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2,844,357

APPARATUS FOR ORIENTING TOOLS IN A BORE HOLE

Filed Oct. 4, 1955

2 Sheets-Sheet 1

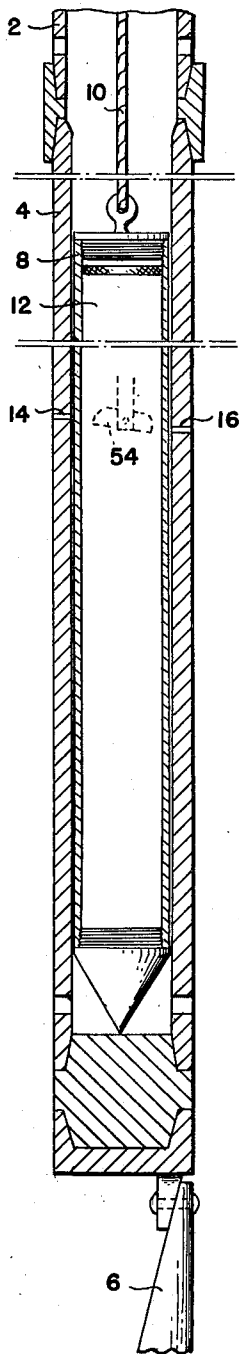


FIG. 1.

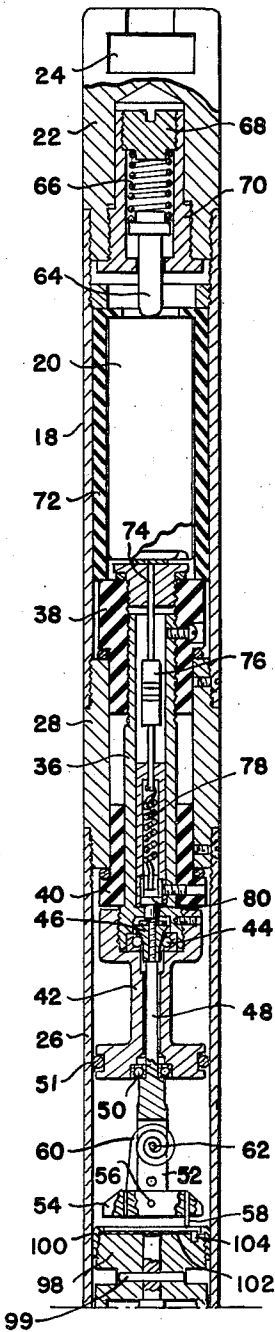


FIG. 2A.

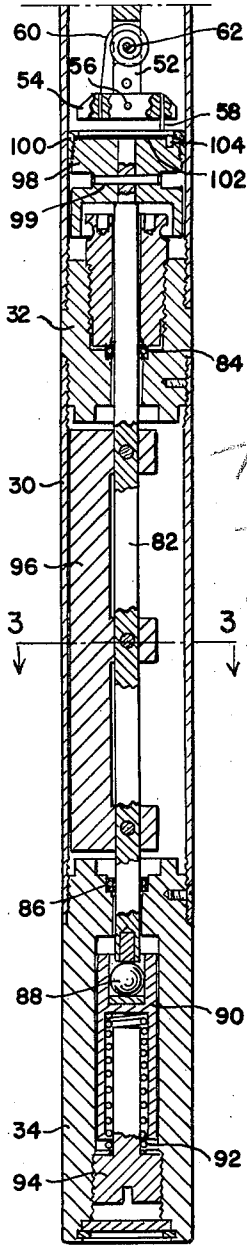


FIG. 2B.

