June 9, 1959 L. L. BROWN, JR 2,890,022

REPLACEABLE DRILL BIT

Filed Sept. 3, 1957

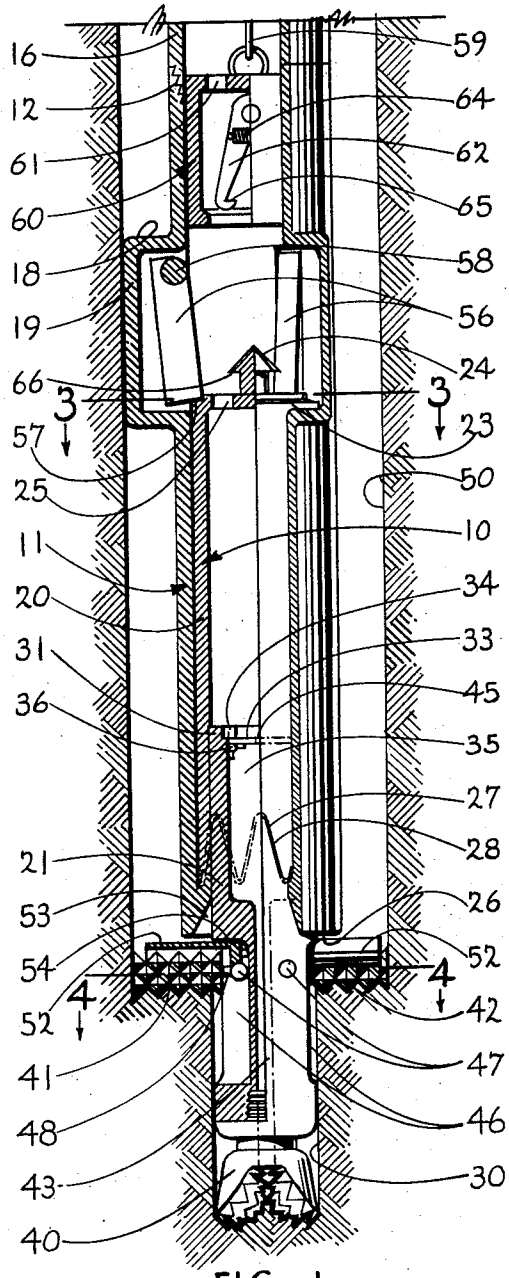

FIG. 1

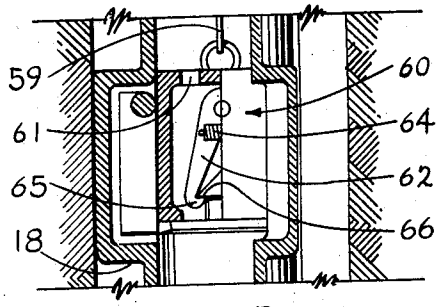

FIG. 2

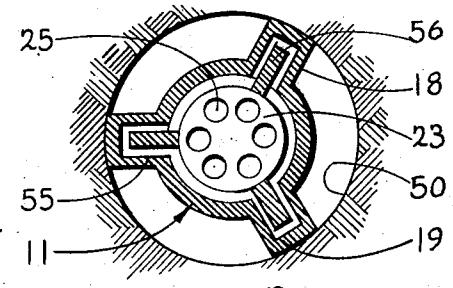

FIG. 3

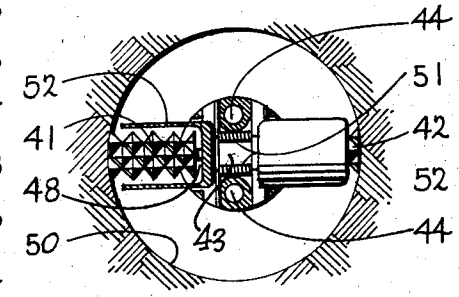

FIG. 4

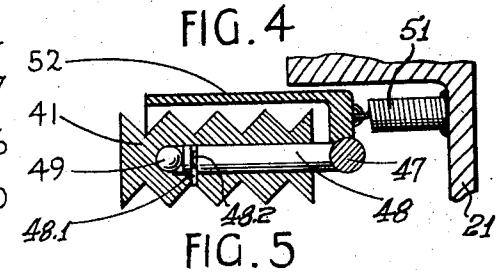

FIG. 5

INVENTOR.

