166-66

Nov. 29, 1966 H. L. BRYANT 3,288,210

ORIENTING METHOD FOR USE IN WELLS

Filed Nov. 4, 1963 4 Sheets-Sheet 1

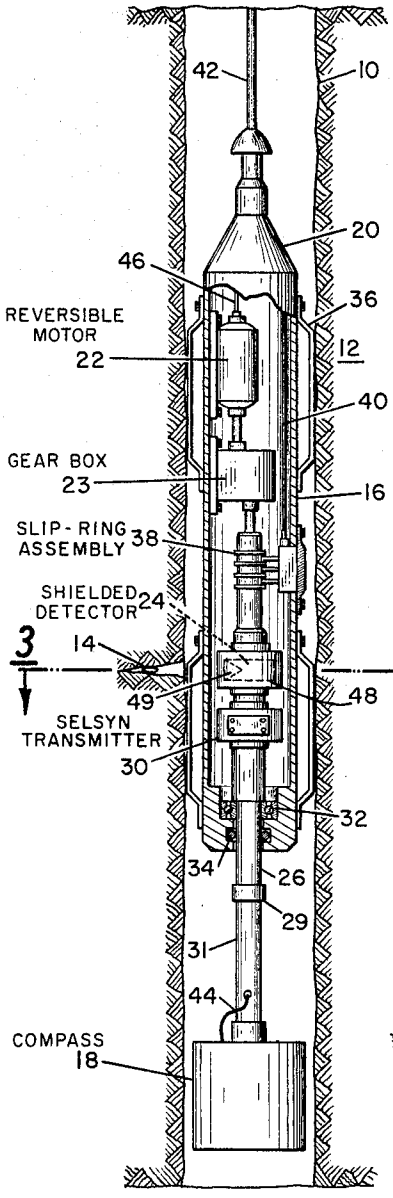


FIG. 1

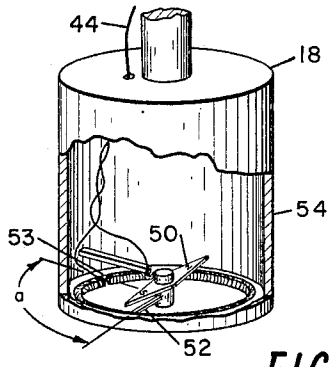


FIG. 2

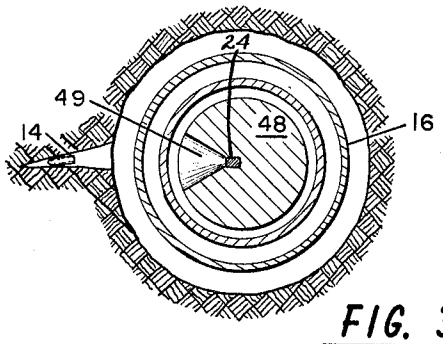


FIG. 3

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ORIENTING METHOD FOR USE IN WELLS

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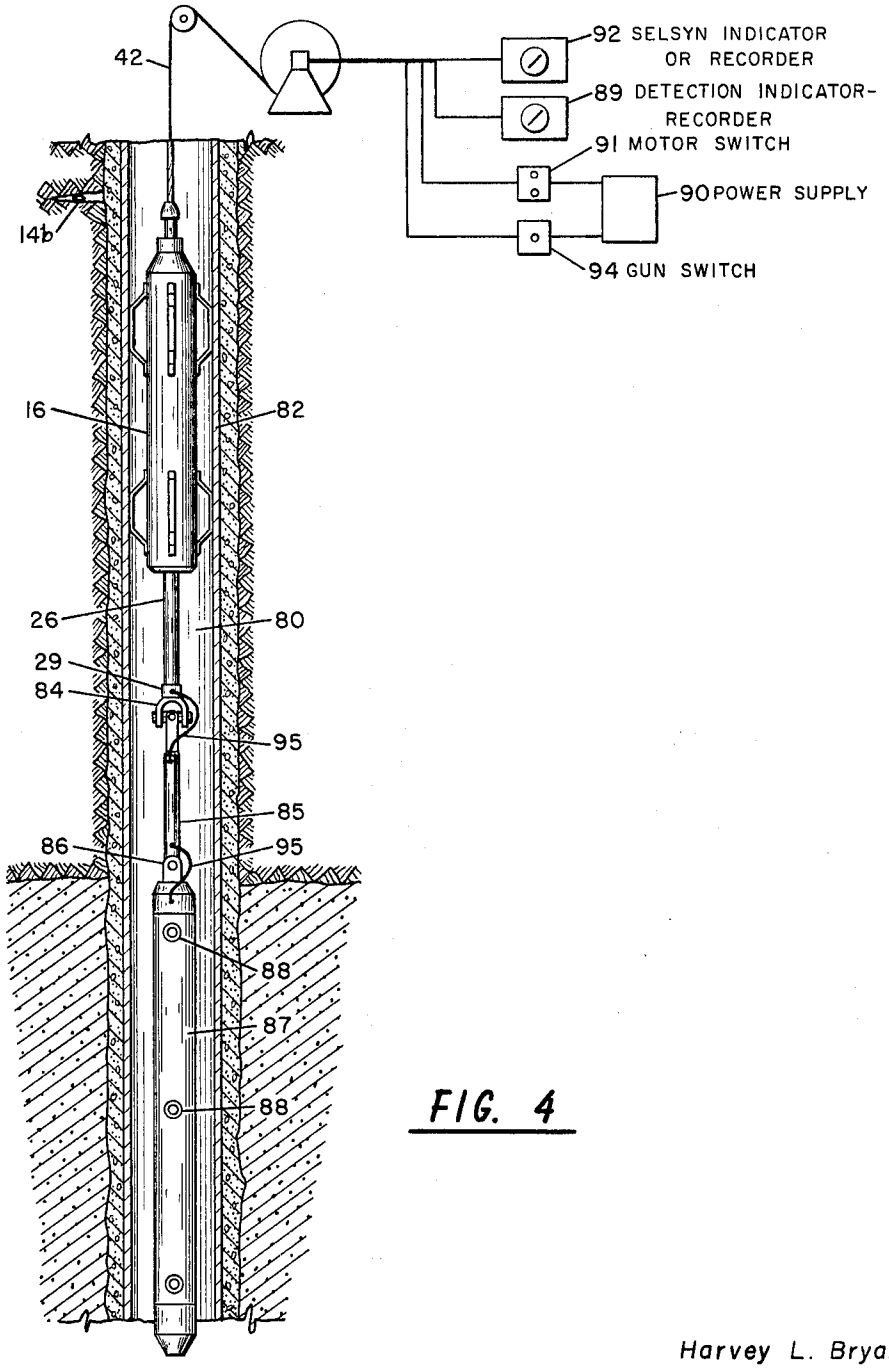


