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WELL APPARATUS

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Fig. 1.

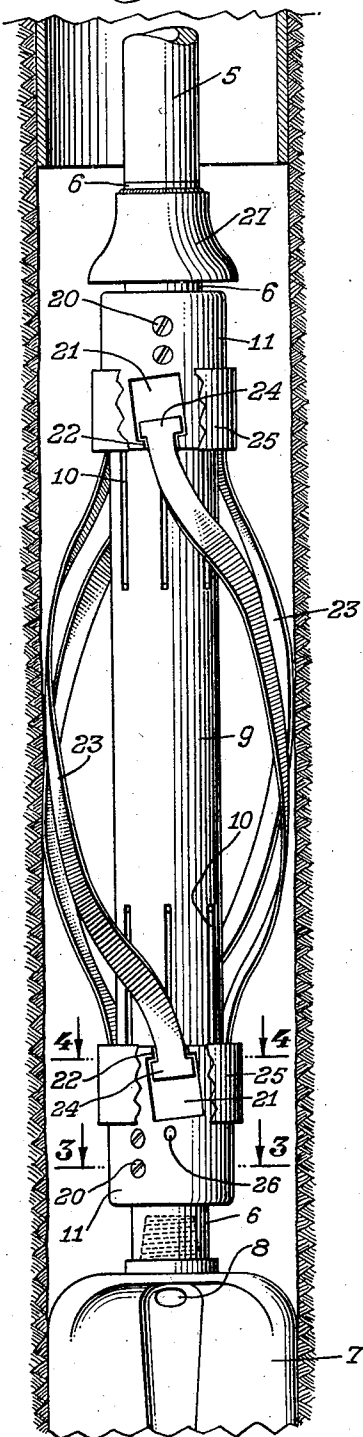


Fig. 2.

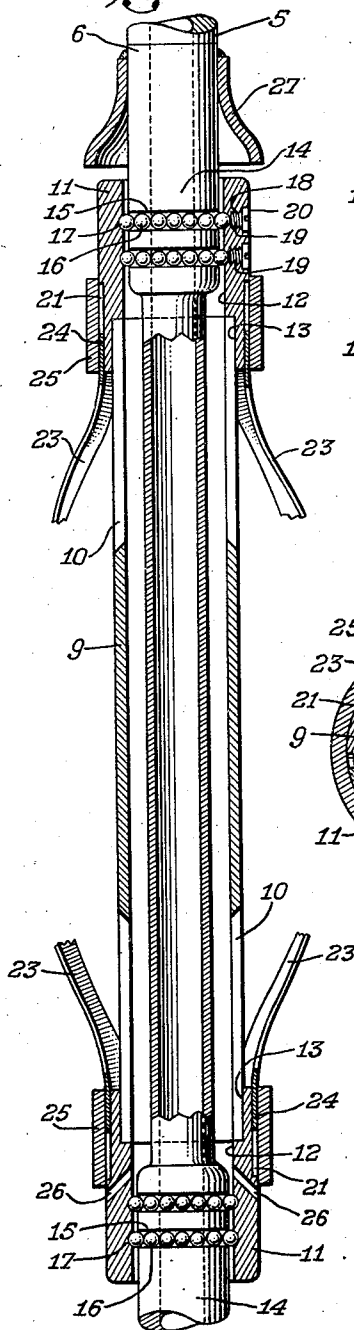


Fig. 3.

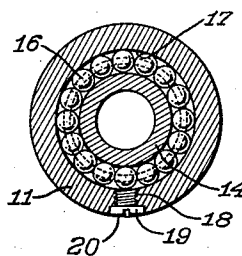
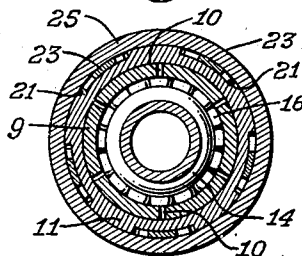


Fig. 4.



