

[54] TRAVELLING DRILL BIT

[75] Inventor: **George S. Werner, Pensacola, Fla.**

[73] Assignee: **Werner Industries, Inc.**, Pensacola,
Fla

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Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 872,070, Oct. 29, 1969, abandoned.

[52] U.S. Cl.....175/262, 175/325

[51] **Int. Cl.** E21b 11/00

[58] **Field of Search**.....|75/262, 325

[56] **References Cited**

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Primary Examiner—James A. Leppink

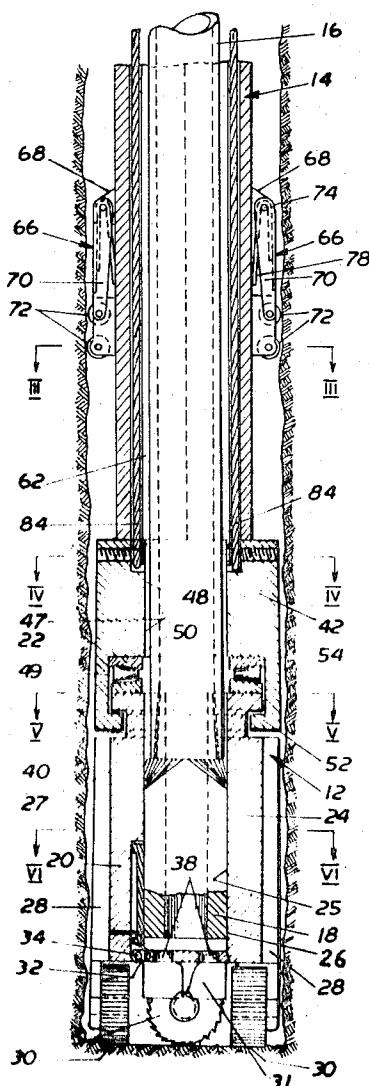
Attorney—Buell, Blenko & Ziesenheim

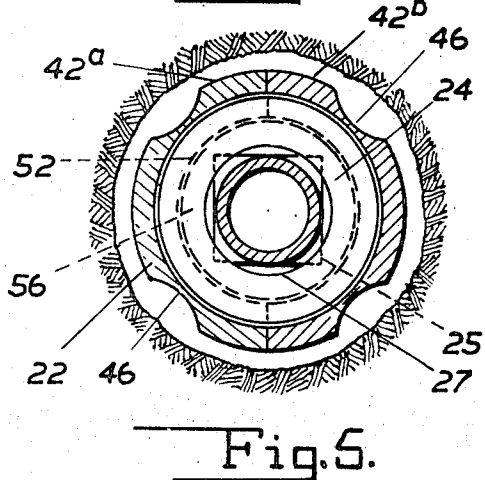
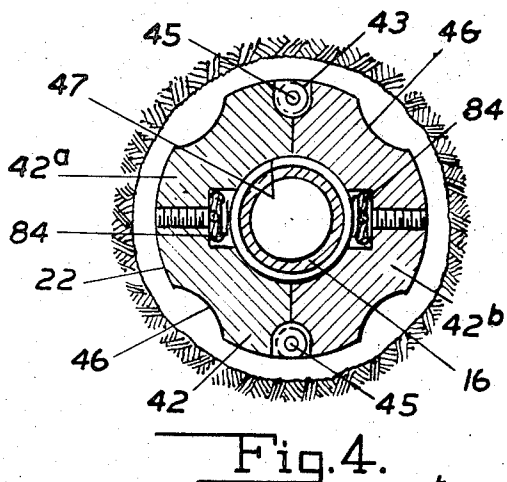
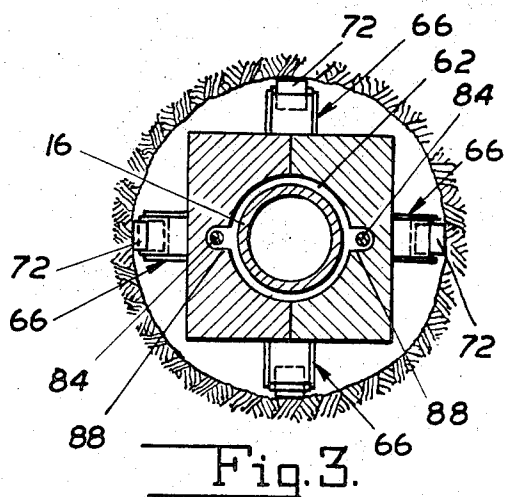
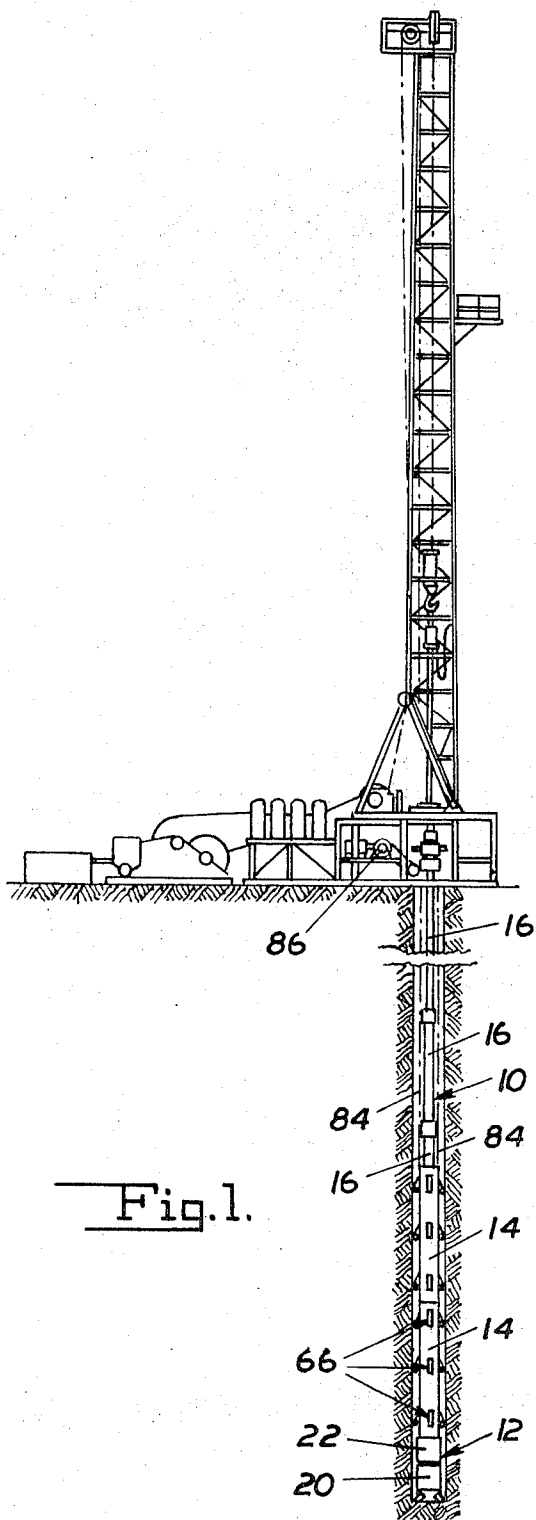
[57] ABSTRACT

