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2,915,286

DEFLECTION TOOL FOR ROTARY DIRECTIONAL DRILLING

Filed April 20, 1953

3 Sheets-Sheet 1

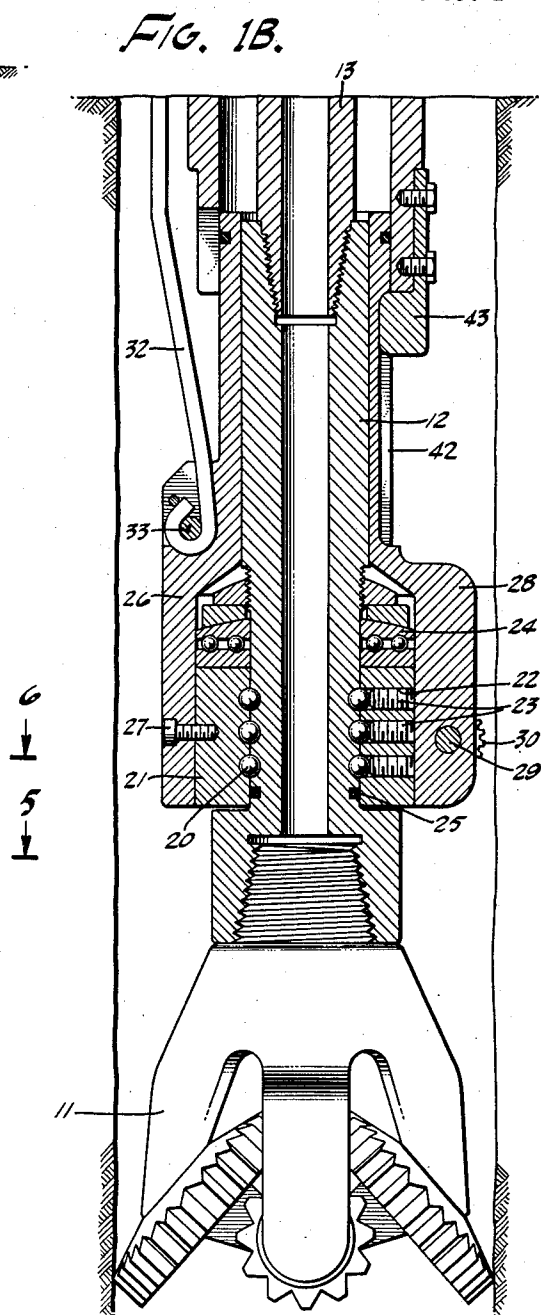
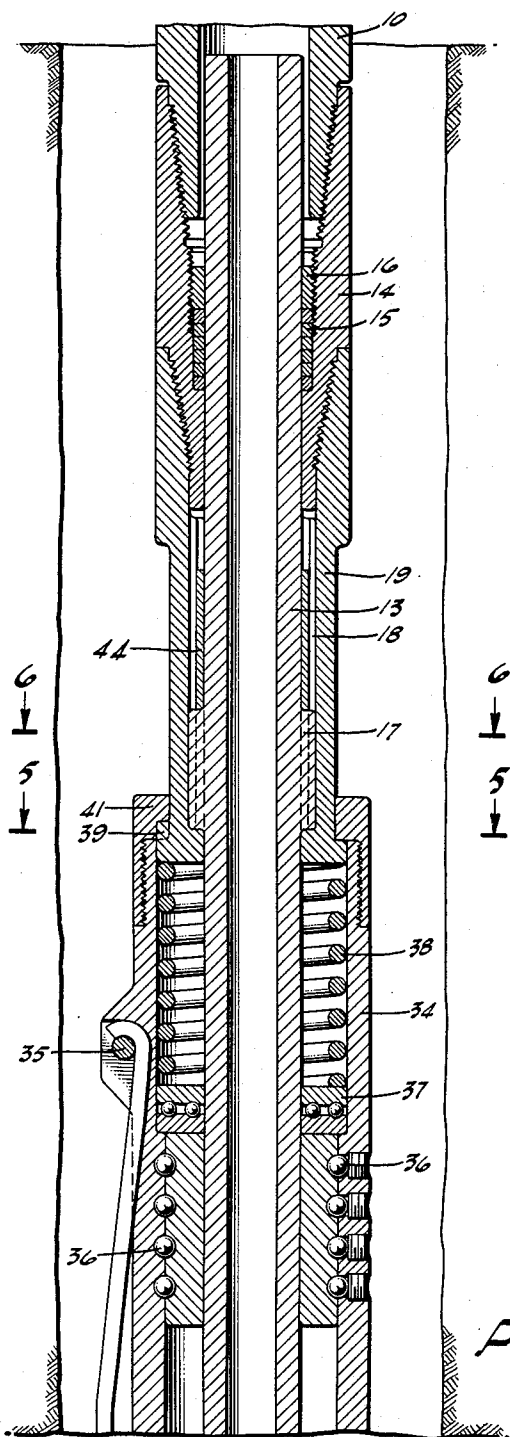


