Nov. 17, 1931. J. E. BRANTLY 1,831,841

DRILLING BIT

Filed Dec. 22, 1928

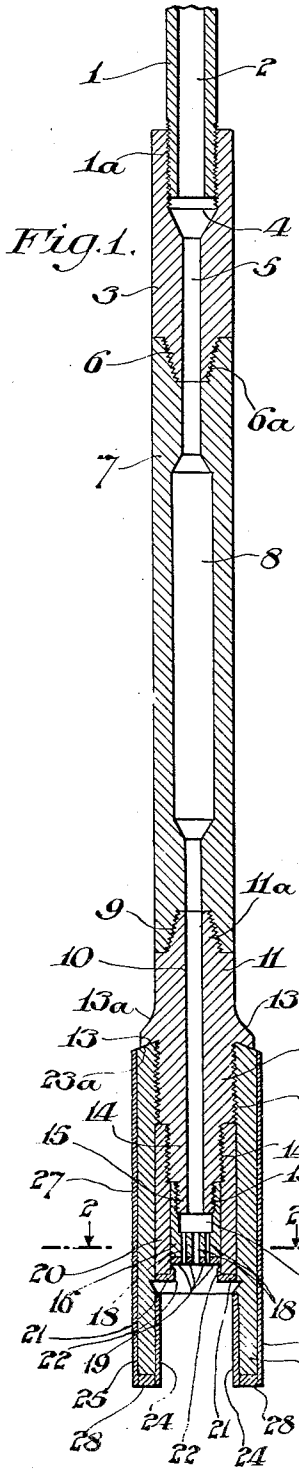


Fig. 1.

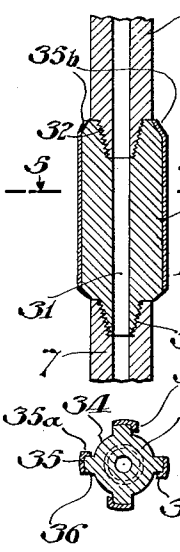


Fig. 4.

Fig. 5.

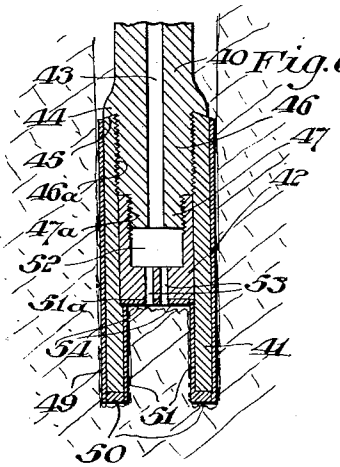


Fig. 6.

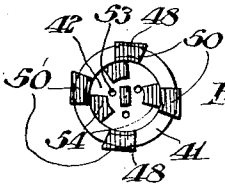


Fig. 7.

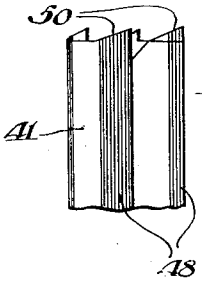


Fig. 8.

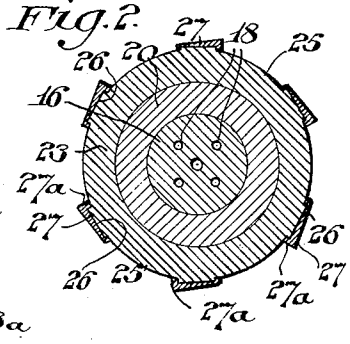


Fig. 2.

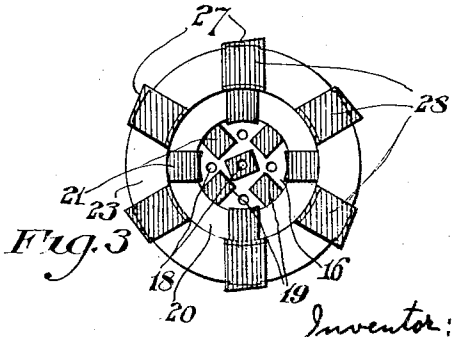


Fig. 3

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UNITED STATES PATENT OFFICE

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DRILLING BIT

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My invention relates to boring or drilling apparatus, and more particularly to apparatus of the type for drilling through earth and rock formations, as for water and oil wells.