Drill bit and drill collar assemblies for use with a drill string which assemblies can be moved up and down the drill string without the need of removing the drill string from the well hole. The drill collar assembly also is shaped, and includes elements, which together serve to prevent excessive lateral shifting of the drill string, thereby assuring the drilling of a straight well hole.

This invention relates to improved drill bit and drill collar assemblies for use in combination with a drill string used in the drilling of wells, such as oil wells, for example.

12 Claims, 11 Drawing Figures

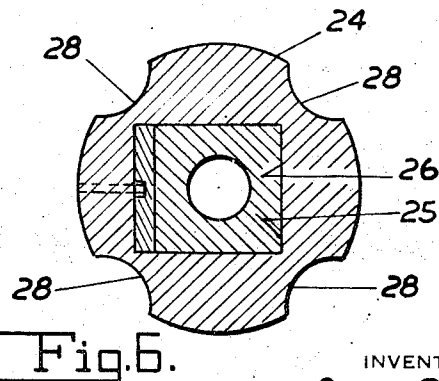
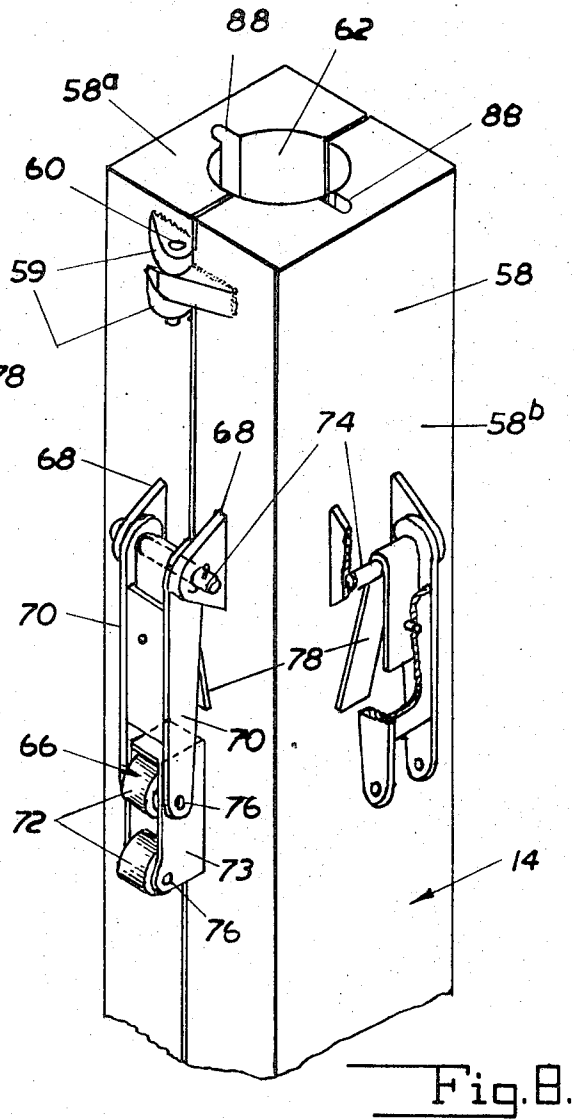
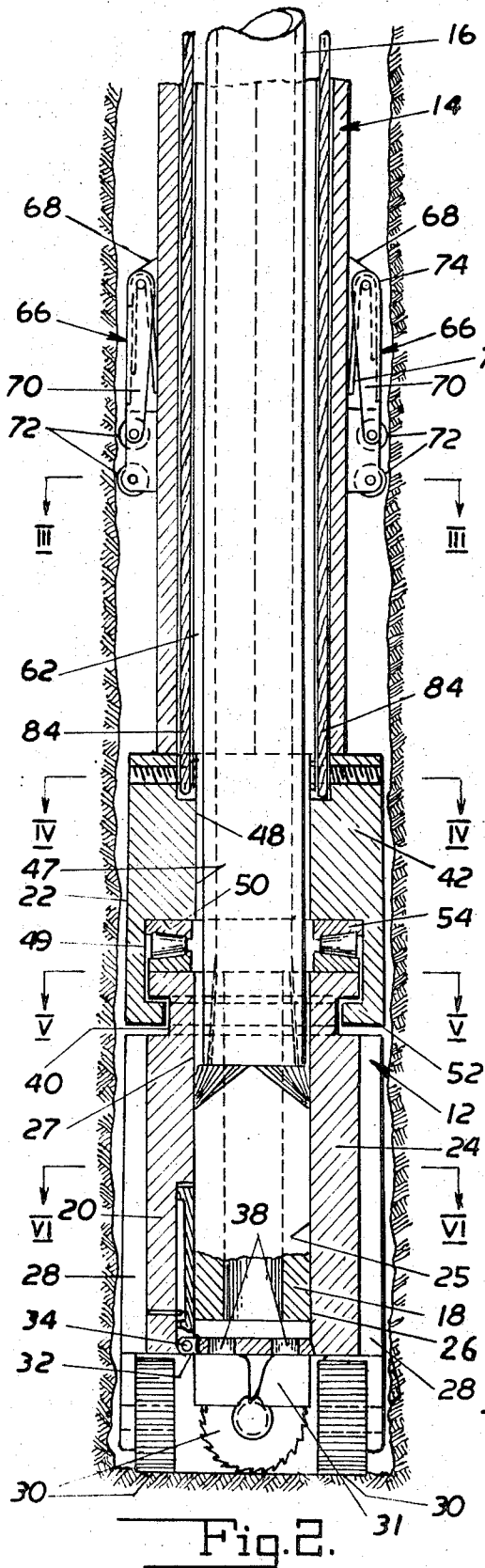




