March 29, 1932. A. G. McCOY ET AL 1,851,319

METHOD OF DIVERTING A WELL DRILLING TOOL

Filed Oct. 17, 1930 2 Sheets-Sheet 1

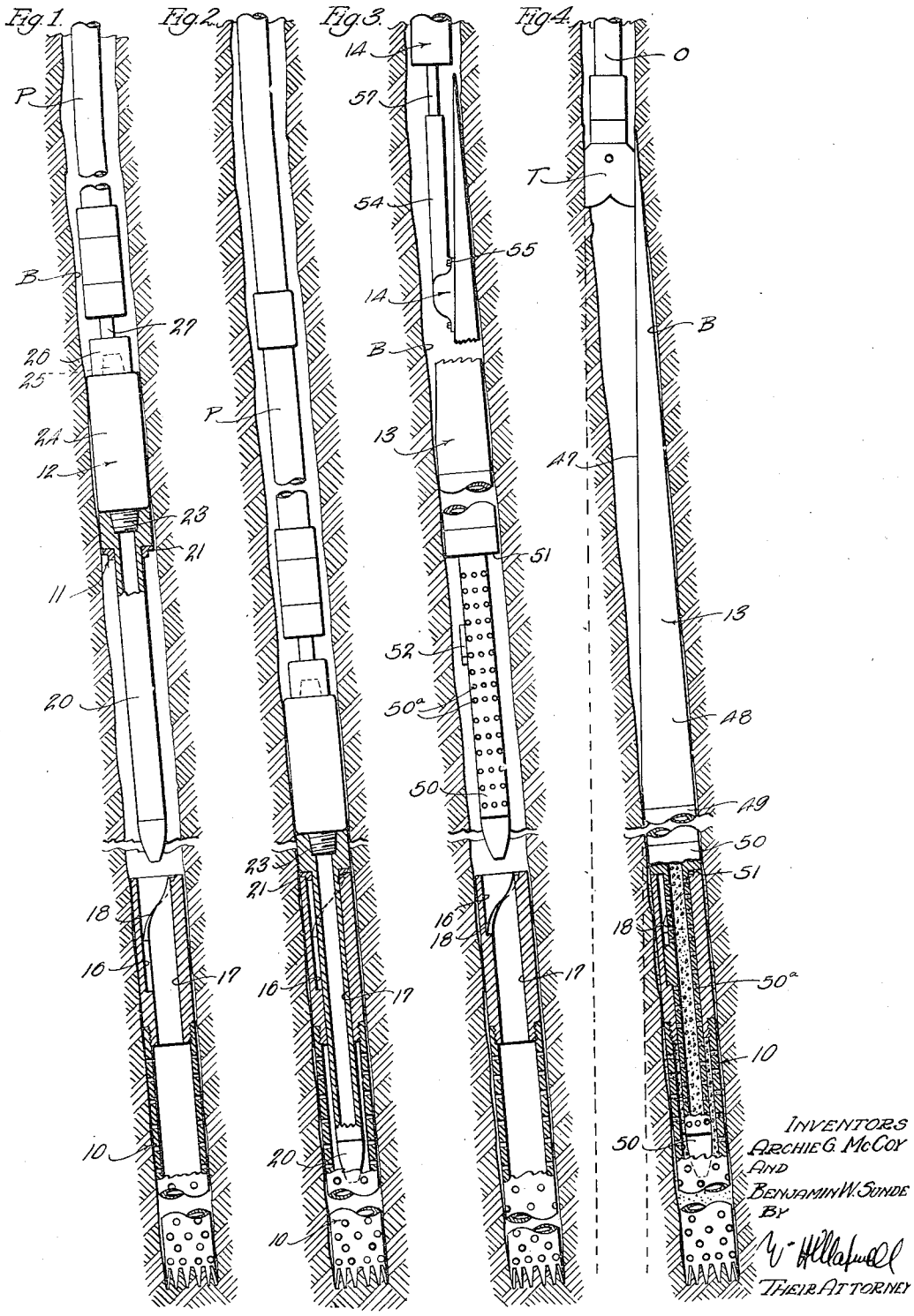

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Fig. 5.

