

Sept. 4, 1962

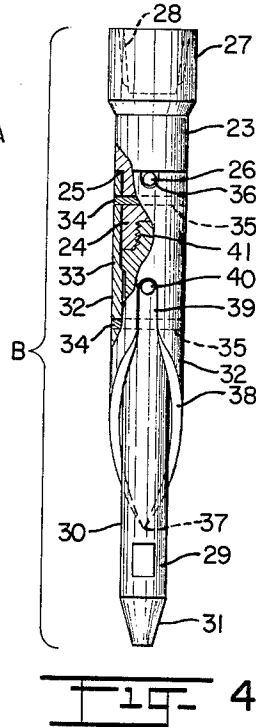
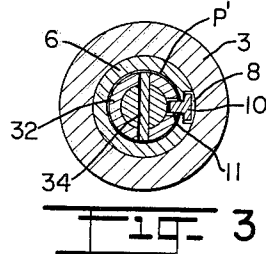
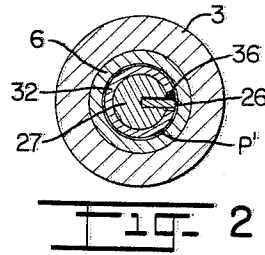
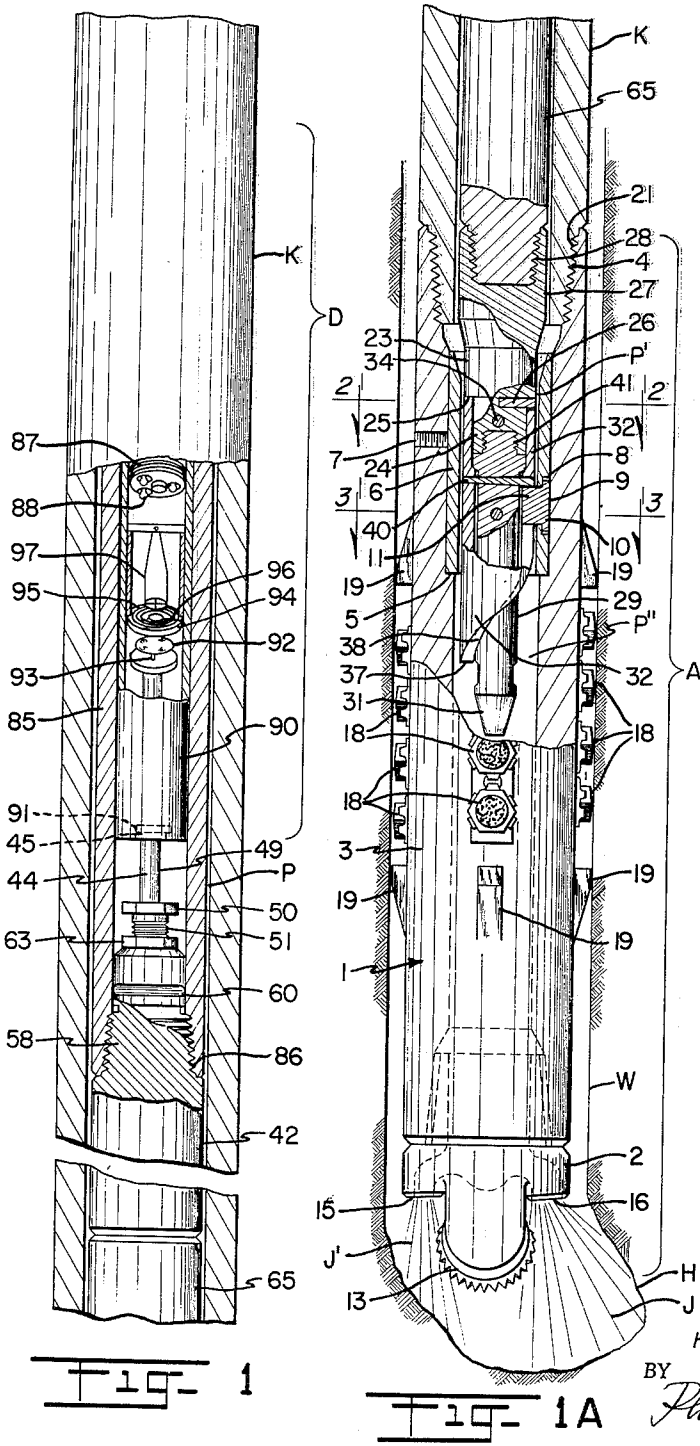
H. J. EASTMAN

