Dec. 29, 1953 A. ARUTUNOFF 2,664,454

SWIVEL ELECTRICAL CONNECTION FOR DEEP WELL DRILLS

Original Filed Nov. 18, 1949 2 Sheets-Sheet 1

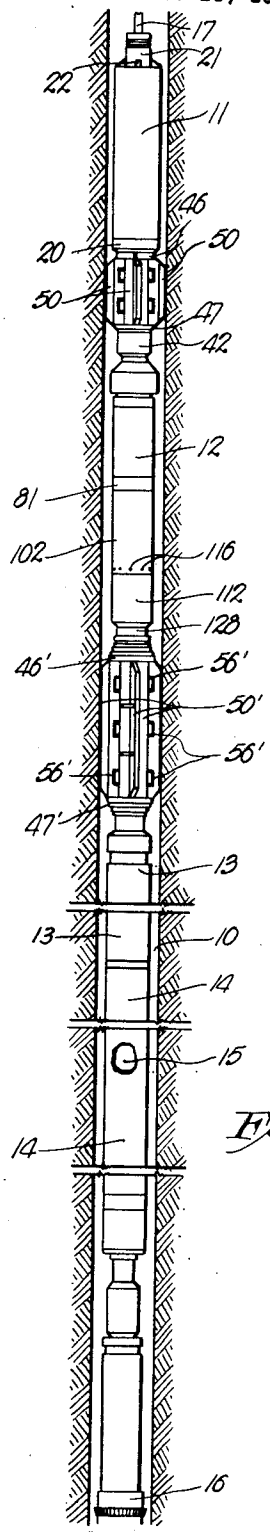

Fig. 1.

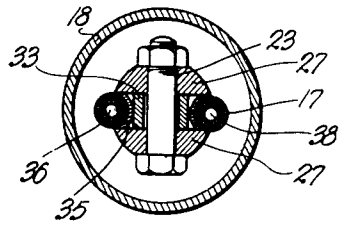

Fig. 3.

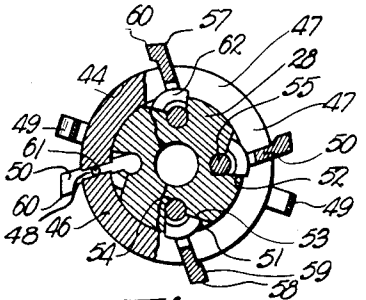

Fig. 4.

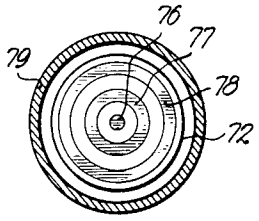

Fig. 5.

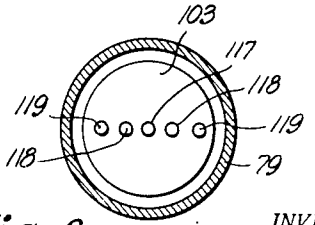

Fig. 6.

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Fig. 2.