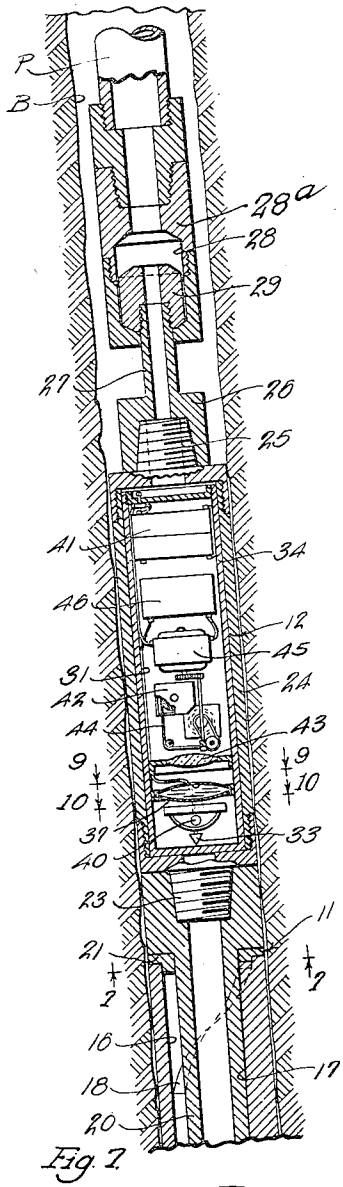


Fig. 6.

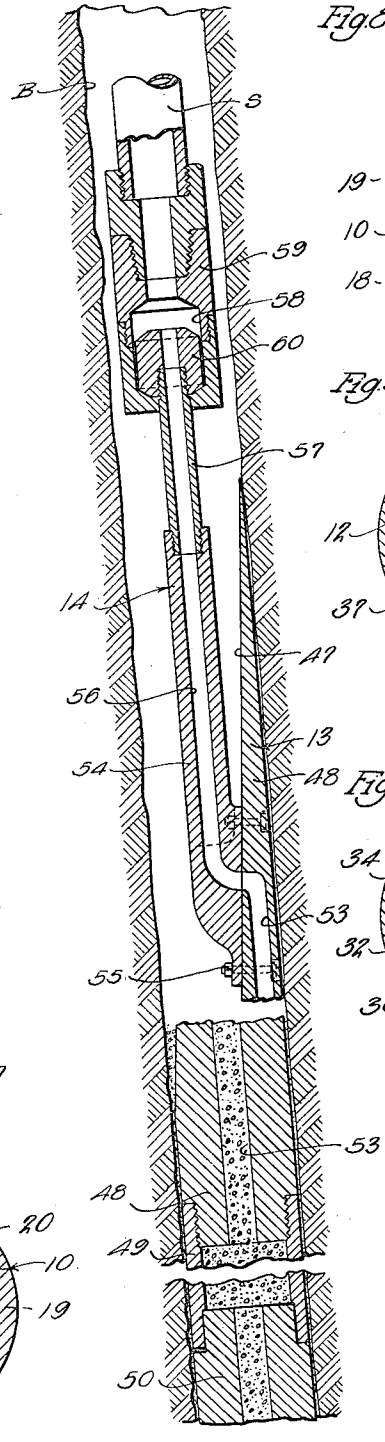


Fig. 8.

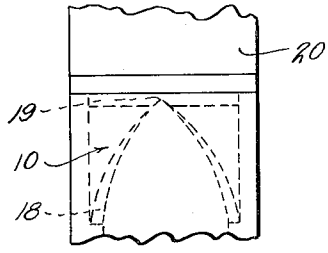


Fig. 9.