INVENTOR

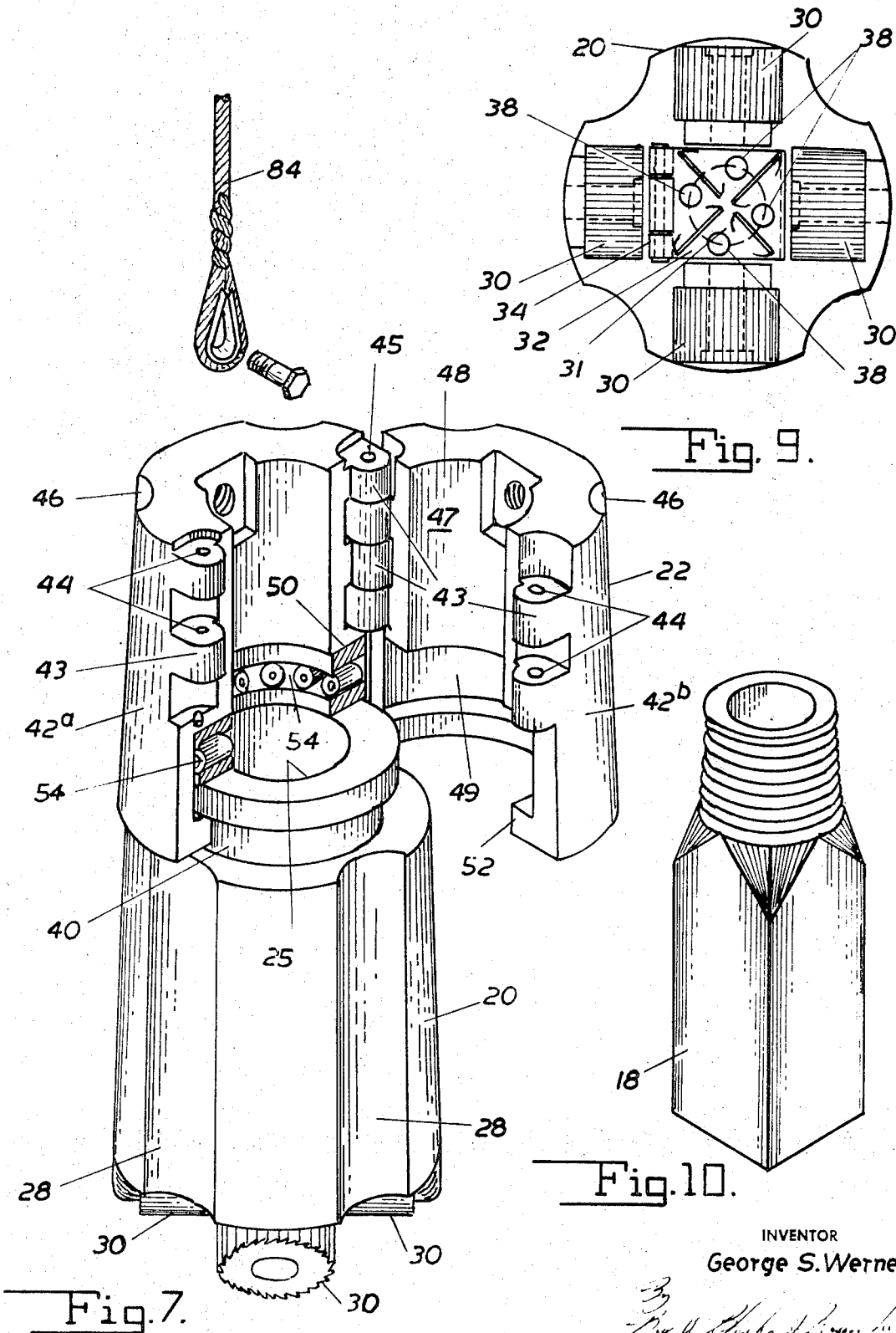
George S. Werner

By *Wells, Bunk & Zischke*
his attorneys



INVENTOR
George S. Werner

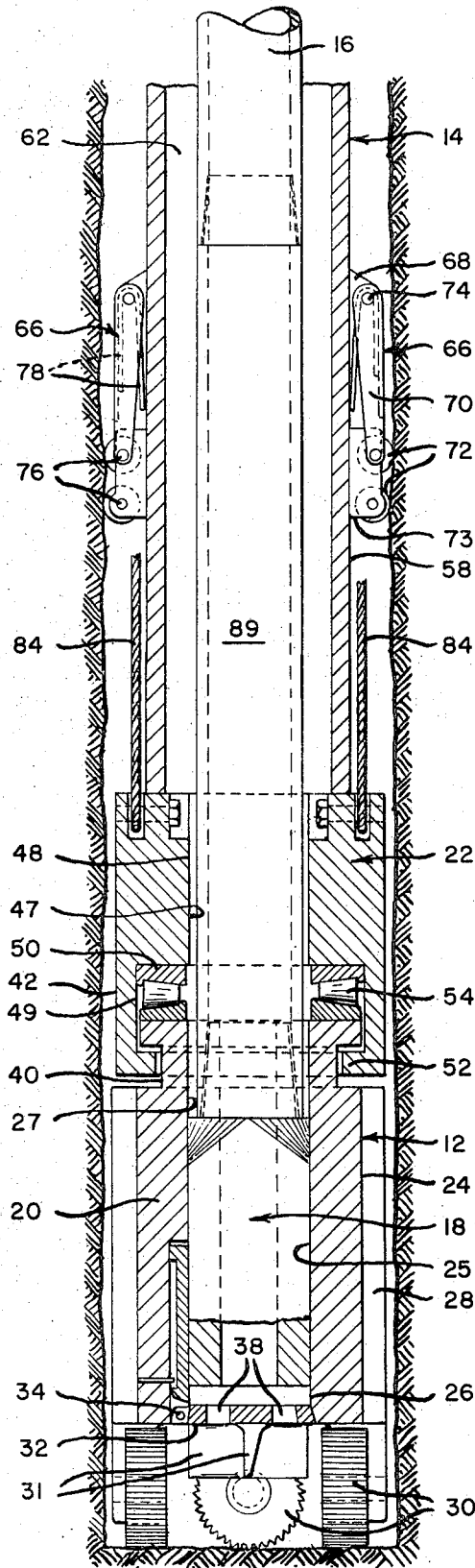
By
Paul W. White & Associates
his attorneys



INVENTOR
George S. Werner

By
Paul H. Huber
Attorney

Fig. 11.



TRAVELLING DRILL BIT

This application is a continuation-in-part of my co-pending application Ser. No. 872,070 filed Oct. 29, 1969, now abandoned.

BACKGROUND

Drilling a deep well, such as an oil well, is a time consuming, expensive operation, and is plagued with many problems. This invention overcomes certain of those problems, and in order to appreciate those problems a brief description of the current method of drilling wells follows.

A drill bit is attached to a section of drill pipe which will pass through a device called a rotary, and the entire drill pipe is rotated. As the well hole progresses additional drill pipe is added. The drill pipe is supported by a swivel which permits the string of pipe, (i.e., the drill string) to rotate while allowing circulating fluid to be pumped through the pipe. The fluid acts as a lubricant and cooling agent for the drill bit, and also serves to carry the cut rock particles to ground level. Weight is required to drive the drill bit downwardly, and this is provided by heavy pipe attached immediately above the drill bit. This heavy pipe is referred to as a drill collar. Several sections of drill collar are attached to each other to provide the necessary weight. The drill collars also serve to add vertical stability to the drill string. However, the drill string does drift away from the centerline of the well hole. If such drifting is not prevented the drill string will come in contact with the side of the well hole and form an off-center hole. Also, drifting of the drill string sometimes results in a rupture of the drill pipe necessitating a fishing operation for the broken parts. Fishing operations often take many days to complete. In addition, an off-center hole may end up on another's property and be abandoned, and another well hole drilled. Aside from the problems of abnormal operation, normal drilling has its problems. The drill bit becomes dull after prolonged use and must be replaced. In order to do so the entire drill string must be withdrawn from the well hole, with each section of pipe being disconnected as it reaches the ground surface. The drill bit is then replaced, and the drill pipe is re-connected and lowered into the well hole. In addition, the circulating liquid system must be shut down while drill bit replacement operation is being carried on. Shutting down the circulating system creates additional problems, especially in maintaining the fluidity of the circulating liquid.