LOTHROP LEE BROWN, JR.

BY

William A. Spencer Attorney

United States Patent Office

2,890,022

Patented June 9, 1959

2,890,022

REPLACEABLE DRILL BIT

Lothrop L. Brown, Jr., Long Beach, Calif.

Application September 3, 1957, Serial No. 681,514

4 Claims. (Cl. 255—76)

This invention relates to well drilling apparatus and more particularly to an improved self-aligning drill bit which is replaceable while the drill string remains in the hole.

In the drilling of oil wells and other bore holes deep in the earth considerable time is lost in the drilling operation due to the time required to periodically change the drill bit. That is, when the bit has been dulled or when a different bit is required due to change of formation, it is necessary in the present state of the art to make a complete trip out of and into the hole. Thus, in order to change the bit all of the drill pipe must be removed, a different bit installed at the end of the string, and the string replaced in the hole. The disadvantages of such an operation are obvious especially considering the length of time involved in a trip into a hole of considerable depth.

Accordingly, it is an object of the present invention to provide a well drilling bit apparatus which can be placed at and removed from the bottom of a drill string without removing the drill string from the hole.

It is another object of the present invention to provide a drill bit apparatus which can be placed in the drill pipe at the surface of the hole and will descend down the drill pipe and be affixed in drilling position at the bottom of the string.

It is a further object of the present invention to provide a drill bit apparatus which can be released from drilling position and removed from the drill string from the surface of the hole without removing the drill pipe from the hole.

It is a still further object of the present invention to provide a drill bit apparatus which may be inserted into drilling position and removed therefrom through the drill pipe but which bores a hole having a diameter greater than the outside diameter of the drill pipe.

Still another object of the present invention is to provide a bottom hole replaceable drill bit apparatus which will maintain a straight or axial direction of drilling without lateral drift or wandering at the bottom of the hole.

A replaceable drill bit apparatus in accordance with the present invention comprises a drill bit of fixed diameter which diameter is less than the inside diameter of the drill pipe to which the bit is to be attached. The drill bit is affixed to a generally cylindrical body having a diameter less than the inside diameter of the drill pipe. The drill bit body carries a plurality of reamer cutters which are retractable into the body to a diameter equal to or less than the diameter of the bit. The reamers are expandable to a diameter equal to the diameter of the hole being drilled. Means are provided for engaging the drill bit body with the drill string by allowing the apparatus to descend downward within the drill string. The drill bit apparatus is engaged such that the body is non-rotatable and immovable with respect to the drill string and such that the bit and reamers extend below

the bottom of the drill string in drilling position. Means are also provided for releasing the drill bit body from such engagement and retrieving the drill bit apparatus through the drill string.

The novel features which are believed to be characteristic of the present invention, both as to its organization and method of operation, together with further objects and advantages thereof will be better understood from the following description considered in connection with the accompanying drawing. It is to be expressly understood, however, that the drawing is for the purpose of illustration and example only, and is not intended as a definition of the limits of the invention.

Figure 1 is a longitudinal view partly in section showing the drill bit apparatus in drilling position engaged with the drill string in a drill hole;

Figure 2 is a partial view corresponding to Figure 1 of the longitudinal retaining means in the released condition with the retrieving means in operable position;

Figure 3 is a sectional view taken along line 3—3 of Figure 1; and

Figure 4 is a sectional view taken along line 4—4 of Figure 1;

Figure 5 is a sectional enlarged partial view of a reamer as affixed to the body.