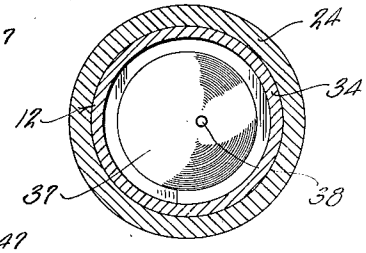


Fig. 10.

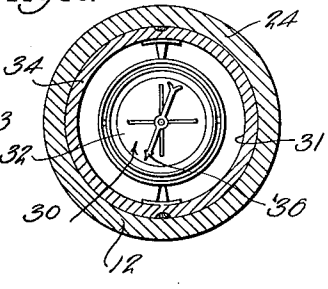
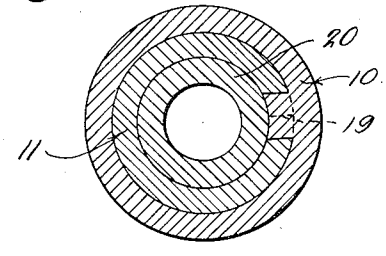


Fig. 7.



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UNITED STATES PATENT OFFICE

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METHOD OF DIVERTING A WELL DRILLING TOOL

Application filed October 17, 1930. Serial No. 489,349.

This invention relates to a method for sidetracking or diverting a drilling tool from a well bore, and it is a general object of the invention to provide a simple, practical, and effective method for diverting a well drilling tool from a well bore.

It is an important object of the present invention to provide a method for diverting a well drilling tool from a well bore in a given or desired direction. The method provided by the invention is particularly well suited for sidetracking a drilling tool from a crooked well bore for straightening the well.

It is another object of the invention to provide a method for diverting or sidetracking a tool from a well bore whereby a drilling tool may be diverted from a well bore in a given direction and at a given or desired angle.

It is another object of the invention to provide a method for positioning a whipstock in a well bore so that its inclined tool-diverting face is in the desired position and at a given angle.

It is a further object of the invention to provide a method for sidetracking or diverting a well drilling tool from a well bore in a given direction and at a desired angle that may be carried out with simple, inexpensive apparatus and on a practical and commercial scale.

The various objects and features of our invention will be best and more fully understood from the following detailed description of a typical preferred manner of carrying it out, throughout which description reference is had to the accompanying drawings, in which:—

Fig. 1 is a longitudinal sectional view of the lower portion of a well bore illustrating a socket in the bore and an impression member carried on a surveying instrument being lowered into the bore. Fig. 2 is a view similar to Fig. 1 showing the impression member seated on or cooperating with the socket. Fig. 3 is a view showing a whipstock being lowered through the well bore. Fig. 4 is a view illustrating the whipstock seated in position on the socket and a drilling tool being diverted from the well bore by the whipstock. Fig. 5 is an enlarged longitudinal detailed sectional view of a suitable well surveying instrument that may be employed in carrying out the invention. Fig. 6 is an enlarged longitudinal detailed sectional view of the upper portion of the whipstock and the connection between the whipstock and a string of pipe. Fig. 7 is an enlarged transverse detailed sectional view taken as indicated by line 7—7 on Fig. 5. Fig. 8 is an enlarged side elevation of the impression member in engagement with the socket. Fig. 9 is an enlarged transverse detailed sectional view taken as indicated by line 9—9 on Fig. 5, and Fig. 10 is an enlarged transverse detailed sectional view taken as indicated by line 10—10 on Fig. 5.

The present invention has particular reference to a method of side-tracking or diverting a drilling tool from a well bore. Throughout the drawings we have illustrated a portion of a crooked or inclined well bore B. The method is particularly well suited for diverting a drilling tool from a crooked or inclined well bore to straighten or continue the well bore in a substantially vertical direction. Throughout the following detailed description the method will be set forth as carried out to divert a typical well drilling bit T from the well bore B to pass in a substantially vertical direction from the side of the well bore. It is to be understood that the invention is not to be considered as restricted in its application to the particular situation illustrated throughout the drawings nor to the particular type of well drilling tool illustrated.