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2 Sheets-Sheet 2

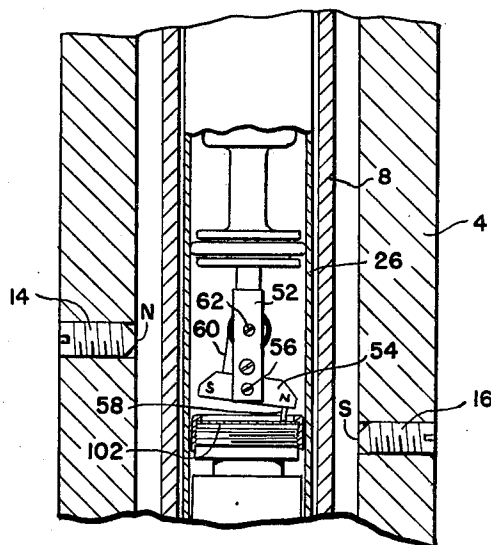


FIG. 4.

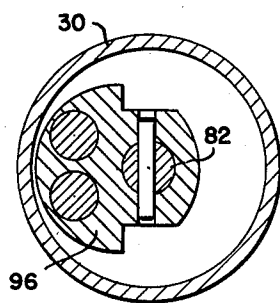


FIG. 3.

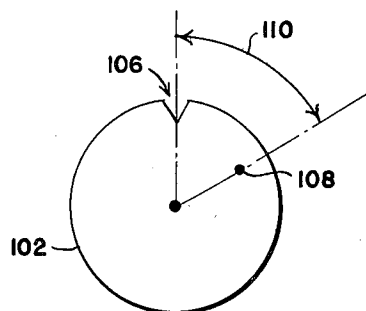


FIG. 5.

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APPARATUS FOR ORIENTING TOOLS IN A BORE HOLE

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Application October 4, 1955, Serial No. 538,320

9 Claims. (Cl. 255—1.6)

This invention relates to the drilling of wells and has particular reference to apparatus for orienting a tool, for example, a whipstock designed to guide a drill, in a definite direction as is necessary, for example, in straightening a crooked bore hole.

As is well known, many bore holes deviate considerably from the vertical during drilling thereof. If a bore hole deviates to a substantial degree from the vertical, it may entirely miss the locality which is believed to contain oil. Accordingly, it is the practice to insert within the bore hole a whipstock having a guiding surface at an angle to the axis of the bore hole to direct the drill in the desired direction to reach its objective. Obviously, it is necessary to properly orient the whipstock to insure that a proper correction for the direction of the bore hole will be made. For this and for other reasons which are well known in the art, it may be necessary to properly orient a tool which is to be located in a predetermined azimuthal position in a bore hole.

Heretofore various apparatus have been proposed for carrying out this purpose. These apparatus generally employ photographic or other type of record which must be removed from the instrument and developed or reproduced or otherwise requires manipulation and the consumption of time before the record can be read. Furthermore, these heretofore employed apparatus have required timing devices and other involved mechanical apparatus, or electrical apparatus to control their operation so that the record is made at the desired time and when the instrument is in the desired location in the drill stem. In the case of photographic instruments, the operation of the instrument is unsatisfactory under high temperature well conditions due to adverse effect of high temperatures on photographic film emulsions.

It is the object of this invention to provide an instrument requiring no timing devices, which will operate in short time intervals even under high temperature well conditions and produces a record which can be read immediately upon removal thereof from the instrument.

More specifically, it is the object of the invention to provide an electrochemical type of recording device which can be used whenever the inclination of a bore hole exceeds two or three degrees and when the direction of the inclination is known from previous directional surveys.

These and other objects of the invention relating particularly to the construction thereof will become apparent from the following description when read in conjunction with the accompanying drawings in which:

Figure 1 is a sectional view showing a drill stem supporting a whipstock and having located therein a position checking instrument;

Figure 2A is an enlarged partly sectional view of the upper portion of the position checking instrument;

Figure 2B is an enlarged sectional view of the lower portion of the position checking instrument;

Figure 3 is a transverse sectional view of a portion of the checking instrument taken on the trace 3—3 of Figure 2B;

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Figure 4 is an enlarged fragmentary vertical section of the instrument and drill stem; and

Figure 5 is a plan view of the record obtained by use of the checking instrument.