3,052,309

APPARATUS FOR ORIENTING WELL DRILLING EQUIPMENT

Filed Oct. 30, 1958

2 Sheets-Sheet 1



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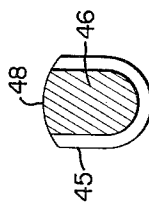
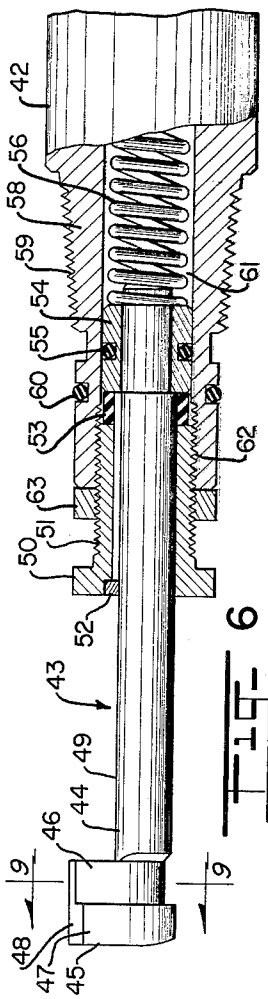
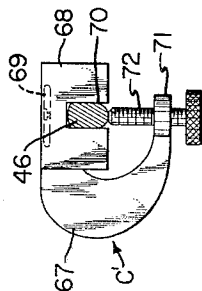
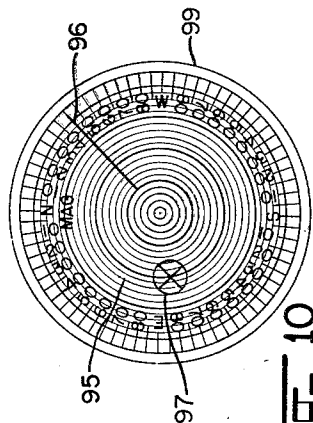
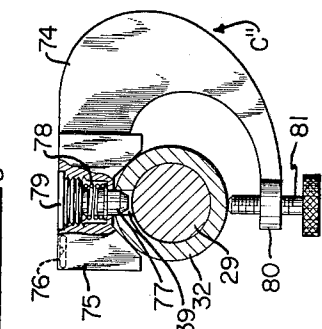
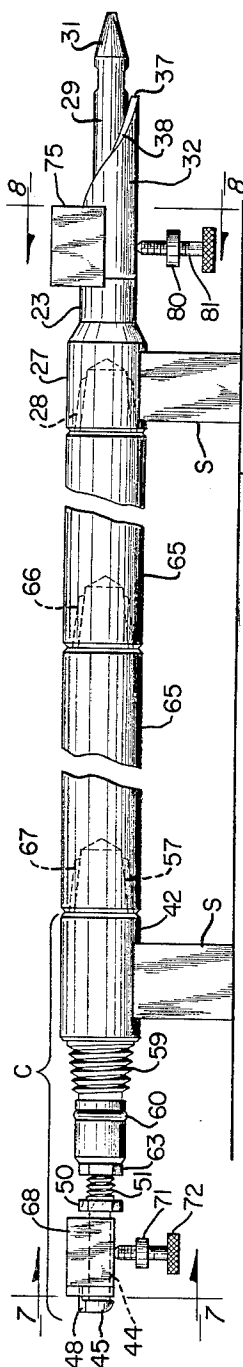
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APPARATUS FOR ORIENTING WELL DRILLING EQUIPMENT

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2 Sheets-Sheet 2



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3,052,309

APPARATUS FOR ORIENTING WELL
DRILLING EQUIPMENT

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Filed Oct. 30, 1958, Ser. No. 770,653

5 Claims. (Cl. 175—45)

This invention relates to apparatus for orienting well drilling equipment utilizing a reorientable deflecting tool and for recording a directional survey and a bottom hole orientation on the same record disc, with a single run of the instrument assembly in the drilling equipment.