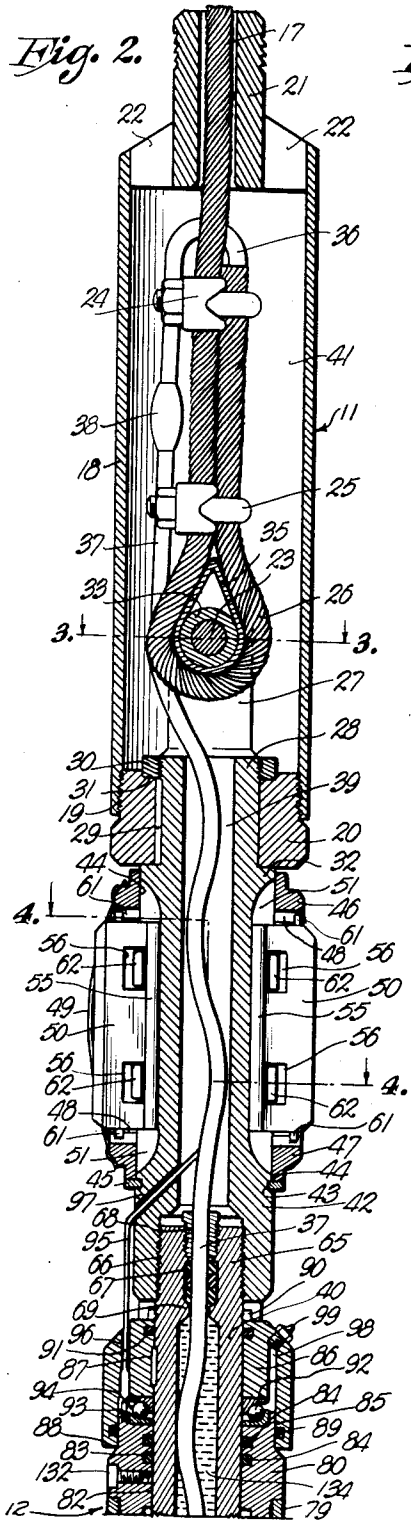
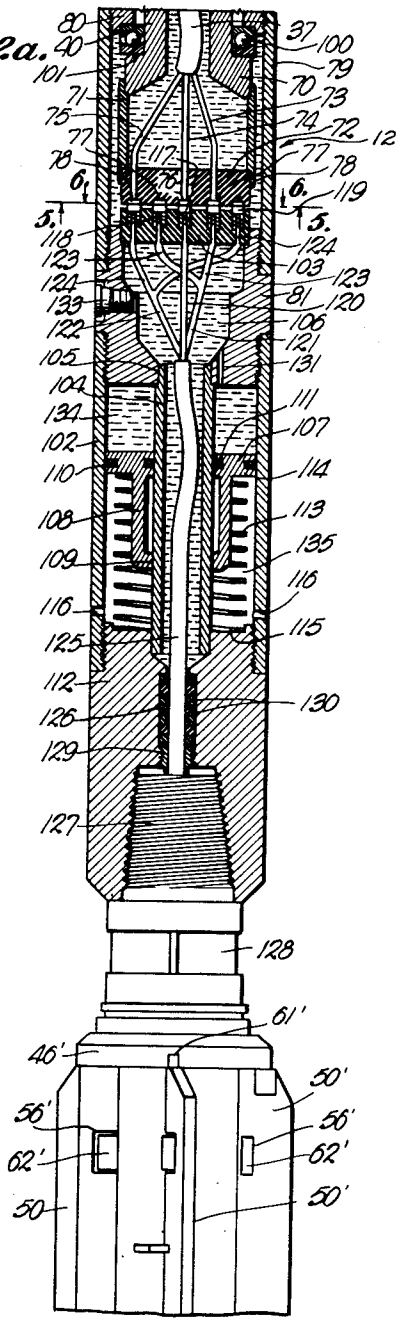


Fig. 2a.



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SWIVEL ELECTRICAL CONNECTION FOR DEEP WELL DRILLS

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4 Claims. (Cl. 174—21)

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My invention relates to apparatus for drilling deep wells, and the present application is a division of my co-pending application Serial No. 60,709, filed November 18, 1949, which in turn was a continuation-in-part of my application Serial No. 711,959, filed November 23, 1946, now Patent No. 2,609,182, dated September 2, 1952.

In general, my invention relates to apparatus for drilling deep oil and gas wells, and it deals more particularly with a drilling unit suspended on a cable, the upper end of the cable being connected to a suitable derrick or hoist at the surface so that it can be paid out as drilling progresses. The drilling unit comprises a rotary drill and means for rotating the same, all suspended from said cable (the means for rotating the drill comprising an electric motor), and the present invention is an improvement in the means for suspending or mounting the drill and rotating means therefor in such a manner as to avoid twisting of the weight carrying or suspending cable.

In particular, the present invention deals with a unique and dependable swivel connection which is provided between the suspending cable and the drive means for the drill to prevent twisting of the cable should the drive means rotate in the well bore. Since the cable from which the drilling apparatus is suspended is so constructed and arranged that it also includes means for conducting the elecrtical energy from above the surface to the motor suspended on the cable, it is an important feature of the invention to provide efficient means for transmitting the energy through the swivel to the drive motor and to the signalling means which is utilized to obtain at the surface an indication of the relative rotation taking place between the dirve means and the cable.