Referring to the figures there is illustrated therein a drill stem 2 the lower portion of which takes the form of a non-magnetic catcher 4 to which there is secured, in any conventional fashion, a whipstock or other tool 6. This connection may take the form, for example, of a rivet which may be sheared when it is desired to fix the whipstock in final position in the bore hole. The whipstock may be of any suitable type designed to be finally held in position either by penetration of the soil or by cementing.

An instrument designed to indicate the position of the whipstock with respect to the inclination of the bore hole is arranged to be lowered into the non-magnetic catcher 4. This instrument may comprise an outer protective casing 8 carried by a line 10. Within the protective casing 8 is the instrument proper 12 which is illustrated in detail in Figures 2A and 2B. The instrument contains a pivotally mounted magnet member and, consequently, it must be of non-magnetic construction to the extent of any parts which might effect the positioning of the magnetic member.

The non-magnetic catcher 4 carries permanent magnets 14 and 16 arranged to cooperate with the pivotally mounted magnet member within the instrument. These magnets are sufficiently powerful so that the effect of the earth field on the pivotally mounted magnet is negligible and so that the attracted ends of the pivotally mounted magnet will be held adjacent thereto regardless of the degree of inclination of the instrument.

The position recording instrument is shown in Figures 2A and 2B. The upper portion of the instrument comprises a casing 18 containing a battery 20 and enclosed by an upper cap 22 which is provided with conventional key slot 24 by means of which the instrument is mounted within the protective casing 8 shown in Figure 1. An intermediate casing 26 is connected to the lower end of the upper casing 18 by means of a coupling member 28. A lower casing 30 is connected to the lower end of the intermediate casing 26 by means of a coupling 32 and the lower end of the lower casing 30 is closed by a cap 34.

A sleeve 36 is mounted in the coupling 28 by means of insulating members 38 and 40. A guide member 42 is affixed to and extends downwardly from the lower end of the sleeve 36. The lower end of the sleeve 36 and the upper end of the guide 42 are formed with recesses within which is mounted a bearing 44 which rotatably supports a conical member 46 affixed to the upper end of a shaft 48 extending downwardly through the guide 42. The lower end of the shaft 48 is positioned within the guide 42 by means of bearings 50. The lower end of the guide 42 is provided with a circumferentially extending recess within which a rubber ring 51 is mounted serving to space the guide from the inner wall of the casing 26.

The lower end of the shaft 48 is formed with spaced downwardly extending plates 52 between which a magnet 54 is mounted on a pivot 56. The right-hand end of the magnet 54, as viewed in Figure 2B, mounts a downwardly extending stylus 58. The left-hand end portion of the magnet 54, as viewed in Figure 2B, mounts the outermost end of a light coil spring 60 the innermost end of which is positioned by a screw 62 extending between the spaced plates 52. The bearing 44 and the conical member 46 provide for rotation of the magnet 54 about the longitudinal axis of the instrument and the pivot 56 provides for rotation of the magnet 54 about an axis extending transversely of the instrument. The spring 60 is adjusted to normally position the mag-

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net 54 on a radial plane within the instrument casing. The spring 60 is not sufficiently strong to prevent rotation of the magnet 54 around the pin 56 as a result of the influence of the magnets 14 and 16 when they are adjacently positioned as will be described.

The upper end of the battery 20 is electrically connected to the casing 18 through a contact member 64, a spring 66 and a plug 68 in a sleeve member 70 threaded to the top cap 22. The battery is otherwise insulated from the sleeve 18 by means of an insulating sleeve 72.

Electrical connection is made from the center terminal of the lower end of the battery through a conductor 74, a current limiting resistor 76, and a spring 78 to a contact member 80 which is urged downwardly by the spring 78 against the upper surface of the rod 48 above the conical member 46. This electrical circuit is continued through rod 48, the plates 52 and to the magnet 54 through the coil spring 60.