Directional drilling deflecting tools generally take the form of two types, the first being those tools which are only oriented once and then sheared or broken away from the drilling string, such as a whip stock, and tools which may be reoriented in the hole for continual use, Lindsay et al. and James et al. Patents 2,819,039 and 2,819,040 as well as the deflecting tool of the Harlan J. Eastman patent application Serial No. 715,614, now Patent No. 2,956,781, filed February 17, 1958, being examples of the second type, both of said patents, said application and the present invention being owned in their entirety by a common assignee. The present apparatus is designed and intended for use with this second type of directional drilling tool or most any reorientable deflecting tool and it includes all of the instrumentation and apparatus required to survey, orient and directionally drill a well. Furthermore, the apparatus of this invention permits recording a directional survey and a bottom hole orientation on the same record disc with a single run of the instrument assembly in the drilling apparatus.

Thus it is the primary object of this invention to provide a new and improved apparatus for orienting directional well drilling equipment utilizing reorientable deflecting tools.

Another object is to provide apparatus of the type described wherein there is provided means for recording a directional survey and a bottom hole orientation on the same record disc, with a single run of an instrument assembly.

Yet another object is to provide an improved apparatus of the type described which is simple to operate and is rugged in construction so as to result in improved orientation at a great saving of rig time and thus expense.

The construction designed to carry out the invention will be hereinafter described, together with other features thereof, and it will be more readily understood from a reading of the following specification and by reference to the accompanying drawings forming a part thereof wherein an example of the invention is shown and wherein:

FIGURE 1 is a longitudinal view partly in section of the upper portion of the apparatus of this invention;

FIGURE 1-A is a longitudinal view partly in section of the lower portion of the apparatus of this invention;

FIGURE 2 is a sectional view taken along the lines 2—2 of FIGURE 1-A;

FIGURE 3 is a sectional view taken along the lines 3—3 of FIGURE 1-A;

FIGURE 4 is a front elevational view illustrating the mule shoe and mule shoe sub part of the apparatus;

FIGURE 5 is an elevational view illustrating the technique of the present invention for aligning the mule shoe and the orienting lug and properly spacing each;

FIGURE 6 is an enlarged detailed view of the orienting lug assembly shown in FIGURE 5;

FIGURE 7 is a detailed view of the clamp utilized with the orienting lug assembly;

FIGURE 8 is a detailed view of the clamp utilized with the mule shoe structure;

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FIGURE 9 is a sectional view along the lines 9—9 of FIGURE 6; and

FIGURE 10 is a view of a typical developed record disc.

There has been a definite need for a method and apparatus which permits orientation of well drilling equipment including a deflecting tool of the reorientable type by taking a directional survey and a bottom hole orientation with a single run of the instrument assembly in the equipment. It is to be understood that such is the main purpose of the present apparatus, although other uses will become apparent. Prior to describing the overall operation even from a general standpoint, it is believed best for a complete understanding to describe the structure involved in individual sections.

The Deflecting Tool

As mentioned, various reorientable deflecting or directional drilling tools may be employed, but for purposes of illustration there is shown by section A a deflecting tool substantially identical with that shown and described in said pending application Serial No. 715,614, now Patent No. 2,956,781. Basically, this tool generally represented at 1, comprises an elongated member 3 which is hollow throughout its longitudinal length to provide the passage P' enlarged at its upper end to form shoulder means 5 for supporting an orienting sleeve 6 which takes the form of a tubular hollow member also having a passage P' therethrough. The upper end of body 3 is threaded as at 4 and the sleeve 6 is maintained in a desired rotative position by means of one or more screws 7 (only one of which is shown) extending through the wall of member 3. The wall of sleeve 6 is slotted as at 8 to receive and carry a T-shaped member 9 having a head 10 and a part 11 which extends inwardly of the sleeve into passage P' to form what is known as an orienting key or part.

The tool 1 includes a drilling bit 2 identical to that shown in said pending application and in this connection the bit 2 is connected to body 3 in a similar manner. As explained in said pending application, bit 2 includes diametrically opposed cones, one of which is shown at 13 and diametrically opposed small and large orifices 15 and 16, respectively, which communicate with passage P', as shown in dotted lines and as explained in said application. When fluid under pressure is directed through the passages of body 3 and through orifices 15 and 16 a jetting action J' and J will be directed against the lower part of a well bore not shown and this will cause a washout or a desired deflection H or still further permit controlled directional drilling, assuming one knows the direction and slope of washout area H and the location of orifices 15 and 16, particularly the latter, in the hole.

The body 3 is provided with wear buttons 18 and fins 19 for reasons that will be apparent by referring to said application, said buttons and fins being identical with those shown in an application Serial No. 770,654, now abandoned, filed substantially concurrently herewith in the name of Harlan J. Eastman and entitled "Stabilizer for Earth Bore Drilling Apparatus," the latter also being owned by the assignee of this invention. The above description constitutes an illustration of a reorientable deflecting tool with drilling means attached which may be employed as part of the present apparatus.