FIG. 4

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ORIENTING METHOD FOR USE IN WELLS

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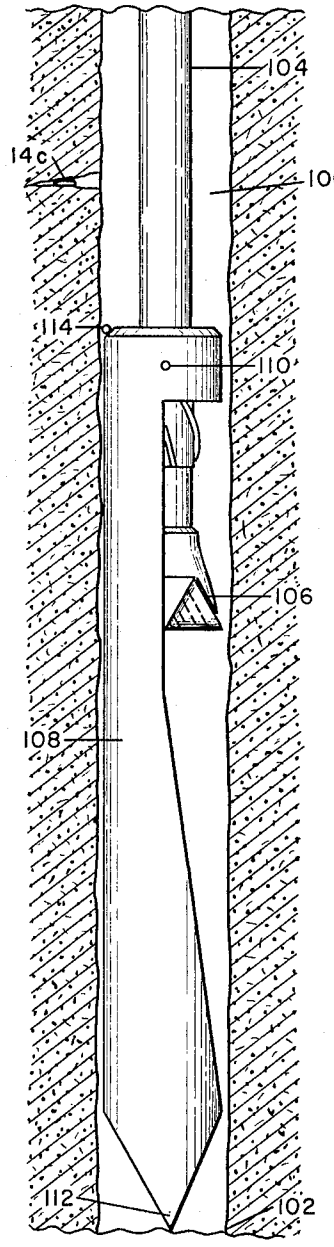


FIG. 5

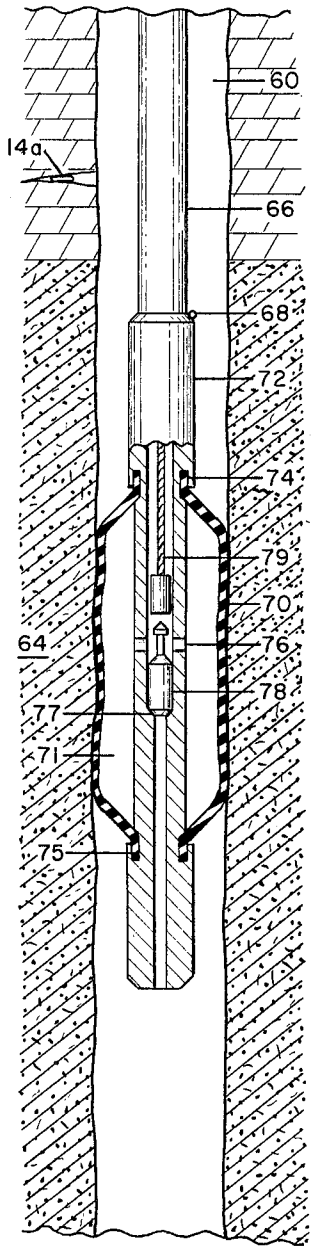


FIG. 6

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ORIENTING METHOD FOR USE IN WELLS

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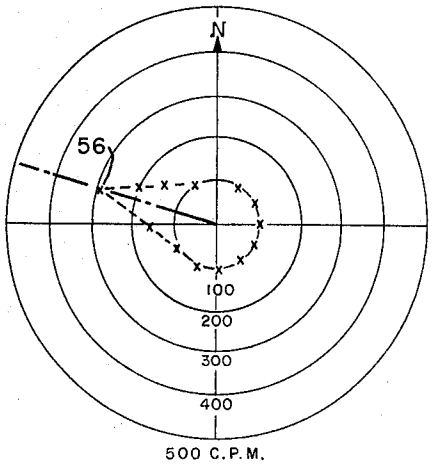