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WELL APPARATUS

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6 Claims. (Cl. 166—18)

This invention relates to rotary well drilling apparatus and in particular, contemplates devices adapted for assembly in a string of drill pipe to resiliently center and guide the pipe string in the well shaft and thereby obviate the tendency of a long string of pipe to bend and spiral in the hole, which, with conventional apparatus, often results in tilting of the bit and the formation of a crooked hole. Numerous other difficulties are encountered in rotary well drilling, as a consequence of the drag of the pipe string on the wall of the hole incident to the bending of the pipe, which are well known to the art.

A principal object is to provide a drill stem which includes a plurality of tubular sections arranged in spaced relation in the length of the string, each section carrying laterally expandible means to bear against the wall of the hole to center and guide the string in the casing and the hole, and particularly maintain the bit in a substantially vertical position.

Another object is the provision of a sleeve through which the drill stem may rotatably extend carrying the upper and lower ends of spiral bowed spring shoes slidably in retaining slots, whereby the shoes adapted to bear against the formation may individually compensate for projections and cavities in the well shaft by the varying degree of their respective lateral extension, while the spiral arrangement of the springs with respect to the axis of the drill stem will facilitate the sleeve in following the bit as the hole is deepened.

Another object is to provide in a device of the character above-indicated, a tubular member having threaded connections for assembly in a drill pipe string carrying bearings for the independent rotatable support of a sleeve, there being a passage formed between the member and sleeve for the upward flow of mud drilling fluid discharged from the bit secured to the lower end of the drill string for cooling and the lubrication of the bearings.

Another object is to provide a series of openings in the rotatable shoe-carrying sleeves to obviate the accumulation of abrasive particles of the drillings carried by mud circulating fluid within the sleeve and around the bearings to minimize wear of the bearings and the races in which they are carried, as well as to avoid settling of other constituents of the mud circulating fluid between the drill stem and sleeve which would otherwise tend to restrict free rotative movement of the sleeve relative to the drill string.

Still another object is to provide a bell-shaped shield mounted on the drill stem to overhang each of the drill stem-centering units to deflect cavings and prevent the accumulation of viscid blocks of shale, clay, and the like, which tends to encircle the rotating drill stem and resist withdrawal of the stem from the well shaft, as well as to close the mud lubricating passages through the centering units of my invention.

Still another object is to provide shoes to resiliently engage the wall of the hole which are curved in cross section to a degree equal to or greater than the curve of the wall of the hole in which the unit is to be located.

Other objects and corresponding advantages as, for example, a greater simplicity of construction and operation, durability, ease of assembly and replacement of worn parts, as well as positive action, will be apparent to those of skill in the art from an examination of the following description read in the light of the accompanying drawing, in which:

Fig. 1 is an elevation of one unit of my invention illustrated as assembled in the drill stem to center and guide the bit;

Fig. 2 is a sectional view of the device taken at right angles to the view of Fig. 1 with the spring shoes partially broken away;

Figs. 3 and 4 are sectional views taken on correspondingly numbered lines of Fig. 1.

Referring to the drawing in detail, the numerals of which indicate similar parts throughout the several views, 5 designates generally a hollow drill pipe section to the lower end of which is threaded a tubular member 6 of the centering unit of my invention. It will be understood that the drill stem is made up of a plurality of stands of drill sections 5 having a series of centering units comprising tubular members 6 threaded at spaced intervals in the string to center and guide the entire drill stem in the well shaft. A fish tail bit 7 of conventional construction is shown in Fig. 1, as attached to the lower end of tubular member 6. Each centering unit comprises, as above noted, a tubular member 6, and communicates through its bore the pipe sections 5 above and below it through which mud drilling fluid introduced at the well surface is pumped for discharge from orifices 8 in the bit head 7.