Referring now to the drawing and particularly to Figure 1, a presently preferred embodiment of the present invention comprises a removable drill bit body **10** which is hollow and substantially cylindrical in configuration. The largest diameter of the body **10** is substantially equal to, but less than, the inside diameter of the drill pipe which is used to make up the drill string. A tubular body **11** into which the drill bit body **10** is engageable, as described hereinafter, is generally vertically disposed with a customary upper threaded box **12** into which may be screwed a service or tool joint for connection of the drilling apparatus at the end of the drill string **16**. The tubular body **11** has inside and outside diameters substantially equal to the inside and outside diameters of the drill pipe **16** and has a plurality of radially extending protrusions **18**, described in further detail hereinafter, which have a radius substantially equal to the radius of the hole being drilled. Thus, the outer surface **19** of the protrusions **18** as shown in Figures 1, 2 and 3 bear against the wall of the hole and act as a guide bearing to maintain the bit in axial alignment during rotation.

The drill bit body **10** is slidably mateable with the tubular body **11** and means are provided for preventing relative rotation between the bodies when the drill bit is in the operative position as shown in Figure 1. Non-rotating interengagement is obtained in this embodiment by forming the drill bit body **10** in two sections, the upper section **20** and the lower section **21**. The upper section **20** is tubular with an outside diameter substantially equal to the inside diameter of the tubular body **11** and has a partially closed upper end **23** to which a grappling cone **24** is affixed. A plurality of openings **25** are provided through the end **23** of the body section **20**, or the end surface is formed as a spider, to allow the free circulation of fluid through the end **23** and into the drill bit body **10**. The end surface **23** of the upper body section **20** is positioned proximate the lower end of the protrusions **18** and the body section **20** extends downward to a position a substantial distance above the lower end **26** of the tubular body **11**. The lower end of the upper body section **20** is serrated or otherwise formed to provide a series of serrations **27** which extend around the circumference of the body **20**. The serrations **27** of the body are tapered and are mateable with a like series of serrations **28** formed upon the upper surface of a collar **29**

which is affixed to the inner surface of the tubular body **11** beneath the upper section **20** of the drill bit body **10**.

The lower section **21** of the drill bit body **10** is affixed to the upper section **20** in this embodiment by forming the outside diameter of the lower section equal to the inside diameter of the upper section and collar **29** along a longitudinal distance of reduced wall thickness of the upper section. Thus, a substantial length of the lower section **21** forms a slip fit partially into the upper section to a shoulder **31** formed by the reduced wall thickness. The lower section **21** is affixed to the upper section by welding or other means known to the art, such that upward forces or rotational forces on the lower section **21** are transmitted to the upper section through the welding and the shoulder **31**. The upper end of the lower body section is partially closed and is provided with means for restricting the flow of fluid therethrough. That is, in this embodiment a flapper valve of the type well known to the art is provided to allow the free flow of fluid in the downward direction, but to restrict the flow of fluid in the upward direction. Thus, a hinged plate **33** is affixed at the upper end of the lower section **21** by means of a hinge **36** and a lock ring **34**. Openings **45** of a predetermined diameter are provided through the plate to allow the restricted flow of fluid upward through the plate. During the free descent of the body **10** through a column of fluid within the drill string, as described hereinafter, the flow of fluid through the interior **35** of the body **10** will close the flapper plate **33** to allow fluid flow through the openings only, to govern the rate of descent of the body. However, if the body is raised within the drill string through a column of fluid the relative direction of fluid flow through the body is downward and the flapper will be opened to allow free flow of fluid through the upper end of the lower section **21** and thus through the body **10**.

In the assembled position of the upper body section **20** and lower body section **21** the wall thickness of the lower section is increased sufficiently to provide a mounting means for a pilot bit **40** and a pair of retractable reamer cutters **41** and **42**. Thus, from a longitudinal position proximate the lower end **26** of the tubular body **11** the lower body section **21** becomes a substantially solid cylindrical body provided, however, with a fluid flow path **43** extending to the pilot bit and a fluid bypass path which is two fluid ports **44** in this embodiment. Thus, referring to Figures 1 and 4, a pilot bit **40** of the tricone roller bit type is affixed at the lower end of the lower body section. The bit is of the type well known to the art and is of fixed boring diameter. The diameter of the bit which is used is substantially equal to the inside diameter of the collar **29** and is less than the inside diameter of the drill string **16**. The fluid path **43** through the lower body section communicates with the fluid ports of the bit to furnish circulation fluid to the bit in the manner well known to the art.

