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FIG. 2

12

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10a

10

18

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22

24

26

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32

32a

32b

32c

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July 28, 1964

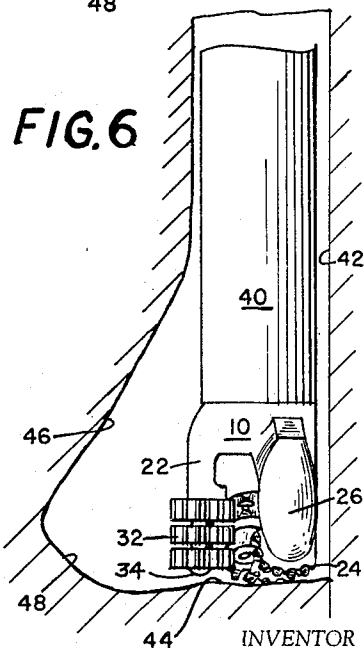
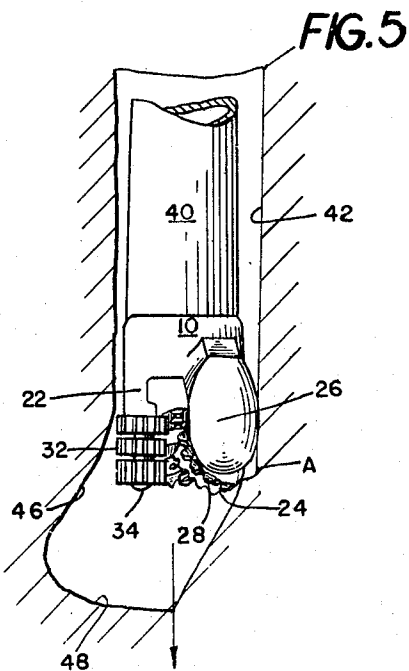
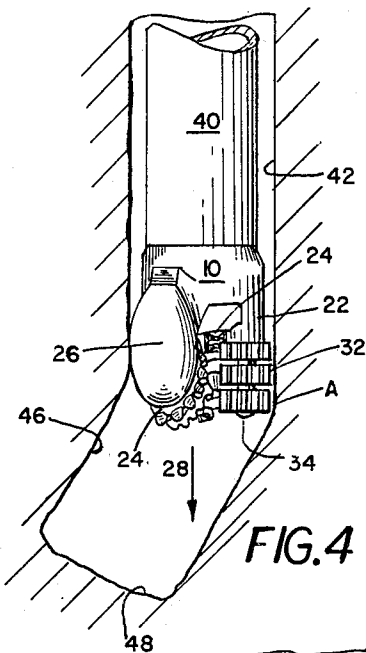
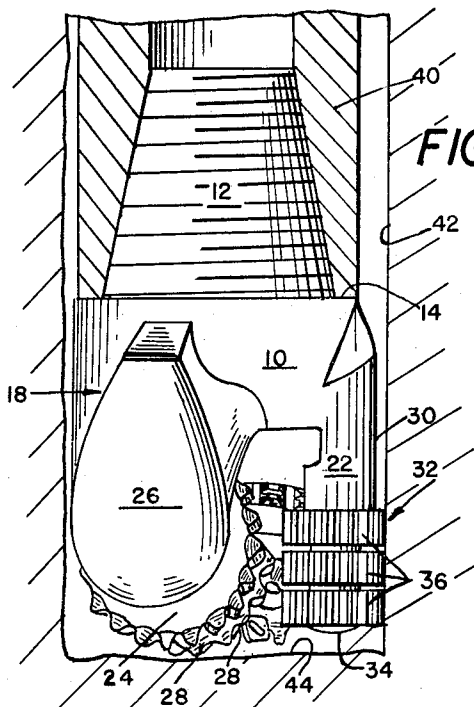
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DRILL BIT