A longitudinally extending rod 82 is rotatably mounted in bearings 84 mounted within the coupling 32 and bearings 86 mounted in the lower cap 34. The lowermost end of the rod 82 is supported on a ball 88 mounted within a member 90 slidably mounted in the cap 34 and supported by means of a spring 92 positioned on a plug 94 threaded into the lowermost end of the lower cap 34. A pendulous member 96 is affixed to the rod 82 in the region of the casing 30 and serves to cause rotation of the rod 82 as it seeks the lowermost position whenever the instrument is inclined.

A record mounting member 98 is affixed to the uppermost end of the rod 82 by means of a pin 99 and is provided with a rim 100 adapted to be threaded on or off the holder 98 and to secure to the uppermost surface thereof a record disc 102. The member 98 is positioned immediately below but normally spaced from the lower end of the stylus 58 carried by the magnet 54. The tension of the spring 60 is adjusted and the position of the spring is fixed by the screw 62 in order to insure the normal maintenance of a horizontal position by the magnet 54 and thus clearance between the lower end of the stylus 58 and the record disc 102. It will be evident that upon rotation of the pendulous member 96 and the shaft 82 the record disc 102 will also rotate. The record disc mounting member 98 is provided with a pin 104 which is adapted to fit within a notch 106 in the periphery of a record disc as shown in Figure 5.

The record member 102 may take various forms but preferably that of a member containing a material which, upon electrolysis will give a color change to indicate the point at which electrolysis is taking place. For example, a preferred form of record member consists of a disc of gelatin coated paper at least the gelatinized surface of which has been impregnated with blue ferrous ferrocyanide or ferric ferrocyanide and a solution of electrolyte salt. This type of record member is fully described in my Patent No. 2,246,319.

The lower surface of the record member 102 forms an electrical contact with the record mounting member 98 which is connected to the instrument casing through the rod 82, the ball 88 and the supporting means therefor. Thus, upon engagement of the stylus 58 with the surface of the record member 102, an electrical circuit is formed from the battery 20 through the conductor 74, the current limiting resistor 76, through the spring 78, the contact member 80, the shaft 48, the spring 60, the magnet 54, the stylus 58, the record member 102, the record holder 98 and the instrument casing to the pin 64 and the uppermost end of the battery 20.

In Figure 4 there is shown a fragmentary portion of the non-magnetic catcher 4 in the vicinity of the instrument magnet 54 when the instrument is seated in the catcher. It will be noted that the magnets 14 and 16 in the catcher are indicated as having north and south ends and the north end of the magnet 14 and the south end

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of the magnet 16 are their respective inner ends. When the magnet 54 comes into the position shown in Figure 4, its north end will be attracted toward the south end of magnet 16 and its south end will be attracted toward the north end of the magnet 14. Thus the magnet 54 will be rotated around the longitudinal axis of shaft 48 and into azimuthal alignment with the magnets 14 and 16. The magnet 54 will also be rotated about the horizontal axis 56 in an effort to lie in linear alignment with the adjacent ends of magnets 14 and 16. Upon this latter rotation, the stylus 58 will be moved downwardly against the urging of spring 60 into engagement with the surface of the record member 102. At this time the record member 102 will have been azimuthally positioned as the result of rotation of the shaft 82 by the pendulous member 96 seeking its lowermost position.

If the magnet 16 is positioned on the same side of the catcher 4 as the tool 6, as shown in Figure 1, and if the pin 104 entering the notch in the record disc is on the opposite side of the shaft 82 from the weight 96, then the record showing a dot, as indicated at 108 in Figure 5, will indicate the angle between the position of the tool fixed to the lower end of the catcher 4 and the uppermost side of the bore hole as being the angle 110 indicated in Figure 5.