SUMMARY OF THE INVENTION

I overcome the above-mentioned problems of drill string drifting and drill bit replacement by my present invention. In the preferred form of the invention, I start by attaching a keying head to a conventional piece of drill pipe, the keying head being preferably square in cross-section. A two section drill bit assembly is placed over the drill pipe with the bit assembly being free to travel up and down the drill pipe. The lower half of the drill bit assembly, or the cutting head section, has bits fixed to the lower end thereof and the bits are arranged so that the cutting head section is free to travel over the drill pipes. The inner surface of the cutting head is also, preferably, square in cross-section and fits snugly on the keying head for rotation therewith. The upper section of the drill bit assembly, or the back-up section, is

separated from the cutting head section by a thrust bearing. Thus, the cutting head section will rotate with the drill string while the back-up section remains stationary. Holding means are provided between the cutting head and back-up sections for holding them axially together while permitting the cutting head section to rotate. After both sections of my drill bit assembly are placed over the drill pipe, a first section of drill collar also embodying my present invention is put in place on top of the back-up section. My drill collars include, preferably, identical longitudinal half sections pivotably connected to each other. The closed drill collar is generally square in cross-section and has a diagonal dimension slightly smaller than the diameter of the well hole. The inside diameter of the drill collar is slightly larger than the outside diameter of the drill pipe, and thus can be readily moved upwardly and downwardly of the drill pipe. The close fit of the drill collars in the well hole serves to maintain the drill string centered in the well hole, thereby preventing the drift mentioned earlier and assuring a straight well hole. Stabilizers are also mounted on my drill collars and will contact the wall of the well hole in such a manner that the drill collar will remain truly centered in the well hole. Thus, additional insurance is provided against drill string drift. In one form, the stabilizers are a plurality of rollers urged outwardly by springs or the like. The drill collar will, accordingly, be able to be moved upwardly and downwardly in the well hole while always remaining centered. The drill bit and collar assemblies also include means for attaching power driven lifting means for lifting or lowering the cutting head and back-up sections, together with the drill collars, out of or into the well hole as desired. On form of the lifting means is a pair of cables or chains reeved over various pulleys, with one end of each cable being connected to the back-up section and the other end being connected to a motor driven winch, or the like. Since the back-up section is secured to the cutting head section and is below the drill collars, pulling on the back-up section will lift all of the drill collar, cutting head section and back-up section. Thus, drill bits can be replaced without any need to withdraw the drill string. In addition, the circulating liquid system can continue to operate during any drill bit change.

Other details and advantages of my present invention will become apparent as the following description of a present preferred embodiment thereof proceeds.

In the accompanying drawings I have shown certain present preferred embodiments of the invention, in which:

FIG. 1 is a view showing, diagrammatically, a rotary drilling rig with the drill string thereof in a well hole, and showing the present invention in position during drilling;

FIG. 2 is an enlarged longitudinal elevational view through the first section of drill pipe forming the drill string of FIG. 1, showing in section the elements forming an embodiment of the present invention;

FIG. 3 is a view taken along the line III—III of FIG. 2;

FIG. 4 is a view taken along the line IV—IV of FIG. 2;

FIG. 5 is a view taken along the line V—V of FIG. 2;

FIG. 6 is a view taken along the line VI—VI of FIG. 2;

FIG. 7 is a perspective view showing the back-up and cutting head sections forming part of the drill bit assembly of the present invention;

FIG. 8 is a perspective view of part of the drill collar assembly of the present invention;

FIG. 9 is an end view of the cutting head section of the drill bit assembly showing an arrangement of the drill bit; and

FIG. 10 is a perspective view of the keying head forming part of the present invention.

FIG. 11 is an enlarged longitudinal section showing a modification of the apparatus in FIG. 2 in which a down hole motor is used to rotate the keying head and drill bit.

Referring now to the drawings wherein like reference numerals refer to like parts throughout the various views, FIG. 1 shows, diagrammatically, a rotary rig with its mast and other operating equipment, and drill string 10 and drill bit assembly 12 in a well hole. The operating equipment of the rotary rig are standard and well-known and do not form part of the present invention. The present invention relates to the drill bit assembly 12 and the drill collars 14 disposed on the drill string 10 above the drill bit assembly.

As shown in FIG. 1, the drill string 10 is formed of a series of elongated tubular drill pipes 16 longitudinally aligned and fixed to one another by well-known threaded connections. FIG. 2 shows the lowermost drill pipe 16 having threadably attached to the lower end thereof an elongated tubular keying head 18 having a generally square cross-sectional shape. The drill bit assembly 12 is shown in FIG. 2 in place ready for drilling. The drill bit assembly 12 includes a cutting head section 20 and a back-up section 22 disposed above the cutting head section. The cutting head section 20 includes an elongated generally cylindrically shaped tubular body 24 with its interior bore 25 having a lower section 26 formed generally square in cross-section from its lower end up to an intermediate point thereof. The outer surface of body 24 is provided with four uniformly spaced longitudinally extending scallops 28 for the upward passage of circulating fluid, rock chips, and the like. The upper section 27 of the bore 25 is circular in cross-section and has a diameter slightly greater than the outside diameter of the drill pipes 16 so that the cutting head section 20 can readily slide over the surface of the drill pipes 16. Lower section 26 of bore 25 is sized to fit snugly on keying head 18 and yet provides enough clearance for the cutting head section 20 to slide on or off the keying head. As shown in FIG. 9, a series of drill bits 30 are suitably attached about the lower end of cutting head section 20. The pattern of the drill bits 30 is suitable for drilling rock formations in forming a well hole.

A retractable drill bit 31 is disposed centrally of the lower end of cutting head section 20 to provide a 360° cutting surface. As shown in FIGS. 2 and 9, the retractable drill bit 31 is arranged to permit the cutting head section 20 to move longitudinally upwardly or downwardly of the drill string. The retractable drill bit 31 is suitably fixed to a plate member 32 pivotably mounted on the lower end of cutting head section 20, as by a suitable hinge 34. The plate member 32 is biased toward the lower end of cutting head section 20 by a suitable spring not clearly shown. A plurality of

passageways 38 extends through plate member 32 and communicates with the bore 25 of body 24. These passageways 38 serve to direct circulating fluid onto the drill bits 30 and 31, which circulating fluid is pumped through the hollow drill string 10 from a pumping station on ground level.