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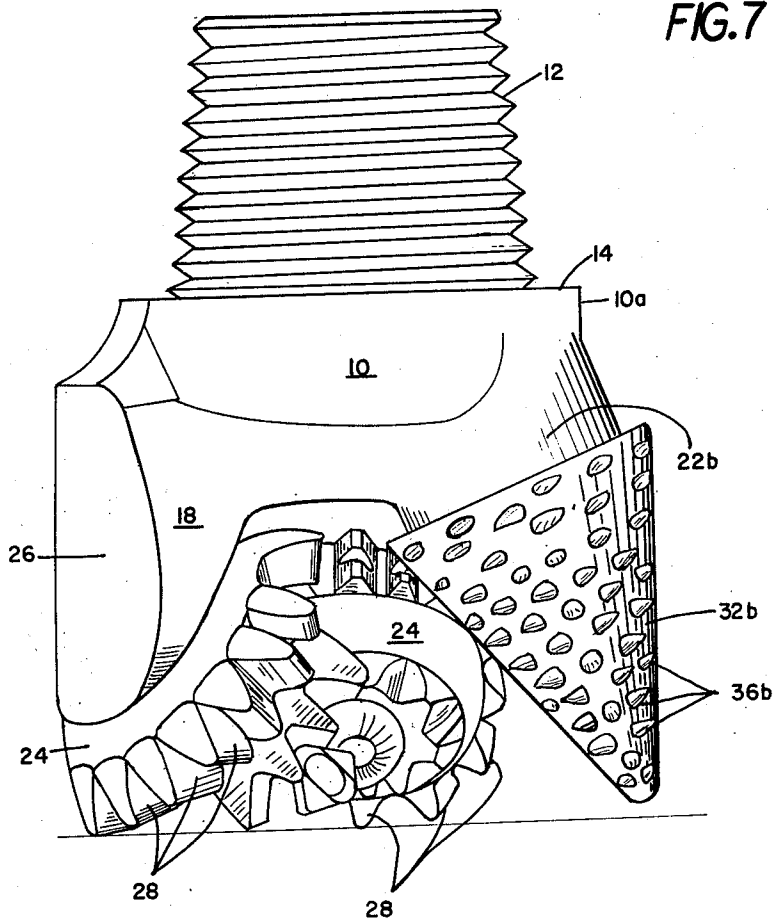
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DRILL BIT

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FIG. 7



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3,142,347

DRILL BIT

Allie C. Barnes, 943 E. Winkler St., Kermit, Tex., assignor, by direct and mesne assignments, of twelve and one-half percent to Emmett J. Rahm, San Antonio, Tex., thirty-six and one-half percent to Billy G. Preston, two percent to Irene Cramer, thirteen percent to Calvin W. Wesch, all of Kermit, Tex., six percent to C. B. McFarlin, six percent to Brinson Development Co., Inc., a corporation of Texas, and six percent to L. H. McElderry and/or Verna Loyce McElderry

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4 Claims. (Cl. 175-349)

The present invention relates to an earth-boring drill bit, and more particularly to an earth-boring drill bit having means to straighten a deviated bore hole.

One of the problems encountered in earth boring is that of the deviated or cocked bore hole. Ideally, the bore hole should be vertical or substantially vertical for the best results, but due to many factors encountered in the drilling operation bore holes often deviate from the desired vertical reference line and the drill string may be caused to bend at the point of deviation. Undesirable deviation can be caused by the striking of a buried obstacle by the drill bit or by the passage of the drill bit from one strata to another strata having a different degree of density, e.g., from a relatively loose strata to a dense strata, or vice versa. This latter occurrence is very prevalent because nowhere is the earth of uniform density from the surface through the mantle of the earth. If the deviation is sufficiently great, the drill string may become bent or will bind in the bore hole causing damage to the rotary rig which drives the string. In addition, most drilling operation contracts provide for a maximum deviation from the reference line.

There have been attempts to correct a deviated bore hole before; however, prior to the subject invention none has proved particularly successful. Such a drill bit is especially important in view of the time and expense required in correcting a deviated hole and replacing damaged equipment.

This invention provides a novel and inexpensive drill bit for correcting a bore hole which has become deviated. It also provides a novel and economical drill bit which will prevent the bore hole from becoming deviated if used at the outset of the drilling operation, or before any bore hole deviation occurs.