Before describing the next section, reference is made to the "K" Monel collar K which is threaded as at 21 for securing the collar to body 3 and, as usual, this collar K is hollow throughout its longitudinal length to provide passage P and is constructed of non-magnetic material as the instrumentation employed in carrying out the method and apparatus of this invention is to be properly positioned therein. Obviously, the top of the collar K,

not shown, is suitably connected to other elements of the drilling string.

Mule Shoe and Sub Therefor

Mule shoe operations are well known in this field of endeavor and the technique thereof is illustrated in prior patents such as Bremner et al., U.S. Patent 2,207,507. Referring to FIGURES 1-A and 4, the mule shoe and sub therefor is generally represented by section B. The sub includes a solid cylindrical body 23 provided with a reduced portion 24 defining shoulder means 25 having a locating pin 26 near its top, and provided with an enlarged portion 27 formed with an upwardly directed threaded socket 28. Element 29 is referred to in the field as a "stinger," but is nothing more than a guide member consisting of a solid cylindrical portion 30 that is tapered as at 31 at one end and securely connected by a threaded extension 41 to reduced portion 24. The mule shoe comprises a hollow body 32 that is of cylindrical configuration at its top 33 where it is connected to the stinger and sub by suitable pin means 34 passing through radially aligned slots 35, this connection taking place after the locating pin 26 is received in arcuate slot 36 of body 32. The lower portion of the mule shoe terminates in a point 37 and is formed above the point so as to provide a pair of oppositely sloped spiral faces 38 which at their top converge to form the mouth of a pocket or slot 39 which extends vertically in the face of the shoe and is of such width that it will receive the key 11. The top of slot 39 receives one end of a tapered deformable lead slug 40 that extends through and is carried by the stinger 29, the slug functioning as a "tell-tale" as will be apparent hereinafter.

The Orienting Lug Assembly

This is represented by section C and is illustrated in FIGURES 5, 6 and 9 and includes a bull plug portion 42 and an orienting lug assembly connoted at 43. First as to the lug assembly, such includes a solid D-shaped member 44 having a hammer or hooked shaped end 45 consisting of portions 46 and 47, and a reference portion in the form of the upwardly directed (as seen in FIGURE 6) convex surface of the end 45 will be referred to by numeral 48. The top surface 49 of member 44 is flat whereby a bushing 50 having threads 51 may be made rotationally integral therewith due to key 52 and yet relative axial movement is permitted. Numerals 53, 54 and 55 represent, respectively, a bumper, piston and fluid seal O-ring, all carried by member 44 which has abutting its end opposite end 45 an extreme convolution of a coiled spring 56. The plug 42 is solid at the center thereof and terminates at one end in tapered threads 57 and its other end 58 is also tapered and hollow and includes a threaded area 59, an O-ring fluid seal 60 and a socket 61 which receives, as shown in FIGURE 6, a portion of the lug assembly and has the other end of resilient means 56 in engagement with its bottom (not shown). At its tip, socket 61 is threaded as at 62 to mesh with threads 51 which also receive in threaded engagement a locking nut 63. The operation and function of this structure will be described more fully hereinafter but it will be pointed out that when nut 63 engages the tip of end 58, as shown, the parts are jammed sufficiently so that the lug assembly and bull plug are in effect rotationally keyed and any relative rotation is prevented.

As will be explained hereinafter, it is undesirable to have element 45 spaced properly with relation to key 11 within the collar K and to permit this proper spacing there may be inserted between plug 42 and sub 23 any desired number of sinker bars 65 which may be threadedly attached as illustrated in FIGURE 5. These bars 65 are nothing more than solid cylindrical members having at one end a threaded tip 66 and at the other end a threaded socket 67 and the illustrated attachment

of one to another and to the bull plug and mule shoe sub should be apparent. In FIGURE 5 the bull plug and orienting lug assembly, together with the mule shoe and sub thereof and the sinker bars 65 are shown supported on the ground G at the surface of a well bore by any suitable stands S and this is for a purpose that will become apparent hereinafter.

