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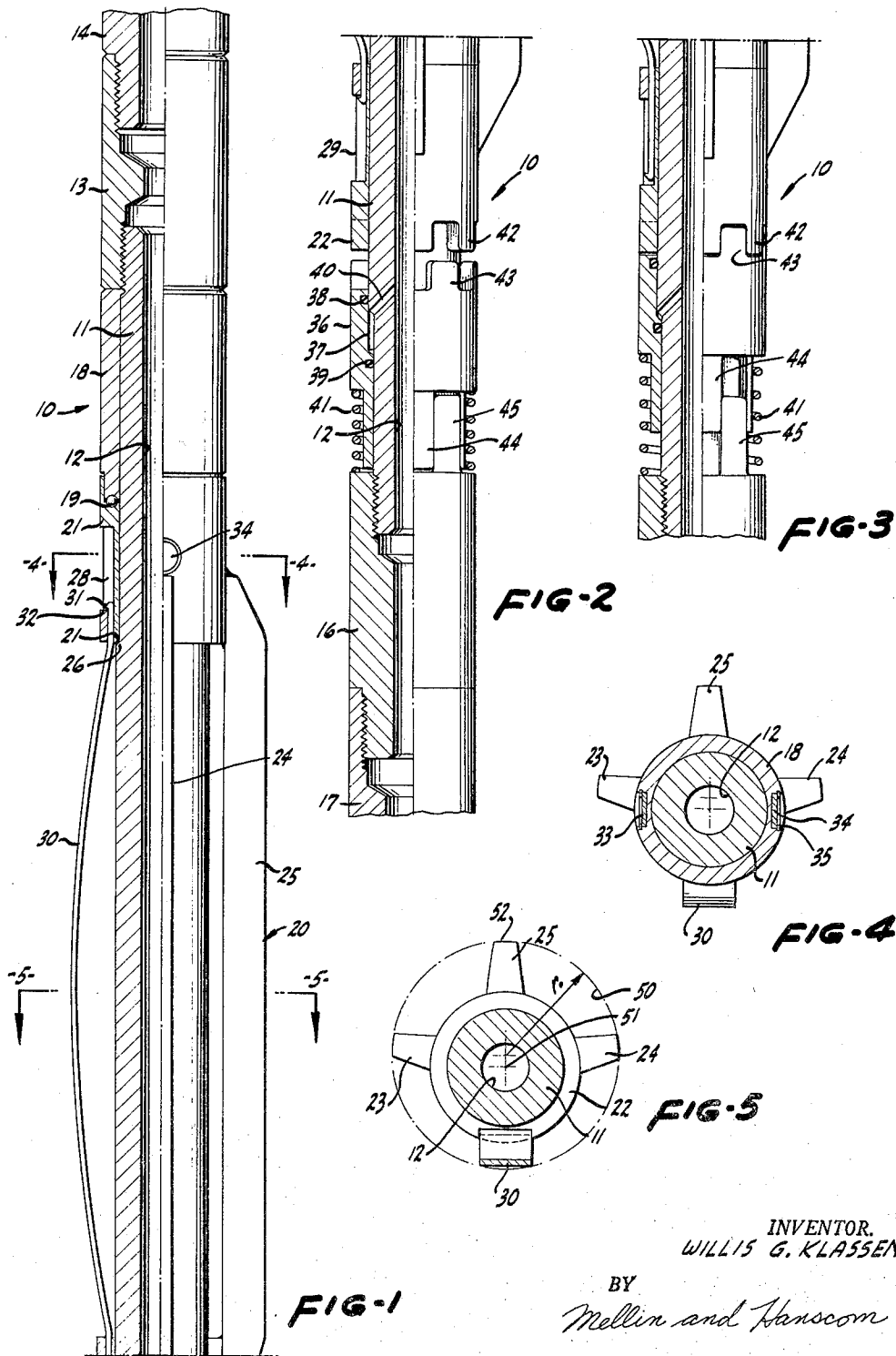
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3,045,767