It is an object, therefore, of the present invention to provide an improved drill bit for use with earth-boring equipment, which drill bit includes means to correct a deviated bore hole.

It is another object of the present invention to provide an improved earth-boring drill bit having means to drill a substantially vertical bore hole and to prevent deviation from the desired vertical reference line.

It is a still further object of the present invention to provide an economical improved earth-boring drill bit which is easy to manufacture and which will insure that the bore hole extends along the desired reference line.

These and other objects and advantages will become readily apparent after consideration of the following detailed specification taken in conjunction with the drawings in which:

FIGURE 1 is a top plan view of the preferred form of drill bit of the present invention;

FIGURE 2 is a side elevational view of the drill bit of FIGURE 1;

FIGURE 3 is a side elevational view, partly in vertical section, of the drill bit of FIGURES 1 and 2 shown in the desired vertical portion at the bottom of a bore hole;

FIGURE 4 is a view corresponding generally to FIG-

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URE 3, but showing the drill bit in a deviated bore hole in the correcting or straightening position;

FIGURE 5 is a view corresponding to FIGURE 4, but showing the drill bit rotated 180°;

FIGURE 6 is a view corresponding to FIGURES 3, 4 and 5, but showing a deviated bore hole which has been corrected; and

FIGURE 7 is a view corresponding to FIGURE 2, but showing a modified device.

Referring now to the drawings and in particular to FIGURES 1 and 2, there is shown the preferred form of drill bit of the present invention not attached to the usual drill string. The earth-boring drill bit comprises the customary generally cylindrical bit body 10 having at its upper end a threaded shank 12 for attachment with a suitable drill string collar or tool joint (not shown). As is preferred for a strong connection, the outside diameter of the shank 12 is less than the overall outside diameter of the bit body 10 to provide a flat annular shoulder portion 14 which abuts the engaging lower end of the drill string when the two are connected for the drilling operation. Both the bit body 10 and shank 12 have an axially extending hollow portion 16 (see FIGURE 1) to permit passage of drilling fluid to flush the bore hole being drilled. If desired, the bit arrangement may also be of the well-known jet type for flushing and washing the bore hole. Either form of drill bit may be employed with the present invention, and no claim of invention is based on the particular bit body type being used.

The lower portion of the bit body 10, or the opposite end from which the shank 12 is disposed, is provided with a plurality, preferably three, equally and circumferentially spaced depending arms 18, 20 and 22. Two of the depending arms 18 and 20 are identical in construction and carrying frusto-conical roller type cutters 24. The two depending arms 18 and 20 include a smooth, curved surface 26 which extends radially outwardly from the periphery 10a of the bit body 10. The curved surfaces 26 of the similar arms 18 and 20 have the same radius of curvature and define substantially the circumference of the bore hole, so that any line tangent to the radius of curvature of the surfaces 26 of the arms 18 and 20 will extend substantially parallel to the axis of the drill bit body 10 and shank 12, or vertically. Each rolling cutter 24 is of the ordinary construction well-known in the art and is mounted on the similarly shaped depending arms described above so that the cutting teeth, or edges, 28 are positioned only to engage the bottom of a bore hole. Ideally, the cutting teeth 28 which actually engage and cut the bore hole lie in a plane substantially perpendicular to the bit body 10 axis. The roller cutters 24 may be bearingly mounted on the depending arms if desired, or by any other commonly used mounting arrangement. As clearly shown in FIGURE 2, no portion of the cutting teeth 28 of each rolling cutter 24 extends radially outwardly beyond the curved surfaces 26 of the depending arms 18 and 20.