A sleeve 9 encircles the tubular member 6 and is provided with a series of slots 10 adjacent the ends thereof which are parallel to the axis of the sleeve and open through the respective ends thereof for a purpose later referred to. The sleeve 9 is held concentric with the member by

means of cylindrical heads 11 having a portion 12 of their bores of the same diameter as the diameter of the sleeve and a portion 13 of their bores enlarged to receive the respective ends of the sleeve 9. The heads 11 and sleeve 9 are held together frictionally or may be welded or otherwise secured by any well known means. The ends of the tubular member 6 are diametrically enlarged as at 14 within the heads and are formed with a pair of peripheral grooves 15 which comprise races for ball bearings 16. The bearings 16 extend laterally of the member and move in complementary grooves 17 formed in the wall of each head. Bearings 16 are inserted through threaded openings 18 which register with the respective grooves 17 in each head. The openings 18 are normally closed by screws 19, the heads 20 of which lie flush with the peripheral surface of the respective heads 11.

A series of rectangular recesses 21 are formed in the periphery of each head at a slight angle to the axis of the drill stem, i. e., slanting in a counterclockwise direction from top to bottom. A second narrower recess 22 extends from each recess 21 through the adjacent ends of the respective heads 11. Bowed spring steel springs or shoes 23 are carried rotatably with respect to the drill stem by the sleeve to resiliently bear against the formation or casing through which the drill stem extends. The shoes 23 are curved in cross section to any desired degree, but preferably are carried to a degree equal to or greater than the curve of the wall of the hole being drilled. Shoes 23 are spiraled around sleeve 9 for a purpose later referred to. The ends of the shoes extend into respective recesses 21 and are enlarged, at 24, to prevent withdrawal through recess 22. A collar 25 encircles each head 11 and is welded or otherwise secured in a position over the ends of the shoes 23. A series of equi-spaced downwardly diverging ports 26 are formed in the lower head 11, and extend from a point within the sleeve above the bearings 16 therein outwardly through the head below the collar 25 to communicate the bore of the head and the well shaft, and thereby permit gritty constituents of the mud and drillings to gravitate away from the bearings. Abrasive particles carried by the lubricating fluid may also flow from the sleeve through slots 10.

A bell-shaped shield 27 encircles the tubular member 6 above the upper bearings being attached to said member by welding or the like. The shield 27 flares outwardly to a diameter greater than the outside diameter of the upper head 11 which it overhangs, but terminates above the upper edge of the upper head to permit the flow of circulating fluid through the sleeve 9, as above referred to.

In operation the centering unit of my invention is threaded into the string of drill pipe as the pipe is assembled and lowered in the hole as above noted. Due to the inherent tendency of the shoes 23 to bow outwardly, they will each individually bear against the casing or, where positioned below the casing, against the wall of the hole above the bit 7, as shown in Fig. 1. Due to the great weight of the drill string, the latter will tend to bend in the hole and as the string is rotated incident to drilling, will, if its tendency to bend is not restrained, drag on the wall of the hole, dislodging debris and preventing efficient "mudding up" of the hole by the circulating fluid and, will further result in tilting the lower end of the pipe and the bit which will be conducive to the formation of a crooked hole. It will be ob-

served that the outward expansion of the spring shoes 23 of the respective centering units of my invention against the casing and hole will reduce to a minimum these results by retaining the drill pipe substantially in the center of the hole in a vertical position. The pressure exerted by shoes 23 against the wall of the hole will be substantially equal regardless of the contour of the formation by reason of their individual operation. Rocks jutting into the hole will cause one or more of the shoes contacting the abutment to recede into respective recesses 21 without nullifying the function of the other shoes, by causing the similar recession of the other shoes into their respective recesses, a difficulty of the prior art which the present invention seeks to overcome. Similarly, enlargements of the diameter of the well shaft incident to the caving of one side thereof will be compensated for by the further lateral extension of the individual shoes moving across the cavity. The sleeve 9 and shoes 23 may, of course, remain nonrotatable as the drill stem and bit are rotated. The spiral arrangement of the shoes on the sleeve 9 facilitates lowering of the units in the well with the drill stem as the shoes will tend to rotate the sleeve slowly as the drill pipe is lowered, and thereby avoid riding directly over jutting obstructions in the hole which might otherwise tend to resist their downward movement. By reason of the cross-sectional curve of the individual shoes, the latter will not cut into the wall of the hole.