In carrying out the method of the present invention we preferably employ the apparatus fully described and claimed in our copending application entitled Whipstock, filed October 17, 1930, Serial Number 489,350. To facilitate a clear and complete understanding of the method, we will first proceed with a description of suitable equipment or apparatus for carrying out the invention.

The apparatus illustrated in the drawings for carrying out the invention includes, generally, a tubular socket 10 adapted to be arranged in the well bore B, an impression member 11 for cooperating with the socket 10, a suitable well surveying instrument 12 for

recording the rotative position and the inclination of the impression member 11 when it is in cooperation with the socket 10, a whipstock 13 adapted to be lowered into the well bore B on a string S of drill pipe, or the like, to cooperate with the socket 10 so that it assumes a definite rotative position relative to the socket, and a releasable or frangible connection 14 between the whipstock 13 and string S whereby the string S may be released from the whipstock after it has been seated on the socket 10.

The socket 10 is intended to be lowered or dropped into position in the well bore B. The socket 10 is tubular, and its lower end is toothed to bite into the formation at the bottom of a well bore. A longitudinal keyway 16 is provided in the walls of the opening 17 of the socket. Spiralled or helical faces 18 extend upwardly from the opposite sides of the keyway 16. The faces 18 are spiralled in opposite directions and join in a beveled edge 19 adjacent the upper end of the socket 10. The keyway 16 is adapted to receive a key on the whipstock 13, and the faces 18 are provided to guide the key into the keyway, as will be hereinafter described. The socket 10 is provided primarily to support the whipstock 13, and its upper end is preferably flat. The beveled edge 19 at the upper ends of the faces 18 may be 180° around the walls of the opening 17 from the center of the keyway 16.

In accordance with the broader principles of the invention, the rotative position of the socket 10 may be determined in any suitable manner. In the present disclosure the impression member 11, together with a well surveying instrument, will be described as employed to determine the rotative position of the socket, it being understood that a keyed member for cooperating with the socket 10 may be used in connection with a suitable well surveying device to orient the socket, as fully described in our co-pending application referred to above.

The impression member 11 is adapted to cooperate with the socket 10 to receive a mark or impression from the beveled edge 19. The member 11 is carried on the member 20 which is in the nature of a guide stem or bull plug. The bull plug 20 is provided with an enlarged upper end presenting a downwardly-facing shoulder 21. The plug 20 is adapted to slidably fit the opening 17 of the socket 10. The impression member 11 is annular and is arranged against the shoulder 21. The impression member 11 is formed of lead or other suitable material that will be marked when the member engages the beveled edge 19.

The impression member 11 is intended to be employed in connection with a suitable well-surveying device. The bull plug 20 may be carried on the surveying instrument 12. In the particular case illustrated the plug 20 is screw threaded onto a tapered pin 23 on the lower end of the instrument 12. The present invention is not primarily concerned with the type of well surveying instrument employed and, in accordance with the broader principles of the invention, any of the well surveying devices in general use may be used. The particular instrument 12 illustrated in the drawings includes a tubular body 24 having a screw-threaded pin 25 at its upper end. The body 24 is adapted to be connected with the lower end of a string P of pipe, or the like. The instrument 12 carrying the member 11 is preferably connected with the string P so that it is free to rotate relative to the string. A connection member 26 is mounted on the pin 25 and has an upwardly-projecting stem 27. The stem 27 extends into a chamber 28 in a box 28^a on the lower end of the string P. An enlargement or head 29 is provided on the upper end of the stem 27 to slidably and rotatably fit the chamber 28.

The well bore surveying instrument 12 is provided to record the compass or rotative position of the impression member 11 and the inclination of the member 11, if any, when it is in engagement with the socket 10.