APPARATUS FOR DIRECTIONAL DRILLING OF WELLS

Filed Nov. 28, 1958

2 Sheets-Sheet 1



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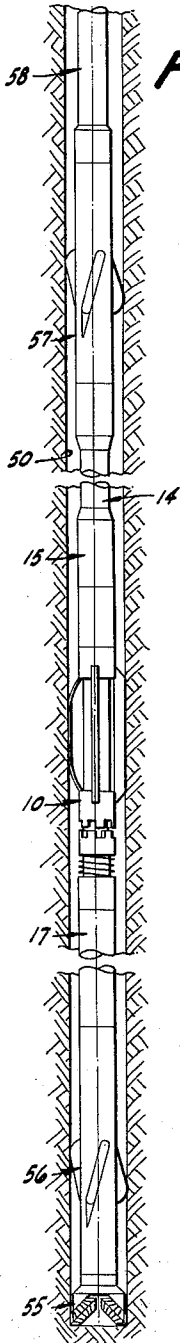


FIG-6

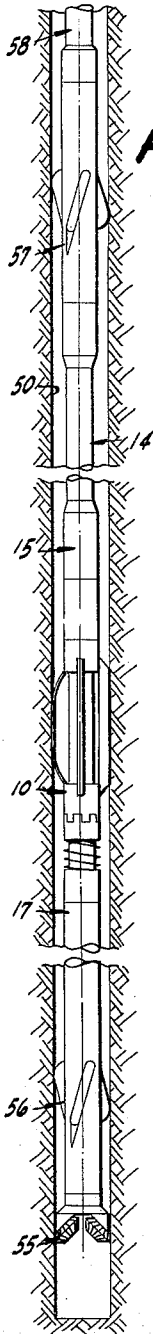


FIG-7

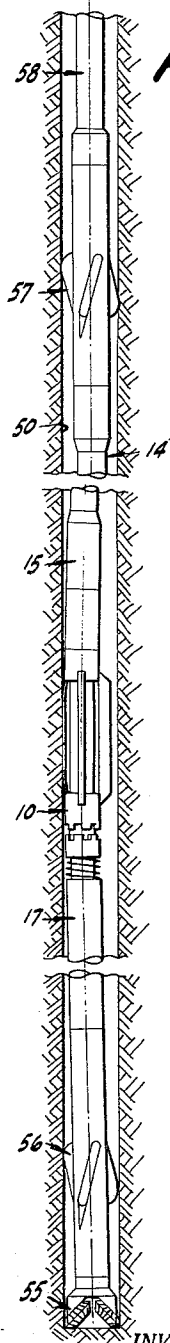


FIG-8

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3,045,767 APPARATUS FOR DIRECTIONAL DRILLING OF WELLS

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This invention relates to the drilling of wells and, more particularly, to a novel apparatus for deviating the direction of drilling of wells.

Directional drilling of oil wells is a commonly employed technique when it is desired to direct the course of a drilled hole in any desired direction and towards any pre-determined objective. Such drilling enables the operator to avoid large losses in time and money that are frequently the result of haphazard drilling practices, as well as providing a way to sidetrack obstructions in the bore, straightening the bore, or deflecting the course of the bore in order to reach otherwise inaccessible locations.

The present technique used in such directional drilling, although quite accurate in performance, are fairly costly in time and money. At present, the most generally used practice is to survey the bore through the drill string to determine whether the drilling should be deviated. If so, the drill string is pulled from the well and a whipstock device is run to the bottom of the well, at which point it is oriented to direct the drill in the proper direction. Drilling is then resumed with the drill bit being diverted by the whipstock into the proper direction. The newly directed bore is then surveyed to see if it is properly deviated. The drill string is again removed, and the whipstock is then removed. After this, the drill string is again lowered into the well to recommence drilling in the new direction. As is apparent, the drill string must twice be completely removed from the well in order to insert the whipstock device whenever it is desired to change direction, and to remove the whipstock after the direction has been changed. In deep wells, many hours are required to remove and re-install a drill string, and consequently labor and production costs are quite high.