FIG. 7

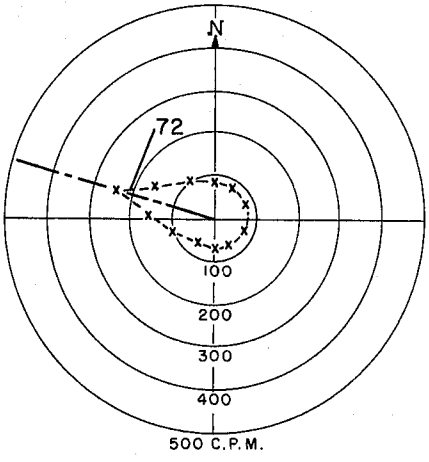


FIG. 8

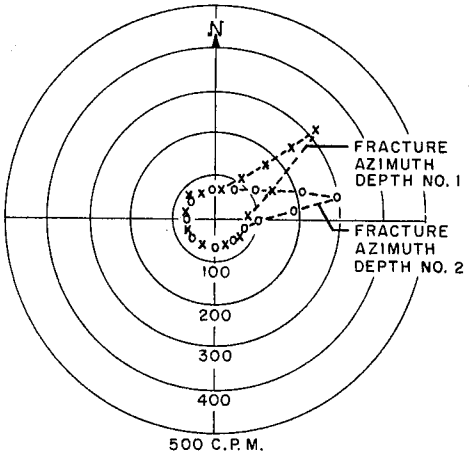


FIG. 9

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United States Patent Office 3,288,210 Patented Nov. 29, 1966

3,288,210

ORIENTING METHOD FOR USE IN WELLS

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Filed Nov. 4, 1963, Ser. No. 321,229
4 Claims. (Cl. 166—4)

The present invention concerns a system for orientation of operations within a well bore. More particularly, the invention relates to an apparatus and method for determining the orientation of well logging or other instruments or devices in a cased hole although it does find use in certain uncased borehole operations.

In conducting various operations in the drilling or logging or completion of wells drilled into the earth, it is quite frequently desirable to know the orientation of a tool or exploring device or the like in the remote location of the borehole. For example, in uncased boreholes it is frequently desirable to determine the orientation of natural fractures; in cased boreholes, it is frequently desirable to perforate at a given azimuth with respect to North, and in determining the orientation of man-made fractures.

In the past, various means have been provided for orienting downhole operations. For example, various compass devices have been designed for such downhole operations. While they are quite helpful in certain instances, they have certain rather serious limitations in that they cannot be successfully used in boreholes which have been cased with steel pipe, nor can they be used successfully where there is a large amount of steel in the tool which is being used or inside a metallic drill string. One method of completing a well is to set casing through the producing formation and then perforate the casing by the lowering of a gun perforator to the selected stratum and firing the gun through the casing. Under existing practices, the direction with respect to North which the gun is fired is not usually known. A compass cannot be used in cased boreholes and gyroscopes are usually too large or otherwise expensive.

Certain refined recovery processes can be more effectively operated if the direction of the perforating of casing can be determined and controlled. Also, many formations when subjected to fracturing pressures, fracture in planes having generally the same direction. If the direction of the planes of the fracture can be determined, then wells can be spaced and oriented with respect to North to take advantage of such knowledge. It is thus seen that there is a need for the reliable orientation of various logging, perforation and other operations performed within a well bore so that the actual directions of such orientation with respect to North can be accurately determined at any time within the life of the well.

Briefly, this invention includes a method of orienting an operation or a tool within a well bore drilled into a subterranean formation. A radioactive mass is placed in the wall of the well bore such as by the firing of a radioactive bullet into the formation. The bullet is placed in the well bore preferably not too far vertically from the proposed subsequent operations. The horizontal orientation of this mass, that is, its azimuth with relation to North, is determined. Subsequent logging or other operations are oriented from and in relation to the radioactive mass whose azimuth is known. The azimuth of the radioactive bullet can be determined in a cased hole or with tools using a considerable amount of steel.

Various objects and a better understanding of the invention can be had with the following description taken in conjunction with the drawings in which:

FIG. 1 illustrates a tool useful in determining the azimuth of a fired radioactive bullet.

FIG. 2 illustrates schematically a remote magnet for use with the device shown in FIG. 1.

FIG. 3 is a section through line 3—3 of FIG. 1.

FIG. 4 illustrates a tool useful for orienting a perforating gun.

FIG. 5 illustrates a means of orienting a whipstock drilling operations.

FIG. 6 illustrates an inflated impression packer in an uncased portion of a borehole.

FIG. 7 illustrates a plot of radiation intensity in an open hole to locate the azimuth of a radioactive bullet.

FIG. 8 illustrates a plot of a radiation intensity in a cased hole to locate the bullet azimuth.

FIG. 9 illustrates plots of radiation to locate a fracture.

Referring to the drawing and FIG. 1 in particular, there is shown a borehole **10** penetrating a subsurface formation **12**. A radioactive bullet or mass **14** has been randomly shot into formation **12**. The borehole in FIG. 1 is open hole—that is, it has no casing set therein. Before discussing the apparatus shown in FIG. 1, a brief discussion will be given on radioactive bullet **14**. The radioactive bullet can be an iodine isotope. The radioactive material should have a half life of at least as long as it is contemplated that operations needing orientation with respect to North may be performed in the well. For example, the radioactive bullets should remain active for many years, for example, thirty to forty years or longer. The radioactive material **14** is placed reasonably close vertically to the point in the well bore at which a subsequent operation requiring orientation is to be performed. For example, for use in a subsequent fracturing operation, bullet **14** is placed at a point approximately 20 feet, for example, above the zone to be fractured. In general, bullet **14** should be close enough to the area of operation, i.e., the area at which subsequent orientation is to be conducted, so that when the radioactive detector tool, described hereinafter, is lowered or raised from the radioactive bullet to the area of operation, the tool does not rotate any substantial amount. It is normally preferred that the radioactive bullet be placed above or below the area at which orientation operations may be conducted in the fracture so that other operations will not dislodge the bullet or cause mistaken readings and the like.

