Oct. 1, 1935. C. E. BANNISTER 2,016,066

WELL DRILLING DEVICE

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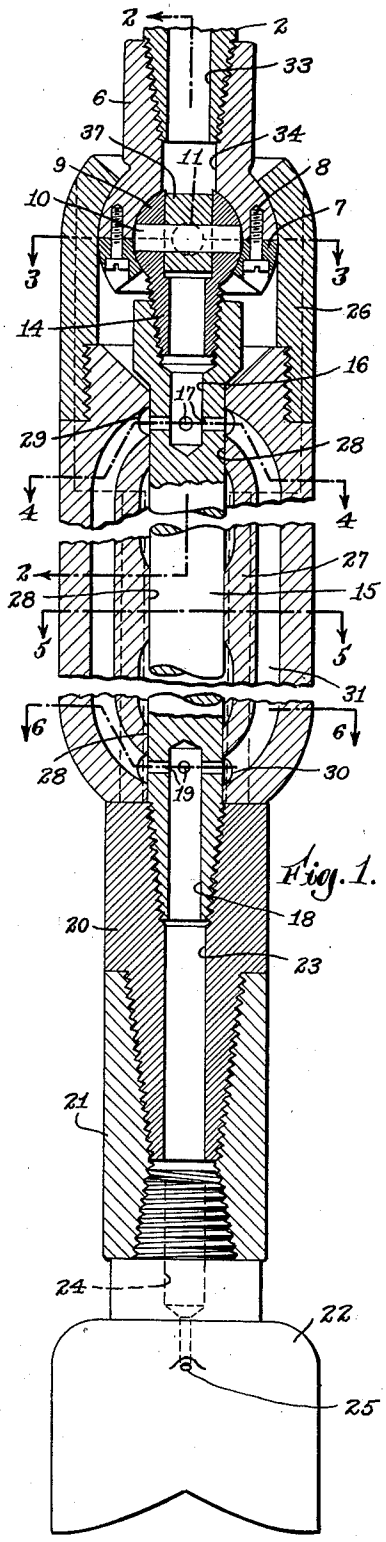


Fig. 1.

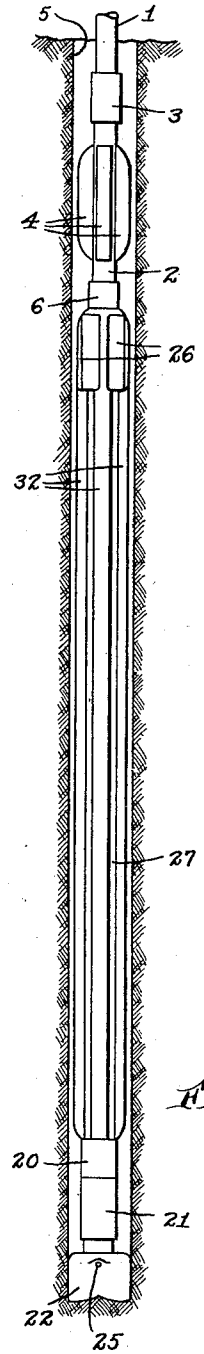


Fig. 7.

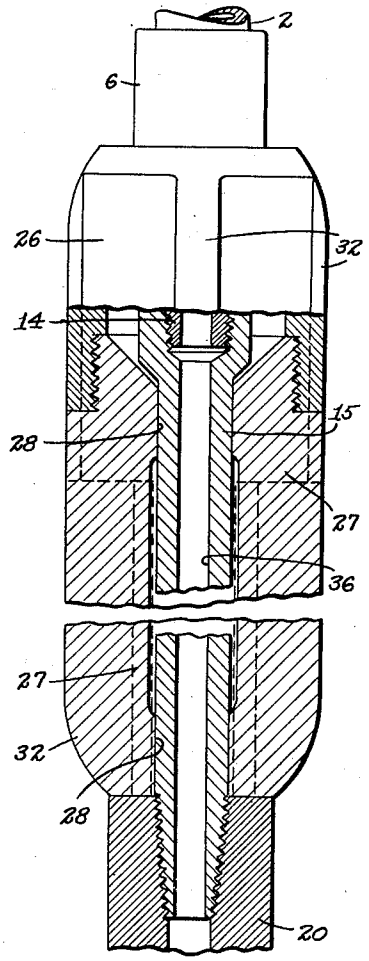


Fig. 10.

