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2,100,418

ORIENTING DEVICE FOR BOREHOLE DEFLECTING TOOLS

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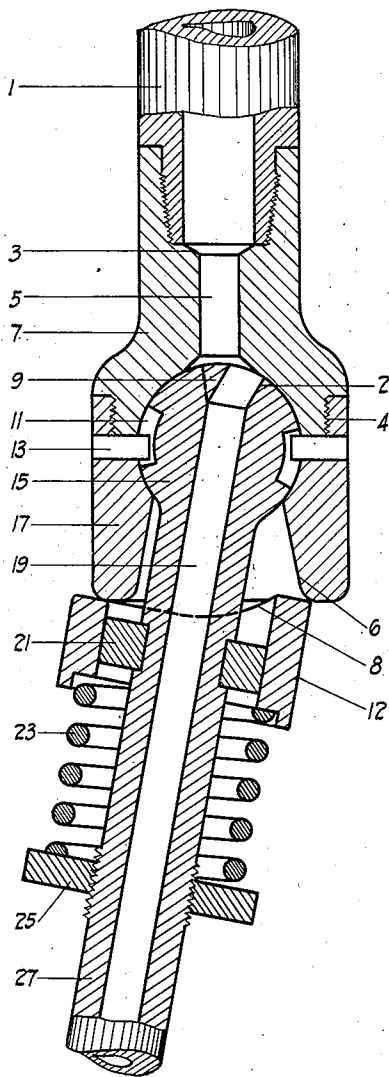


FIG. 1

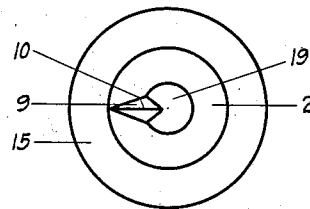


FIG. 2

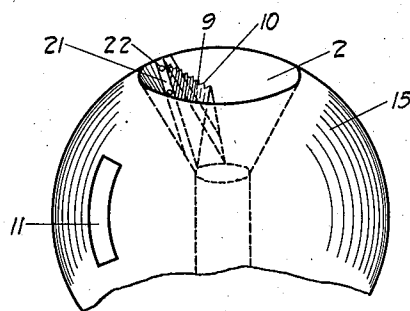


FIG. 3

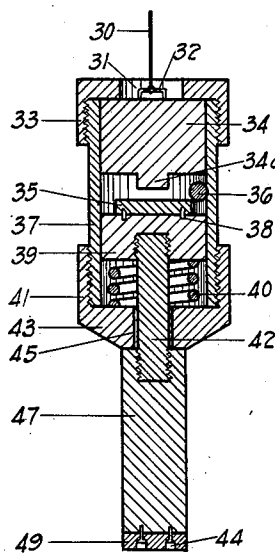


FIG. 4

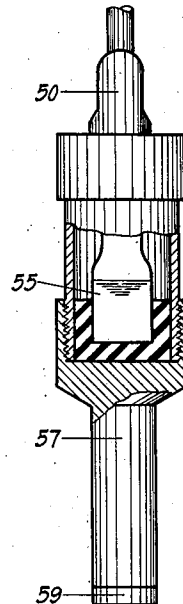


FIG. 5

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UNITED STATES PATENT OFFICE

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ORIENTING DEVICE FOR BOREHOLE DEFLECTING TOOLS

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5 Claims. (Cl. 255—1)

The present invention pertains to the art of directional drilling, and is more particularly concerned with an improvement in borehole deflecting tools of the universal or knuckle-joint type, whereby said tools may be properly oriented in an inclined borehole.

In drilling wells, it often happens that the direction in which a borehole is being drilled deviates from the vertical. In such cases it may be desirable to change the direction of drilling either in order to bring the borehole back to the vertical, or to deflect it in another direction, or to increase the angle of deviation still further, as, for example, in sea shore drilling, in drilling relief wells while extinguishing well fires, etc.

Boreholes may be deflected in any desired direction by means of tools such as whipstocks, knuckle joint drill bits, etc. These tools, however, must be properly oriented in the borehole in order that the latter may be extended in a desired direction. The orientation of whipstocks, knuckle joints, etc., is usually effected by means of methods involving the use of sighting devices, such as described in the Anderson Patent No. 1,770,224, or by means of orienting devices comprising magnetic or gyroscopic compasses, box levels, etc., as described in the Williston Patent No. 2,012,152.