It is another important feature of my invention to provide a swivel connection that is provided with electrical contacts that are so mounted that a circuit will be maintained between the conductors in the cable suspending the apparatus and the conductors leading to the motor that drives the rotating parts of the drilling apparatus at all times as the two parts of the swivel turn relative to each other about their axis, said electrical connections comprising contact rings and spring pressed contact members engaging with said contact rings to maintain the electrical connections.

Means is provided for insulating the electrical conductors comprising a body of oil surrounding the same and the above referred to contacts and

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to maintain a pressure on said body of oil higher than that of the drilling fluid, that contains water, in which the drilling apparatus is submerged.

It has been found, where high voltage current is conducted through conductors that are contained in a body of oil to provide the necessary insulating means for said conductors, that oil under pressure is not sufficient protection for preventing deterioration of said insulating oil and thus loss of dielectric strength. It has also been found that where there is the possibility of seepage or leakage of either the oil or a liquid containing water through a seal, that if such leakage occurs and water enters the body of oil, the moisture entering from the body of water will readily travel downwardly through the intermolecular space in the oil, thus contaminating the entire body of oil and lowering the dielectric strength thereof, whereas this deteriorating process does not occur where the point of contact of the water with the oil underlies the body of oil so that the travel of the moisture would have to be upwardly through the body of oil. It is one of the purposes of my invention to provide sealing means for the chamber containing the body of oil that is of such a character that all of the seals at which the outer body of water and the inner body of oil might come in contact are so located that the body of water lies below the body of oil at the seal, and thus any point of contact with the water would underlie the body of oil.

With the above objects in view as well as others which will appear as the description proceeds, my invention consists in the novel features herein set forth, illustrated in the accompanying drawings and more particularly pointed out in the appended claims.

In the drawings:

Fig. 1 is a side elevational view of my drilling apparatus, partly broken away, showing the same located in a well bore.

Fig. 2 is an enlarged longitudinal sectional view of the upper portion of the means for suspending the drilling unit from the cable,

Fig. 2*a* is a similar view of the lower portion thereof, the lower gripping means being shown in elevation and being partly broken away,

Fig. 3 is a section taken on the line 3—3 of Fig. 2 in the direction of the arrows,

Fig. 4 is a similar view taken on the line 4—4 of Fig. 2,

Fig. 5 is a similar view taken on the line 5—5 of Fig. 2*a*, and

Fig. 6 is a similar view, taken on the line 6—6 of Fig. 2a.

Referring more particularly to Fig. 1 of the drawings, the reference numeral 10 indicates a well bore in which my drilling unit is located. The drilling unit comprises an upper section 11, a section 12 swiveled thereto, a bailer section detritus collector 13 connected to the lower end of the section 12, and a section 14 which contains the motor 15 for driving the drill 16 through suitable reduction gearing, not shown. In the drawings, the drill is shown as being a core drill, although any other suitable drill may be utilized.

The upper section 11 of the drilling tool is suspended from a weight supporting cable 17. The cable 17 is connected with the section 11 in the manner illustrated in Figs. 2 and 3 of the drawings, said section 11 comprising an open ended tubular portion 18, which is internally screw-threaded at 19 and is engaged at said threaded end portion by a nut 20. The upper end of said tubular member 18 has a tubular guide member 21 mounted centrally thereof, which is connected with the tubular member 18 by means of ears 22. The member 21 is what is commonly referred to as a "fishing neck." The cable 17 extends through the member 21 and is secured to the bolt 23 by means of cable clamps 24 and 25, by means of which said cable 17 is formed into a loop 26 embracing the bolt 23. The bolt 23 is mounted in a pair of upstanding ears 27 on an inner tubular member 28 provided in the section 11, the tubular member 28 being fixed to the nut 20 by means of a key 29 and a nut 30 screw-threadedly engaging with the end thereof and seated against a shoulder 31 on the nut 20, said tubular member 28 also having an annular shoulder 32 thereon so that said tubular member 28 is fixed by key 29 in position relative to the tubular member 18 by means of the nut 30 clamping the shoulder 32 against the nut 20.