The third depending arm 22 also includes an outer curved peripheral surface 30 which may have the same, or greater radius of curvature as the periphery 10a of the bit in FIGURE 2 of the drawing. The arm 22, however, is shorter than the arms 18 and 20, and instead of mounting a third frustoconical rolling cutter 24, as is customary, mounts a bore hole straightening cutter 32. Depending arm 22 includes a vertically depending shaft 34 upon which the bore hole straightening cutter 32 is mounted for rotation, either by bearings (not shown) or not, as desired. The preferred bore hole straightening cutter 32 is cylindrical and rotates about the shaft 34 when the bit body 10 is rotated by the drill string. The bore hole

straightening cutter 32 is provided with cutting teeth or edges 36 which extend radially outwardly of the cutter and beyond depending arm surface 30 so as to only engage the side of the hole being drilled, and not the bottom. In the preferred embodiment of the invention, a circle generated by the radius of curvature of the surfaces 26 of arms 18 and 20 defines the outer extremity of the teeth 36 on the straightening cutter 32. That is, although teeth 36 project outwardly beyond the surface 30 of arm 22, no portion of the teeth 36 extends further outward than either surface 26 of arms 18 and 20. The shaft 34 terminates a short distance above the plane in which the cutting teeth 28 of the frusto-conical rolling cutters 24 lie when in cutting position, as described previously in connection with FIGURE 2. It is important that the teeth 36 of the straightening cutter do not contact the hole bottom, but may be spaced above the bottom of the hole from $\frac{1}{32}$ "-5" dependent upon the outside diameter and type of bit. The straightening bit cutter may be composed of a plurality of annular elements 32a co-axially arranged on the shaft 34 or it may include a single element having one or more rows of cutting teeth 36, depending on the characteristics of the earth being drilled. Alternatively, the structure of the teeth of cutter 32 will vary, depending upon the formation being drilled. Tungsten carbide compacts may be inserted into cutter 32 to maintain full gauge hole while drilling chert, quartz, sharp sands and any other abrasive formations.

With reference now to FIGURES 3-6, the operation of the preferred form of drill bit will be described. In FIGURE 3 the bit body 10 is shown attached to the lowermost end of a drill string 40 so that it may be rotated thereby. As the bore hole 42 in FIGURE 3, is vertical, as desired, the cutting teeth 28 of the rolling cutters 24 are in engagement with the bottom 44 of the hole and drilling proceeds as normal and customary. In view of the short length of shaft 34 the straightening cutter 32 does not engage the bore hole bottom 44, but the peripheral teeth 36 thereof lightly engage the bore hole interior wall as the bit body 10 rotates. As long as the hole 42 remains substantially vertical, the cutter 32 is relatively inactive; the rolling cutters 24 function as normal and drilling proceeds along the desired reference line.

FIGURE 4 illustrates a bore hole 46 that has deviated to the left of the desired reference line, shown by the arrow, as would occur if a normal drill bit had encountered a hard obstacle or large strata variation. It is to be understood, of course, that in an actual drilling operation the deviation may be in any direction. For purposes of convenience only, the degree of deviation has been exaggerated so as to more clearly point out the operation of the straightening cutter 32. Assuming that the deviation has been discovered, and the usual drill bit has been replaced by that of the present invention, the hole 46 will be straightened in the following manner. As the drill string 40 rotates, the bit body 10 will rotate so that at one stage of each rotation the straightening cutter 32 will engage the side of the bore hole 46 nearest to the desired vertical reference line shown by the arrow. In this position the cutter 32 will engage the side of the bore hole 42 nearest the vertical reference line, thereby biting out a portion of formation, leaving a track in which cutters 24 follow.

In FIGURE 5 the drill bit is shown in one of its rotational positions when the straightening cutter 32 is not in engagement with the bore hole 46 side nearest the desired vertical reference line, and consequently is in a non-operative position. The rolling frusto-conical cutters 24 engage the portion of bore hole 46 previously occupied by cutter 32, as shown in FIGURE 4. Further rotation of the drill string 40 causes the straightening cutter 32 to once again engage the area of earth between the side of the bore hole 46 nearest the reference line, as shown at A, and enlarge the area A until the entire intervening