In operation of the instrument, the instrument is assembled with a record disc 102 placed on the record holding member 98 and secured thereto by means of the rim 100 with the pin 104 extending through the notch 106 in the record disc. The position checking instrument may be lowered into the bore hole by means of a cable 10 as shown and, when it comes to rest in the non-magnetic catcher, the magnet member 54 will be inclined as previously described in connection with Figure 4 bringing the stylus into engagement with the surface of the record member 102 causing a record to be made. The position of the magnet 54 will be determined by magnets 14 and 16 and the position of the record disc 102 will be determined by the pendulous unit 96 and the shaft 82.

After the instrument has been at rest in the catcher for a sufficient period of time to allow the electrochemical action to make a suitable record dot on the record member, the instrument will be withdrawn from the bore hole and opened whereupon the record may be examined and the desired information obtained immediately.

It will be noted that in contradistinction to those systems employing photographic recording means, this apparatus does not require any timing means and the record members may be handled in the light and the instrument loaded and unloaded with a minimum of inconvenience. A further and most essential and desirable result obtained by the use of this instrument is that the record can be read immediately upon the withdrawal of the instrument from the bore hole. There is no time delay involved during which the record is developed or otherwise reproduced.

As previously noted, the desired position of the whipstock will have been determined from preliminary bore hole surveying data. A measurement of the angle 110 in the record produced by this apparatus will immediately indicate the actual position of the whipstock. If, after this actual position has been determined from a record 102, the drill stem may then be rotated a sufficient amount to bring the whipstock into the desired and predetermined position. The degree of rotation of the drill stem required to place the whipstock in the desired position can readily be determined from the angle 110 previously described and before the whipstock or other tool which may be involved is set in its final position, the checking instrument may again be lowered and a final record made and brought to the surface whereupon it may immediately be examined to determine whether the whipstock has been located in the desired position. If it has not yet been

located in the desired position, it may again be relocated and its position rechecked by the instrument until the desired whipstock position has been obtained.

It will be evident that this apparatus permits the orientation of a tool in a bore hole over a wide range of angles of inclination commencing with any angle sufficient to effect the pendulous unit. Angles exceeding two or three degrees are sufficient to actuate the pendulous unit. The apparatus avoids the use of timing devices and the time intervals required for the timing devices to operate. Due to the avoidance of the use of photographic film, the record member is of the type which will operate satisfactorily even under high temperature conditions and has the further advantage of not requiring development of the record. This results in the use of a record which may be freely exposed to daylight and which may be read immediately upon its recovery from the instrument. It will be evident that changes may be made in the specific embodiment of the instrument disclosed herein without departing from the scope of the invention as set forth in the following claims.

What is claimed is:

1. Apparatus for orienting a tool carried by a drill stem in a bore hole comprising a magnetic element carried by the lower portion of a drill stem, an instrument arranged to pass through said drill stem and come to rest in a predetermined longitudinal position therein, pendulous means mounted within said instrument for rotation on an axis extending longitudinally of said instrument in response to inclination of said instrument, a magnet and means mounting said magnet within said instrument in the vicinity of said magnet element when said instrument has come to rest in said predetermined position, said mounting means providing for rotation of said magnet on an axis extending longitudinally of said instrument in response to said magnetic element and for movement of a portion of said magnet generally longitudinally of said instrument in response to said magnet element, one of said pendulous means and said magnet including means mounting a record member moveable therewith and the other mounting means for engaging the surface of a mounted record member, said record mounting means and said engaging means being positioned to provide engagement of said engaging means and a positioned record member upon longitudinal movement of said magnet in response to said magnet element.