Shown in FIG. 1 is a device for locating the orientation of radioactive bullet **14**. Included therein is remote reading or recording radioactive directional detector **24** and a remote recording compass **18** connected below the the detector **24**. Radioactive directional detector tool **16** is similar to that described in co-pending patent application Serial No. 780,387 filed December 15, 1958 for John C. McDuffie, Jr. Tool **16** includes a housing **20** in which is arranged a reversible motor **22**, operable from the surface, and to which is connected a gear box **23**, which in turn is connected to a rotatable shaft **26**. This shaft **26** is connected to radiation detector **24** and a selsyn transmitter **30**. Shaft **26** extends through the lower end of housing **20** and connects with the housing of compass **18** in a fixed position through a collar or union or other desirable connectable joint **29**, and a subshaft **31**. Subshaft **31** is made of a nonmagnetic material and is of a length to place compass **18** at a position sufficiently removed from detector tool **16** so that any magnetic material in the detector tool does not seriously interfere with the compass.

Housing **20** is provided with bearings **32** which permit shaft **26** to rotate relative to housing **20** and sealing means such as O rings **34** are adapted to prevent fluid from entering housing **20**. Drag springs **36** are arranged on the exterior of housing **20** and function to prevent rotation of housing **20** and to centralize the housing. The latter

function is desired in order to maintain consistent radiation detection readings in any direction. Shaft **26** is provided with a slip ring assembly **38** for conducting electrical signals transmitted through a multiple conductor cable **40** which in turn is connected to multiple conductor cable **42** which leads to the surface. Conductor **44** conducts signals from compass **18** through one of the slip rings of assembly **38** to one conductor of multiple conductor **40** which is connected to multiple conductor cable **42** which extends to the surface. Other slip rings of assembly **38** conduct electrical signals from detector **24** to other conductors within multiple conductor unit **40** to multiple conductor cable **42** which transmits such electrical signals from the detector **24** to the surface. A conductor **46** connects multiple conductor cable **42** to motor **22**; thus, there are individual electrical connections between the surface and motor **22**, from the surface to detector **24** and from the surface to compass **44**. Selsyn motor or transmitter **30**, mounted about shaft **26**, is connected through one ring of assembly **38** through a conductor circuit in multiple cables **40** and **42** to a selsyn indicator **92** located at the surface and as shown in FIG. 4. Selsyn transmitter **30** is not needed for operations in which compass **18** is operative but is useful in other operations discussed hereinafter.

Detector **24** is provided with a shield **48** having a window **49** so designed to confine the area of detection to a limited arc, as for example, an arc of 15° of the well bore. This limited arc of investigation is more clearly seen in FIG. 3.

Compass **18** can be any compass which gives a remote reading at the surface of the direction in which a reference point on the tool is directed. For example, it can comprise, as shown in FIG. 2 a magnetic needle **50** which actuates a wiper **52** of a potentiometer **54**. The measured resistance corresponds to the azimuth (angle *a*) of contact **53** which is taken as a reference electrode in defining the instrument position. The housing of potentiometer **54** is fixed with respect to shaft **26**. The relationship of the radial position of reference contact **53** of potentiometer **54** and window **49** are the same or are known. Thus, by measuring the resistance of potentiometer **54**, the direction of window **49** of detector **24** is at all times known. A suitable compass can be similar to that shown in U.S. Patent 2,609,513.

An important step in the system of this invention is the determination of the horizontal azimuth or radial position or orientation of radioactive bullet **14** with respect to a standard direction such as magnetic north. Attention will now be directed to the operation of the tool in FIG. 1 for determining the azimuth with respect to north of radioactive bullet **14**. As stated above, radioactive bullet **14** is shot at random into the borehole wall. Such means for doing this are known. After bullet **14** has been placed in the formation, the tool shown in FIG. 1 is lowered into the open hole to the depth at which bullet **14** was fired. Means, such as bow or drag springs **36**, are provided to prevent the tool from rotating. When the tool is placed in the borehole opposite bullet **14**, its radial orientation is immediately known by the signal received at the surface through conductor **44** from compass **18**. The actual radial position of window **49** can be aligned at the corresponding radial position of FIG. 7 with respect to north. Reversible motor **22** is then started and continuous readings or spot readings are made of the intensity detected by detector **24** as it is rotated 360°. As detector **24** is rotated, shield **48** permits detector **24** to detect radiation only in a limited arc described by window **49** as the arc sweeps around 360° of the borehole. As shown in FIG. 7 a chart or record is made of the intensity of the radiation detected as the detector sweeps around the circumference of the borehole. The radiation from bullet **14** is of much greater intensity than that of the rest of the borehole. Thus, when the window of the shielded detector, which can be a standard commercially available sector-type gamma ray logging tool, points in the direction of the radioactive bullet, the increase in radiation caused by the radioactive bullet gives a large increase in reading as shown at **56** on the chart of FIG. 7. The azimuth of bullet **14** with response to magnetic north is thus located accurately as the position of the compass **18** is recorded or known at the time the detector detects or points in the direction of the radioactive bullet as indicated by the detection of maximum radiation intensity. On the chart of FIG. 7, from the center outwardly reflects an increase in radiation detected by detector 24. Such a chart as shown in FIG. 7 is made by a suitable detector recorder or can be manually plotted as illustrated by the *x*'s of FIG. 7. In FIG. 4 reference numeral **89** represents a detection indicator and/or recorder.