A sleeve 33 surrounds the bolt 23 and a sheet metal guard member 35 is mounted between the sleeve 33 and the loop 26 formed in the cable 17. The cable 17 is made in a similar manner to that shown in my above referred to copending application, in that it has an outer weight sustaining sheath, and mounted within said sheath is an insulated electrical cable 36. The cable 36 is connected with an insulated cable 37 by a suitable splice 38. The electrical cable 37 extends into the central passage 39 in the tubular member 28 and into the tubular swivel member 40 carried by the tubular member 28. It will be noted that the tubular member 18 is removable from the member 20 and thus from the member 28 so as to provide ready access to the cable clamps and the electrical connections within the same by merely unscrewing the same from the nut-like member 20 and sliding the sleeve-like member 21 upwardly on the cable 17. Also it will be noted that when the tubular member 18 is in position as shown in Fig. 2 it is open at the top thereof so that any debris that may be loosened above the location of the drilling apparatus will drop into the container provided by said tubular member 18, and container having a large chamber 41 therein that constitutes a debris or "junk" basket.

The tubular member 28 is provided with a cylindrical outer surface that extends from the shoulder 32 to the portion 42 thereof. The surface 44 is provided with an annular groove 43 and a stop collar or ring 45 is seated in the groove 43. A pair of rings 46 and 47 are mounted for relative rotation thereto on the cylindrical outer face of the member 28. The rings 46 and 47 are the same in construction, except for the fact that these are reversed. Each of said rings has a plurality of radial slots 48 therein, as shown in Fig. 4, and each has the ends of a pair of bowed out springs 49 fixed thereto (see Figs. 2 and 4). The springs 49 are of such a curvature that these will be flexed upon engagement with the wall of the bore 10 so as to firmly engage by spring pressure with the wall of the bore to hold the rings 46 and 47 against rotation in said well bore.

The springs 49 and the rings 46 and 47 constitute part of a gripping means for holding the upper section 11, which constitutes the upper member of a swivel connection, against rotation in the well bore. Said gripping means further comprises a plurality of shoes 50 that may be referred to as torque shoes, in that these shoes engage the wall of the well bore to prevent rotation of the tubular member 28 and thus of the upper section 11 of the well drilling device, which might otherwise occur due to the torque developed by the motor 15 in rotating the drill bit 16. The member 28 is provided with a plurality of longitudinally extending grooves 51, which have a pair of side walls 52 and 53, the side walls 53 being inclined much more to the radial than the side walls 52. Each of the grooves furthermore has a partly cylindrical bottom wall 54, which serves as a socket for receiving the integral hinge pin portion 55 on each of the shoes 50. Each of said shoes 50 also has a pair of longitudinally elongated openings 56 therein adjacent the hinge pin portions 55 thereof and has a thickened outer end 57, which has faces 58 and 59 thereon that meet at a sharp corner 60 so as to provide a gripping surface on each outer end of said shoes adapted to engage the wall of the bore to prevent rotation of the member 28 in a counter-clockwise direction as viewed in Fig. 4.

The shoes 50 are moved into gripping position upon any slight counter-clockwise rotation of the member 28 relative to the rings 46 and 47 by means of the projecting lugs or fingers 61 provided on each end of each of the shoes 50, which operate in the radial slots 48 in the rings 46 and 47. It will be obvious that if the member 28 is rotated in a counter-clockwise direction relative to the rings 46 or 47, as viewed in Figs. 1 and 4, the pivot pin portions 55 will be swung around relative to the position of the lugs 61 so as to throw the gripping members 50 outwardly into engagement with the wall of the bore.

As the forces that will be acting on the shoes 50 are very great, the construction of the mounting of the shoes must be quite rugged. For that reason the pivot members of the shoes are mounted in the grooves in the thick tubular member 28 and are provided with strong retaining members comprising the arcuate bars 62 that have flat end faces that are welded face to face to the faces 52 and 53 of the grooves at 63 and 64, respectively, said arcuate bars 62 passing through the openings 56 in the members 50.

The tubular swivel member 40 is provided with an upper screw-threaded end portion 65 that is threaded into the internally threaded end portion 66 of the member 28, and a stuffing box is provided in the upper end of said swivel member 40 comprising the compressible packing 67 and the gland member 68 that compresses the packing 67 between itself and the annular shoulder 69 providing a reduced neck portion in the swivel member 40 within which the cable 37 fits. The packing 67 is thus compressed around the

cable so as to provide a liquid tight joint around the cable within the member 40. The cable 37 extends to the lower end of the member 40, which has an annular enlargement 70 thereon, on which the cylindrical extension 71 is secured.