My invention resides in boring or drilling apparatus of the rotary type comprising a bit head or support to which is secured a plurality of individual cutter elements; and more particularly one of said elements is an outer cutter sleeve comprising a cylindrical member having its outer surface and lower edge provided with cutting elements of material harder than that of said sleeve, welded to, imbedded in, or otherwise mounted in the body thereof; and still more particularly the outer surface of said sleeve is longitudinally fluted or grooved to form seats for the cutting elements disposed thereon, and to serve as a guide for the cutting elements.

My invention further resides in drilling apparatus of the character above referred to wherein a grinding or breaker element comprising another of the cutting elements is mounted within and centrally of the cutter sleeve at an appreciable distance above the lower cutting edge of the same; and more specifically wherein a second or inner cutter sleeve is mounted concentrically within and adjoining said first cutter sleeve.

My invention further resides in a drill assembly wherein a plurality of concentrically disposed cutting elements have their cutting surfaces in planes spaced vertically with respect to each other, and wherein one of said elements, more particularly an outer cutter sleeve, is provided with locking means for maintaining an inner cutter member in operative position.

My invention further resides in apparatus of the character hereinafter described and claimed.

For an illustration of some of the forms my invention may take, reference is had to the accompanying drawings in which:

Fig. 1 is a sectional elevational view of drilling apparatus constructed in accordance with the present invention.

Fig. 2 is an enlarged plan sectional view taken along the line 2—2 of Fig. 1.

Fig. 3 is an enlarged plan view, looking upwardly, of the apparatus shown in Fig. 1.

Fig. 4 is an elevational sectional view of a reamer constructed in accordance with the present invention.

Fig. 5 is a plan sectional view taken along the line 5—5 of Fig. 4.

Fig. 6 is an elevational sectional view of a modified form of my invention.

Fig. 7 is a plan view, looking upwardly, of the apparatus shown in Fig. 6.

Fig. 8 is an elevational view of part of the structure shown in Fig. 6.

Referring to Fig. 1, a section of drill-rod or pipe 1, having a centrally extending passage 2, is secured, as by screw threaded union 1*a*, to a tool joint 3. The tool joint comprises a body portion having a recess 4 which receives a threaded end of drill-rod 1. A fluid passage 5 extends centrally through the tool joint, and is in communication with passage 2 in the drill rod through the recess 4. A tapering screw threaded portion 6 of the tool joint extends into a correspondingly shaped recess in the upper part of a drill collar 7, and is joined thereto, as by the threaded union 6*a*.

The drill collar 7 comprises an elongated cylindrical member having a fluid passage 8 extending centrally therethrough, communicating, and axially aligned with the fluid passage 5. The fluid passage 8 is of enlarged diameter intermediate the extremities of the drill collar and communicates, through a threaded union 9, with a fluid passage 10 extending through a member hereinafter described.

Mounted on the lower end of drill collar 7, is a member 11 upon which cutter or drill elements are adapted to be mounted and generally referred to as a bit head or support, comprising a threaded tapering portion 11*a* to which the drill collar is joined, and a main body portion of material having an appreciable degree of hardness and toughness, such as heat treated steel or an alloy thereof. The body portion of the bit head comprises a plurality of cylindrical portions, reduced progressively in diameter, the portion of largest diameter 12 having an annular shoulder 13 co-acting therewith. The cylindrical por-

tion 12 has a threaded surface 12*a*, adapted to receive a cutter or bit member hereinafter described, and makes with the adjoining face of the aforesaid shoulder 13 an angle of substantially 80 degrees, for a purpose hereinafter described. That is, the face of shoulder 13 which is adjacent the threaded surface 12*a* makes approximately a 10 degree angle with a horizontal plane. Portion 14, which is of less diameter than portion 12, has a threaded surface 14*a*, and adjoins a third portion 15 of still less diameter having threaded surface 15*a*. The fluid passage 10 extends centrally and longitudinally through the bit head 11, including the cylindrical portions above described. The annular surface 13*a* comprising the upper side of abutment or shoulder 13 may be provided with cutting elements (not shown) for a purpose hereinafter described.