After the radioactive bullet has been shot into the formation and its azimuth determined, many different operations can be conducted from the marker thus established. For example, the system of the invention is especially useful in precisely locating the depth, azimuth, and nature of naturally occurring fractures in open hole. The determination of depth and azimuth of naturally occurring fractures is quite important to improve the engineering of secondary recovery projects, that is, where a driving fluid is injected through one well and fluid is produced from a second well. For example, the Sprayberry Field in West Texas utilizes wells located along azimuth of natural fracture systems. It was found there, after a long and tedious reservoir engineering study, that the natural fractures of the system extended in planes which were more or less parallel, i.e., all in the same direction. The permeability in the direction of the azimuth of the natural fractures of the system was about 144 times greater than the permeability perpendicular to the trend of the natural fracturing system.

In the practice of this system for determining the natural azimuth of natural fractures, a radioactive bullet **14***a* is first shot into the formation and then its orientation or its azimuth is determined as well as its depth. This is similar as described above in relation to FIG. 1 and FIG. 3. Attention is next directed to FIG. 6. Shown in FIG. 6 is a standard impression packer which can, for example, be a Lynes "Pip" packer which is described on page 3085 of the 1962–63 Composite Catalog of Oil Field Equipment and Services, published by World Oil, Houston, Texas. Shown thereon is a hole **60**. A tubing **66** is suspended from the surface within the borehole. The packer of FIG. 6 has been modified from the standard version. A radioactive bead **68** is fixed at one radial position on the packer assembly and the packer assembly is supported from the lower end of tubing **66**. The packer assembly includes an elastic inflatable sealing element **70** which is made, for example, from a resilient resistant rubber. The packer includes a hollow mandrel **72** which is secured to the lower end of tubing **66**. The interior of mandrel **72** is in fluid communication with the interior of tubing **66**. The ends **74** and **75** of sealing element **70** are sealings affixed to the exterior of mandrel **72**. Ports **76** provide fluid communication between the interior of mandrel **72** and the interior **71** of sealing element **70**. Mandrel **72** has a valve seat **77** below port **76**. A wire-line operated dog **78** seats or mates with seat **77** so as to close the lower ends of the interior of mandrel **72**. The dog **78** is retrievable by wire line **79** to which a conventional overshot latch is attached.

The packer element **70** is inflated in a normal manner in the open hole at the depth corresponding to formation **64** where it is desired to determine the orientation of naturally occurring fractures. For example, dog **78** is dropped against seat **77** closing the lower end of mandrel **72**. The tubing is filled with fluid and pressure is applied to the fluid and held. The packer is thus set. When the packer **70** is expanded against the borehole wall, it is expanded with such pressure that any fractures or cracks

in the borehole wall are indicated on the exterior of packer element **70** inasmuch as the rubber material tends to be forced into such fissures or fractures and such indications are observable when the tool is removed to the surface. After the packer has been inflated, it is held long enough for impressions to set up which need take only a relatively short period of time depending on the rubber, but in most cases will be from about five minutes to an hour.

When packer **70** is set by inflation, radioactive bead **68** is also set in a fixed position. At this time, detector tool **16**, shown in FIG. 1 from which compass **18** has been removed as by manipulation of joint **29**, is lowered through tubing **66** until it reaches the depth of radioactive bullet **14***a*. At this time, the tool is operated similarly as in the obtaining of the chart of FIG. 7. This time the plot of the radiation intensity is made through or from within the tubing to locate the bullet azimuth as illustrated in FIG. 8 which shows the maximum intensity when the tool window **49** is pointed toward the active bullet as illustrated at **72**. Thus, it is known that when the window of the detector **24** reaches maximum intensity it is at the azimuth previously determined when the compass **18** was connected to the tool in open hole. Thus, the orientation of tool **16** with respect to north is known. The detector tool **16** is then lowered a short distance until it is adjacent radioactive bead **68** fixed to the packer mandrel. This is easily accomplished as it is known how many joints of tubing are suspended in the well bore and the exact depth to bead **68** is known. When the tool **16** is lowered the short distance, it is in substantially the same radial position as it was when it surveyed the radioactive bullet **14***a*.

The azimuth is next determined for the bead **68** which is done in a manner similar to that described above with regard to the radioactive bullet **14**. A plot of intensity of radiation detected is plotted as detector **16** is rotated. Such a plot is similar to that shown in FIG. 8 with the point of maximum intensity being pointed toward bead **68**. The exact radial position of bead **68** in relation to the bullet is known as selsyn indicator **92**, shown in FIG. 4, shows or indicates the rotation of detector **24** from its position at which window **49** was adjacent bullet **14***a*. As the horizontal azimuth of the bullet **14***a* is known, from previous determinations, then the orientation of the bead **68** is known. This determines the orientation of packer element **70** with respect to north. After the packer has been inflated long enough to obtain impressions thereon, pressure is equalized across the packer by removing dog **78** with a wire line overshot. The packer is then removed to the surface where it is examined. When the packer **70** is removed to the surface, the impressions on the packer can be studied and observed and an orientation of the fractures with respect to north can be determined precisely and accurately.