FIG. 1A.

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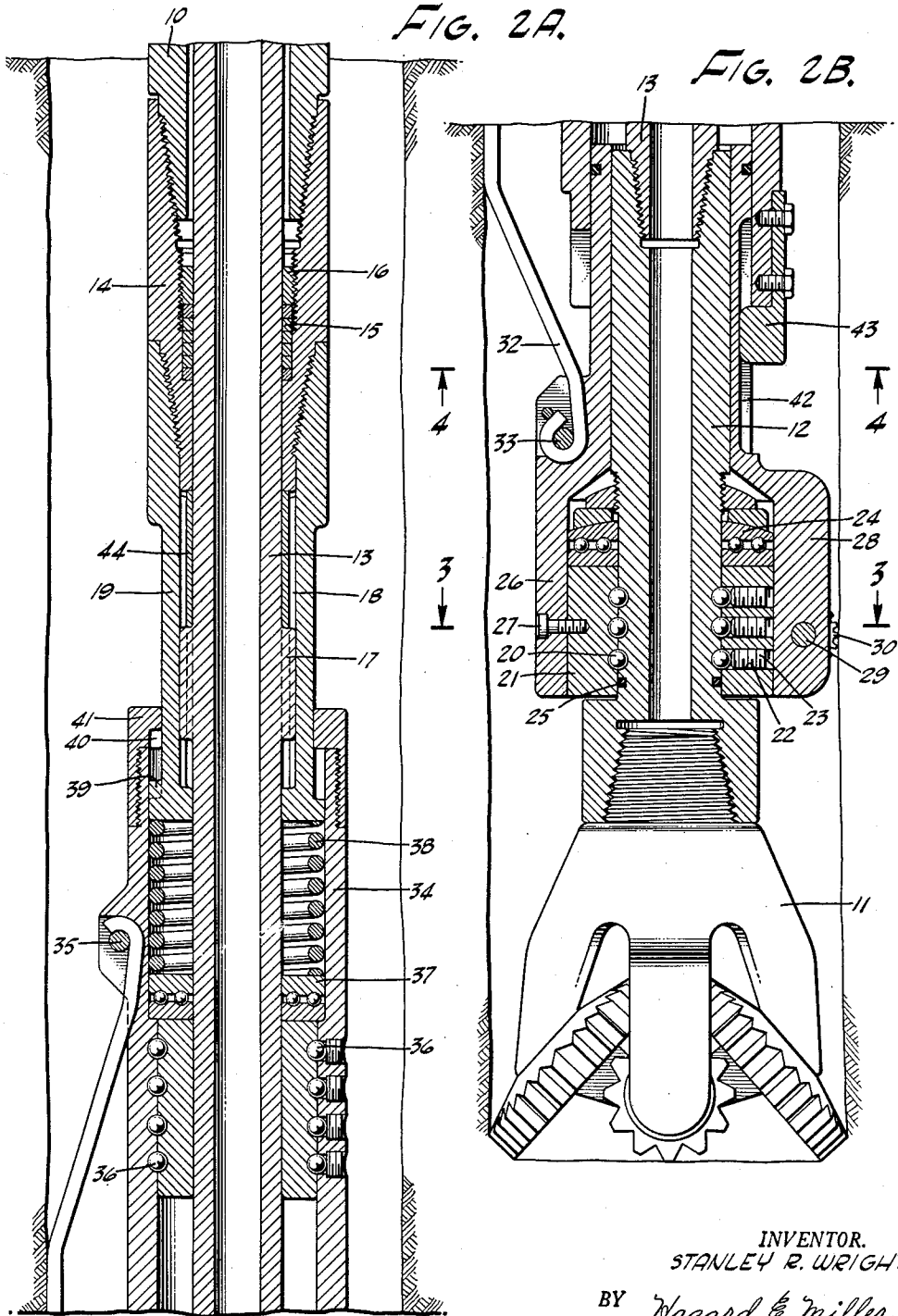
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3 Sheets-Sheet 2