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Fig. 2.

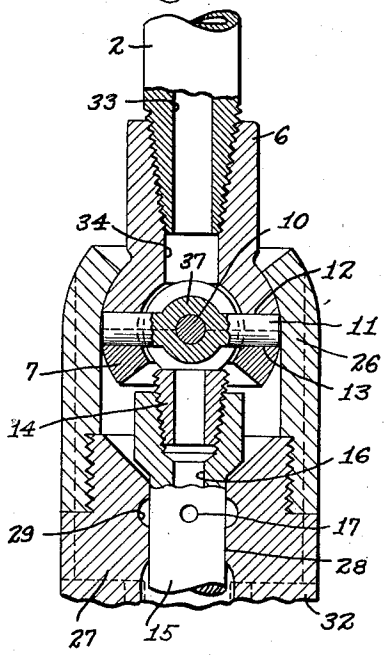


Fig. 3.

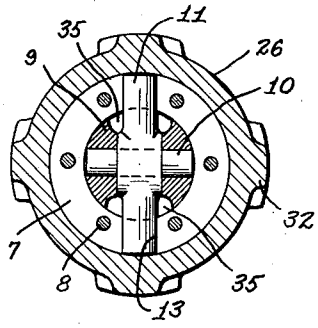


Fig. 4.

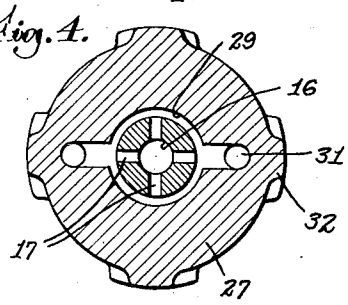


Fig. 8.

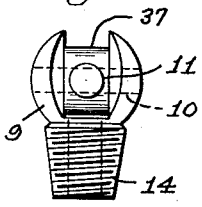


Fig. 5.

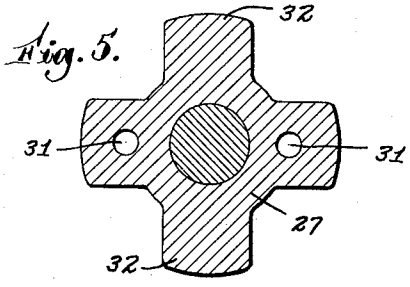


Fig. 9.

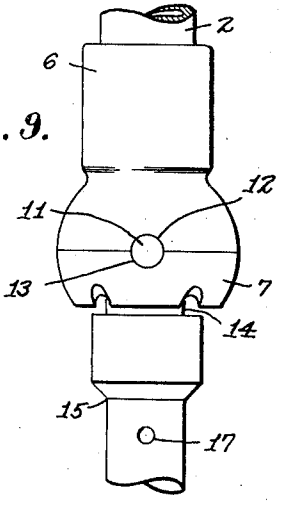
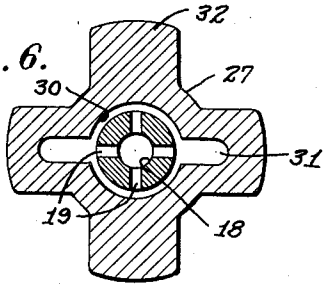


Fig. 6.



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Fig. 11.