The bit head 11 is adapted to support a plurality of bits or cutter members, the same being assembled with respect to the bit in such sequence that the last bit or cutter member serves to lock the other or others in proper position with respect to the bit head.

The cutter member which is first mounted on the bit head, and in particular upon reduced portion 15, comprises a cylindrical breaker plug 16 for a purpose hereinafter described, having a centrally extending recess 17 which is threaded interiorly to engage the corresponding threaded surface 15*a*. A plurality of fluid passages 18 communicate with recess 17 and extend through the breaker plug. The breaker plug is comprised of material, such as soft tough steel, for example, which permits elements of harder material to be welded thereto, or caulked in the material thereof. Secured to the lower surface of plug 16 are a plurality of cutter elements 19, as better viewed in Fig. 3, which may comprise hardened elements of a metal or alloy welded or suitably secured to the lower surface of the plug, or crystalline elements such as black diamonds or carbons caulked in the comparatively softer metal.

Mounted concentrically and exteriorly of plug 16 is a hollow cylindrical member or cutter sleeve 20, which is adapted to be slipped over plug 16 and secured by threaded engagement to portion 14 of bit head 11. Cutter sleeve 20 is threaded interiorly to engage the threaded surface 14*a*, and as in the case of the breaker plug 16, is of material such as soft tough steel to which cutter elements or teeth 21 of suitable material may be welded to, caulked, inserted or otherwise suitably secured in the lower edge thereof. For a short distance above the lower edge of cutter sleeve 20 the interior surface is provided with grooves or flutes 22 which terminate in shoulders overlying and adjacent the lower surface of plug 16. It is evident, therefore, that when cutter sleeve 20 is mounted properly upon the bit head, the shoulders formed by flutes 22 serve to lock plug 16 in position, and to prevent it from becoming loose on the bit head so long as sleeve 20 is in proper position.

Mounted on bit head 11 upon portion 12 is a main or outer cutter sleeve 23 which comprises a hollow cylindrical member screw threaded at its inner surface to engage threaded portion 12*a*. Cutter sleeve 23 is of such internal diameter that it may slide over cutter sleeve 20 to threadedly engage portion 12. The upper edge of the cutter sleeve is beveled at 23*a* at approximately an angle of 10 degrees, so that the beveled edge corresponds with the co-acting face of shoulder 13. Accordingly, when sleeve 23 is screwed firmly into engagement with shoulder 13, the annular recess formed by shoulder 13 with respect to the body portion 11 provides a substantially fluid tight joint, and serves to provide a more permanent connection between the bit head and outer cutter sleeve. Furthermore, the inclined shoulder 13 serves to prevent "belling" or spreading of the upper edge of the sleeve.

At the lower end of cutter sleeve 23 and along the interior surface thereof, a plurality of grooves or flutes 24 extend longitudinally of sleeve 23, and terminate in shoulders adjacent and overlying the lower edge of cutter sleeve 20. Accordingly, cutter sleeve 23, when in proper position, serves to lock not only cutter sleeve 20 on the bit head, but also breaker plug 16 which is necessarily held in position by sleeve 20. The raised portions of grooves or flutes 24 may be faced with a hard, wear-resisting material such as stellite, for example.