A circumferential groove 40 is formed in the upper end portion of the body 24 of cutting head section 20. As will be more clearly described hereinafter, groove 40 serves as part of the holding means for axially securing cutting head section 20 with back-up section 22.

Back-up section 22 is disposed above cutting head section 20, and includes an elongated generally cylindrically shaped tubular body member 42. The outer surface of body member 42 is provided with four longitudinally extending scallops 46 for the upward passage of circulating fluid, rock chips, and the like. Body member 42 is formed of two longitudinal semi-cylindrical sections 42a and 42b, shown in perspective in FIG. 7. The two sections 42a and 42b are provided with suitably arranged ears 43 which allow the sections to be mated with each other in a hinged relationship. The ears 43 are provided with longitudinal coaxial openings 44 suitably sized to receive a hinge pin 45. When the sections 42a and 42b are closed about a drill pipe 16 a hinge pin 45 is inserted through the formerly separated ears to thus provide a means for locking the back-up section 22 around the drill string 10. The bore 47 through the body member 42 of back-up section 22 is divided into an upper portion 48 having a diameter slightly greater than the outside diameter of the drill pipe 16, and a lower portion 49 larger in diameter than upper portion 48, thereby defining a shoulder 50 therebetween. A radially inwardly extending lip 52 is formed at the lower end of the body member 42 of back-up section 22. Lip 52 is suitably sized to loosely fit into groove 40 to thereby axially secure the back-up section 22 to the cutting head section 20. As shown in FIG. 2, there is a slight axial clearance between lip 52 and groove 40 to permit a small axial movement between the back-up and cutting head sections. When I use the expression "axially secured" herein with regard to the back-up and cutting head sections it means that the sections are held axially together with a slightly loose fit between the lip 52 and groove 40. The loose fit is desirable for ease of attaching the back-up section to the cutting head section. The lip 52 and groove 40 are also suitably sized so that the cutting head section 20 is able to rotate with respect to back-up section 22 when the drill string 10 is rotated. A thrust bearing 54 of any well-known type is interposed between the back-up section 22 and cutting head section 20 in abutment with the upper end surface of the cutting head section 20 and the shoulder 50 of back-up section 22.

When the cutting head section 20 and back-up section 22 are arranged on the drill pipe 16, the drill collars 14 are located about the drill pipe 16. Each drill collar 14 includes an elongated, tubular main body 58 having a generally square cross-section shape with a diagonal dimension slightly less than the diameter of the well hole being drilled. For example, the diagonal dimension of the main body 58 could be about 1 inch less than the diameter of the well hole. This would give about a ½ inch clearance between the well hole and the corners of the drill collar which clearance would be

enough to permit the drill collars to be lifted out or lowered into the well hole while at the same time providing a positive centering of the drill string in the well hole. The main body 58 of the drill collars is comprised of a pair of longitudinal sections 58a and 58b suitably hinged to each other as by interlocking ears 59 and hinge pins 60 much in the same fashion as the hinge arrangement for the sections forming back-up section 22. When the sections 58a and 58b are closed around a drill pipe to form main body 58 hinge pins 60 are inserted into the formerly separated ears 59 to thereby lock the main body around the drill string. The bore 62 is generally circular in cross-section and has a diameter slightly greater than the outside diameter of the drill pipes 16 to thereby permit the drill collars 14 to be slid over the drill string 10. Pairs of diametrically opposed stabilizer means 66 are arranged in main body 58 of the drill collars 14. As shown in FIG. 1, each face of the main body 58 has three longitudinally spaced stabilizer means 66, thereby totaling 12 stabilizer means for each drill collar 14. It may be convenient to employ a different number or style of stabilizer means or to arrange them in a different pattern. One of the stabilizer means 66 shown in FIGS. 2 and 8, will be described with it being understood that such description relates to all of them. The stabilizer means 66 includes a pair of longitudinally extending parallel arms 70 suitably pivotably mounted by hinge pin 74 at their respective upper ends to brackets 68 suitably secured to the main body 58. A pair of longitudinally spaced rollers 72 are disposed in a hollow housing 73 which in turn is suitably pivotably supported between the lower ends of arms 70. The housing 73 is suitably sized for receiving the respective rollers 72 such that a portion of the rollers extends radially outwardly of the housing. Pins 76 extend through the housing 73, the rollers 72 and the arms 70 to hold the rollers 72 in place with respect to the arms and housing. A flat spring 78 is suitably supported by hinge pin 74 and is arranged to engage the main body 58 and arms 70 to bias the arms 70 radially outwardly with respect to main body 58 such that the rollers 72 contact the wall of the well hole when the drill collars 14 are around the drill string 10. The spring 78 is suitably selected so that the stabilizer means 66 gives when the drill collars 14 is moved upwardly or downwardly with respect to the drill string 10, while at the same time the stabilizer means 66 maintains the drill collars 14, and in turn the drill string 10, centrally oriented with respect to the well hole.

Attachment means are provided for lifting the drill collars and drill bit assembly. One representative means for lifting or lowering the cutting head section 20, back-up head section 22, and drill collars 14 is illustrated as a simple motor driven winch and cable arrangement. A pair of cables 84 extend around suitable pulleys and idlers into the well, with one end connected to the drum of motor driven winch 86 and the other ends suitably fixed to the upper surface of back-up section 22. The cables 84 will run along the drill pipes 16 and pass through longitudinal slots 88 provided in the bore 62 of main body 58 of the drill collars 14.