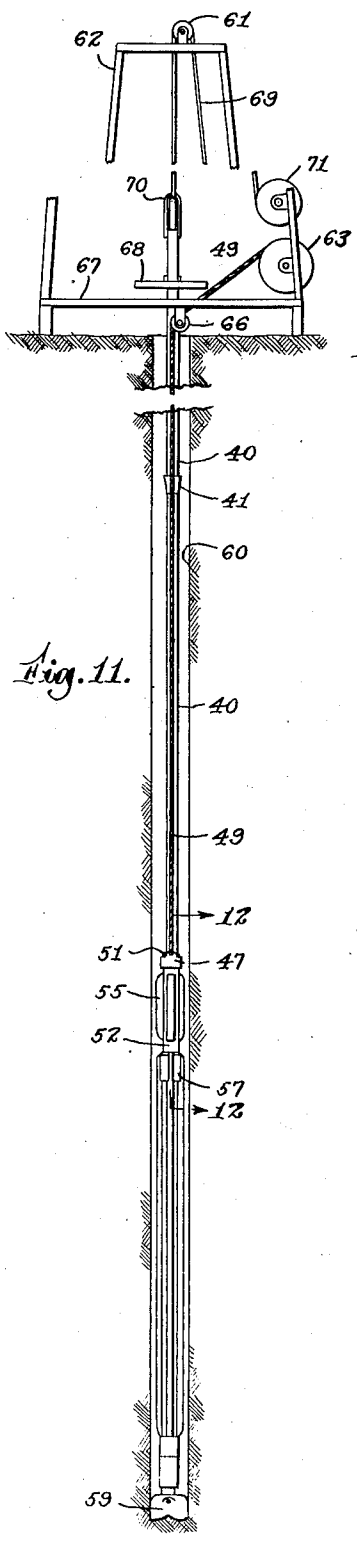


Fig. 12.

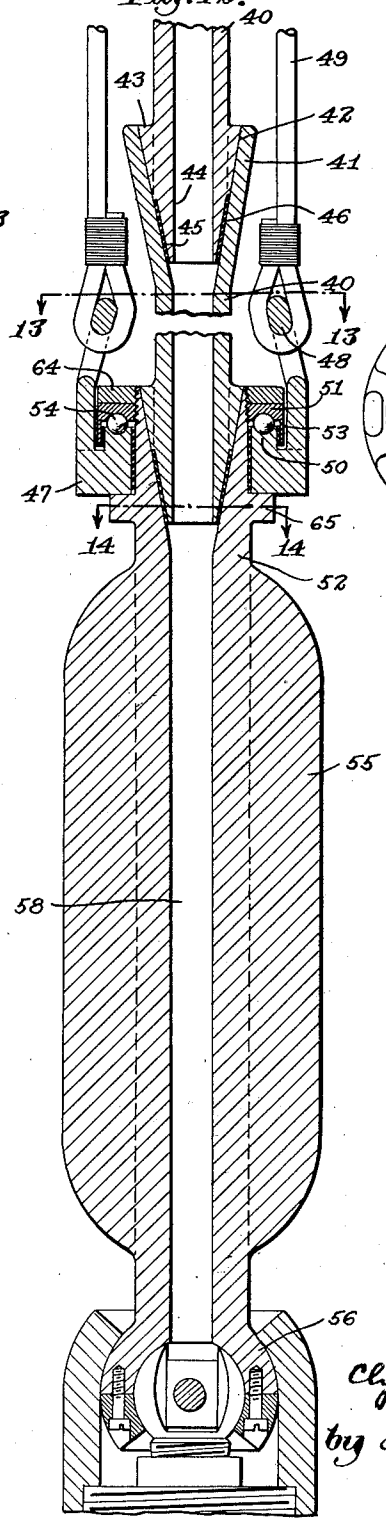


Fig. 13.

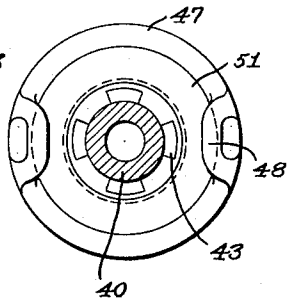
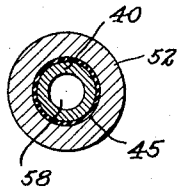


Fig. 14.



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UNITED STATES PATENT OFFICE

2,016,066

WELL DRILLING DEVICE

Clyde E. Bannister, Akron, Ohio

Application November 15, 1933, Serial No. 698,140

11 Claims. (Cl. 255—28)

The invention of the present application relates to the drilling of deep wells or bores, such as oil wells, and relates more particularly to a novel and improved apparatus or device for use in such drilling.