An insulating block 72 is mounted in the lower end of the cylindrical member 71, being seated in a recess in the end thereof, as shown in Fig. 2a, and the three conductors 73, 74 and 75 that are provided in the cable 37 extend from the lower end of said cable through suitable passages in the insulating block 72 to contacts provided on said insulating block. Said contacts, as shown more clearly in Fig. 5, comprise a central substantially circular contact 76 and a pair of flat ring-like contacts 77 and 78. The contact 76 is mounted on the axis of the cylindrical member 71 and thus on the axis of the swivel member 40 and the ring contacts 77 and 78 are concentric therewith. The conductor 74 is connected with the central contact 76, the conductor 73 with the ring contact 77 and the conductor 75 with the ring contact 78.

The member 12, which is swiveled on the member 11, comprises an outer tubular housing 79, with which an upper head 80 is screw-threadedly connected at one end thereof, and a lower head 81 is screw-threadedly connected at the other end thereof. The head 80 has a bearing portion 82 fitting the outer periphery of the tubular member 40, and said bearing portion is provided with a plurality of grooves 83, in which compressible sealing rings 84 are mounted. The head member 80 has an upwardly extending end portion 85 that is slightly reduced in diameter and is provided with a cylindrical outer surface, while the swivel member 40 has a flanged collar 86 keyed thereto by means of a key 87 so as to rotate therewith, said collar having a depending annular flange 88 overlapping the reduced upper end portion 35 of the head 80 of the member 12 and having a groove therein, in which the compressible sealing ring 89 is mounted. The retaining ring 90, mounted in a groove in the swivel member 40 holds the collar 86 from endwise movement and the joint between the collar 86 and the swivel member 40 is sealed by means of the sealing ring 91. An upper ball thrust bearing 92 is mounted between the members 80 aand 86, a space being provided between the members 80 and 86 for mounting this thrust bearing.

Mounted within said space is also a contact 93, which is carried by the upper end member 80 provided on the tubular housing 79 and thus rotating with the member 12 and grounded to said member 80 and thus to the metallic parts of the drilling apparatus and the outer sheath of the cable 17. A spring pressed contact 94 is mounted in a recess in the collar 86 and a conductor 95 extends to said contact through the passage 96 in the collar 86, said conductor 95 being contained within the cable 37 and passing therefrom in the passage 39, as will be obvious from Fig. 2, a side passage 97 being provided from the passage 39 for the conductor 95 so as to bring the same out of the member 28. It will be seen that as the member 80 rotates relative to the member 86 and thus as the member 12 rotates or swivels on the member 11, the contacts 93 aand 94 will engage once during each rotation of said parts. This is utilized as an indicating means or signal means to indicate by means of any suitable signal above the ground surface connected with the proper conductor within the cable 17 and grounded to the outer sheath of said cable 17 to indicate as to whether the upper and lower members of the swivel are rotating relative to each other and thus whether the apparatus is functioning properly. In fact the frequency of the signals will indicate the conditions in the well bore as, if any slippage of the gripping means 50 occurs, the relative rotation of the members 80 and 86 will either be retarded or will cease entirely. If in any case the gripping means 50 is not functioning perfectly, then the rotation induced in the upper section 11 due to the slight frictional resistance in bearing 100 and seals 84 and 91 will result in an undesirable twist in the cable 17.

The collar 86 is provided with a longitudinal passage 98 therein, which leads to the space between the lower end of the member 86 and the upper end of the member 80, and a valve 99 is provided thereon through which oil under pressure, which is an electrical insulator, is inserted in the passage 98 and all spaces in communication therewith. As the apparatus will be in a body of water in the well bore when the drilling operation is taking place, there will be water surrounding the members 80 and 86 and accordingly there will be water on the lower side of the seal 89 and oil on the upper side of said seal when the apparatus is in operation. However, it has been found that there will be no contamination of the oil and thus of its insulating and lubricating properties by upward passage of the moisture through the seal 89 into the body of oil, because, when the body of oil is above the body of water in the seal, no such intermingling of the moisture with the oil as would cause the same to deteriorate, will take place.