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3 Sheets-Sheet 3

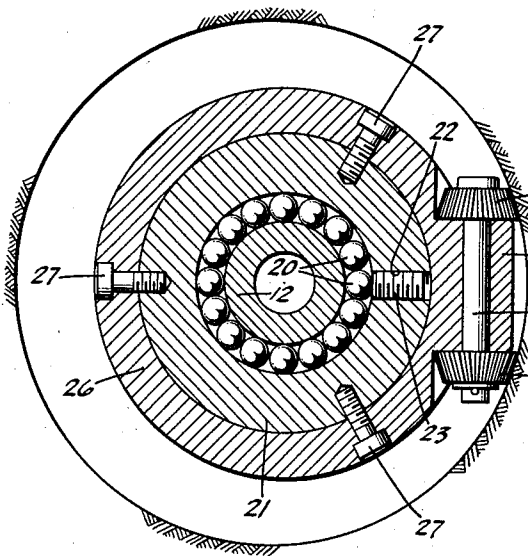


FIG. 3.

FIG. 5.

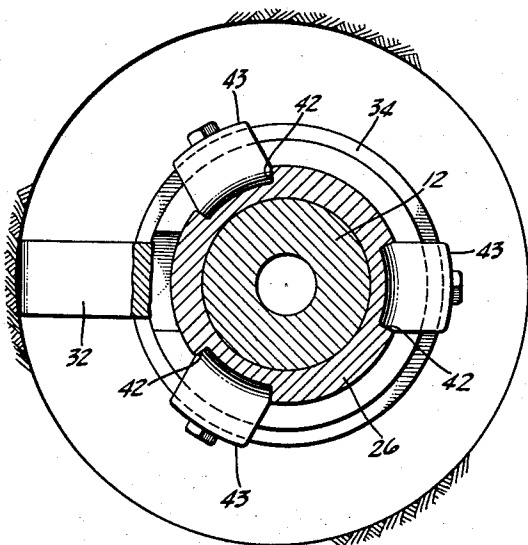
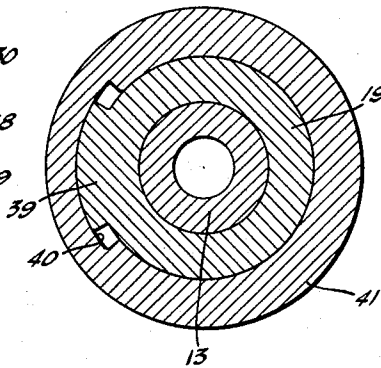
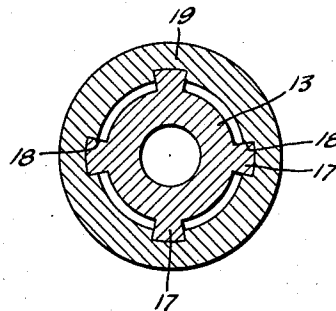


FIG. 4.

FIG. 6.



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DEFLECTION TOOL FOR ROTARY DIRECTIONAL DRILLING

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Application April 20, 1953, Serial No. 349,650

2 Claims. (Cl. 255—1.6)

This invention relates to a deflection tool for rotary directional drilling.