It is a primary object of this invention to provide an apparatus permitting controlled directional drilling in a well bore without the necessity for removing the drill string from the well.

A further object of the invention is to provide apparatus for deviating the direction of drilling in a hole in which the drill string above the drill bit is bowed in a desired direction and held bowed in that direction as drilling resumes.

A further object is to provide a novel directional stabilizer usable with common well tools for using the invention set forth above.

Another object of the invention is to provide a novel means for directional drilling whereby the drill string is centered in the well bore adjacent the drill bit and at a vertically spaced point therefrom and in which the drill string is laterally bowed intermediate these points so that drilling can be performed along the arc formed by the drill string.

Yet another object is to provide means for deviating the direction of drilling having a minimum of working parts, which is rugged and which is relatively inexpensive in manufacture.

Other objects and advantages will become apparent in the course of the following detailed description.

In the drawings, forming a part of this application, and in which like parts are designated by like reference numerals throughout the same,

FIGS. 1 and 2 are continued elevational views, shown partly in section, of a controllable directional stabilizer

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constructed in accordance with the invention, and showing the clutch in disengaged position.

FIG. 3 is a view similar to FIG. 2, illustrating the clutch in engaged position.

FIG. 4 is a sectional view taken on the line 4-4 of FIG. 1.

FIG. 5 is a sectional view taken on the line 5-5 of FIG. 1.

FIG. 6 is an elevational view showing a drill string assembled in accordance with the invention, with the drill string shown in drilling position with the clutch of the controllable stabilizer disengaged.

FIG. 7 is a view similar to FIG. 6, illustrating the drill string raised in the well bore with the controllable stabilizer clutch engaged.

FIG. 8 is a view similar to FIGS. 6 and 7, illustrating the arrangement of parts when the drilling of the well bore recommences at a deflected angle to the original direction of the well bore.

Referring now to the drawings, and more particularly to FIGS. 1 through 5, the controllable directional stabilizer, generally referred to by the reference numeral 10 includes an elongated mandrel 11 having a main bore 12 therethrough for the passage of drilling fluids. The mandrel 11 is made of non-magnetic material, as, for example, from Monel metal or stainless steel.

A top sub 13 threadedly engages the upper end of mandrel 11 for connection of the mandrel to a drill collar 14 of the drill string 15. Similarly, a bottom sub 16 threadedly engages the lower end of the mandrel 11 for connection to a drill collar 17 of the drill string, as will be hereinafter described more fully.

A spacer sleeve 18 surrounds the upper end of mandrel 11 and has formed on the lower surface thereof an annular ball race for the reception of thrust balls 19. The spacer sleeve 18 may or may not be formed integrally with the top sub 13 or the mandrel 11, as desired.

A stabilizer sleeve 20 is disposed around mandrel 11 and comprises an upper cage ring 21 and a lower cage ring 22 to which are rigidly connected the vertically elongated rigid stabilizer wings 23, 24 and 25, which operate as a spacing means. The upper cage ring 21 has an annular ball race on its upper end for the reception of the thrust balls 19, and is prevented from moving downwardly on mandrel 11 by the interengagement of shoulders 26 and 27 formed on the cage ring and mandrel, respectively.

The upper and lower cage rings 21 and 22 are longitudinally slotted at 28 and 29 for the reception of the ends of the bow, or leaf, spring 30 thereinto. The upper end of bow spring 30 has an outward projection 31 engageable with the shoulder 32 of the cage ring 21 to prevent accidental removal of the spring from slot 28. The lower end of the spring is similarly maintained in place in the lower cage ring. The bow spring has an unstressed position as indicated in FIG. 1, but is capable of collapsing inwardly towards the mandrel upon sufficient force being applied laterally thereto.

The upper cage ring 21 has two pockets formed therein on opposite sides of the slot 28 for the reception of permanent magnets 33 and 34 which are held in place by suitable means, such as split rings 35. The upper cage ring is also formed of a suitable non-magnetic material.