formation is removed and the bore hole 46 straightened, as shown in FIGURE 6. Drilling may then be continued in the normal manner, as above described. If the drilling bit of the present invention had been used originally, the deviation shown in FIGURES 4-6 would never occur because as soon as the hole began to cock or deviate from the vertical, the straightening cutter 32 would begin to function as described heretofore, to dig away any formation between the desired reference line and the line of deviation to automatically insure a vertical hole. If the normal commercially used drill bit encountered a condition that would cause deviation, it would continue to follow the line of deviation until discovered because the drilling or boring teeth engage only the bore hole bottom. In the device of this invention, however, there is provided a straightening cutter which immediately begins to correct any deviation as soon as it commences. And if called into play after deviation occurs, the hole will become corrected by varying the revolutions per minute of the drill string and the weight of the drill string applied to the bit. For example, in soft formations 30-40 r.p.m. and 20,000 to 30,000 pounds weight may be applied; in medium formations 40-45 r.p.m. and 25,000-35,000 pound; whereas in hard abrasive formations, 40-60 r.p.m. and 35,000-80,000 pounds. Once the deviation has been corrected, the same bit may be utilized to continue the ordinary drilling operations until the cutters need to be replaced because of wear.

In the embodiment shown in FIGURE 7, the bit of FIGURES 1 and 2 has been modified so that the straightening cutter 32b is conical in shape, and the depending arm 22b of the bit body 10 is disposed at an angle with respect to the bit body axis, and extends outwardly and downwardly therefrom. This particular arrangement affords a somewhat stronger bit, and one in which lateral forces exerted by the bore hole against the straightening bit 32b are transferred along the slanted axis on which the cutter is mounted, and then through the angled depending arm 22b. The straightening cutter 32b in this particular arrangement is conical, and when mounted upon the outwardly slanted depending arm 22b presents an outer surface which extends parallel to the bit body axis and thus the side of the bore hole. As in the case of the previously described embodiment, the teeth 36b of the straightening cutter 32b do not extend beyond the circumference of a circle generated by the radius of curvature of the surfaces 26 of depending arms 18 and 20. In the particular straightening cutter 32b, shown in FIGURE 7, the cutting teeth 36b, rather than being integrally formed with the cutter body, comprise a plurality of individual inserts (referred to as "compacts"), which may be formed of tungsten carbide or other suitable hard material. It is to be understood, however, that if desired the cutting teeth 36b may be formed integrally with the cutter body 32b depending upon the characteristics of the earth being bored.

It will thus be seen that there has been provided by this invention a structure in which the various objects hereinbefore set forth, together with many practical advantages, are successfully achieved. As various possible embodiments may be made of the mechanical features of the above invention, all without departing from the scope thereof, it is to be understood that all matter hereinbefore set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

It is claimed:

1. An earth boring drill bit for correcting a bore hole which has deviated from a desired substantially vertical drilling reference line comprising: a substantially cylindrical bit body having means on one end for connection with a drill string; a pair of arms depending from the periphery of the other end of said bit body, each having a vertically disposed arcuate outer surface generated by a radius of curvature substantially equal to that of the bore hole to be drilled; a substantially frusto-conical cutter

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mounted for rotation on each of said arms, each cutter extending inwardly from said arms and having a plurality of teeth thereon, the outermost radial extent of said teeth on each of said frusto-conical cutters being not greater than the outermost radial extent of said arcuate outer surfaces of said pair of arms whereby said teeth will bitingly engage only the bottom of the bore hole; a third arm depending from said bit body adjacent said pair of depending arms; and a straightening cutter mounted for rotation at the base of said third arm having a plurality of teeth thereon which extend generally radially relative to the bit axis, the outermost radial extent of the cutting teeth on said straightening cutter being greater than the outermost radial extent of said third arm and substantially as great as but no greater than the outermost radial extent of said arcuate outer surfaces of said pair of arms and the lower end of said straightening cutter being positioned slightly higher than the lowermost extent of the teeth of said frusto-conical cutters so that the cutting teeth of said straightening cutter will not engage the bore hole bottom and will operatively bitingly engage the side of the deviated bore hole nearest said desired substantially vertical drilling reference line.

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2. The drill bit set forth in claim 1 wherein said depending arms are located at approximately 120° intervals about the periphery of the bit body.

3. The drill bit set forth in claim 1 wherein said straightening cutter is substantially cylindrical in shape including a plurality of axially spaced annular elements, and is mounted about an axis parallel to the axis of the drill string.

4. The drill bit set forth in claim 1 wherein said straightening cutter is substantially conical in shape and is mounted about an axis disposed at an angle to the axis of the drill string.

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