Referring to Figs. 2 and 3, the cutter sleeve 23 has formed on the outer surface thereof a plurality of grooves or flutes 25 extending longitudinally of the axis of said sleeve. The resulting raised portions 26 disposed between the flutes, said material being as in the previous instances of such material as soft tough steel, has its working or biting edge faced with a cutting element or elements. In the present illustration there are shown welded to the portions 26 teeth or cutting elements 27 of hardened material such as heat treated steel or alloy thereof or other suitable metal or alloy. The hardened cutting elements comprise a portion 27*a* (Fig. 2) which faces the entire working or cutting edge of the portions 26 or a part thereof. The cutting elements 27 comprise, together with sleeve 23, a reamer for maintaining the drill hole at substantially the desired gauge. Grooves or flutes 25 serve to provide passages for the return of drilling, fluid from the bottom of the well bore, and also act as guides for insuring vertical descent of sleeve 23.

The lower edge of sleeve 23 comprises a cutting edge to which are secured cutting elements 28 of hardened metal of the character

above described, spaced circumferentially with respect to said sleeve. The cutting surface of the sleeve may also comprise black diamonds or carbons caulked in the material thereof, in lieu of the hardened metallic elements which are welded thereto, as viewed in Fig. 3, and it shall be understood that any suitable number of such elements may be mounted thereon.

In Fig. 4, there is illustrated a reaming element 30 which is adapted to be interposed between the tool joint 3 and drill collar 7. Reamer 30 comprises a substantially cylindrical body portion having a fluid passage 31 extending centrally therethrough and tapered threaded portions 32 and 33 for connecting to corresponding portions of the tool joint and drill collar respectively. The outer surface of the reamer is longitudinally fluted, as best illustrated in Fig. 5, the grooves or flutes 34 having their working or cutting edges faced with cutter elements 35, said elements preferably being of hardened metal or alloy welded to the comparatively softer metal forming raised portions 36 between flutes 34. In the present instance, cutting elements 35 are shown to be of substantially the same construction, and are mounted in substantially the same manner as the cutter elements 27 of the outer cutter sleeve 23 above described. That is, the hardened biting elements or teeth 35 comprise portions 35*a* substantially facing the working edges of the flutes, and portions extending transversely to said edge forming a larger surface of wear-resisting material for the reamer, as well as providing sufficient contact area for securing the teeth, as by welding, to the body portion. Cutting elements 35*a* extend substantially along the entire working edges of the longitudinal flutes, which in the present instance are substantially the length of the body portion of the reamer 30. Secured in any suitable manner to the upper beveled edge of reamer 30 are cutting elements 35*b*, so that in case of cave-in above the reamer, the drill may be withdrawn by drilling upwardly to cut away the rock and débris tending to hold the drill in the bore. In the same manner, cutting elements (not shown) mounted along surface 13*a* on the bit head 11 serve also to provide means for drilling out of the bore.

Reamer 30 may be quickly attached to the drilling apparatus by disconnecting tool joint 3 from the drill collar 7 at the threaded joint 6*a* whereupon reamer 30 is inserted between said members and is secured thereto by engagement of cooperating screw threaded surfaces. In the same manner, reamer 30 may be detached from the drilling apparatus when it is not needed without disturbing the remaining apparatus.

Referring to Fig. 6, a drill assembly is shown similar in most respects to that illustrated in Fig. 1, with the exception that the inner cutter sleeve 20 is dispensed with. The apparatus shown in Fig. 6 is especially adapted for drilling or boring holes of smaller diameter as compared with the apparatus in Fig. 1, and comprises a bit head or support 40 upon which an outer cutter sleeve 41 and the breaker plug 42 are mounted. Bit head 40 comprises a fluid passage 43 extending centrally therethrough, and an annular shoulder 44 whose face 45 is inclined approximately 10 degrees with respect to the horizontal. Reduced portions 46 and 47 having threaded surfaces 46*a* and 47*a* extend axially of bit head 40 and support members 41 and 42 respectively. As in the previous instance, the outer cutter sleeve 41 comprises a hollow cylindrical member having its upper edge beveled to correspond with surface 45 of the shoulder 44, and has its exterior surface longitudinally fluted at positions spaced around its periphery.