Aligning Clamps

Both the orienting lug assembly 43 and the mule shoe 32 have clamps that may be used to properly align each or more specifically to align slot 39 with tip 48. The first of these clamps C' is shown in FIGURE 7 and includes a C-shaped body 67 having an enlarged portion 68 that includes a liquid level 69 that is readable from the top thereof and a slot 70 for receiving portion 46. There is nothing novel about the structure of these clamps per se and base 71 of body 67 is provided with an opening to receive a threaded screw member 72 which is to engage the element 43 upon the lug flattened portion 46 being positioned within slot 70 and the clamp C' located as shown in FIGURES 5 and 7. With the clamp C' thus attached, if the lock nut 63 is unloosened the lug assembly 43 including bushing 50 may be rotated until bubble 69 is level, at which point it may be tightened and if the mule shoe slot 39 is similarly located with respect to a level bubble, then the slot 39 of the mule shoe will be in alignment with the lug tip 48. It should be pointed out that regardless of the position of nut 63, element 43 including piston 54 may be moved axially within bushing 50 and socket 61 to the extent permitted by spring 56 which acts as a shock absorber for instrumentation attached to the lug assembly. FIGURE 8 illustrated a clamp C'' securable to the mule shoe 32 and this also includes a C-shaped member 74 having enlarged body portion 75 containing a liquid level 76 and a spring biased centering pin or plunger 77 which is received in slot 39 of the mule shoe 32, all as shown. The pin 77 is biased downwardly as viewed in FIGURE 8 by spring 78 interposed between the pin and cap 79. Also, the member 74 includes a base 80 having an opening therein for threadedly receiving a screw member 81 which also engages the mule shoe 32 to maintain the clamp in position.

Angle Unit and Camera and Watch

This part of the apparatus is illustrated schematically, as per se it is well known and a standard part of applicant's directional drilling equipment with the exception of two elements that will be specified. Element 85 consists of an instrument barrel and one end is threaded at 86 for attachment to the threads 59 of plug 42. Within this barrel, represented by section D in FIGURE 1, is a combined angle unit assembly and a camera, record disc and watch assembly. Since the latter type of instrumentation is well known and has been in use for many years, such will only be represented by the body 87 having exposure lights 88 depending therefrom. The angle unit 90 is of standard type except that the base thereof has been modified to include a special slot 91 for receiving the lug portion 45 and when the lug end 45 is within the slot 91 a reference line 96 will be within a known rotative position within shell K. The angle unit includes a magnetic compass 92 suitably supported by well known means 93 and spaced above the compass is a glass ring 94 having a plurality of concentric markings 95 thereon and the reference line 96, the latter being the other modified element referred to and, of course, these two changes in standard equipment, namely orienting line 96 and slot 91, are necessary to the function of the present method. Above the ring 94 is a suitable support for pivotally supporting a plumb bob arrangement 97.

Typical Developed Record Disc

A developed record disc is shown at 99 in FIGURE

10, the degree indicia thereof being obtained from the compass markings, the concentric lines 95 and the orienting or reference line from the ring 94 and the plumb bob marking from the unit 97. This disc constitutes a typical reading which will serve as an operational example hereinafter.

Operation

When the apparatus of this invention is used in conjunction with a deflecting tool that may be reoriented in the hole, the instrumentation within barrel 85 serves as both a "single shot" and "B.H.O." during the actual directional drilling. By "single shot" is meant well known apparatus, such as shown in the Eastman catalog 59-60 of the assignee of this invention, pp. 1614-1617, and comprising among other things a camera, a sensitized record disc and watch mechanism. The single shot reading provides information as to the angle or present declination from the vertical of the hole as well as the direction in which the hole is heading. A B.H.O. or bottom hole orientation reading provides information as to the facing of the deflecting tool at the time of the reading. In other words, the B.H.O. technique and reading, which by itself is well known and shown in said catalog, is for orienting the tool in the bottom of the well in a known relation to magnetic north. The essence of the apparatus and method of this invention resides in the combined operation that is permitted, as distinguished from separate single shot and B.H.O. surveys. In other words, it provides all of the instrumentation required to directionally drill a well in a single set of equipment and means for recording a directional survey and a bottom hole orientation on the same record disc, with a single run of the instrumentation assembly. Obviously, this saves many hours of valuable rig time.