Heretofore, in all methods of drilling, as the tools have worked their way downwardly in the bore which they are forming, there has been a tendency for said tools to "crawl", or in other words to depart or deviate from a perpendicular descent and form inclined or crooked holes or bores. In many cases this crawling has resulted in the bore or hole of one driller entering the property and frequently crossing the bore of another driller. This frequently results in destroying both bores and necessitating abandonment of the crossed bores, with resultant expense, and other disadvantages. There have been many attempts to overcome or remedy this serious difficulty, but so far as I am aware, none have succeeded, prior to my entry into this field, in devising apparatus which will form a substantially perpendicular bore, with a minimum of bends or curves.

With prior drilling apparatus, also, should a boulder or other obstruction be encountered during the descent of the working tools, the bit will glance off, unless it should strike the obstruction squarely, and once the drill has left its vertical descent the tendency has been for the drill to increase the deviation or "crawl" rather than to return to its normal or original perpendicular position.

An important object of the present invention, therefore, is the provision of deep well drilling apparatus which will automatically insure a vertical descent of the cutting, drilling, or boring tool, and which will reduce the tendency to "crawl".

The advantages and results attained by this straight drilling are manifold, and will be instantly appreciated and understood by those skilled in this art.

Another feature of the invention is the reduction of power required or necessary to operate the cutting tools. I accomplish this advantageous result by utilizing an inertia barrel or sleeve of considerable weight adjacent the lower end of the drill stem, said drill stem being freely rotatable within said barrel. Thus the torque of the drill stem is not transmitted to the inertia barrel, thereby greatly reducing the power which would be required were the inertia barrel rotatable with the drill stem.

The drilling of a straight hole or bore lessens the likelihood of caving, and simplifies the withdrawal and replacement of the drill stem or cutting tools, there being a substantially straight pull to the surface of the ground, rather than an inclined pull, or a pull around bends. I also increase the speed of drilling, as by my present novel apparatus I am enabled to apply any desired weight on the boring tools without materially increasing the power required to operate said tools.

It will be apparent from a glance at the drawings, and from the description which follows, that my novel apparatus functions in the nature of an automatic plumb bob, constantly seeking a vertical descent, and if, in its descent, the bit should be deflected from its vertical descent, my novel device will exert a constant tendency to return the bit to its vertical descent.

Because of the inertia barrel which I utilize in my present device, the rotary drill stem will be even further discouraged from crawling than if a rotary leaded or weighted barrel were utilized. The tendency of rotary drill stems and tools to crawl is notorious and well known to those skilled in this field.

In the drawings of the present application I have illustrated my invention applied to a rigid, rotating drill stem, but so arranged that the lower end of the stem carrying the bit or cutting tool will hang freely from, and be tiltable relatively to the main drill stem. I accomplish this by utilizing the novel combined ball and socket and universal joint illustrated. Interposed between this combined ball and socket and universal joint and the bit is positioned a heavy, preferably leaded, inertia barrel of considerable weight. The tiltable drill stem extends downwardly through said barrel, and is rotatably mounted on bearings located at predetermined or desired intervals throughout the length of the interior of said barrel. This inertia barrel is suspended from the lower end of the rigid drill stem by a second ball and socket joint, so that it is freely suspended therefrom, and will thus always tend to hang straight, because of its weight, or in other words, to function in a manner similar to a plumb bob, at the same time conveying this important characteristic or tendency to the tiltable drill stem which rotates therein and consequently to the bit or boring tool itself.

By the novel combined ball and socket and universal joint illustrated herein, the torque of the main drill stem is constantly imparted to the bit

carrying stem, without the use of a clutch, thus affording a positive drive.

Another object of the invention resides in the provision of novel means for conveying the flushing fluid to the bottom of the bore to flush away the cuttings of the bit or tool.