A compass 30 is mounted within the lower portion of the opening 31 in the instrument body 24. The compass 30 includes a case 32 mounted within the opening 31 on suitable gimbals so that it may remain level or horizontal when the instrument is inclined. A weight or plumb bob 33 may be carried by the case 32. The walls of the opening 31 may be lined with a suitable insulating material 34 so that the compass 30 will not be affected by magnetic formations, etc., encountered within the well bore. The upper and lower sides of the case 32 are closed by suitable transparent material so that the magnetic or compass needle 36 may be readily seen and may be photographed, as will be hereinafter described. A level is mounted in the opening 31 above the compass 30 to indicate the inclination of the instrument and the impression member 11 carried by the instrument. The level may include a container or chamber 37 arranged transversely across the opening 31. The container 37 is adapted to hold a suitable fluid, say, alcohol, water, or the like, and is formed of glass or other transparent material. A bubble 38 of air is permitted to remain in the container 37 to indicate the inclination of the instrument.

Means is provided in the instrument 12 for photographing the positions of the compass needle 36 and the bubble 38 when the members 11 is in engagement with the upper end of the socket 10 to record the rotative position and the inclination of the socket 10. A lamp or electric light 40 is arranged in the opening 31 below the compass 30. The lamp 40 is

energized or supplied with current from a battery 41 in the upper portion of the opening 31. A camera mechanism 42 is arranged in the opening 31 above the level container 37. The camera includes a lensed aperture 43, a film 44 for passage across the aperture 43, an electric motor 45 for moving the film 44, and various other parts. A clock works or escapement mechanism 46 is provided to control the energization of the motor 45 and the light 40. The camera may be actuated at regular predetermined intervals as desired. The instrument 12 carrying the bull plug 20 and the member 11 may be lowered into the well bore B on the string P so that the plug 20 fits into the opening 17. When the impression member 11 is in engagement with the edge 19, the instrument 12 is operable to record the inclination of the socket 10 and member 11 and the rotative position of the member 11.

The whipstock 13 is adapted to be lowered into the well bore B on the string S after the string P and the instrument 12 have been withdrawn from the well. In practice the string of pipe P may be employed to lower the whipstock into the well after the instrument 12 has been removed from it. The whipstock 13 is adapted to cooperate with or seat on the socket 10 and is provided on its upper end with an inclined face 47 for diverting the drilling tool T from the bore B. The whipstock 13 includes an upper section 48 having an inclined face, intermediate or spacer sections 49, and a lower section or bull plug 50. The plug 50 may be similar to the bull plug 20. The bull plug proper is adapted to slidably fit into the opening 17 of the socket 10, and a downwardly-facing shoulder 51 is provided on the bull plug to seat against the upper end of the socket when the whipstock is in position. A key 52 projects from the bull plug 50 and is adapted to seat in the keyway 16. The spiralled faces 18 act to guide the key 52 into the keyway, and the cooperation of the key with a face 18 causes turning of the whipstock 13 to bring the inclined face 47 to the proper position as will be hereinafter described. The face 47 may have any degree of inclination desired. After the rotative position of the socket 10 has been determined by means of the instrument 12 and the impression member 11, or by any other suitable means, the whipstock 13 may be constructed so that the face 47 is positioned or related to the key 52 so that it will be in a given desired position when the whipstock is seated on the socket 10.

A fluid passage 53 is provided in the whipstock 10. The fluid passage 53 extends longitudinally through the whipstock from the face 47 to the lower end of the bull plug 50. Lateral openings 50[a] may be provided in the walls of the plug 50.