Below the lower cage ring 22 and surrounding the mandrel 11 is piston sleeve 36. As will be noted in FIG. 2, the inner diameter of the upper end of piston sleeve 36 is greater than the lower end thereof, so as to form with mandrel 11 a variable capacity piston chamber 37, sealed by O-rings 38 and 39. Ports 40 communicate the interior of the piston chamber with the main bore 12 of the mandrel. When sufficient fluid pressure is exerted in chamber 37, the piston sleeve 36 will be moved down-

wardly on mandrel 11, against the force of compression spring 41, so that the clutch teeth 42 and 43 formed on the lower cage ring 22 and piston sleeve 36, respectively, will become disengaged, as shown in FIG. 2. Conversely, when the force of spring 41 exceeds the pressure within chamber 37, the piston sleeve will be forced upwardly by spring 41 to engage the clutch teeth 42 and 43, as shown in FIG. 3. Thus, means operated by the fluid pressure, which is applied from the top of the well, is provided for selectively coupling sleeve 20 to said drill pipe.

The piston sleeve 36 and the bottom sub 16 are provided with interengaging longitudinal splines 44 and 45, respectively, which allow the piston sleeve to move longitudinally along mandrel 11 between the positions shown in FIGS. 2 and 3, while preventing rotation of the piston sleeve relative to the bottom sub 16 and the mandrel 11.

Referring now to FIG. 5, wherein the stabilizer 10 is shown in a well bore 50, it is to be noted that the lateral distance from the center 51 of the stabilizer 10 to the outermost edge 52 of the stabilizer wing 25 is greater than the radius "r" of the well bore. Thus the stabilizer 10 will be held offset from the well bore axis by the stabilizer wing 25. It has been found that a half inch offset is a practicable amount, but the invention is not restricted to such an amount. The bow spring 30 normally holds the stabilizer wing 25 in engagement with the well bore 50.

The side wings 23 and 24 preferably form an angle of about 80° with the wing 25 so as to enable the stabilizer 10 to move laterally in the bore 50 in a direction away from the engagement of wing 25 therewith, without undue interference of wings 23 and 24 with the well bore during such movement.

As will be seen from the above description, the stabilizer sleeve 20 is free to rotate on mandrel 11 but is prevented from moving longitudinally thereon. Also, the piston sleeve 36 is capable of moving longitudinally on mandrel 11 but is restrained from rotating relative thereto.

Turning now to FIGS. 6, 7 and 8, in the operation of drilling the well bore 50, a drill string 15 is assembled, comprising from the bottom up: a conventional drill bit 55, a lower rigid stabilizer 56, a non-magnetic drill collar 17, the controllable stabilizer 10, a modified drill collar 14, an upper rigid stabilizer 57 and drill pipe 58 extending to the top of the well.

The lower and upper rigid stabilizers 56 and 57 act to center the drill string in the well bore 50 below and above the directional stabilizer 10. These rigid stabilizers are commonly employed in well drilling.

The modified drill collar 14 is made from a conventional drill collar by reducing its wall thickness to increase lateral flexibility. This provides an increase in the bend thereof when the drill bit 55 is bottomed in the well and sufficient weight is applied thereto. Accordingly, the well string is provided with a flexible portion (drill collar 14) between stabilizers 56 and 57.

The drill string 15 is illustrated in FIG. 6 in normal drilling position in the well bore 50 with enough of the weight of the drill string being supported at the top of the well to prevent lateral deflection of the modified drill collar 14. The bow spring 30 of the directional stabilizer 10 holds the wing 25 thereof against the wall of the well bore so that the axis of the drill string is but very slightly offset at that point from the axis of the well bore. The pressure of the drilling fluid pressing down through the drill string is exerted in the piston chamber 37 to force the piston sleeve 36 downwardly in order to disengage the clutch teeth 42 and 43. Such disengagement permits rotation of the drill string, including mandrel 11, while the stabilizer sleeve 20 remains stationary in the well bore.