Another disadvantage with present rigid drill stems consists in the fact that each drill stem section is threaded to its adjacent sections. Thus, in making up or breaking down a drill stem, it is necessary to unthread each of these sections, or desired numbers of sections. Furthermore, with a threaded drill stem there is the constant likelihood of the sections becoming unthreaded while in the bore, necessitating extensive and tedious fishing operations to recover the balance of the stem remaining in the bore.

Another object of my invention, therefore, resides in the provision of a novel joint between the pipe sections, so that in making up a drill stem it is only necessary to drop a drill stem section into the cooperating end of the next lower section, and in breaking down the drill stem no unthreading operation is necessary, each section simply being lifted out of the next lower section.

A further feature of the present invention, and one which is particularly adaptable with the type of drill stem last described, although it is equally advantageous with other types of rigid drill stems, resides in the provision of means adjacent to the lower end of the drill stem to support the weight of the drill stem, which, in a deep bore, is tremendous. By separately supporting the weight of the drill stem, the drill stem is required only to carry out its two functions of transmitting torque from the power medium on the surface to the bit and conveying the flushing fluid. This permits the use of a much lighter drill stem that would be required if the stem itself were required to carry its own weight in addition to transmitting torque.

Other features and objects of the invention reside in the particular construction of various portions of my device.

The above and other objects and features of the invention, details of construction, combination of parts, and advantages, will be hereinafter more fully pointed out, described, and claimed.

Referring to the drawings, illustrating preferred embodimeants of the present invention,

Fig. 1 is a vertical sectional view illustrating my novel device;

Fig. 2 is a vertical sectional view of the device, on the line 2—2 of Fig. 1;

Fig. 3 is a cross-sectional view on the line 3—3 of Fig. 1;

Fig. 4 is a cross-sectional view on the line 4—4 of Fig. 1;

Fig. 5 is a cross-sectional view on the line 5—5 of Fig. 1;

Fig. 6 is a cross-sectional view on the line 6—6 of Fig. 1;

Fig. 7 is a side elevation of the complete apparatus in position in a well bore;

Fig. 8 is a side elevation of the ball portion of the universal joint;

Fig. 9 is a side elevation of the combined universal joint and ball and socket;

Fig. 10 is a vertical sectional view illustrating a modification of fluid transmission, wherein the fluid passage is continuous through the tool holding portion of the drill stem;

Fig. 11 is a side elevation illustrating my novel type of drill stem joints and cable suspension in position in a well bore;

Fig. 12 is an enlarged fragmentary vertical sectional view on the line 12—12 of Fig. 11;

Fig. 13 is a cross-sectional view on the line 13—13 of Fig. 12, and

Fig. 14 is a cross-sectional view on the line 14—14 of Fig. 12.

Referring now to the drawings for a particular description of the invention, its construction, assembly and operation, my novel apparatus comprises a rigid drill stem consisting of a plurality of sections, such as 1 and 2, united by suitable couplings 3 and rotated or driven from a suitable source of power, preferably above ground. On the lower section 2, as illustrated in Fig. 7, I preferably provide guiding means, such as the guiding fins 4, which may be formed integral with the drill stem section 2 or which may be formed on a separate sleeve surrounding said stem section. The fins 4 are of sufficient length and extent to guide the section 2 in the bore 5 and to retain the finned portion of the stem in the center of said bore.

The lowermost section 2 of the rigid drill stem is threaded, and has secured thereto one portion 6 of a socket member, the other section or portion 7 of said socket member being secured to the portion 6 by screws 8, 8. Adapted to rock in the socket member composed of the sections 6 and 7, is a ball member 9 carrying the shafts 10 and 11 of a universal joint structure. The shaft 10 has bearings in the ball member 9, and the shaft 11 has bearings in cooperating grooves 12 and 13 in the sections 6 and 7 respectively. Through the medium of the shaft or pin 11, the torque of the drill stem will be transmitted to the ball member 9.