These methods, however, have the disadvantage of involving a considerable, and sometimes unnecessary waste of time, since the orientation of deflecting tools does not necessarily have to be effected with regard to the points of the compass. Very often, it is only important to ascertain the position of the deviation plane of the borehole, that is, of the vertical plane passing through the axis of the deviating borehole with regard, for example, to the symmetry plane of a whipstock or of a knuckle joint. Any desired directional change in drilling may thereupon be effected by a suitable adjustment in the angle between said deviation plane and said symmetry plane.

It is the object of the present invention to provide an improvement in knuckle joints, such, for example, as the Lewis knuckle joint described in Patent No. 2,016,042, whereby said knuckle joint may be readily and positively oriented with regard to the deviation plane of a borehole by means of a clinometer of simple construction, such as a rolling ball or an acid bottle clinometer.

It is a further object of this invention to provide an improvement in knuckle joints, whereby the actual angle of flexure of the knuckle joint in a vertical plane can be positively determined.

These and other objects of the present invention will be better understood from the following description, wherein:

Fig. 1 is cross-sectional elevation view of a knuckle-joint provided with marking means for orienting said knuckle joint according to the method of the present invention.

Fig. 2 is a plan view of the ball member of the knuckle joint.

Fig. 3 is an enlarged perspective view of said ball member.

Fig. 4 is a cross-sectional elevation view of a preferred type of rolling ball clinometer used in orienting knuckle joints according to the present invention.

Fig. 5 is an elevation view, partly in cross-section, of an acid bottle clinometer.

Referring to Fig. 1, which shows a conventional knuckle joint of the Lewis type, the lower end of a drill string 1 is shown attached to the upper portion 7 of the socket member of said knuckle joint. The lower portion 17 of this socket member is attached to said upper portion by means of screw threads 4, and cooperates therewith in snugly and securely enclosing and holding a ball member 15, forming thereby a ball and socket universal joint. The ball member 15 forms the upper portion of a shaft 27, to the lower end of which a drill bit (not shown) of any desired type may be attached.

In order to transmit the rotation of the drill string to the drill bit, the ball member 15 is provided with vertical slots 11 in registry with pins 13 projecting inwardly through the socket member.

In order that the drill bit shaft 27 may assume a desired flexure angle with the drill string, the axial bore through the lower socket member 17 is given a conical shape, as shown at 6.

The universal joint is flexed, and shaft 27 is made to assume an angular position with regard to the drill string by means of a cam collar 12, slidably mounted for longitudinal movement along the shaft 27, and keyed against rotational movement with regard thereto by means of keys 21. The slidable cam collar 12 is normally urged upwards by a strong spiral spring 23 mounted around the shaft 27 and held in place by a nut 25.

The upper face of the cam collar 12 is raised on one side, as shown at 8, whereby the pressure of the spring 23, tending to force the cam collar in contact with the lower edge of the socket member 17, flexes the universal joint and deflects the drill bit shaft 27 with regard to the drill string, as shown in Fig. 1.

In order that the drilling fluid may be supplied to the bit, the socket member 7 is provided with an axial bore 5 registering with the drill pipe. A similar bore 19 extends through the drill bit shaft 27 and the ball member 15. In order that the flow of the fluid be not impeded when the universal joint is flexed and the bore through the socket member 7 is partially thrown out of register with the bore 19 through the ball member 15, the latter bore is enlarged at its upper end to form an upwardly opening funnel, as shown at 2.

A projecting marking member 9, is affixed to the wall of the funnel opening, as shown in elevation on Fig. 1, in plan view in Fig. 2, and in enlarged perspective view in Fig. 3. This member may be cast or machined together with the ball member 15, or may be provided with flanges 21 and attached to the ball member by means of screws or bolts 22, as shown in Fig. 3. The marking member has a sharp upper edge 10, which may be cut to form a series of sharp tooth points. The sharp edge 10 is given a desired calibrated length, such for example, that when the drill bit shaft 27 is deflected to its extreme position, the outermost tooth point of the marker 9 is projected to intersect the axial line of passage 5. The marking member 9 is affixed in known relationship to the raised portion 8 of cam collar 12: for example, it may be placed in the plane passing through keys 21, so that sharp edge 10 lies in the symmetry or deflection plane of the knuckle joint and indicates the direction in which the latter is deflected. Owing to its relatively small size, and its preferably triangular vertical cross-section, the marking member 9 offers no appreciable resistance to the flow of drilling fluid.