After drilling has proceeded for a desired time, a conventional double magnetic survey instrument is run down the drill string so that the upper survey instrument is positioned adjacent the magnets 33 and 34 contained in the upper wing cage 21 and so that the lower survey in-

strument is positioned in the non-magnetic drill collar 17. The lower survey instrument will record the amount of well bore deviation from vertical and the direction of such deviation, and the upper survey instrument will record the relationship of the permanent magnets 34 and 35 relative to Magnetic North. This latter recording will thus enable the relationship of the bow spring 30 to Magnetic North to be found.

The above surveying is generally performed with the drill string raised off of the bottom of the well bore, as illustrated in FIG. 7. The circulation of drilling fluid through the drill string is temporarily stopped decreasing the pressure in the piston chamber 37, which enables spring 41 to move the piston sleeve 36 upwardly so that the clutch teeth 42 and 43 will be engaged with one another.

An appraisal of the readings of the double survey will then indicate the necessity for deflecting further drilling. If it is determined that the well bore requires deviating, the drill string is rotated from the top of the well through a proper amount to orient the directional stabilizer sleeve 20 so that the bow spring 30 thereof engages the well bore on the side thereof opposite to the direction in which the well bore is desired to be drilled. So positioned, the stabilizer wing 25 will force the axis of the stabilizer 10 away from the axis of the well bore in a direction opposite to the direction of desired further drilling. If desired, an additional survey may be made to assure that the stabilizer 10 is properly oriented.

The drill string is again lowered in the well bore to position the drill bit at the bottom of the well and the circulation of the drilling fluid is recommended, causing the clutch 42, 43 to disengage. Rotation of the drill string is again begun and sufficient weight is placed upon the modified drill collar 14 such as to cause it to laterally bend. Since the directional stabilizer 10 is already offset from the axis of the well, the bending of the drill collar 14 will collapse the bow spring inwardly towards mandrel 11 so that the axis of the directional stabilizer 10 becomes even more offset from the well bore axis, as depicted in FIG. 8.

Further drilling will cause the drill bit to drill in a direction along the arc defined by the centers of the two rigid stabilizers 56 and 57 and the center of the directional stabilizer 10 which latter member will not rotate with the drill string due to the disengagement of the clutch teeth 42 and 43. The drilling will be continued in this direction until a later survey reveals the necessity for changing the further direction of drilling, at which time the direction may be rechanged as above described, so that drilling may be resumed in the newly desired direction.

As may be seen from the foregoing, the present invention greatly reduces the time and expense in directional drilling by eliminating the necessity for pulling the drill string whenever it is desired to deviate the drilling from a former direction of drilling.

It is to be realized that the invention herewith shown and described is a preferred embodiment of the same, and that various changes in the shape, size and arrangement of parts may be resorted to without departing from the spirit of the invention or the scope of the attached claims. As, for example, FIG. 6 shows the modified drill collar 14 as being attached to the upper rigid stabilizer 57. However, one or more steel drill collars could be coupled between the modified drill collar 14 and the stabilizer 57 in order to provide more weight. Other modifications will be apparent to those skilled in the art.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

1. A directional stabilizer for use in directional drilling in a well bore having a given radius comprising a tubular mandrel adapted to be connected in a drill string, a first annular sleeve member mounted on said mandrel for free relative rotation therewith and fixed against longitudinal movement thereon, a second annular sleeve member mounted on said drill member for longitudinal move-

ment thereon and fixed against relative rotation therewith, spring means resiliently biasing said sleeve members into engagement with each other, interengageable clutch means on said sleeve members for preventing relative rotation therebetween when in engagement with each other, said mandrel having a lateral opening therethrough, means forming a variable capacity piston chamber between said second sleeve member and said mandrel and in communication with said mandrel opening so that introduction of fluid pressure from said mandrel into said chamber will move said second sleeve member out of engagement with said first sleeve member, an outwardly extending spacing member rigidly mounted on said first sleeve member, the distance from the axis of said first sleeve member to the outermost part of said spacing member being greater than said well bore radius, and a vertically elongated, outwardly extending and inwardly collapsible bow spring means mounted on said first sleeve on the side thereof opposite to said spacing member.