Depending from the ball member 9 is a hollow threaded stem 14, to which is threaded another drill stem section 15 having a recess 16 therein from which extend radial channels 17. The lower end of the stem 15 also has a recess 18 therein from which extend radial channels 19. Threaded or otherwise secured to the bottom of the stem section 15 is the pin joint 20 of a rotary tool joint, a box joint 21 being threaded to the pin joint, and a bit or other cutting instrumentality or tool being threaded to the box joint 21.

A channel 23 is formed through the pin joint 20, communicating with a channel 24 in the bit 22 which, in turn, communicates with apertures 25 adjacent the cutting edges of the bit 22. Fluid forced through the device and out through the apertures 25 will thus exert considerable pressure and force at the bottom of the bore, flushing away the cuttings from the blades of the bit and forcing the same upwardly through the bore outside of the drilling device and drill stem.

Depending from the ball member 6 is a socket member 26 and secured thereto in any desirable manner, as by the threaded joint illustrated, is a leaded barrel 27, of considerable weight. The leaded barrel, through the medium of the socket member 26, is loosely suspended from the drill stem and is tiltable relatively thereto. The drill stem section 15 is freely rotatable within the barrel 27, having bearing points throughout the length of said barrel, as at 28, 28. Thus the barrel 27 is stationary, relative to the stem 15, and the only torque required is that necessary to rotate the said stem 15, the stationary or inertia barrel 27 eliminating the necessity of any power being transmitted thereto, and thus requiring considerably less power to operate the device than would be required were the barrel 27 compelled to rotate with the drill stem.

The barrel 27 has a pair of grooves 29 and 30 therein, communicating, respectively, with the channels 17 and 19, and through the barrel 27 extend channels 31 which are in communication with the grooves 29 and 30. Thus, fluid will pass through the channels 17 into the groove 29, through the channels 31, into the groove 30 and back into the channels 19, thus affording a continuous channel or passage for the flushing fluid.

Formed on the socket member 26 and barrel 27 are a plurality of fins or ribs 32, extending substantially throughout the length of the barrel and socket member, providing great weight while permitting the drilling fluid to flow upward, between the ribs 32, to wash the cuttings from the well. Any tendency on the part of the bit or tool 22 to crawl, or otherwise deviate from a vertical descending course will be automatically overcome by the considerable weight of the leaded inertia barrel, which will constantly have a tendency to right itself and hang perpendicular from the ball member 6 at the bottom of the rigid drill stem.

Also, should the tool 22 encounter a boulder or other obstruction in its descent, and glance off therefrom, thus being deflected from its straight downward course, the weight of the leaded inertia barrel, and the free hanging thereof, coupled with the free hanging of the tool-carrying portion 15 of the drill stem, will automatically work the tool back to its original straight descent or cutting course. Thus a bore drilled or formed with my novel apparatus will have substantially a straight course from the surface of the ground to the bottom of the bore, with a minimum of bends or curves therein, a feature which is not possible of achievement or attainment with any other rotating, rigid drill stem and bit of which I am aware.

The fluishing fluid travels down the hollow interior 33 of the drill stem sections and into the hollow interior 34 of the combined socket and ball member 6. Thence it will pass through the spaces or channels 35 formed in the ball member 9, around the shaft 11, whence it follows the course above described.

In Fig. 10 I have illustrated a modification of this fluid course, wherein the stem section 15 has a continuous bore or channel 36 therethrough, through which the fluid will have a direct passage to the apertures 25 in the bit or tool 22, the form illustrated in Fig. 10 being relatively inexpensive and simple to manufacture.

The preferable method of assembling the ball member 9 and the shaft 10 and 11 of the universal joint would be to first insert the shaft 11 in the yoked end of the ball member 9, and then drive the shaft or pin 10 through a suitable aperture provided in the hub 37.

The use of the universal joint with the centering means above it and the heavy plumb-bob barrel below it provides for the drilling of a substantially straight hole even though sections of the drill pipe above the assembly be in a state of compression with the attendant leaning of such sections, and thus the assembly as described permits the supporting of the series of sections of drill pipe from below and consequently permits the use of slip-joints instead of the usual threaded couplings between the sections of pipe.