The connection 14 between the whipstock 13 and the string S is such that the whipstock is free to turn during the cooperation between the key 52 and a spiralled face 18. The connection 14 is frangible so that it may be released when the whipstock has been finally or permanently seated in the well bore and is adapted to pass fluid or a cementing mixture from the string S to the passage 53. In the particular apparatus illustrated in the drawings the connection 14 includes a fitting 54 arranged against the inclined face 47. The fitting 54 is secured to the whipstock 13 by comparatively small bolts 55. The bolts 55 are in the nature of shear bolts and may be readily broken or sheared off by applying a downward pressure on the fitting 54. A fluid passage 56 extends longitudinally through the fitting 54 and discharges into the upper end of the passage 53. A tubular stem 57 is screw threaded into the upper end of the fitting 54 and extends into a chamber 58 in a member 59 on the lower end of the string S. A head 60 is provided on the upper end of the stem 57 within the chamber 58. The head 60 is adapted to rotate and slide within the chamber. The chamber 58 communicates with the interior of the string of pipe S.

The whipstock 13 is adapted to be lowered into the well bore on the lower end of a string S to a position where the key 52 cooperates with a face 18. Cooperation between the key 52 and the face 18 causes the whipstock 13 to be turned to a position where the inclined face 47 is in the desired position with reference to the socket 10 when the key is in the keyway 16. After the whipstock has been positioned on the socket 10, cement in a fluid state may be passed through the string S and the connection 14 to be discharged from the lower end of the bull plug 50. The cement may fill the lower end of a socket 10 and the well bore around the lower end of the socket and whipstock to effectively secure the socket and whipstock in the well bore. After the cement has set or hardened, a downward pressure may be exerted on the string S to shear off the bolts 55 so that the string S may be withdrawn from the well bore.

The method provided by the present invention includes, generally, the following steps:—arranging the socket 10 in the well bore B, determining the rotative position of the socket 10, providing or constructing a whipstock 13 that has its inclined face 47 related to the key 52 in such a manner that the face will be in the desired or given rotative position and at the desired angle when the whipstock is seated on the socket 10, lowering the whipstock into the well to cooperate with or seat on the socket 10, passing a cementing mixture down the string S to cement the socket and whipstock in the well bore, breaking or releasing the connection 14 between the whipstock and the string S, and then lowering the drilling tool T through the

well bore to be diverted by the face 47 to pass into the formation at the side of the bore.

The socket 10 may be arranged in the well bore B in any suitable manner. In practice it has been found desirable to drop the socket 10 through the well bore so that its toothed lower end will rest on and bite into the formation at the bottom of the bore. The determination of the rotative position of the socket 10 may be accomplished by means of a keyed member, similar to the bull plug 50, carried on a well surveying instrument or by bringing the impression member 11 into engagement with the beveled edge 19 and making a record of the inclination and rotative position of the member 11 when it is in engagement with the beveled edge by means of the surveying device 12. After the impression has been made on the member 11 and the record has been made by the surveying device 12, the string P may be withdrawn from the well bore and the rotative position of the socket 10 may be computed from the impression on the member 11 and the record made by the device 12. The rotative position of the beveled edge 19 with reference to the keyway 16 is known so that the rotative position of the keyway 16 may be readily determined from the record made by the device 12 and the impression made by the beveled edge 19. When the rotative position and the inclination of the socket 10 has been determined, a whipstock 13 may be constructed or provided which has its inclined face 47 related to the key 52 so that the face 47 will be in the proper rotative position when the whipstock is seated on the socket and the key is in the keyway.

In the event that the whipstock is to be employed to divert a tool for straightening the well bore, the face 47 may be inclined and rotatably positioned so that the drilling tool will be diverted in a substantially vertical direction from the inclined well bore. The whipstock 13 may be lowered into the well bore on the string S so that it cooperates with or seats on the socket 10 in a position where the key 52 is in the keyway 16. After the whipstock 13 has been seated on the socket 10, fluid or plastic cement may be passed down through the string S to discharge from the end of the bull plug 50. The cement is provided to effectively mount and secure the socket 10 and the whipstock in the well bore B. After the cement has set or hardened, the bolts 50 may be sheared off by exerting a downward pressure on the string S, and the string S may be withdrawn from the well bore.