Referring to Fig. 8, the working edges of the flutes are faced with cutter elements 48 of hardened metal welded to the raised body portions of sleeve 41 comprised between flutes 49. Also cutter elements or teeth 50 of suitable material are secured to the lower edge of cutter sleeve 41, and as previously described, these teeth may comprise black diamonds or carbons caulked within the comparatively soft metal of sleeve 41, or hardened metallic elements welded to the lower edge of the sleeve. Flutes 51 are formed along the lower inner surface of sleeve 41, and terminate in shoulders 51*a* adjacent and overlying the lower surface of plug 42, and adapted to lock the same in position upon bit head 40.

As viewed in Figs. 6 and 7, the breaker plug 42 comprises a cylindrical member having a recess 52 in its upper portion communicating with passage 43 in bit head 40. Fluid passages 53 extend from recess 52 through the lower portion of the plug. To the lower surface of breaker plug 42 are secured cutter elements 54 in the manner and of the character of teeth 50.

In drilling or boring operations wherein a shaft is sunk through earth formations to a considerable depth for either exploration or scientific purposes, it is generally essential that the desired gauge or diameter of the hole or shaft be maintained substantially constant throughout its length, and that at the same time the normal rate of boring be maintained. To this end it has previously been customary to drill the shaft as rapidly as possible without particular regard to the exact gauge, and to thereafter ream out the hole by a separate reaming operation. This method consumed considerable time since two separate operations were involved. Although combined cutting and reaming apparatus have heretofore been utilized to perform the boring and

reaming simultaneously, my invention comprises an improvement over such apparatus in that it comprises a bit head assembly wherein a plurality of cylindrical cutter members are substantially interlocked with respect to each other, and wherein one of said members is a combined reamer and drilling tool.

Referring again to the apparatus shown in Fig. 1, which illustrates drilling apparatus for drilling comparatively large holes or wells, the drill rods 1, which are connected to a source of power (not shown) rotate the entire structure about its longitudinal axis so that cutter sleeve 25 tends to bore an annular channel in the earth or rock with which it is in contact. As the drilling apparatus descends, a cylindrical core of earth or rock is formed within sleeve 25, and upon further descent of the drilling apparatus the teeth or cutting elements 21 of cutter sleeve 20, and shortly thereafter the cutting elements 19 of breaker plug 16, come in contact with the upper part of the core and tend to break it down by the grinding action of said cutter elements.

In order that the drilling operation may proceed smoothly without "gumming up" of the bit due to excess of soft material in the bore, a fluid of suitable consistency, such as water or a mud-laden fluid is caused to circulate by pumps (not shown) downwardly through the drill rod 1 and the communicating fluid passages leading to recess 17 of plug 16, from where it passes through passages 18 to wash away the loose material and to carry the same in the form of fine particles to the surface of the ground by a return passage comprising the space between the bore or well and the drilling apparatus. At the same time the circulation of such fluid serves to prevent overheating of the cutter members, thereby enabling them to retain their proper cutting edges for a longer length of time.

While the drilling apparatus is descending in the bore, the reaming elements 27 disposed along the flutes of sleeve 23 serve to ream the bore and to maintain it at substantially the desired gauge. As previously stated, the reaming elements 27 also act as guides for the cutting elements 28, and provide passages for the return of the mud-laden fluid or equivalent. The longitudinally extending flutes 25, in addition to providing seats for the reaming elements, also provide fluid passages for the return of the circulating fluid to the upper surface.