A ball thrust bearing 100 is mounted between a shoulder on the lower end of the member 80 and a shoulder 101 provided at the enlargement 70 on the swivel member 40. The section 12 further comprises a tubular member 102, which is screw-threadedly connected with the head 81, which thus serves as a coupling means between the tubular members 79 and 102. The member 81 has a seat at its upper end for an insulating block 103 and has an inner tubular member 104 secured in an opening 105 in the lower end thereof, which communicates with the chamber 106 within the member 81. The tubular member 102 serves as a piston chamber in which a piston 107 is mounted, which slides on the tubular member 104, serving as a guide for said piston, and within the bore of the tubular member 102. The piston has a rearward extension 108 having an additional guide opening 109 therein cooperating with the tubular member 102. Sealing rings 110 and 111 are provided in suitable grooves in the piston cooperating with the walls of the tubular members 102 and 104, respectively. A coupling 112 is screw-threadedly connected with the tubular member 102 and a compression coil spring 113 is mounted between the rear wall 114 of the piston 107 and the end wall 115 of the coupling 112. A series of openings 116 is provided in the tubular member 102.

Spring biased contact members 117, 118 and 119 are mounted in the insulating block 103, there being two of the contacts 118 and two of the contacts 119 arranged substantially diametrically opposite each other. Thus there are two contacts 119 engaging with the contact ring 78 and two contacts 118 engaging with the contact ring 77, and the single contact 117, which is on the axis of the swivel member 40, engaging with

the contact 76. With this arrangement of contacts there will be assurance that there will always be a connection between the conductors 120, 121 and 122, and the conductors 74, 73 and 75, respectively, through said contacts, the conductor 121 having branch conductors 123 leading to the contacts 118 and the conductor 122 having branch conductors 124 leading to the contacts 119. The conductors 120, 121 and 122 extend from the cable 125, which extends through the passage in the tubular member 104 and leads to the motor 15. The motor 15 is a three phase motor and the electrical energy is thus supplied to said motor from the cable 36 in the supporting cable 17 through the cable 37 and the cooperating contacts to the cable 125 having the conductors that are connected with said motor.

The coupling 112 has a passage 126 therein, which leads to a suitable passage in the threaded end portion 127 of a member 128, which is connected with the coupling 112 and which is in turn connected with the section 13. The passage 126 is provided with a stuffing box comprising the packing gland 129 and the layers of compressible packing 130, which provide a liquid tight joint around the cable 125 in said passage 126.

A chamber is thus provided that is sealed so as to retain a body of liquid therein, which chamber includes the passage within the tubular member 104 and the chamber between the piston 107 and the bottom end wall of the member 81. In order to provide communication between this chamber and the chamber 106 in the member 81, a liquid passage 131 is provided in said member 81. The liquid chamber 106 communicates with the space between the tubular members 71 and 79 and also with the space within the tubular member 71 and thus with the passage in the swivel member 40. There being no seal between the member 40 and the tubular member 79, the space between the tubular swivel member 40 and the members 79 and 80 up to the sealing rings 83 will also be in communication with the other above referred to spaces. An insulating oil is injected into the spaces under pressure through the valve 133 in the member 81 and the air released through the valve 132 in the member 80. The insulating oil is indicated by the numeral 134 in Figs. 2 and 2a.

As the drilling apparatus will be in a body of liquid containing water when in operative position in the well bore the column of water above the openings 116 will cause the liquid in the well bore under pressure to fill the chamber 135 back of the piston 107. However, the spring 113 will further urge the piston upwardly and thus the pressure on the oil 134 will be greater than the pressure of the liquid in the chamber 135 and, accordingly, at all seals the outward pressure exerted by the body of oil will be greater than the pressure of the liquid containing water on the outside of the seals. Thus if there is any leakage or seepage through the seals, it will be an outward seepage or outward leakage of oil rather than an inward passage of the liquid containing water.