A pair of diametrically opposed pockets or recesses **46** are provided in the lower body section **20** above the bit **40** to accommodate the retractable reamer cutters **41** and **42**. That is, a pair of roller reamer cutters of the type well known to the art are pivotally mounted in the body upon the mounting pins **47** which are pivotally affixed to the body. The reamer cutters **41**, **42** are freely rotatable about the respective shafts **48** which are in turn affixed to the mounting pins **47** for pivotal movement with respect to the body. A ball bearing **49** is positionetd at the end of each shaft **48** to act as a roller and thrust bearing with respect to the cutter and shaft to insure free rotation. The reamers are affixed rotatably upon the respective shaft **48** by means such as the set screw **48.1** which extends radially through the wall of the reamer and into a circumferential groove **48.2** in the shaft **48**. The reamers are mounted upon the mounting pins to extend radially and to cut to the diameter of the well bore being drilled. Thus, the reamer cutters extend the diameter of the well bore from that drilled by the pilot bit **40** to the full required hole diameter **50**. Means are provided to yieldably urge the reamers to the outward cutting position as shown in Figure 1. Spring, hydraulic, or torque means of the type known to the art may be used to urge the reamers outward although in this embodiment springs **51** are used. A shield **52** is affixed to the reamer mounting means to substantially enclose the reamers in the retracted position and to furnish a means for retracting the reamers when the drill bit body **10** is within the tubular body **11** or the drill string **16**. The pivot point of the reamers are positioned within the body such that when the reamers are pivoted downward and into the recesses **46** the reamers and shields are completely contained within the diameter of the drill bit body **10** in order that they can pass through the drill string. Thus, the reamers are retractable to a diameter less than the inside diameter of the drill string. A downwardly and outwardly extending taper **53** is formed on the lower inside edge of the collar **29** to provide a retracting force upon the reamers when the drill bit body is withdrawn upward through the tubular body as described hereinafter. At the fully expanded position of the reamers the reamer assembly is in bearing contact with the body **10** at the shoulder **54** which restricts the reamers to a substantially transverse plane and transmits any load upon the reamers to the body.

Means are provided for engaging the drill bit body **10** within the tubular body **11** to prevent relative longitudinal movement of the drill bit apparatus when in the assembled and operative condition shown in Figure 1. Thus, referring to Figures 1, 2 and 3, the protrusions **18** define chambers **55** extending radially beyond the inside diameter of the tubular body **11** and above the upper end **23** of the drill bit body **10**. A plurality of holding devices are positioned within the chambers to form longitudinal locking means which can be disengaged. In the embodiment shown a locking lever **56** is pivotally mounted in each protrusion. The lever is of substantial weight and is of such length as to be mateable with an engaging shoulder **57** at the upper end **23** of the drill bit body in the assembled position. Means are provided for urging the levers radially inward at the lower end thereof to the latching position. In this embodiment the weight of the lever is used to achieve this movement by pivoting the lever at a point radially inward of the vertical centerline of the lever. That is, each lever is pivotally mounted upon a mounting pin **58** positioned proximate the upper end of the lever but to the radially inward side of the longitudinal centerline of the lever. Thus, the weight of the lever will force the lower end of the lever inward to the engaging position shown in Figure 1.

The means for retrieving the drill bit apparatus is shown in the non-engaged position in Figure 1 and in the engaged position in Figure 2. The retrieving grapple **60** comprises a cylinder substantially open at the lower end and closed at the upper end but provided with fluid flow openings **61** at the upper end. The cylinder has an outside diameter substantially equal to the inside diameter of the tubular body **11** and an inside diameter sufficient to pass over the grappling cone **24** on the drill bit body **10**. A cable **59** is attached to the upper end of the grapple to retrieve it from the drill string. A pair of spring loaded grappling arms **62** are pivotally mounted within the grapple cylinder substantially symmetrical about the centerline of the grapple. The grappling arms are substantially mateable with the cone **24** and are spring loaded by a spring **64** in tension which urges the arms together to a closed position as shown in Figure 3 in which the fingers **65** are in vertically holding contact with the grappling surface **66** of the cone **24**.