When it is desired to maintain the gauge of the bore within quite accurate limits, the auxiliary reaming element 30 may be attached to the drilling apparatus in the manner previously described, and may be adapted to ream the bore to a slightly greater diameter than is accomplished by cutter sleeve 23. The longitudinally extending flutes or grooves 34 of the reaming element also serve to provide fluid passages for the return flow of the circulating fluid to the surface. Reamer 30 also acts as a guide member for the lower cutting elements by providing a guide surface acting on the walls of the bore an appreciable distance from the lower cutter sleeve. In other words, a total effective guide length for the cutting elements is provided extending from the lower edge of the cutter sleeve to the upper edge of the reamer 30. Accordingly, the bore may be drilled straighter than in the case of a comparatively short guide. When reamer 30 is to be used mainly for guide purposes, it is substantially of the same gauge as the lower cutter sleeve.

For drilling holes of smaller diameter, the bit head assembly illustrated in Fig. 6 may be utilized wherein the inner cutter sleeve is omitted. This is due to the fact that even in holes of comparatively large diameter the teeth on the outer cutter wear down at a greater rate than the teeth on the inner sleeve and plug, and since the core in a small bore is much more readily broken down, it is possible to dispense with the inner cutter sleeve, and to grind or break down the core by the breaker plug 42 alone. An important practical advantage of my invention lies in the fact that the entire bit head assembly does not have to be changed or replaced when but a portion of the teeth thereon need re-setting or re-dressing. Since the teeth on the outer cutter sleeve 23 tend to lose their cutting edge more quickly than the others, it is possible to remove sleeve 23 and to mount a fresh cutter sleeve upon bit head 11 without in any sense interfering with the other cutter members mounted on said bit head. In the same manner, the remaining cutter elements being detachably mounted on the bit head, are readily removed therefrom so that sharpened or re-dressed cutter members may be mounted on the bit head in place thereof.

A further practical advantage of my bit head assembly lies in the fact that the inner cutter sleeve and breaker plug are locked on the bit head by the outer sleeve 23, thereby preventing such members from becoming loose and dropping out of the bit assembly. It is very important that every possible precaution be taken to prevent loss of tools in the bore or well, since considerable time may be spent in "fishing" operations before the tool is recovered.

It shall be understood that the expression "drill rods" as used in the above specification and appended claims is intended to comprehend any means for effecting rotation of the drill including both drill pipe and drill rods.

It shall be further understood that black diamonds or carbons or equivalent, may be utilized as cutting elements in lieu of the hardened metal teeth particularly described and illustrated as welded or otherwise suit-

ably secured to the body portions of the cutter members, and that the black diamonds or carbons or equivalent may comprise either the reaming teeth or drilling teeth or both.

It shall be still further understood that the threaded portions of the bit head 11 for supporting the cutter members may be tapered, as in the case of tapered tool joints such as are shown for example in Fig. 1; and for the purposes of brevity, the term "cylindrical" as used in the above specification and appended claims with reference to the bit head supporting portions and the corresponding cutter members shall be understood to include 'conical' or 'frustro-conical'.

What I claim is:

1. Drilling apparatus of the rotary type comprising, a cylindrical breaker member having cutter elements disposed along the lower surface thereof, and a hollow cylindrical member mounted concentrically and exteriorly of said breaker member, the lower edge of said hollow member being spaced from the lower surface of said breaker member, and an annular shoulder on the interior surface of said hollow member overlying and adjacent said breaker member for relatively positioning the same.

2. Drilling apparatus, of the rotary type comprising, a cylindrical breaker plug having cutter elements disposed along the lower surface thereof, and a hollow cylindrical cutter member mounted concentrically and exteriorly of said plug comprising cutter elements disposed around the lower edge thereof, said edge being appreciably lower than the lower surface of said plug, said hollow member provided along the lower interior surface thereof with grooves terminating in shoulders adjacent the lower surface of said plug for maintaining the same in relative position with respect to said member.

3. In drilling apparatus, a bit head assembly comprising a bit head, a breaker plug detachably mounted thereon, a cutter sleeve detachably mounted concentrically and exteriorly of said plug and serving to lock the same in proper position, and a second cutter sleeve detachably mounted on said bit head concentrically and exteriorly of said plug and first-named sleeve and serving to lock both in proper position with respect to said bit head.

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