2. A directional stabilizer for use in directional drilling in a well bore having a given radius comprising a tubular mandrel adapted to be connected in a drill string, a first annular sleeve member mounted on said mandrel for free relative rotation therewith and fixed against longitudinal movement thereon, a second annular sleeve member mounted on said drill member for longitudinal movement thereon and fixed against relative rotation therewith, spring means resiliently biasing said sleeve members into engagement with each other, interengageable clutch means on said sleeve members for preventing relative rotation therebetween when in engagement with each other, said mandrel having a lateral opening therethrough, means forming a variable capacity piston chamber between said second sleeve member and said mandrel and in communication with said mandrel opening so that introduction of fluid pressure from said mandrel into said chamber will move said second sleeve member out of engagement with said first sleeve member, a vertically elongated and outwardly extending spacing member rigidly mounted on said first sleeve member, the distance from the axis of said first sleeve member to the outermost part of said spacing member being greater than said well bore radius, a vertically elongated, outwardly extending and inwardly collapsible spring means mounted on said first sleeve on the side thereof opposite to said spacing member, and vertically elongated and outwardly extending fins mounted on opposite sides of said first sleeve between said spring member and spring means.

3. A directional stabilizer for use in directional drilling in a well bore having a given radius comprising a tubular mandrel adapted to be connected in a drill string, a first annular sleeve member mounted on said mandrel for free relative rotation therewith and fixed against longitudinal movement thereon, a second annular sleeve member mounted on said drill member for longitudinal movement thereon and fixed against relative rotation therewith, spring means resiliently biasing said sleeve members into engagement with each other, interengageable clutch means on said sleeve members for preventing relative rotation therebetween when in engagement with each other, said mandrel having a lateral opening therethrough, means forming a variable capacity piston chamber between said second sleeve member and said mandrel and in communication with said mandrel opening so that introduction of fluid pressure from said mandrel into said chamber will move said second sleeve member out of engagement with said first sleeve member, a vertically elongated and outwardly extending spacing member rigidly mounted on said first sleeve member, the distance from the axis of said first sleeve member to the outermost part of said spacing member being greater than said well bore radius, said first sleeve having a portion thereof made of non-magnetic material, and magnet means mounted in said non-magnetic sleeve portion, said mandrel having

the portion thereof adjacent said magnet means made of non-magnetic material.

4. A directional stabilizer for use in directional drilling in a well bore having a given radius comprising a tubular mandrel adapted to be connected in a drill string, a first annular sleeve member mounted on said mandrel for free relative rotation therewith, a second annular sleeve member mounted on said drill member and fixed against relative rotation therewith, means to allow longitudinal movement of at least one of said sleeve members along said mandrel so that said sleeve members may be engaged with one another, spring means resiliently biasing said sleeve members into engagement with each other, interengageable clutch means on said sleeve members for preventing relative rotation therebetween when in engagement with each other, said mandrel having a lateral opening therethrough, means forming a variable capacity piston chamber between the longitudinally movable sleeve member and said mandrel and in communication with said mandrel opening so that introduction of sufficient fluid pressure from said mandrel through said opening and into said chamber will move said longitudinally movable sleeve member out of engagement with the other sleeve member, a vertically elongated and outwardly extending spacing member rigidly mounted on said first sleeve member, the distance from the axis of said first sleeve member to the outermost part of said spacing member being greater than said well bore radius, a vertically elongated, outwardly extending and inwardly collapsible bow spring means mounted on said first sleeve on the side thereof opposite to said spacing member, vertically elongated and outwardly extending fins mounted on opposite sides of said first sleeve between said spring member and spring means, said first sleeve having a portion thereof made of non-magnetic material, and magnet means mounted in said non-magnetic sleeve portion, said mandrel having the portion thereof adjacent said magnet means made of non-magnetic material.