In some operations it is desired to perforate, in a specific direction, a casing which has been set in a borehole. An example of such a situation is when it is desired to inject a fluid from one well bore to drive formation fluid toward a second well bore. In such instances it is frequently desired that the casing in the first well be perforated in the radial direction toward the second or producing well. Attention is now directed to FIG. 4 which shows a well bore **80** having casing **82** suspended therein. In this system, the radioactive bullet **14***b* was shot into the formation and its orientation determined as shown above in regard to bullet **14** before casing **82** was set. Tool **16** can be similar to the tool to that shown in FIG. 1. However, in FIG. 4 compass **18** has been disconnected by manipulation of joining means **29**. In FIG. 4, connected to shaft **26** of tool **16** is a swiveled joint **84**. Extension joint **85** is connected to flexible joint **84**. At the lower end of extension **85** is a second flexible joint **86** to which is connected gun perforator **87**. Gun perforator **87** has gun elements **88** which are arranged in a vertical row and are of a character such that when fired, are all fired in the same radial direction within the borehole. Gun perforator **87** is connected through conductor **95** and multiple conductor cable **42** to gun switch **94**. When it is desired to perforate in a selected direction, the tool as shown in FIG. 4 is lowered through the casing **82** until the detector **24** of tool **16** is opposite bullet **14***b*. At this time detector **24** is rotated until the bullet is detected as illustrated above in regard to FIG. 8. When detector **24** is rotated, the gun perforator **87** is also rotated as they are both nonrotatably connected to shaft **26**. After the orientation of window **49** is determined the entire tool is lowered until gun perforator **87** is in the vertical position at which it is desired to perforate the casing **82**. As the tool can be lowered several feet without any substantial rotation within the casing, e.g. 50 to 100 feet, the direction in which gun elements **88** are pointed are known. In other words, the direction of fire of gun elements **88** is fixed relative to the location of the radioactive bullet **14***b*. Detector **24** then may be rotated by means of motor **22** to a position wherein the direction of fire is that selected at the surface. The gun elements are then fired by means of gun switch **94** in a conventional manner. A power supply **90** is provided for motor switch **91** and the gun switch **94**.

In the drilling of boreholes in the ground, quite frequently it is desired to directionally deviate such holes. Directionally deviating means to change the drilling of the hole from the vertical to an angle with the vertical in a desired direction. A typical example of such a situation is when it is desired to drill several wells from one location. This can occur when the location of the drilling derrick is on land and the location at which the well bore is desired to penetrate the producing formation is under water. One of the problems in such directional drilling is the determination of the direction in which the directional deviation tool is oriented. This invention includes a system whereby the direction of the tool can be accurately determined and oriented.

Attention is now directed to FIG. 5. Shown thereon is a borehole **100** in which a radioactive bullet **14***c* has been placed at a point above the elevation indicated at **102** where it is desired to start deviating the hole **100** from the vertical. Shown in well **100** is tubular drill string **104** suspended in a conventional manner from the surface by equipment not shown. At the lower end of drill pipe **104** is a bit **106**. A whipstock **108** is shown suspended from casing **104**. A radioactive bead **114** is placed off-center on the upper portion of whipstock **108** similarly as bead **68** of FIG. 6 to form an orienting point. A shear pin **110** connected to drill string **104** just above bit **106** supports the whipstock **108** in a fixed relationship with the drill string until the shear pin is sheared. The whipstock illustrated in FIG. 5 can, for example, be any well-known commonly used whipstock such as the Homco circulating and releasing whipstock shown on page 247 of the above-mentioned Composite Catalog of Oil Field Equipment and Services.

Before drill pipe **104** and whipstock **108** are positioned as shown in FIG. 5, a radioactive bullet **14c** is randomly shot into the borehole at a point which will be slightly above shear pin **110**. The azimuth of bullet **14***c* with respect to North is then determined as shown above. The drill pipe-whipstock combination shown in FIG. 5 is then lowered to where the point **112** of the whipstock is just above the bottom of the borehole so that the whipstock can be rotated easily. A tool **16** is then lowered to the wellbore until it is opposite radioactive bullet **14***c*. At that time the orientation of the tool **16** is determined with respect to the bullet by rotating detector **24** until window **49** is facing bullet **14***c*. Tool **16** then is lowered from the level of bullet **14c** down to where the detector **24** is at the same depth as bead **114**. The detector is then rotated by reversible motor **22** and a record or indication made of the azimuth or radial location of bead **114** with respect to the azimuth of bullet **14***c* which is the same

azimuth as the position of window **49** prior to rotation of detector **24**. The radial relationship determines the direction at which the whipstock will direct the bit. As it is known which direction it is desired to direct the bit and the azimuth with respect to North of the radioactive bullet **14***c* is known, then the required radial relationship of the bullet **14***c* and radioactive bead **114** can be determined. The drill pipe is then rotated from the surface until this relationship is obtained.