Thus, in operation, referring to Figures 1 and 2, to

remove the drill bit apparatus from the assembled and drilling position shown in Figure 1, the grapple **60** is lowered on the cable **59** into the drill string. As the grapple moves downward fluid flows through the fluid openings **61** to allow downward progress. The grapple passes beyond the protrusions **18** such that the outside diameter of the grapple cylinder forces the locking levers **56** outward and moves the levers out of engagement with the drill bit body **10**. As the grapple arms **62** tongs strike the inclined surface of the cone **24** they are forced outward against the action of the spring **64**. Further downward movement of the grapple and tongs allows the fingers **65** to pass beyond the inclined face of the cone and to be pulled inward by the spring **64** to engage the grappling surface **66** of the cone as shown in Figure 2. The cable is then raised to raise the drill bit apparatus out of the hole. As the drill bit body **10** is raised the reamer assemblies, i.e., the reamer shields **52** strike the lower end of the tubular body **11** and are forced inward against the action of the expanding springs **51** by the tapered surface **53** on the collar **29**. As the drill bit body continues to be raised the reamers are thus retracted into the recesses **46** at a diameter less than the inside diameter of the tubular body **11** and the drill string **16**. Thus, the entire drill bit body **10**, including the bit **40** and reamers **41** and **42**, will pass upward through the drill string. During upward passage of the drill bit body the flapper plate **33** pivots downward to allow free passage of the drill bit apparatus through fluid in the drill string. Thus, the drill bit apparatus is raised through the drill string to the surface of the hole.

In order to place the drill bit apparatus in the operative position the drill bit apparatus with the reamers retracted is placed in the drill string at the surface of the hole with the gripple **60** removed from the string. The drill bit body **10** is allowed to fall freely down the drill string which contains circulation fluid. As the drill bit apparatus falls within the string the flapper valve **33** closes by pivoting upward and fluid must pass relatively upward through the body by passing through the openings **45** in the flapper plate. Since the openings are somewhat restrictive the descent of the apparatus will be at a controlled rate. As the drill bit body **10** falls into the position shown in Figure 1 the reamers pass beneath the end of the tubular body **11** and are free to move outward to the expanded position and will be forced outward by the progress of the pilot bit **40** as the hole is drilled. When the body **10** reaches the position of Figure 1 the serrations **27** on the body **10** and the serrations on the tubular body **11** will mate and prevent relative rotation of the drill bit body **10** within the tubular body **11**. Similarly, as the upper end **23** of the body **10** passes beneath the locking levers **56** the levers will pivot inward at the lower end to engage the drill bit body **10** and prevent relative longitudinal movement of the drill bit body within the tubular body **11**. The drill bit apparatus is thus in the assembled drilling condition. The drill string is then rotated to bore the required hole. The pilot bit **40** will drill a pilot hole **30** which is expanded to the desired full hole diameter by the following reamer cutters which have been forced to the fully opened position. The operation utilizing a pilot bit followed by reamer cutters directly above will maintain the axial alignment of the hole being drilled and prevent the lateral drift or wandering a hole bottom which is encountered when a single bit is used. In addition, the protrusions **18** have a bearing surface **19** equal to the hole diameter **50** which bear upon the sides of the hole to act as an alignment bearing above the drilling apparatus to further insure aligned and straight progress of the drilled hole.

While the present invention has been particularly described in connection with the method of drilling wherein the drill string is rotated it is equally applicable to the method of drilling wherein the drill string remains stationary while the drill bit is rotated by means of a turbine or the like contained within the drill bit body.

Thus, what has been disclosed is an improved drill bit apparatus which can be inserted into and removed from a drill string in a well bore without removing the drill string from the bore. The apparatus of the present invention further insures true alignment of the hole to be drilled without lateral drift from the axial course desired.