5. Apparatus for directional drilling in a well bore comprising: a drill string adapted to be lowered into said well bore; stabilizing means mounted upon said string at vertically spaced points for centering the drill string in the well bore, said means providing well bore engaging surfaces, and a directional stabilizer rotatably mounted upon said string at a point intermediate said vertically spaced points for displacing a portion of said string away from the central axis of said well bore, said stabilizer comprising a tubular mandrel connected in said drill string, a first annular sleeve member mounted on said mandrel for free relative rotation therewith, a second annular sleeve member mounted on said mandrel and fixed against relative rotation therewith, means to allow longitudinal movement of at least one of said sleeve members along said mandrel so that said sleeve members may be engaged with each other, means resiliently biasing said sleeve members into engagement with each other, interengageable clutch means on said sleeve members for preventing relative rotation therebetween when in engagement with each other, means responsive to a predetermined fluid pressure within said mandrel for moving said sleeve members against the bias of said biasing means and out of engagement with each other, and an outwardly extending spacing member mounted on said first sleeve member, the distance from the axis of said first sleeve member to the outermost part of said spacing member being greater than said well bore radius.

6. Apparatus for directional drilling in a well bore comprising: a drill string adapted to be lowered into said well bore; stabilizing means mounted upon said string at vertically spaced points for centering the drill string in the well bore, said means providing well bore engaging surfaces, and a directional stabilizer rotatably mounted upon said string at a point intermediate said vertically spaced points for displacing a portion of said string away from

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the central axis of said well bore, said stabilizer comprising a tubular mandrel connected in said drill string, a first annular sleeve member mounted on said mandrel for free relative rotation therewith, means preventing relative longitudinal movement between said first sleeve and said mandrel, a second annular sleeve member mounted on said mandrel and fixed against relative rotation therewith, means to allow longitudinal movement of said second sleeve member along said mandrel into and out of engagement with said first sleeve member, spring means resiliently biasing said second sleeve member into engagement with said first sleeve member, interengageable clutch means on said sleeve members for preventing relative rotation therebetween when in engagement with each other, means responsive to a predetermined fluid pressure within said mandrel for moving said sleeve members against the bias of said spring means and out of engagement with each other, and a vertically elongated and outwardly extending spacing member rigidly mounted on said first sleeve member, the distance from the axis of said first sleeve member to the outermost part of said spacing member being greater than said well bore radius.

7. Apparatus for directional drilling in a well bore comprising a drill string adapted to be lowered to the bottom of said well bore, a pair of vertically spaced-apart stabilizers connected in said drill string for centering said drill string in said well bore, said drill string having a laterally flexible portion provided between said stabilizers,

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a stabilizer sleeve rotatably mounted on said drill string between said stabilizers, outwardly extending spacing means on said sleeve engageable with said well bore for normally holding said sleeve and the drill pipe therewithin at least slightly displaced from the center of the well bore, clutch means for releasably engaging said drill string and stabilizer sleeve together to prevent relative rotation therebetween in either direction, spring means for normally engaging said clutch means, and means operable by a predetermined magnitude of fluid pressure within said drill string for releasing said clutch means to disengage said drill string and stabilizer sleeve for relative rotation therebetween.

References Cited in the file of this patent

UNITED STATES PATENTS

2,061,316	Brack et al. -----	Nov. 17, 1936
2,120,670	Hyer -----	June 14, 1938
2,316,409	Downing -----	Apr. 13, 1943
2,327,658	Miller -----	Aug. 24, 1943
2,711,879	Ring -----	June 28, 1955
2,712,434	Giles et al. -----	July 5, 1955
2,745,635	Zublin -----	May 15, 1956
2,805,840	Thompson -----	Sept. 10, 1957
2,819,040	James et al. -----	Jan. 7, 1958
2,829,864	Knapp -----	Apr. 8, 1958
2,915,286	Wright -----	Dec. 1, 1959