Circulating mud fluid introduced into the drill stem at the well surface will discharge from the orifices of the bit 7 to cool the same and will thence flow upwardly toward the well surface in the usual manner. A portion of the fluid discharged from the bit will flow through the sleeve 9 to cool and lubricate the bearings 16. Abrasive particles tending to pack in the lower end of the sleeve will gravitate through ports 26.

Occasionally cavings and accretions of drillings, particularly from sticky shale and clay formations, accumulate around the drill pipe over collars and the like and not only obstruct efficient operation of the drill pipe and impede circulation, but also make difficult the removal of the pipe from the well. In the present invention the flare of the shield 27 will enlarge the hole through the pipe-encircling accumulations whereby they will more easily pass over the head and bowed shoes to the bottom of the hole where they may be thoroughly disintegrated by the bit and removed from the well by circulating fluid.

Restriction in the well shaft will occasionally tend to obstruct the running of a pipe carrying the bowed springs of my invention into and out of the hole. However, by reason of the fact that each shoe is retained within the recesses of respective heads by the enlargement on the ends of the shoes, the lower head will pull the shoes through such a restriction if the latter is met as the string is being lowered in the well, and the upper head will similarly pull the shoes through a restriction formed as by cavings encountered as the string is being pulled from the well, thereby obviating the tendency of the spring shoes to pile up or buckle, which is a result common in conventional devices which operate to push the bowed shoes through the well shaft.

It will thus be seen that I have provided an efficient drill pipe centering and guiding device, any number of which may be assembled in the string of pipe to bear against the wall of the hole and in the upper part of the string against the

wall of the casing, the shoes of which operate independently to exert a substantially equal pressure against the sides of the hole so as to resiliently resist bending, tilting, and other distortion of the pipe.

While I have described but one embodiment of my invention, it will be understood that numerous changes in size, design, shape, number and proportion of the various parts may be made, and that any features may be adopted in similar apparatus for centering and guiding sucker rod or tubing strings in a casing or in an open hole, without departing from the spirit of my invention as defined by the appended claims.

What I claim and desire to secure by Letters Patent is:

1. In a device of the character described, a drill stem, a sleeve rotatably encircling said drill stem, said sleeve being of greater inside diameter than the outside diameter of said drill stem to form a circulation passage through said sleeve around said stem, a plurality of bowed spring shoes having their ends slidably attached to said sleeve.

2. In a device of the character described, a drill stem, a sleeve encircling said stem, bearings between said sleeve and said stem, there being a passage formed between said sleeve and stem for admission of fluid from the well to lubricate said bearings, said sleeve having lateral openings therein above said bearings for removal of abrasive particles in the fluid.

3. In a device of the character described, a drill stem carrying a bit at its lower end, a sleeve encircling said stem carrying a series of shoes to engage the wall of the hole through which the stem is lowered, and an annular shield encircling the stem and secured thereto above said sleeve

and movable through the hole with said stem, said shield being flared laterally and downwardly to the diameter greater than the diameter of the upper end of said sleeve to enlarge the opening through debris accumulated in the well above the sleeve to facilitate withdrawal of said stem from the hole through the debris.

4. In a device of the character described, a drill stem, a plurality of shoes, means on said stem to receive the lower end of each shoe, said shoes being longitudinally slidable relative to said stem, means rigidly attached to said stem to limit the upward sliding movement of said lower attached end of each shoe relative to said stem as the stem is lowered in the well to pull the shoes through the well shaft.

5. In a device of the character described, a tubular member, a plurality of outwardly bowed springs, means to slidably connect the ends of each of said springs independently of one another to said tubular member, and means rigidly attached to said tubular member to limit the sliding movement of said springs relative to said tubular member.

6. In a device for centering a drill pipe string in a well hole, a series of bowed spring shoes, a pair of sleeves connected by said string in spaced relationship, each of said sleeves having a recess therein to slidably receive the ends of said shoes, and means connected to said lowermost sleeve to limit the upward movement of the lower end of said shoes while the string is being lowered in the well, the upper end of said shoes being movable upwardly in the recess of said upper sleeve while the lower ends of said shoes are engaged by said last-named means.

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