Fig. 4 illustrates a preferred type of clinometer used in orienting the knuckle joint described above.

This clinometer comprises a cylindrical casing 37, closed at the top by a cap 33, provided with an opening 31, and at the bottom with a cap 43, having an axial bore 45. A piston 34 fits snugly inside the casing 37, and is provided on its upper face with a suitable attachment device 32, by means of which the clinometer may be lowered inside the drill pipe into the borehole, at the end of a wire line or of a sucker rod string, during which operation the piston 34 is held in its uppermost position by the lowering means. A second piston 39 is slidably fitted within the clinometer, and is normally urged upwards by a spring 40 supported on the lower cap 43. The upper end of a piston rod 42 is screwed into the piston 39, while its lower end is screwed into a cylindrical member 47, the piston rod passing slidably through the bore 45 in the lower cap 43. A disc 35, made of lead or any other suitable deformable material is affixed in known position to the upper face of piston 39, for example, by means of pins 38. A metallic ball 36 is placed within the clinometer between the pistons 34 and 39, and is free to roll therein under the action of gravity, being preferably supported between the edge of the disc 35 and the inside wall of the clinometer casing. The lower face of piston 34 may be provided, if desired, with a downwardly projecting central portion 34a. The distance between the lower face of this projection and the lead disc 35 is made smaller than the diameter of ball 36, and only very slightly greater than the distance between ball 36 and the lower face of piston 34. The length of the spring 40 is selected so that when it is fully expanded there is a certain clearance space between the ball 36 and the upper piston 34.

The cylindrical member 47, which is attached to the piston rod 42, is adapted to enter the passage 5 in the socket member 7 of the knuckle joint. It carries at its lower end a second lead disc 49, which is attached thereto by any suitable means, for example, by means of countersunk screws 44.

The lead discs 35 and 49 are affixed to the clinometer in known relationship to each other, and may carry identifying marks from which their angular position with regard to each other may be determined.

In order to determine the position of the symmetry or deflection plane of the knuckle joint tool with regard to the deviation plane of an inclined borehole, the following procedure is followed:

The knuckle joint is lowered into the borehole on the end of a drill string. The clinometer is then lowered inside the drill string, for example, on the end of a wire line, which permits the operation to be carried out very quickly. The clinometer comes to rest on the seat 3, formed at the coupling of the last drill with the knuckle joint. The member 47 enters the passage 5 in the socket member of the universal joint, the disc 49 coming to within a small distance of the marker 9 which projects into said passage due to the deflection of the ball and shaft member 15—27 under the action of spring 23 and cam collar 12.

A fluid under pressure may then be pumped through the drill string. The flow of the fluid being stopped by the clinometer seated on seat 3, the pressure of the fluid acts to move the piston 34 downwards. The ball 36 is caught between the lower face of piston 34 and the deformable disc 35, the pressure applied being sufficient to produce an impression on the soft material of the latter.

On further downward motion of piston 34, the pressure is transmitted, through ball 36 and, if desired, through the downwardly projecting central portion 34a of the piston 34, to the piston 39, which moves downwards against the action of the spring 40. The piston rod 42 and the member 47 move together with piston 39, the disc 49 on the member 47 coming into contact with the marker 9 and receiving an impression therefrom.

Since, as stated above, the marker 9 is affixed to the funnel-shaped passage opening of the ball member 15 in known angular relationship to the cam collar 12, for example, in such manner that the sharp upper edge 10 of the marker indicates the direction in which the bit of the knuckle joint is deflected, and since the ball 36 assumes by gravity the lowermost position within the clinometer, the two marks on discs 35 and 49 provide, on withdrawing the clinometer and correlating the two discs, positive means for ascertaining the angular relationship of the borehole deviation plane to the knuckle joint symmetry plane, whereafter this relationship may be adjusted in any desired manner.

If, for some reason, such as jamming or an insufficient diameter of the bottom hole, the knuckle joint is not deflected to the desired full extent, the marker 9 will project only partially into the passage 5, and only a few of the teeth of the sharp edge 10 will leave their impression on the disc 49. The exact angle at which the knuckle joint is deflected, and therefore the angle at which the borehole will be extended may be determined from these impressions, or, if desired, the knuckle joint may be withdrawn and adjusted, or the bore-

hole enlarged with a bottom hole reamer to a desired diameter.