Alternatively, tool **16** may be lowered to adjacent bead **114** initially. Detector **24** then is rotated until window **49** faces bead **114**. When tool **16** is in this position, it is raised to the level of bullet **14***c*. The drill pipe is then rotated until a maximum reading is obtained which occurs when window **49** of detector **24** faces bullet **14***c*. The whipstock then can be properly oriented with respect to the direction of the radioactive bullet **14***c*, and consequently, with respect to North by rotating the drill string and placing the face of the whipstock in any desired direction, as selected at the surface. At this time, the whipstock is properly oriented with the direction as selected at the surface. At this time, pressure or force is applied to whipstock **108** as by letting the weight of the drill string downwardly onto the whipstock. The point of whipstock **112** is then set in the borehole. Additional pressure shears shear pin **110**, then the bit is guided off the face of the whipstock and drilling proceeds in desired direction.

In recent years hydraulic fracturing procedures for increasing fluid production from subterranean formations have been used quite extensively. Basically, these hydraulic methods consist of pumping fluid into a formation, which contains fluid desired to be produced, under sufficient pressure to cause fracturing of the formation under treatment. The hydraulic pressure applied is sufficient to overcome rock stresses, thus creating a parting or fracturing within the formation. When the formation fractures, pumping of the fracturing fluid into the formation is continued so as to enlarge the fracture and extend them away from the well bore. Usually the fluid injected carries suspended grains of material which remain in the fractures as a propping agent to keep the fractures from closing when applied pressure of the fracturing fluid on the rock formation is released. Quite frequently such hydraulic fracturing method is performed in formations through which a casing has been set and the fracturing fluid is injected through perforations of the casing.

Studies of reservoir engineering can be greatly improved or simplified if it can accurately be determined what the orientation of the man-made fractures are. The system of this invention permits the accurate determination of the azimuth or orientation of the fractures behind cased well bores. To accomplish this, a radioactive bullet is shot into the wall of the well bore before the casing is run at a point either above or below where the fracturing is to take place. The orientation with respect to North of the radioactive bullet is determined as described above in relation to bullet **14** in FIG. 1. After the azimuth with respect to North of the radioactive bullet is determined, casing is set in the well bore in the usual manner. After the casing is set, it is perforated. Then a hydraulic fracturing fluid is pumped into the well bore through the perforations to fracture the formation. The fracturing fluid used in this invention, however, has a radioactive tracer added thereto. The radioactive tracer can be added toward the end of the fracture operation so that it is in that part of the fractures that are adjacent the casing at the end of the fracturing operation so that it can be easily detected by a radioactive detector within the well bore. The radioactive material can comprise a part of the propping agent which is normally placed in the fracturing fluid to maintain the fractures apart. Thus, when the pressure is released from the fracturing fluid, the particles having radioactive material or tracer will remain in the fractured zones and not be displaced by subsequent operations.

Tool **16** shown in FIG. 1 with compass **18** removed is then used to form a plot of the radioactive intensity detected at a point in the well bore at the same depth at which the formation is fractured. The orientation of the detector **24** at the depth of the fractured formation is determined relative to the azimuth of the radioactive bullet, similarly as described in the other operations hereinbefore. Usually, in determining the fracturing pattern it is desired to run the survey at more than one vertical location opposite the fractured formation. For example, there are two fracture azimuths plotted in FIG. 9, at depth No. 1 and at depth No. 2. From the two fracture azimuths determined in FIG. 9, the fracture pattern can be oriented. In general, it can be said if there is a high point of intensity detected as the detector tool **24** is rotated, then the fractures are more or less vertical, whereas, if the intensity is essentially the same as the tool is rotated, the fractures are more or less horizontal.

While there are disclosed above but a limited number of embodiments of the present invention, it is possible to produce still other embodiments without departing from the spirit or scope thereof. For example, the system is useful for determining the orientation of a core which is cut during the drilling of a borehole. Many core barrel assemblies are composed of an outer barrel which rotates with the bit in cutting the core and an inner core barrel for receiving the core. The inner barrel is used to catch the core when the desired length of core is cut, the core catcher of the inner barrel locks with the core and upon raising the core barrel assembly, the core is broken off from the formation. That system is modified by placing a radioactive bead in a nonaxial position on the assembly in a fixed relationship with the core catcher of the inner barrel. Just before the core is broken from the formation, the tool **16** is used to determine the orientation of the bead with relation to a radioactive bullet of known azimuth similarly as the orientation of bead **68** with bullet **14***b*. It is therefore intended that the invention not be limited to the specific examples presented and it is desired that only such limitations be imposed on the appended claims as are stated therein.

What is claimed is:

1. An orienting method for use in wells comprising the steps of:

placing in a stratum surrounding a well bore a radioactive marker capable of being detected by a radiation detector;

lowering into said well bore to the level of said radioactive marker a first radiation detector having a selected radical direction of radiation detection and capable, when rotated, of transmitting to the earth's surface the angular position of said radioactive marker relative to the selected direction of radiation detection and compass means capable of transmitting to the earth's surface the direction of North relative to said selected direction of radiation detection;

rotating said first radiation detector and compass means and determining thereby the angular position of said radioactive marker relative to the selected direction of radiation detection and thereby the angular position of said radioactive marker relative to the direction of North;

removing said first radiation detector and compass means from said well bore;

lowering in said well bore to the level of said marker a perforator having a selected radial direction of perforation and connected to a second radiation detector having a selected radial direction of radiation detection and capable when rotated of transmitting to the earth's surface the angular position of said radioactive marker relative to the selected direction of radiation detection, said selected radial direction of perforation of said perforator being in a

known fixed relationship to the selected direction of radiation detection of said second radiation detector;

rotating said second radiation detector and said perforator until said direction of radiation detection is directed toward said radioactive marker;

lowering said radiation detector and said perforator to adjacent a desired level of perforation; and

then orienting said perforator to a desired direction of perforation relative to the angular position of said radioactive marker and the direction of north.