FIG. 4 shows a modification of the apparatus illustrated in FIG. 2 in which a motor is interposed in the drill string between the drill bit assembly and the top of the well. Like numbers are used to designate like parts.

A down hole motor 89 is connected between the lowermost drill pipe 16 and the keying head 18. Down hole motors are well known and produce rotary motion resulting from the passage of drilling mud through the motor. If the drill string and pipe 16 are secured against rotation, the motor will rotate keying head 18 when drilling mud is pumped through the motor.

In the arrangement of FIG. 11 cables 84 are connected to pass down the well outside of the drill collar 14.

Many modifications can be made to the present invention as those skilled in the art would readily recognize. For example, a rack and gear type lifting means could be used for raising and lowering the cutting head section, back-up section, and drill collars; various retractable bit arrangements could be substituted for that shown and described; the drill collar could be shaped circular in cross-section, or for that matter any other suitable cross-section; the drill bit arrangement need not have a retractable bit, but can simply be provided with a central opening of sufficient size to permit the cutting head section to slide over the drill string; the cutting bit may be replaced by a core bit for core sampling; apparatus for logging a well may be used in conjunction with the invention; many various stabilizer means could be adapted to the present invention.

In the operation of the arrangement shown in FIG. 2, the drill string is rotated, causing keying head 18 and cutting head section 20 to rotate. Drill collar 14 and back-up section 22 will not rotate but will remain substantially in one angular position because of the interposition of thrust bearing 54. Circulation fluid such as drilling mud is pumped down the drill string and will pass around the cutting bits and will carry freshly cut rock and earth back to the surface in the conventional manner. When it becomes necessary to replace the drill bits, the lower assembly is lifted by lifting cables 84. The drill bit assembly 12, and collars 14 will be lifted to the surface while the drill string remains in place. After necessary maintenance the assemblage is lowered into the well, where cutting head section 20 may be readily located on keying head 18. Drilling is then resumed.

In the arrangement of FIG. 11, rotational motion of the keying head and cutting head assembly is provided by down hole motor 89 and the drill string above motor 89 remains stationary against rotation. The drill bit assembly may be removed for maintenance and repair in the same manner as previously described.

In some circumstances it may be desirable not to provide a permanent connection from the drill bit assembly and drilling collars to the lifting means. In such instances a specialized coupling or fishing tool may be employed to raise the entire assemblage.

While I have shown and described a present preferred embodiment of the present invention it is to be distinctly understood that the invention is not limited thereto but may be otherwise variously practiced within the scope of the following claims.

I claim:

1. A drill bit assembly for use in combination with a drill string including a plurality of longitudinally aligned hollow drill pipes, comprising:

an elongated tubular keying head member removably fixed with and longitudinally aligned with the lowermost drill pipe in the drill string;

drill bit housing means movable longitudinally upwardly and downwardly of the drill string, and including a tubular cutting head section longitudinally slidably arranged around said keying head member and non-rotatable with respect thereto, and a tubular back-up section disposed around a drill pipe above said cutting head section;

rotary drilling bit means fixed to the lower end surface of said cutting head section;

holding means on said cutting head and back-up sections for axially securing said sections to each other while permitting said sections to rotate with respect to each other;

bearing means operatively arranged between said sections for allowing said cutting head to rotate with the rotating drill string while said back-up section remains stationary;

tubular secondary back-up members disposed around a drill pipe above said back-up section of said drill bit housing means; and

attachment means operatively connected to said drill bit assembly for lifting and lowering said drill bit assembly out of and into a well.

2. A drill bit assembly as set forth in claim 1 wherein said back-up head section is divided into longitudinal sections including at least a pair of elongated body members, hinge means between adjoining body members for opening and closing the body members with respect to the drill string, and locking means for locking said body members around the drill string.

3. A drill bit assembly as set forth in claim 1 wherein said rotary drilling bit means includes a plurality of bits fixed about the surface of the lower end of said cutting head section, an elongated plate member extending transversely across the lower end of said cutting head section and pivotably connected thereto, resilient means bearing said plate member against the surface of the lower end of said cutting head section, a bit fixed to an intermediate portion of said plate member and extending downwardly with respect thereto, and said cutting head section having a plurality of passageway means extending from the interior thereof through the lower end thereof and directed toward said bits for providing egress for circulating fluid passing through the drill string.

4. A drill bit assembly as set forth in claim 1 wherein said holding means includes a radially inwardly extending annular lip fixed to said back-up section at the lower end thereof, a circumferential groove formed in the end portion thereof, said lip fitting loosely into said groove such that said sections are axially secured to each other while said sections can rotate with respect to each other.

5. A drill bit assembly as set forth in claim 1 wherein said rotary drilling bit means includes a plurality of bits fixed about the surface of the lower end of said cutting head section, a central bit means disposed centrally on the lower end of said cutting head section and being retractable and extensible with respect to said cutting head section for retracting when said cutting head section is moved upwardly or downwardly with respect to the drill string and for extending into cutting position when said cutting head section is positioned on said keying head member.