2. Apparatus for orienting a tool carried by a drill stem in a bore hole comprising a magnetic element carried by the lower portion of a drill stem, an instrument arranged to pass through said drill stem and come to rest in a predetermined longitudinal position therein, pendulous means mounted within said instrument for rotation on an axis extending longitudinally of said instrument in response to inclination of said instrument, a magnet and means mounting said magnet within said instrument in the vicinity of said magnet element when said instrument has come to rest in said predetermined position, said mounting means providing for rotation of said magnet on an axis extending longitudinally of said instrument in response to said magnetic element and for movement of a portion of said magnet generally longitudinally of said instrument in response to said magnet element, one of said pendulous means and said magnet including means mounting a record member moveable therewith and the other mounting means for engaging the surface of a mounted record member, said record mounting means and said engaging means being positioned to provide engagement of said engaging means and a positioned record member upon longitudinal movement of said magnet in response to said magnet element, and yielding means urging said engaging means away from a positioned record member except when said instrument is in said predetermined position and said yielding means is overcome by the action of said magnetic element.

3. Apparatus for orienting a tool carried by a drill stem

in a bore hole comprising a magnetic element carried by the lower portion of a drill stem, an instrument arranged to pass through said drill stem and come to rest in a predetermined longitudinal position therein, pendulous means mounted within said instrument for rotation on an axis extending longitudinally of said instrument in response to inclination of said instrument, a magnet, and means mounting said magnet within said instrument in the vicinity of said magnet element when said instrument has come to rest in said predetermined position, said mounting means providing for rotation of said magnet on an axis extending longitudinally of said instrument in response to said magnetic element and for rotation of said magnet on an axis extending transversely of said instrument in response to said magnet element, one of said pendulous means and said magnet including means mounting a record member moveable therewith and the other mounting means for engaging the surface of a mounted record member, said record mounting means and said engaging means being positioned to provide engagement of said engaging means and a positioned record member upon rotation of said magnet around said transversely extending axis in response to said magnet element, and yielding means urging said engaging means away from a positioned record member except when said instrument is in said predetermined position and said yielding means is overcome by the action of said magnetic element.

4. Apparatus for orienting a tool carried by a drill stem in a bore hole comprising a magnetic element carried by the lower portion of a drill stem, an instrument arranged to pass through said drill stem and come to rest in a predetermined longitudinal position therein, pendulous means mounted within said instrument for rotation on an axis extending longitudinally of said instrument in response to inclination of said instrument, a magnet and means mounting said magnet within said instrument in the vicinity of said magnet element when said instrument has come to rest in said predetermined position, said mounting means providing for rotation of said magnet on an axis extending longitudinally of said instrument in response to said magnetic element and for movement of a portion of said magnet generally longitudinally of said instrument in response to said magnet element, one of said pendulous means and said magnet including means mounting a record member moveable therewith and the other mounting means for engaging the surface of a mounted record member, said record mounting means and said engaging means being positioned to provide engagement of said engaging means and a positioned record member upon longitudinal movement of said magnet in response to said magnet element, said record member being capable of being marked electrolytically by the passage of an electric current and means within said instrument providing for a flow of electric current between said record member and said record member engaging element.

5. Apparatus for orienting a tool carried by a drill stem in a bore hole comprising a pair of magnetic elements carried on spaced radial planes and on diametrically opposite sides of the lower portion of a drill stem, an instrument arranged to pass through said drill stem and come to rest in a predetermined longitudinal position therein, pendulous means mounted within said instrument for rotation on an axis extending longitudinally of said instrument in response to inclination of said instrument, a magnet and means mounting said magnet within said instrument between the two radial planes of said pair of magnetic elements when said instrument has come to rest in said predetermined position, said mounting means providing for rotation of said magnet on an axis extending longitudinally of said instrument in response to said magnetic element and for rotation of said magnet on an axis extending transversely of said instrument in response to said magnet elements, one of said pendulous means and said magnet including means mount-

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ing a record member moveable therewith and the other mounting means for engaging the surface of a mounted record member, said record mounting means and said engaging means being positioned to provide engagement of said engaging means and a positioned record member upon rotation of said magnet around said transversely extending axis in response to said magnet elements.