The drilling tool may be lowered into the well bore on an operating string O. Upon the drilling tool T engaging the inclined face 47 it is diverted from the well bore B and passes or cuts through the side wall of the bore. In the drawings we have illustrated a typical fish tail bit T in engagement with the inclined face 47. It is to be understood that any type of well bit or well tool may be used in connection with the whipstock 13.

It is to be noted that the present invention provides a method for sidetracking a drilling tool from a well bore whereby the drilling tool may be diverted in any desired direction and at any desired angle from the bore. The method is particularly useful in diverting a drilling tool from a crooked or inclined well bore so that it will pass vertically downward through the walls of the inclined bore.

Having described only a typical preferred form of our invention, we do not wish to limit ourselves to the specific details set forth, but wish to reserve to ourselves any changes or variations that may appear to those skilled in the art or fall within the scope of the following claims.

Having described our invention, we claim:

1. The method of diverting a tool from a well bore in a given direction which includes, positioning a socket in the well bore, determining the inclination and the rotative position of the socket, providing a whipstock that will have its inclined face in a given position and at a given angle when the whipstock is seated on the socket in a given rotative position relative to the socket, seating the whipstock on the socket in the said position cementing the whipstock in the socket, and passing the tool through the well bore to engage the inclined face of the whipstock.

2. The method of diverting a drilling tool in a substantially vertical direction from an inclined well bore which includes, arranging a socket in the inclined bore, determining the inclination and the rotative position of the socket, providing a whipstock that will have its tool diverting face in a substantially vertical position and in a given rotative position when the whipstock is seated on the socket in a given rotative position relative to the socket, seating the whipstock in the said position, cementing the socket and whipstock together in the well bore, and then passing the drilling tool into the well bore to engage and to deflect from the inclined face.

3. The method of diverting a tool from a well bore in a given direction which includes, arranging a socket in a well bore, determining the rotative position of the socket, providing a whipstock that has a tool diverting face that will be in a given position when the whipstock is seated on the socket in a given rotative position relative to the socket, lowering the whipstock into the well bore on a tubular string to seat on the socket in the said position, passing a cementing mixture into the spring to cement the socket and whipstock in the well bore, releasing the string from the socket and withdrawing it from the well bore, and then passing the tool

into the well bore to be deflected from the tool diverting face of the whipstock.

4. The method of diverting a tool from a well bore in a given direction which includes, arranging a socket in a well bore, determining the rotative position of the socket, providing a whipstock that has a tool diverting face that will be in a given position when the whipstock is seated on the socket in a given rotative position relative to the socket, lowering the whipstock into the well bore on a string to seat on the socket in the said position, passing a cementing mixture through the string to cement the socket and whipstock in the well bore, releasing the string from the socket and withdrawing it from the well bore, and then passing the tool into the well bore to be deflected from the tool diverting face of the whipstock.

5. The method of diverting a tool from a well bore in a given direction which includes, arranging a socket in a well bore, determining the rotative position of the socket, providing a whipstock that has a tool diverting face that will be in a given position when the whipstock is seated on the socket in a given rotative position relative to the socket, lowering the whipstock into the well bore on a string to seat on the socket in the said position, passing a cementing mixture through the string and the whipstock to cement the socket and the whipstock in the well bore, releasing the string from the socket and withdrawing it from the well bore, and then passing the tool into the well bore to be deflected from the tool diverting face of the whipstock.

6. The method of diverting a tool from a well bore in a given direction which includes, arranging a socket in the well bore, determining the rotative position of the socket, providing a whipstock having an inclined face that will be in a given position when the whipstock is seated on the socket in a given rotative position relative to the socket, seating the whipstock on the socket to assume the said position, permanently and rigidly cementing the whipstock and socket together and to the walls of the well bore, and passing the tool through the well bore to engage the inclined face.

In witness that we claim the foregoing we have hereunto subscribed our names.

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