6. A drill bit assembly for use in combination with a drill string including a plurality of longitudinally aligned hollow drill pipes, comprising:

an elongated tubular keying head member having a generally square cross-section removably fixed with and longitudinally aligned with the lowermost drill pipe in the drill string;

drill bit housing means moveable longitudinally upwardly and downwardly of the drill string, and including a tubular generally cylindrically shaped cutting head section having its interior bore formed at least in part in a generally square cross-sectional shape conforming substantially to the shape of said keying head member and longitudinally slidably arranged on said keying head member, and a tubular back-up section disposed around a drill pipe above said cutting head section and including a pair of semi-cylindrical body members articulated to each other for opening and closing around the drill string;

locking means for locking said body members around the drill string;

said back-up head having a radially inwardly extending annular lip, one half of which is on each of said body members, on the lower end portion thereof, said cutting head section having a circumferential groove formed in the external surface thereof, said lip fitting loosely into said groove such that said sections are axially secured to each other while said sections can rotate with respect to each other;

thrust bearing means operatively arranged between said cutting head and back-up sections for allowing said cutting head section to rotate with the rotating drill string while said back-up section remains stationary;

rotary drilling bit means fixed to the lower end surface cutting head section and arranged for cutting a well hole while permitting said cutting head section to be moved upwardly and downwardly of the drill string; and

power driven lifting means fixed with said back-up section for lifting and lowering said cutting head and back-up sections together into and out of a well.

7. A drill collar assembly for use in combination with a drill string including a plurality of longitudinally aligned hollow drill pipes and a drill bit assembly having a stationary upper back-up section, comprising:

an elongated tubular body shaped to fit longitudinally slidably around drill pipes and having external dimensions slightly less than the diameter of the well hole being drilled such that lateral shifting of the drill will be prevented, said body including a plurality of longitudinal sections articulated to each other for opening and closing around a drill string;

locking means for locking said sections around the drill string; and

stabilizer means for positioning said body centrally of the well hole supported by said body and including a plurality of roller members extending radially outwardly of said body, and biasing means supported by said body and connected with said roller members outwardly of said body.

8. A drill collar assembly as set forth in claim 7 wherein said body has longitudinal passageway means therethrough by receiving cables forming part of a lifting means for lifting and lowering the drill bit and drill collar assemblies together.

9. A drill collar assembly as set forth in claim 7 wherein said body has a generally square cross-sectional shape with the diagonal dimension thereof being slightly less than the diameter of the well hole being drilled, and said body includes a pair of longitudinal sections.

10. A drill bit assembly for use in combination with a rotatable drill string including a plurality of longitudinally aligned hollow drill pipes and adapted to be raised and lowered into and out of a well hole without disturbing said drill string, comprising:

drill bit housing means movable longitudinally upwardly and downwardly of said drill string, and including:

- i. a tubular cutting head section connected to the bottom portion of the lowermost section of said drill string in a manner to permit relative longitudinal sliding motion but to prevent relative rotational motion therebetween, and
- ii. a tubular back-up section disposed around a drill pipe above said cutting head section;

rotary drilling bit means connected to the lower portion of said cutting head section;

holding means on said cutting head and back-up sections for axially securing said sections to each other while permitting said sections to rotate with respect to each other; and

bearing means operatively arranged between said cutting head section and said back-up section for allowing said cutting head to rotate with the rotating drill string while said back-up section remains stationary.

11. A drill bit assembly with a combination of a drill string including a plurality of a longitudinally aligned hollow drill pipes, comprising:

a power means removably fixed longitudinally aligned with the lowermost drill pipe and non-rotatable with respect thereto;

an elongated tubular keying head member removably fixed with and longitudinally aligned with said power means and rotatable by said power means;

drill bit housing means movable longitudinally up-

wardly and downwardly of the drill string, and including a tubular cutting head section longitudinally slidably arranged around said keying head member and non-rotatable with respect thereto, and a tubular back-up section disposed around a drill pipe above said cutting head section;

rotary drilling bit means fixed to the lower end surface of said cutting head section;

holding means on said cutting head and back-up sections for axially securing said sections to each other while permitting said sections to rotate with respect to each other;

bearing means operatively arranged between said sections for allowing said cutting head to rotate with the rotating drill string while said back-up section remains stationary;

tubular secondary back-up members disposed around a drill pipe above said back-up section of said drill bit housing means; and

attachment means on said back-up section of said drill bit housing and on said secondary back-up members for lifting said cutting head, back-up section and secondary back-up members together into and out of a well.

12. A drill collar assembly adapted for use in combination with a drill string, said drill string comprising a plurality of longitudinally aligned hollow drill pipes extending from the surface of the ground to the bottom of a well and a drill bit assembly at the lower end of the drill pipes, said drill bit assembly having a larger diameter than the drill pipes and being vertically keyed to the lower end of the drill pipes for vertical movement of the drill bit assembly relative to the drill pipes,

said drill collar assembly comprising an elongated hollow tube-like member having an outside diameter smaller than the diameter of the well and an inside diameter larger than the drill pipes and the joints thereof but smaller than the outside diameter drill bit assembly, whereby said collar may be lifted to the top of the well without lifting the drill pipes and may be lowered to rest upon the drill bit assembly, said drill collar assembly comprising stabilizing members supported by the tube-like member, movable radially, and biased outwardly to continuously engage the wall of the well, whereby said drill collar assembly is radially positioned in the well during positioning of the drill bit assembly and during drilling.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,729,057 Dated April 24, 1973

Inventor(s) George S. Werner

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 2, line 35, "On" should read -- One --. Column 8, claim 7, line 56, after "drill" insert -- string --.

Signed and sealed this 26th day of February 1974.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents