defining an outward-facing recess for an elongated roller 33. The roller is rotatably mounted on a spindle 34 the ends of which are secured in the arms 31 of the carrier 30. The spindle 21 and its associated roller carrier 30 have interengaging torque-transmission splines 35. Each arm 31 is engageable by one of the cams 14 along an axial surface comprising a cam-responsive portion 36 joined by an intermediate portion 37 to a cam-locking portion 38.

In FIGURE 1 portions of the carrier arms 31 are shown in chain lines to indicate the axial extent of the arms although they are not seen in that longitudinal section.

The rollers 33 may be of mild steel faced with tungsten carbide, rubber or any other suitable material. The carriers 30, the spindles 34, and the torsion bars 25 may be of stainless steel.

During assembly of the stabiliser components, the three sub-assemblies of roller 33, spindle 34 and carrier 30 are assembled around the body 11, and then the carrier spindles 21 and torsion bars 25 are inserted through the body passages 23 and carrier stems and part way into the body recesses 22. The torsion levers 27 are then rotated through approximately 40° in the anti-clockwise direction from the dotted position indicated in FIGURE 2 in order to preload the torsion bars and so, through the sets of splines 28, 35, bias the carrier arms and their rollers to the retracted position in which the latter abut the shaft 10, as seen in full lines in FIGURE 3. Then, to maintain the torsion loading, the levers 27 are pushed axially into their respective slots 26 in the body portion 17. The cam-bearing shaft 10 is inserted axially into the assembly to engage at one end in a recess 40 of the body portion 18, the flange 13 abutting the body portion 17 and serving to retain the levers 27 in their locking slots 26. Finally, the shaft and body are clamped together by the flanged nut 12 which is then locked by any suitable means against accidental disengagement.

The stabiliser may operate in the following manner. During insertion of the drill string into the borehole 41 (FIGURE 3), when drilling fluid is not pumped down the drill string to drive the hydraulic turbine, the shaft 10 is not rotated by the turbine, and the roller-carrying arms 31 are retained in their retracted, inoperative position by the torsion bar loading. When the drill bit meets the bottom of the borehole and drilling fluid is pumped down to drive the turbine, the shaft 10 begins to rotate under the driving torque from the turbine. The body 11 does not immediately rotate at the same speed as the shaft, due to the initial resistance offered to rotation of the drill bit by the bottom of the borehole. Thus the shaft rotates relatively to the body, causing the sets of cams 14 to urge the carrier arms outwards, the carriers pivoting about their spindles as the tangential surfaces 16 of the cams slide along the portions 36, 37 of the arms until the cams reach the portions 38. When the leading end of the surface 16 of each cam slides past a line from the carrier spindle perpendicular to the portion 38, it prevents further outward movement of the arm, and at the same time the cam can move no further. In this situation, the roller 33 is designed to lie just clear of the borehole wall 42. In this position the arms and their rollers act to space the shaft 10 from the borehole wall and to limit any lateral deflection of the shaft.

Driving torque from the shaft 10 is then transmitted via the shaft cams to the body 11, and thence to the inertia sub and drill bit, through the two sets of arms 31, the carrier spindles 21 and the engagement of the latter in the recesses 22 of the body portion 18. When the supply of drilling fluid is stopped and the turbine ceases to rotate, the roller-carrying arms still remain in their extended position because of the frictional resistance between the abutting surfaces of the shaft flange 13 and body portion 17 due to the axial loading on the drill bit. When however the drill bit is raised from the borehole bottom, the body 11 is no longer in compression and the frictional resistance between the flange 13 and the portion 17 is sufficiently reduced to permit the preloading of the torsion bars 25 to cause the carrier arms to pivot inwards to their retracted position, turning the cams 14 and the shaft 10 anti-clockwise, as seen in FIGURE 3, in doing so. The roller-carrying arms are then in their retracted position remote from the borehole wall so as to reduce the possibility of these spacer elements catching against the wall of the borehole during raising of the drill string.

The body 11 is formed with ribs 45 (FIGURE 1 and FIGURE 4) which, when the body is rotating during drilling, are intended to act on rock fragments in the borehole drilling fluid which are being borne upward to the surface and prevent their accumulation between the extended arms and the shaft 10 which might otherwise obstruct subsequent retraction of the arms.

Where it is intended to carry out deflection drilling, the stabiliser may be located lower down, between the

inertia sub and a "cross-over sub" immediately above the drill bit. In such a position the stabiliser, being closer to the bit, centralises the bit more accurately in the borehole.

In the arrangement shown in FIGURE 5, a bit 50 is connected to an inertia sub 51 which is connected to a turbine 52 driven by drilling fluid pumped down inside the drill string. The turbine 52 is connected to a field test adaptor 53. The adaptor 53 is connected to a stabiliser 54 which is connected by drill collars 55 to another stabiliser 56 which is connected to further drill collars 57 connected to the lowermost length of drill pipe 58. The drill collars are similar to drill pipes but have walls of greater thickness so that the weight of the collars puts the drill pipes into tension and acts downwards on the bit.

We claim:

1. A stabiliser for use in a drill string in borehole drilling, the stabiliser comprising two members coupled together with rotary lost motion, and capable of connection respectively to an upper and lower part of a drill string, spacer elements each pivoted to one of the stabiliser members about an axis parallel to the axis of relative rotation of the stabiliser members and movable between radially retracted and extended positions in response to relative rotary motion of the members, the other stabiliser member carrying a cam cooperating with a cam surface on each spacer element, and means for transmitting torque from one member to the other when the elements are extended.

2. A stabiliser according to claim 1, including means for automatic retraction of the spacer elements which come into operation when the stabiliser is not being driven and the driven member is not under axial compression.

3. A stabiliser according to claim 1, in which the cams and cam surfaces serve to transmit torque from one stabiliser member to the other when the spacer elements are in extended positions.

4. A stabiliser according to claim 1, including a torsion bar acting on each spacer element and urging it towards retracted position, and axially facing cooperating friction faces on the two stabiliser members, serving to resist relative rotation during transmission of axial compression.

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