In Figs. 11 to 14 inclusive I have illustrated my novel drill stem joint, as well as the novel cable suspension for a rigid drill stem. As clearly shown in Fig. 12, the upper end of each drill stem section 40 is flared as at 41, being provided with a plurality of inclined keyways 42 in which are splined the keys 43 on the lower end of each drill stem section 40. The extreme lower outside edge of each drill stem section is tapered, as illustrated at 44, and is provided with a coating 45 of rubber or other suitable cushioning material, adapted to form a water-tight seat against the inclined inner face 46 of the upper end 41.

Thus, in making up a drill stem, it is only necessary for operators to drop a drill stem section into the flared end of the next lower drill stem section, the joined portions of these sections automatically forming water-tight seals, and the splines 43 in the keyways 42 constituting torque transmission means. In breaking down a drill stem, when removing same from the bore, as for the purpose of replacing a boring tool, it is only necessary to pull the sections apart as they emerge from the bore instead of going through the tedious unthreading operations theretofore required.

A joint of the type illustrated and described herein also obviates and eliminates the possibility of the separation of drill stem sections in the bore due to unthreading thereof, as has frequently occurred with the customary threaded type of rigid drill stem.

In order to provide adequate support for the drill stem sections 40 and prevent their separation longitudinally, I provide a swivel which constitutes an annulus 47, provided with a pair of handles 48, these handles being adapted to receive the lower ends of cables 49 which are secured to said handles in any desired manner. The annulus 47 is provided with a vertical flange 50 which constitutes one-half of an anti-friction bearing, the other half of said bearing being formed in a threaded collar 51 which is threaded on the upper end of the drill stem section 52, being held against displacement by a lock nut 64. The inner portion of the upper end of the section 52 is constructed identically with the upper end of each of the sections 40 to receive the splined lower end of the next adjacent section. The collar 51 is provided at its outer edge with a depending lip 53, said lip projecting downwardly outside of the flange 50 to constitute a water-tight joint for the anti-friction bearing 54. A collar 65 is formed on the section 52 to limit downward movement of the annulus 47 and insure a tight joint at the bearing 54 to prevent the entrance of mud or other foreign matter.

Thus the rigid drill stem may rotate upon the annulus 47 without effecting a twisting of the cables 49. The section 52 is provided with fins or ribs 55 to maintain the ball end 56 of the section 52 centrally in the bore being formed. A socket member 57 rides on the ball end 56 in exactly the same manner as described for the ball portion 7 and socket member 26. All of the drill stem sections are provided with central longitudinally extending bores constituting a fluid conducting passage 58, the fluid conducted through the passage 58 flushing out the cuttings at the bottom of the bore and at the same time constituting a cooling element for the bit 59.

The cables 49 extend vertically through the bore 60 and over the guiding idlers 66 located beneath the derrick floor 67, thence ascending and being taken up on the hoist drum 63 which is operated from any suitable source of power, as will be readily understood. The cable suspension and swivel arrangement illustrated therein is equally adaptable for use with rigid drill stems of the threaded joint type, and will perform an important function in combination therewith.

The driller, being enabled to sustain as much of the load of the drill stem as desired, is also enabled to determine the amount of weight being imposed upon the bit **59**, and he can so control this weight on the bit **59** that only the weight from below the swivel **47** will be borne by the bit. This will enable the use of a much lighter drill stem, since the sole function of the drill stem is then to transmit torque, whereas previously the drill stem had to be of sufficient strength to support its tremendous weight. The guiding idlers **66** are located under the derrick floor **67** so that they will not interfere with the rotary **68**, which is here illustrated in conventional form, the drill stem sections projecting upwardly through the rotary. A separate cable or line **69** is utilized, together with lifting tongs **70**, or the like, to handle the drill stem sections when uncoupling same. The cable **69** runs over the crown block **61** on the derrick **62** and from thence to a suitable drum **71**.

While I have necessarily described my present invention somewhat in detail, it will be appreciated that it is possible to vary the size, shape, and arrangement of parts within reasonably wide limits without departing from the spirit of the invention.