A primary object of the invention is to provide a tool attachable to a rotary drill string designed to be located immediately behind the bit thereof and which, when in operation, will cause the bit to be deflected with respect to the axis of the well hole previously drilled. The foregoing function is very much the same as that accomplished by the conventional whipstock but the conventional whipstock has the objection that it is difficult to locate the whipstock properly in the well and to maintain its position so that the bit will thereafter continue to drill in the desired direction.

It is, therefore, a more specific object of the invention to provide a tool for directional drilling which can be located or set in the well in the desired position so that the bit will be deflected in the desired direction and as drilling proceeds, this deflection in the desired direction will be continued.

Another object of the invention is to provide a deflection tool for rotary directional drilling consisting essentially of a mandrel on which a sleeve is rotatably mounted so that the mandrel may be rotated by the drill string within the sleeve. The sleeve is equipped with a fulcrum-providing means engageable with a well wall and an expansion means is disposed thereabove and so connected thereto that the expansion means may be expanded into engagement with the opposite wall of the well, thus cooperating with the fulcrum in altering the position of the mandrel so as to cause the bit to be directed in the desired direction.

A further object of the invention is to provide a deflection tool having the above-mentioned characteristics wherein the sleeve carrying the fulcrum and expansible means that cooperates therewith is releasably clutched to the drill string so that it may be held in a definite position with respect to the drill string while it is being lowered into the well and then accurately positioned and then unclutched. In this manner, the sleeve may be accurately positioned to deflect the bit in the desired direction and the mandrel may be subsequently rotated relatively to the sleeve by the drill string as the drilling proceeds.

Still another object of the invention is to provide a deflection tool wherein the fulcrum is formed by roller means engageable with the well wall which roller means is rotatable about a horizontal axis so that, as the drilling proceeds, the roller-fulcrum may merely roll down the well walls without sliding or rotating relatively thereto and thus maintain the device in its position which will cause the bit to be deflected in the desired direction.

With the foregoing and other objects in view, which will be made manifest in the following detailed description and specifically pointed out in the appended claims, reference is had to the accompanying drawings for an illustrative embodiment of the invention, wherein:

Figures 1A and 1B are vertical sections of the upper and lower portions respectively, of the deflection tool

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for rotary directional drilling embodying the present invention, the parts being shown in that position in which the tool is being lowered into the well;

Figs. 2A and 2B are similar views both illustrating the parts in that position when the tool has been set and directional drilling may proceed; and

Fig. 3 is a horizontal section taken substantially upon the line 3—3 upon Fig. 2B in the direction indicated;

Fig. 4 is a horizontal section taken substantially upon the line 4—4 upon Fig. 2B in the direction indicated;

Fig. 5 is a horizontal section taken substantially upon the line 5—5 upon Fig. 1A in the direction indicated; and

Fig. 6 is a horizontal section taken substantially upon the line 6—6 upon Fig. 1A in the direction indicated.

Referring to the accompanying drawings wherein similar reference characters designate similar parts throughout, 10 indicates the lower end of a string of drill pipe to which a bit 11 is connected that it is desired to deviate or deflect in a desired direction. 12 and 13 indicate two parts of a hollow mandrel that are mutually connected together, the lower part 12 being adapted to be connected directly to the bit 11, or in some instances to a sub or drill collar attached to the bit. The upper part 13 extends upwardly through a sub 14 that is attached to the drill string 10 and this sub is preferably recessed to accommodate packing 15 adapted to be tightened about the mandrel, such as by a packing nut 16.

On the exterior of the upper part 13 there are feathers or splines 17 which are vertically slidable in keyways or splineways 18 formed on the interior of a tubular member 19 that is attached to the sub 14. In this manner, the mandrel may be rotated by means of the drill string 10 so as to rotate the bit 11, but by reason of the splined connection between the mandrel and the tubular member 19 the drill string 10 may be raised or lowered relatively to the mandrel.