What is claimed is:

1. A replaceable drill bit apparatus to be affixed at the end of a tubular drill string comprising: a substantially vertically extending tubular body, said body being affixed at the lower end of said tubular drill string substantially coextensive therewith; a generally cylindrical drill bit body removably engaged within said tubular body extending a substantial distance below the lower end thereof, said drill bit body having an outside diameter less than the inside diameter of said drill string and said tubular body; a drill bit of substantially fixed diameter affixed at the lower end of said cylindrical body, said fixed diameter being less than said inside diameter of said drill string and said tubular body; a plurality of retractable reamer cutters affixed to said drill bit body below said tubular body, a plurality of mounting shafts upon which said cutters are mounted, means for pivotally affixing said shafts upon said drill bit body whereby said cutters are expandable to a desired diameter of the well to be bored, which diameter is greater than said fixed diameter of said drill bit, said reamer cutters being retractable to a diameter less than said inside diameter of said drill string and said tubular body; and a plurality of protrusions extending radially outward from said tubular body to a diameter substantially equal to said diameter of the well, a releasable engaging lever in each of said protrusions, whereby said levers affix said drill bit body against relative longitudinal movement with respect to said tubular body when said drill bit body is in said releasably engaged position, means for releasably affixing said drill bit body against relative rotational movement with respect to said tubular body, and means for releasing said levers and grappling said drill bit body from the surface of said well.

2. The apparatus of claim 1 wherein said releasing and grappling means includes a conical protrusion extending from the upper surface of said drill bit body, said conical protrusion being upwardly convergent and having an engaging shoulder therein, a grappling means, said grappling means including a substantially tubular body, said grappling body having an outside diameter substantially equal to, but less than the inside diameter of said tubular body, spring loaded tongs within said body, whereby said body disengages said levers and said tongs engage said protrusion, and a cable affixed to said grappling body extending from said surface.

3. A replaceable drill bit apparatus to be affixed at the end of a tubular drill string comprising: a substantially vertically extending tubular body, said body being affixed at the lower end of said tubular drill string substantially coextensive therewith; a generally cylindrical drill bit body removably engaged within said tubular body extending a substantial distance below the lower end thereof, said drill bit body having an outside diameter less than the inside diameter of said drill string and said tubular body; a drill bit of substantially fixed diameter affixed at the lower end of said cylindrical body, said fixed diameter being less than said inside diameter of said drill string and said tubular body; a plurality of retractable reamer cutters affixed to said drill bit body below said tubular body, a plurality of mounting shafts upon which said cutters are mounted, means for affixing said shafts upon said drill bit body whereby said cutters are expendable to a desired diameter of the well to be bored, which diameter is greater than said fixed diameter of said drill bit, means for biasing said cutters to said expanded position, said reamer cutters being retractable to a diameter less than said inside diameter of said drill string and said

tubular body; and a plurality of protrusions extending radially outward from said tubular body to a diameter substantially equal to said diameter of the well bore, a releasable engaging lever in each of said protrusions, whereby said levers affix said drill bit body against relative longitudinal movement with respect to said tubular body when said drill bit body is in said releasably engaged position, means for releasably affixing said drill bit body against relative rotational movement with respect to said tubular body, and means for releasing said levers and grappling said drill bit body from the surface of said well.

4. The apparatus of claim 3 wherein said releasing and grappling means includes a conical protrusion extending from the upper surface of said drill bit body, said conical

protrusion being upwardly convergent and having an engaging shoulder therein, a grappling means, said grappling means including a substantially tubular body, said grappling body having an outside diameter substantially equal to, but less than the inside diameter of said tubular body, spring loaded tongs within said body, whereby said body disengages said levers and said tongs engage said protrusion, and a cable affixed to said grappling body extending from said surface.

References Cited in the file of this patent

UNITED STATES PATENTS

2,046,106	Bozeman	June 30, 1936
2,134,988	Stokes	Nov. 1, 1938
2,330,083	Sewell	Sept. 21, 1943