Now let us assume that the apparatus of FIGURES 1 and 1-A, with the exception of instrumentation included in barrel 85 of Section D and the mule shoe and lug assemblies of Sections B and C has been utilized to drill a straight or vertical hole W. The bit 2, of course, would have done the drilling, this bit in combination with body 3 constituting a reorientable deflecting tool 1. Prior to even starting this straight drilling, at the surface jet orifice 16 is aligned axially with key 11 by properly rotating and setting sleeve 6, all as explained in copending application Serial No. 715,614. Assuming deflection is desired whereby there will be drilling at an angle to vertical, this may be accomplished by properly orienting jet orifices 15 and 16 and then jetting to form wash-out H and then continuing drilling operations until the bore W is progressing at a controlled deviation, all as explained in application Serial No. 715,614. Accordingly, we can assume now, for the purposes of description, that bore W is at an angle and that it is desired to determine if the hole is progressing as planned, and if it is not, how much and in what direction the deflection tool 1 must be turned to accomplish the desired results.

At the surface slot 39 is aligned with tip 48 by the use of clamps C' and C'' and proper rotation of lug assembly 43 and tightening of nut 63. When carrying out this latter operation the desired number of sinker bars 65 are employed between the orienting bull plug 42 and the shoe 32 in order to correctly space compass 92 in the collar K. Next the barrel 90 is connected with the lug assembly by inserting lug 45 within slot 91 and the tip 48 will be aligned with line 96, due to the fact that the latter was aligned axially with slot 91 when constructed. Thereafter the barrel 85 is threaded onto plug 42 and connected as at 86. This entire assembly is now lowered from the surface by running same in the bore W on a wire line until it assumes the positions shown in FIGURES 1 and 1-A. During this connection the guide member 29 travels into body 2 until the cam means 38 engages the orienting key 11, whereupon continued downward movement will align the key with the slot 39 and will

relatively move upwardly in the slot until the key engages the lead slug 40. Deformation of the latter provides an indication or "tell-tale" that all parts are properly positioned with the orifice 16, key 11, slot 39, surface 48 and line 96 being properly axially aligned and spaced. Of course, the bit is on bottom and the plumb bob 97 will pivot in accordance with the hole deviation. In the usual manner a picture is taken, such as the one developed at 99 in FIGURE 10.

"Single shot" and "B.H.O." information is revealed in FIGURE 10, orienting line 96 indicating that the orifice 16 is facing N 45° W, and plumb bob 97 shows that the present declination is 10° from the vertical (each concentric marking 95 representing 1 degree) in a direction of N 80° E. From this reading the operator can determine if the hole is progressing as planned and, if it is not, how much and in what direction further deflection is needed.

The objects and advantages of this apparatus should be clear from the foregoing operational description. Also it will be apparent that there are many other uses of the overall assembly. For example, when the angle and direction of the hole have been established, the instrumentation setup can be converted to any standard single shot assembly by deleting the orienting bull plug and mule shoe assembly and adding standard top or bottom landing equipment. The same assembly may also be used as a B.H.O. only to orient any deflecting tool by either the direct or indirect method. In the latter event, the assembly is made up without the collar K and the bull plug may then be screwed directly into the mule shoe sub without the sinker bars. Accordingly, the sinker bars 65 are employed to establish the desired spacing of the instrumentation assembly relative to the sub 23, and the number of sinker bars employed will of course depend upon the length of the collar or non-magnetic section K since the instrumentation assembly must necessarily be positioned for example with the compass therein positioned within the non-magnetic section and away from the other joint. Again, the section K may be of varying lengths depending upon the particular application and type of directional drilling equipment and accordingly the sinker bars 65 will vary in number in accordance with the length thereof.

The foregoing disclosure and description of the invention is illustrative and explanatory thereof and various changes in the size, shape and materials, as well as in the details of the illustrated construction and described method, may be made within the scope of the appended claims without departing from the spirit of the invention.

What is claimed is:

1. In apparatus for orienting directional drilling equipment in a well bore wherein there is provided orienting means comprising an orienting assembly including a plug element and a lug assembly providing a reference portion at one end thereof with said lug assembly being rotatably adjustable and having locking means associated with said lug assembly for selectively locking said lug assembly against rotative movement, a mule shoe including a slot, at least one sinker bar interposed between said plug element and said mule shoe to regulate the spacing therebetween, the combination therewith of aligning clamps including a first aligning clamp having a liquid level thereon for disposition on said mule shoe with said level being axially aligned in relation to the slot on said mule shoe and a second aligning clamp including a liquid level thereon for disposition on said lug assembly with said liquid level being axially aligned with the reference portion on said lug assembly whereupon correlation of the liquid levels on the respective aligning clamps the reference portion on said lug assembly is brought into axial alignment with the slot on said mule shoe.