The lower part 12 of the mandrel provides an inner race for a radial anti-friction bearing made up of balls 20. These balls are disposed within an outer race 21 and are positioned between the races by being fed through apertures 22 in the outer race which are subsequently closed as by plugs 23. A self-aligning thrust bearing 24 is mounted on the mandrel and occupies a position above the outer race 21. An O-ring or equivalent seal 25 prevents ingress of foreign matter to the radial and thrust bearings. Surrounding the bearings there is a sleeve 26 which is secured to the outer race 21, such as by radial cap screws or the equivalent indicated at 27. In this manner, the sleeve 26 is rotatably mounted on the mandrel so that the mandrel may rotate within the sleeve in the course of drilling. On one side of the sleeve there is a laterally extending boss 28 through which a horizontal pin 29 extends. This pin serves to rotatably support at its ends toothed rollers 30 and 31. These rollers are engageable with a wall of the well to form a fulcrum, and as drilling proceeds, these rollers merely roll down the well wall. They are preferably toothed and so shaped that they will bite into the well wall sufficiently to hold the sleeve 26 against rotation sympathetically with the mandrel. On the opposite side of the sleeve 26 and some distance above the pin 29 an expansible means in the form of a belly spring 32 is connected, such as by a pin 33. The upper end of the expansible means is connected to an upper sleeve 34 as by a pin 35. The upper sleeve is also rotatably mounted on the mandrel such as by an anti-friction radial bearing 36 and a thrust bearing 37, whereby the mandrel may rotate within the upper sleeve while the upper sleeve remains stationary in the well. A compression spring 38 is interposed between the thrust bearing 37 and the bottom of the tubular member 19. This compression spring

is effective to urge the upper sleeve 34 downwardly with relation to the tubular member. On the exterior of the tubular member there is a shoulder on which the clutch tooth 39 is formed which is loosely receivable in recess 40 on the interior of the cap 41 which closes the top of the upper sleeve about the tubular member 19. The sleeve 26 may have several keyways 42 formed on the exterior thereof in which keys 43 secured to the upper sleeve are slidable. In this manner, although the upper sleeve 34 may descend relatively to the lower sleeve 26, it is held against rotation relatively thereto.

The operation of the above-described construction is substantially as follows:

When the tool is to be lowered into the well its parts assume the position shown in Figs. 1A and 1B wherein the compression spring 38 urges the upper sleeve downwardly with relation to the tubular member 19, causing the clutch element 39 to be in its recess 40 and releasably hold the upper sleeve against rotation relatively to the drill string 10. In this position it will be noted that the expansible means or belly spring 32 is collapsed, or in its contracted condition. The position of the fulcrum afforded by the rollers 30 and 31 and the belly spring 32 with relation to the first stand of drill pipe of the drill string is noted at the time the tool is introduced into the well and from markings transferred from one string of drill pipe to the succeeding stand of drill pipe, the position of the fulcrum and of the belly spring can be determined on the surface when the tool has been lowered to the bottom of the well. When the tool reaches the bottom of the well the drill pipe may be rotated to that position which will so locate the fulcrum rollers and belly spring as to cause the bit to deviate in the desired direction. The drill pipe is then lowered, positioning the bit 11 on the bottom of the well bore. When the drill string 10 is thereafter lowered it causes the tubular member 19 to telescope downwardly within the upper sleeve, compressing the compression spring 38 and causing the clutch 39 and 40 to disengage. This frees the mandrel 13 so that it may rotate within the sleeves. Rotation of the mandrel is accomplished by reason of the splined connection 17, 18 between the mandrel and the drill string. If the drill string is further lowered it will compress the spring 38 adequately to force the upper sleeve 34 downwardly relative to the lower sleeve 26, thus expanding or bowing outwardly the belly spring 32. This belly spring, on engaging the well wall crowds the mandrel toward the opposite wall of the well and causes the fulcrum rollers 30 and 31 to press firmly against the well wall. As the belly spring 32 engages its wall of the well some distance above the fulcrum rollers a moment is created about the fulcrum which causes the bit to be directed downwardly and toward the left as viewed in Fig. 2B. Drilling may then be proceeded with by rotating the drill string 10. As the bit 11 continues to make a hole the lower sleeve 26 follows the bit downwardly and in the course of such following movement the rollers 30 and 31 merely roll down the well wall. The fact that the belly spring is disposed in a vertical position contributes to the biting effect of the rollers on the well wall in resisting rotation of the sleeves. During the downward movement, as drilling progresses, the belly spring merely slides on the well wall. In this manner the bit may be deviated in the desired direction. Whenever it is desired to withdraw the tool, such as for the replacement of bits, upward movement of the drill string 10 allows the belly spring to again collapse or contract, disengaging the entire tool from the well wall and enabling it to be withdrawn.