The member 128 has gripping means provided thereon that are of identical construction to the gripping means that comprise the shoes 50 above described, except that said gripping means are of greater length. However, the shoes 50' of said gripping means operate in the same manner as the shoes 50 above described, and are mounted in a similar manner on the member 128 so as to cause the same to be thrown outwardly into engagement with the well wall upon any tendency of reverse rotation of the member 128 due to the rotation of the drill 16. Instead of providing a pair of openings in the shoes for the retaining means, three openings 56' are provided in each of said shoes, and it is obvious that any desired number of such openings and retaining bars or bands 62', which are the same in construction as the members 62 above described, can be provided, dependent upon the length of the gripping means and of the shoes. The shoes are provided with lugs 61' corresponding to the lugs 61 of the shoes 50, which operate in radial slots in ring members 46' and 47' corresponding to the ring members 46 and 47 previously described. The operation of the lower gripping means comprising the shoes 50' is exactly the same as that of the upper gripping means having the shoes 50.

It will accordingly be seen that the torque exerted on the apparatus by the rotary drilling operation will thus be resisted first by the shoes 50' to thus reduce rotation of the section 12 to a minimum. Furthermore the tendency of this rotation to be transferred to the section 11 will be entirely eliminated due to the cooperation of the upper gripping means 50 holding the section 11 stationary and the swivel connection between the section 11 and the section 12. Thus any tendency of the cable 17 to twist will be entirely avoided by the combination of gripping devices and swivel connection between the same provided in this drilling apparatus.

It will be noted also that the seals that are provided between two moving parts, where the only possibilities of leakage of liquid might occur, are so arranged that the outer body of liquid containing water is on the lower side of the seal and the insulating oil comprising the inner body of liquid is on the upper side of the seal. This is true of the seals 110, 111 and 89.

By the particular mounting of the pivoted shoes 50 and 50' by means of the bar-like member 62, a very strong connection is provided between these pivoted shoes and the members on which the same are mounted. The electrical connections and contacts are all in the body of insulating oil and the contacts are so constructed and arranged that there will always be a good contact between the cooperating contact members for any position of the parts of the swivel connection relative to each other. In addition to that, means is provided by means of the cooperating contacts 93 and 94 to give an instant indication or signal at the surface as to the performance of the gripping means and of the swivel connection.

The tubular member 18 serves as a housing for the cable clamping means so as to prevent any damage thereto and at the same time provides a basket for catching anything that might otherwise drop down to a point where it would interfere with the operation of the gripping shoes or other moving parts of the apparatus.

Having thus described my invention, I claim:

1. A swivel assembly for electrical drilling of deep wells comprising an oil chamber, a pair of insulating discs with sliding contact members in said oil chamber, a cable connected to contacts of the upper of said insulating discs, a cable connected to contacts of the lower of said insulating discs, stuffing box packings around said cable at the upper and lower ends of said oil chamber, and an annular piston chamber around the cable in the lower part of said assembly, said piston

being provided with a spring to maintain an overpressure of said oil in said chamber.

2. In a well drilling apparatus, a first member, a second member swiveled on said first member for rotary movement relative thereto, each of said members having complementary wall portions defining an oil chamber between said members, a pair of insulating discs with sliding contacts in said oil chamber, said discs being carried respectively by said first and second members, cables connected to the contacts of discs and extending respectively through openings at the opposite ends of said oil chamber, stuffing box packings around said cables in said openings, a piston chamber in the second member having open communication with said oil chamber, and a spring-loaded piston in said piston chamber acting on the oil in said chambers to maintain same under continual pressure.

3. In a well drilling apparatus, a first member, a second member swivelled on said first member for rotary movement relative thereto, each of said members having complementary wall portions defining a chamber between said members adapted to contain an insulating liquid, a pair of insulating discs with sliding electrical contacts juxtaposed in said chamber, said discs being carried respectively by said first and second members, oppositely extending electrical cables connected respectively to the contacts of said

discs, said cables extending through openings at the opposite ends of said chamber, stuffing box packings around said cables in said openings, an annular pressure chamber around said cable in said second member adapted to contain insulating fluid, an annular piston within said pressure chamber, resilient means engaging said piston on one side thereof, said pressure chamber on the other side of said piston having open communication with said first chamber whereby a continual pressure is exerted on the insulating liquid contained therein.

4. Apparatus as in claim 3 wherein said piston chamber on said one side of said piston is in open communication with the well bore whereby the well bore pressure is transmitted to the piston.

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