I claim:

1. Well-drilling apparatus comprising supporting means at the top of the well, suspension means extending downward therefrom into the well, means near and closely confined to the region of the lower end of said suspension means for substantially centering the same in the well, an elongated member having universal-hinge connection to the suspension means immediately below said centering means and of such mass as to provide by its weight a substantial drilling pressure, and a full-gauge-well-drilling bit mounted at the lower end of the said weight member.

2. Well-drilling apparatus as defined in claim 1, in which the suspension means is a drill pipe adapted to transmit torque from the top of the well to the bit and in which the bit member is connected thereto by a torque-transmitting universal joint.

3. Well-drilling apparatus comprising a torque-transmitting drill pipe, a full-gauge-well-drilling rotative bit, an elongated, pendulous member interposed operatively between the two and of such mass as to provide by its weight a substantial drilling pressure, the bit having torque-transmitting universal joint connection to the drill pipe, and centering means on the drill pipe assembly immediately above the said connection and of an effective diameter at least as great as that of any part of the structure below the said connection except that of the bit.

4. Drilling apparatus comprising substantially rigid suspension means adapted to be lowered in a well, an elongated member having hinged connection to said suspension means and of such mass as to provide by its weight a substantial drilling pressure, a full-gauge-well-drilling rotative bit having connection to said suspension means and directionally controlled by the said weight member acting in the manner of a plumb-bob, and centering means on the suspension means assembly immediately above the said hinged connection and of an effective diameter at least as great as that of any part of the structure below the said connection except that of the bit.

5. Well-drilling apparatus of the kind described, comprising a rigid drill-pipe assembly, a boring tool, a member providing universal-joint drive connection between said assembly and said tool, and a weight in which the said connecting member is journaled, the said weight being adapted to act in the manner of a plumb-bob for directing the tool.

6. Well drilling apparatus of the kind described, comprising a rigid drill-pipe assembly, a driving and fluid-conducting universal joint on the lower end thereof, a stationary barrel with relation to which the universal joint is rotatably but non-slidably mounted, a tool carry stem having driving connection to the drill-pipe assembly through said universal joint and a boring tool mounted on said tool-carrying stem.

7. Well-drilling apparatus comprising a rigid drill-pipe assembly of the rotary type comprising a series of connected fluid-conducting long and rigid sections, a swivel joint surrounding said assembly adjacent to its lower end, flexible supporting means fixed to said swivel joint, means for rotating the assembly within said swivel joint independently of rotative movement of said flexible supporting means, and a rotary bit mounted on said stem.

8. Well-drilling apparatus comprising a plurality of rotary drill-pipe sections, each section being splined to adjacent sections and adapted for sealed, final and complete mating therewith wholly by simple axial thrust, flexible means to support the section assembly from adjacent to its lower end during the drilling operation, a bit mounted on the lowermost of said sections, and means for rotating at least the assembly of drill pipe sections while they are so supported.

9. Well-drilling apparatus comprising a plurality of hollow rotary drill-pipe sections, each section being splined to adjacent sections and adapted for final and complete mating therewith wholly by simple axial thrust, resilient means constituting a water-tight joint between the ends of adjacent sections, flexible means to support said drill stem from adjacent to its lower end, and a bit mounted on the lowermost of said sections.

10. Well-drilling apparatus comprising a plurality of hollow rotary drill-pipe sections, each section being splined to adjacent sections and adapted for final and complete mating therewith by simple axial thrust, resilient means constituting a water-tight joint between the ends of adjacent sections, flexible means to support said drill stem from adjacent to its lower end, means to permit rotation of said drill stem independently of said flexible supporting means, and a bit mounted on the lowermost of said sections.

11. Well drilling apparatus comprising a plurality of pipe sections provided at their ends with plug-and-socket members adapted to mate finally and completely by direct axial movement without rotation, said sections being assembled in a conduit structure in the well and being wholly unencumbered by helically threaded members, flexible means extending downward into the well and having connection to the said structure below at least one of said sections for supporting the same, and a rotary well-drilling device mounted on the lower end of said conduit structure.

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