In lieu of the belly spring 32 other forms of expansible means may be employed, such as for example linkages pivotally connected to the upper and lower sleeves which can be expanded when the sleeve is forced downwardly relatively to the lower sleeve. Such linkages by way of example are illustrated by the arms 21 and 22 in U.S.

Patent No. 2,061,316, issued November 17, 1936, to J. D. Brack et al.

To a certain extent the degree to which the belly spring 32 is expanded against the well wall can be controlled or regulated by controlling the extent to which the compression spring 38 is compressed. This may be accomplished by positioning within the tubular member 19 a replaceable sleeve or bushing 44. This bushing or sleeve rests on top of the splines or feathers 17 and is engageable by the bottom of the sub 14, limiting downward movement of the sub relative to the upper part 13. This sleeve or bushing may be omitted entirely, in which event the tubular member 19 may descend a major portion of its length compressing the compression spring 38 to a maximum extent and causing the belly spring 32 to be expanded to a maximum extent. Where the sleeve 44 is present downward movement of the tubular member is limited and consequently compression of the compression spring 38 is limited and the expansion of the belly spring is correspondingly limited by replacing the sleeve 44 with other sleeves of various lengths. The degree of expansion of the belly spring can be varied or adjusted.

From the above-described construction it will be appreciated that an improved deflection tool for rotary directional drilling has been provided which enables the tool to be accurately positioned in the well and to remain in this position as drilling progresses so that the bit may be directed in the desired direction.

Various changes may be made in the details of construction without departing from the spirit and scope of the invention as defined by the appended claims.

I claim:

1. A deflection tool for directional drilling comprising a hollow mandrel attachable to a well drilling bit, a sleeve formed of two parts rotatable upon the mandrel enabling the mandrel to be rotated therein, means keying said parts together against rotation relative to each other but permitting the parts of the sleeve to move toward and away from each other on the mandrel, fulcrum-providing means extending laterally from the lower of said parts so as to be engageable with the well wall at a point relatively close to the bit, laterally movable means above the fulcrum-providing means and connecting said parts of the sleeve on the opposite sides thereof from the fulcrum-providing means, said laterally movable means being movable laterally with respect to the mandrel to engage the well wall opposite that wall which is engageable by the fulcrum-providing means at a point above that engaged by the fulcrum-providing means, connecting means having a limited splined connection with the mandrel and a limited telescopic connection with the upper of said parts of the sleeve for connecting the mandrel to a drilling string so that the mandrel may be rotated by the drilling string, means for transmitting axial forces from the connecting means to the upper of said parts of the sleeve to cause it to move downwardly on the mandrel relative to the lower of said parts and cause the laterally movable means to move laterally relative to the mandrel when the connecting means is lowered relatively to the mandrel, and a clutch releasably connecting the connecting means to the upper of said parts of the sleeve arranged to be disengaged when the connecting means is moved downwardly relative to the upper of said parts of the sleeve, said clutch serving when engaged to enable the sleeve to be rotated by the connecting means and drilling string whereby the tool with the bit attached to the mandrel may be lowered into a well by the drilling string, rotated thereby properly positioning the fulcrum-providing means and the laterally movable means and upon thereafter lowering the drilling string the clutch will be disengaged and the laterally movable means will be caused to move laterally to engage a well wall and press the fulcrum-providing means on the sleeve against the opposite well wall at a point therebelow thus causing the

mandrel and sleeve to function as a lever fulcrumed on the fulcrum-providing means and urge the bit in a lateral direction as it is being rotated by the drilling string, connecting means and mandrel, the latter rotating within the sleeve.

2. A device as claimed in claim 1 wherein the fulcrum-providing means includes a roller rotatably mounted on the lower part of the sleeve for rotation about a substantially horizontal axis and arranged to be engageable with the well wall.

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