The desired impressions on discs 35 and 49 may also be obtained without applying fluid pressure to the clinometer. For example, if the clinometer is lowered at the end of a sucker rod string, the weight of said string when properly released at the top is sufficient to force pistons 34 and 39 downwards and to obtain the desired indications.

It is understood that the construction of clinometer illustrated in Fig. 4 is described here only by way of an example, and that the same results may be achieved by the use of any other type of clinometer capable of indicating the deviation plane of an inclined borehole. For example, an acid bottle clinometer, shown in Fig. 5, may be lowered into the borehole at the end of a sucker rod string 50. It comprises a casing and a lower member 57 similar to that of the clinometer of Fig. 4. The member 57 is made slightly longer than the member 47 of the rolling ball clinometer, so that the lead disc 59 is forced into contact with the marker 9 at the moment when the acid bottle clinometer comes to rest on seat 3. The clinometer of Fig. 5 contains a properly cushioned acid bottle 55. Due to the inclination of the borehole, the acid etches, in well known manner, an elliptical line on the glass of the bottle. Since the major axis of this ellipse lies in the deviation plane of the well, the coordinated indications of the acid bottle 55 and of the disc 59 provide means for determining the angular relationship between the deviation plane of the borehole and the symmetry plane of the knuckle joint, and the desired adjustment between these two planes may be effected as described.

I claim as my invention:

1. In a method for orienting in an inclined borehole a deflecting drilling tool comprising a universal joint provided with marking means indicating the deflection plane of said joint, the steps of lowering said tool in a flexed position into a borehole on a drill string, lowering into the drill string a clinometer capable of indicating the deviation plane of the borehole and adapted to receive an impression from the marking means on the universal joint when said joint is flexed, and recording the angular displacement in a horizontal plane of the deviation plane of the borehole with the deflection plane of the universal joint.

2. In a method for orienting in an inclined borehole a deflecting drilling tool comprising a universal joint provided with marking means indicating the deflection plane of said joint and the extent of its flexure, the steps of lowering said tool in a flexed position into a borehole on a drill string, lowering into the drill string a clinometer capable of indicating the deviation plane of the borehole and adapted to receive an impression from the marking means on the universal joint when said joint is flexed, and recording the angular displacement in a horizontal plane of the deviation

plane of the borehole with the deflection plane of the universal joint, and the extent of flexure in a vertical plane of said joint.

3. In a deflecting drilling tool adapted to be lowered into a borehole on a drill pipe string, a universal joint operatively connecting said tool to the drill pipe, means to flex said universal joint, a bore through said tool and through said universal joint coaxial with the passage through the drill pipe, marking means on the flexing member of the universal joint indicating the deflection plane of the universal joint and actuated by the flexure of the universal joint into operative position within said bore, and a removable clinometer adapted to be lowered through the drill pipe and to record the deviation plane of the borehole, said clinometer being provided with deformable means adapted to come in contact and to receive an impression from the marking means when said marking means are in operative position.

4. In a deflecting drilling tool adapted to be lowered into a borehole on a drill pipe string, a socket member attached to the drill pipe, a ball member held within the socket member and forming therewith a universal joint, a shaft member attached to the ball member, means to deflect the ball and shaft members with regard to the socket member, a bore through the socket, ball and shaft members co-axial with the passage through the drill pipe, marking means affixed to the ball member and adapted to project within the passage through the socket member when the universal joint is flexed, a removable clinometer adapted to be lowered through the drill string and to record the deviation plane of the borehole, said clinometer being provided with deformable means adapted to enter the bore through the socket member and to receive an impression from the marking means on the ball member when the ball and shaft members of the universal joint are deflected with regard to the socket member.

5. In combination with a deflecting drilling tool attached to a drill pipe and comprising a universal joint, a bore through said joint co-axial with the passage through the drill pipe, and marking means indicating the deflection plane of the universal joint and actuated into operative position within said bore by the flexure of the universal joint, a removable clinometer adapted to be lowered into the drill pipe, comprising gravity responsive means and deformable means cooperating therewith for recording the deviation plane of the borehole, deformable means cooperating with the marking means of the universal joint for recording the deflection plane of the universal joint, and pressure responsive means actuating said first and second deformable means into contact with said gravity responsive means and said operatively positioned marking means to record the relative angular position of the deviation plane and of the deflection plane.

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