6. Apparatus for orienting a tool carried by a drill stem in a bore hole comprising a pair of magnetic elements carried on spaced radial planes and on diametrically opposite sides of the lower portion of a drill stem, an instrument arranged to pass through said drill stem and come to rest in a predetermined longitudinal position therein, pendulous means mounted within said instrument for rotation on an axis extending longitudinally of said instrument in response to inclination of said instrument, a magnet and means mounting said magnet within said instrument between the two radial planes of said pair of magnetic elements when said instrument has come to rest in said predetermined position, said mounting means providing for rotation of said magnet on an axis extending longitudinally of said instrument in response to said magnetic element and for rotation of said magnet on an axis extending transversely of said instrument in response to said magnet elements, one of said pendulous means and said magnet including means mounting a record member moveable therewith and the other mounting means for engaging the surface of a mounted record member, said record mounting means and said engaging means being positioned to provide engagement of said engaging means and a positioned record member upon rotation of said magnet around said transversely extending axis in response to said magnet elements, said record member being capable of being marked electrolytically by the passage of an electric current and means within said instrument providing for a flow of electric current between said record member and said record member engaging element.

7. Apparatus for orienting a tool carried by a drill stem in a bore hole comprising a magnetic element carried by the lower portion of a drill stem, an instrument arranged to pass through said drill stem and come to rest in a predetermined longitudinal position therein, pendulous means mounted within said instrument for rotation on an axis extending longitudinally of said instrument in response to inclination of said instrument and including means rotating therewith for positioning a record member transversely of said instrument, a magnet, means mounting said magnet within said instrument adjacent to a positioned record member and in the vicinity of said magnet element when said instrument has come to rest in said predetermined position, said mounting means providing for rotation of said magnet on an axis extending longitudinally of said instrument and for movement of a portion of said magnet toward and away from the record member, and means moveable with said magnet in response to said magnetic element for engaging the surface of said record member.

8. Apparatus for orienting a tool carried by a drill stem in a bore hole comprising a magnetic element carried by the lower portion of a drill stem, an instru-

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ment arranged to pass through said drill stem and come to rest in a predetermined longitudinal position therein, pendulous means mounted within said instrument for rotation on an axis extending longitudinally of said instrument in response to inclination of said instrument and including means rotating therewith for positioning a record member transversely of said instrument, a magnet, means mounting said magnet within said instrument adjacent to a positioned record member and in the vicinity of said magnet element when said instrument has come to rest in said predetermined position, said mounting means providing for rotation of said magnet on an axis extending longitudinally of said instrument and for movement of a portion of said magnet toward and away from the record member, means moveable with said magnet in response to said magnetic element for engaging the surface of said record member, and yielding means urging said engaging means away from a positioned record member except when said instrument is in said predetermined position and said yielding means is overcome by the action of said magnetic element.

9. Apparatus for orienting a tool carried by a drill stem in a bore hole comprising a magnetic element carried by the lower portion of a drill stem, an instrument arranged to pass through said drill stem and come to rest in a predetermined longitudinal position therein, pendulous means mounted within said instrument for rotation on an axis extending longitudinally of said instrument in response to inclination of said instrument and including means rotating therewith for positioning a record member transversely of said instrument, a magnet, means mounting said magnet within said instrument adjacent to a positioned record member and in the vicinity of said magnet element when said instrument has come to rest in said predetermined position, said mounting means providing for rotation of said magnet on an axis extending longitudinally of said instrument and for movement of a portion of said magnet toward and away from the record, means moveable with said magnet in response to said magnetic element for engaging the surface of said record member, and yielding means urging said engaging means away from a positioned record member except when said instrument is in said predetermined position and said yielding means is overcome by the action of said magnetic element, said record member being capable of being marked electrolytically by the passage of an electric current and means within said instrument providing for a flow of electric current between said record member and said record member engaging element.

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