2. An orienting method for use in wells comprising the steps of:

placing in a stratum surrounding a well bore a radioactive marker capable of being detected by a radiation detector;

lowering into said well bore to the level of said radioactive marker a first radiation detector having a selected radial direction of radiation detection and capable, when rotated, of transmitting to the earth's surface the angular position of said radioactive marker relative to the selected direction of radiation detection and compass means capable of transmitting to the earth's surface the direction of north relative to said selected direction of radiation detection;

rotating said first radiation detector and compass means and determining thereby the angular position of said radioactive marker relative to the selected direction of radiation detection and thereby the angular position of said radioactive marker relative to the direction of north;

removing said first radiation detector and compass means from said well bore;

lowering a pipe string on which an inflatable impression packer is arranged into said well bore until said packer is adjacent a section of the strata surrounding said well bore below said radioactive marker at which it is desired to determine the presence of fractures;

inflating said impression packer to a set position against the borehole wall;

said packer being provided with a reference radioactive marker capable of being detected by said radiation detector and having a fixed angular position relative to the angular position of said radioactive marker placed in said stratum when said packer is in its set position;

lowering a second radiation detector having a selected radial direction of radiation detection and capable when rotated of transmitting to the earth's surface the angular position of said radioactive marker placed in said stratum and the angular position of said radioactive marker provided on said packer relative to the selected direction of radiation detection in said pipe string to adjacent said radioactive marker placed in said stratum;

rotating said second radiation detector until said direction of detection is directed toward said radioactive marker placed in said stratum;

lowering said second radiation detector to adjacent said radioactive marker provided on said packer;

rotating said second radiation detector until the direction of detection is toward said radioactive marker provided on said packer and determining the relative angular positions of said radioactive markers to determine thereby the angular position of said radioactive marker provided on said packer and north; and

then deflating said packer and removing it to the surface.

3. An orienting method for use in wells comprising the steps of:

placing in a stratum surrounding a well bore a radioactive marker capable of being detected by a radiation detector;

lowering into said well bore to the level of said radioactive marker a first radiation detector having a selected radial direction of radiation detection and capable, when rotated, of transmitting to the earth's surface the angular position of said radioactive marker relative to the selected direction of radiation detection and compass means capable of transmitting to the earth's surface the direction of north relative to said selected direction of radiation detection;

rotating said first radiation detector and compass means and determining thereby the angular position of said radioactive marker relative to the selected direction or radiation detection and thereby the angular position of said radioactive marker relative to the direction of north;

removing said first radiation detector and compass means from said well bore;

lowering in said well bore to below said radioactive marker a drill pipe provided with a whipstock having a face directed in a selected radial direction;

said whipstock being provided with a reference radioactive marker in a known fixed angular relationship to the radial direction of said whipstock face;

lowering a second radiation detector having a selected radial direction of radiation detection and capable when rotated of transmitting to the earth's surface the angular positions of said radioactive markers relative to the selected direction of radiation detection in said drill pipe to the level of said radioactive marker placed in said stratum;

rotating said second radiation detector until said direction of detection is directed toward said radioactive marker placed in said stratum;

lowering said second radiation detector to adjacent said radioactive marker provided on said whipstock;

rotating said second radiation detector until the direction of detection is toward said radioactive marker provided on said whipstock and determining the relative angular positions of said radioactive markers to determine thereby the direction of north relative to the direction of the face of said whipstock; and

then orienting the face of said whipstock relative to north.

4. An orienting method for use in wells comprising the steps of:

placing in a stratum surrounding a well bore a radioactive marker capable of being detected by a radiation detector;

lowering into said well bore to the level of said radioactive marker a first radiation detector having a selected radial direction of radiation detection and capable, when rotated, of transmitting to the earth's surface the angular position of said radioactive marker relative to the selected direction of radiation detection and compass means capable of transmitting to the earth's surface the direction of north relative to said selected direction of radiation detection;

rotating said first radiation detector and compass means and determining thereby the angular position of said radioactive marker relative to the selected direction of radiation detection and thereby the angular position of said radioactive marker relative to the direction of north;

removing said first radiation detector and compass means from said well bore;

lowering a drill pipe provided with a whipstock having a face directed in a selected radial direction;

said whipstock being provided with a reference radioactive marker in a known fixed angular relationship to the radial direction of said whipstock face;

lowering a second radiation detector having a selected radial direction of radiation detection and capable when rotated of transmitting to the earth's surface the angular position of said radioactive marker rela-

tive to the selected direction of radiation detection in said drill pipe to the level of said radioactive marker provided on said whipstock;

rotating said second radiation detector until said direction of detection is directed toward said radioactive marker provided on said whipstock;

raising said second radiation detector to adjacent said radioactive marker placed in said stratum;

rotating said drill pipe and thereby rotating said second radiation detector until the direction of detection is toward said radioactive marker placed in said stratum and determining the relative angular positions of said radioactive markers to determine thereby the direction of north relative to the direction of the face of said whipstock; and

then orienting the face of said whipstock relative to north.

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