2. In apparatus for orienting directional drilling equipment in a well bore wherein there is provided orienting means comprising an orienting assembly having a plug

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element including a lug assembly providing a reference portion at one end thereof with said lug assembly being rotatably adjustable and including a locking nut associated with said lug assembly for selectively locking said lug assembly against rotative movement, a mule shoe including a slot, at least one sinker bar for threaded connection between said plug element and said mule shoe to regulate the spacing therebetween, the combination therewith of aligning clamps including a first aligning clamp having a liquid level thereon for disposition on said mule shoe with said level being axially aligned with the slot on said mule shoe and a second aligning clamp including a liquid level thereon for disposition on said lug assembly with said liquid level being axially aligned with the reference portion on said lug assembly whereupon leveling of the liquid levels on the respective aligning clamps, said clamps are cooperative to axially align the reference portion on said lug assembly with the slot on said mule shoe.

3. In apparatus for orienting directional drilling equipment in a well bore wherein there is provided a tubular non-magnetic section above the directional drilling equipment for disposition of an instrumentation assembly therein, said instrumentation assembly including means forming an orienting line being axially aligned with a recess defining a keyway at the lower end thereof, the combination of an orienting assembly having a lug assembly providing a reference portion at one end thereof for connection into the recess on the instrumentation assembly in alignment with the orienting line, a mule shoe including a slot thereon axially aligned in predetermined relation with respect to the directional drilling equipment with spacing means on said orienting assembly for interconnection with said mule shoe and whereupon the instrumentation assembly is positioned to extend for the desired distance into the non-magnetic section, said lug assembly being rotatable with respect to said mule shoe and having locking means associated therewith to selectively lock said lug assembly against rotatable movement whereupon the reference portion on said lug assembly is rotatable into fixed axial alignment with respect to the slot thereby to axially align the orienting line with the directional drilling equipment when said lug assembly is connected into said instrumentation assembly.

4. Apparatus for orienting directional drilling equipment in a well bore comprising a drill string having a drill bit, a deflecting tool including a deflecting element thereon with an orienting key being axially aligned with said deflecting element, a non-magnetic section interposed in said drill string for accommodating an instrumentation assembly therein, said instrumentation assembly including means forming an orienting line and a compass together with a barrel portion having a keyway therein, and means for positioning said instrumentation assembly in a predetermined relation in said non-magnetic section with the orienting line therein being aligned in known

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angular relationship to said deflecting element, said means being defined by a mule shoe including a slot therein for receiving said orienting key, an orienting assembly at the opposed end of said means including a rotatably adjustable lug assembly at one end thereof having a reference portion thereon and being dimensioned for keyed connection into the keyway on said barrel portion, spacing means on said orienting assembly for connection to said mule shoe in accordance with the length of said non-magnetic section to properly position said instrumentation assembly therein, and locking means associated with said lug assembly to selectively lock said lug assembly in position with the reference portion on said lug assembly being axially aligned with the slot on said mule shoe so that when the lug assembly is disposed in the keyway the orienting line is axially aligned with said orienting key and said deflecting element.

5. Apparatus for orienting directional drilling equipment in a well bore comprising a drill string having a drill bit, a deflecting tool including a deflecting element thereon and an orienting key axially aligned with said deflecting element, a tubular non-magnetic section interposed in said drill string for accommodating an instrumentation assembly therein, said instrumentation assembly including means forming an orienting line and a compass together with a barrel portion having a keyway therein, and means for positioning said instrumentation assembly in predetermined relation in said non-magnetic section with the orienting line therein being aligned in known angular relationship to said deflecting element, said means being defined by a mule shoe including a slot therein for receiving said orienting key, an orienting assembly at the opposed end of said means including a lug assembly at one end thereof having a reference surface thereon and being dimensioned for keyed connection into the keyway on said barrel portion, said lug assembly being normally rotatable with respect to said mule shoe, sinker bars on said orienting assembly for connection to said mule shoe in accordance with the length of said non-magnetic section to position said instrumentation assembly therein, and locking means on said lug assembly adapted to lock said lug assembly against rotation with the reference surface on said lug assembly axially aligned with the slot on said mule shoe whereby when the lug assembly is disposed in the keyway, the orienting line will be axially aligned with said reference surface, slot, orienting key and deflecting element.

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