

April 23, 1957

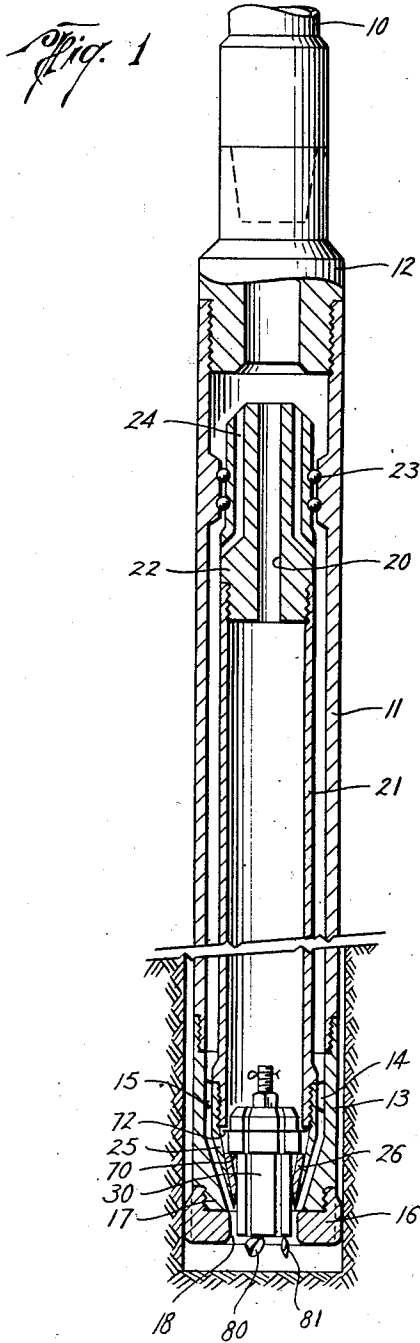
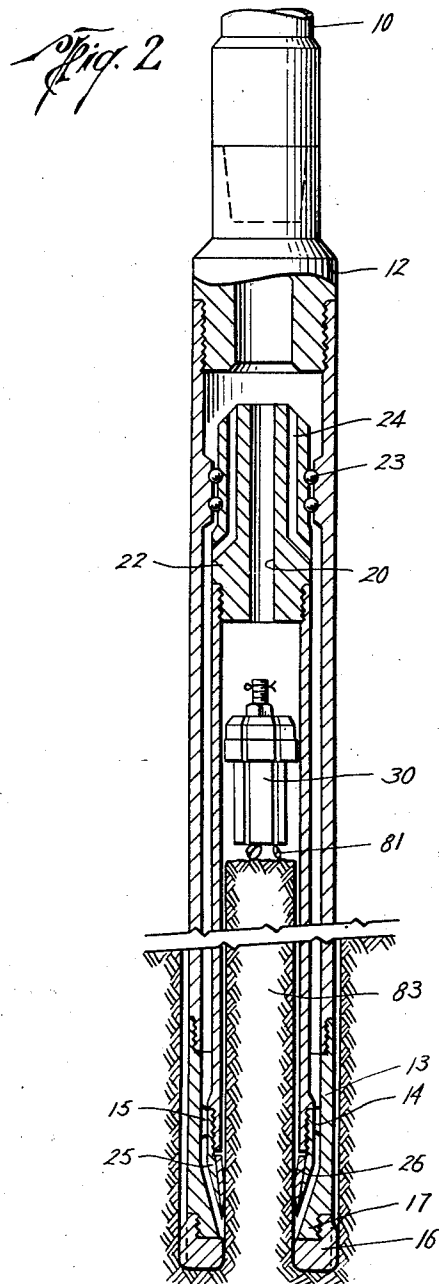
J. H. KIRBY II

2,789,790

CORE DRILLING APPARATUS

Original Filed Sept. 24, 1953

2 Sheets-Sheet 1



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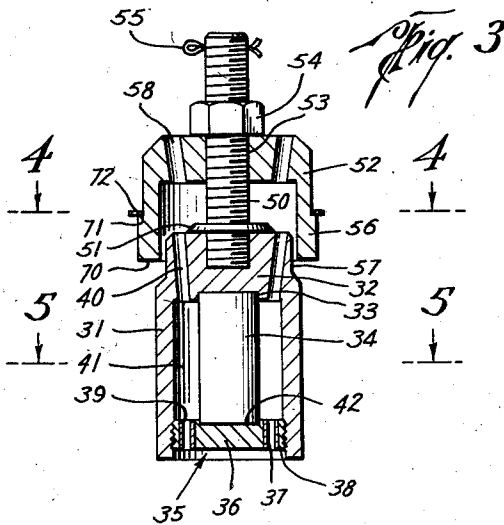
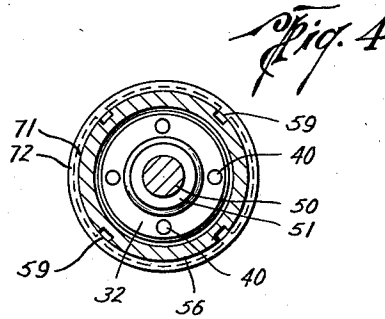
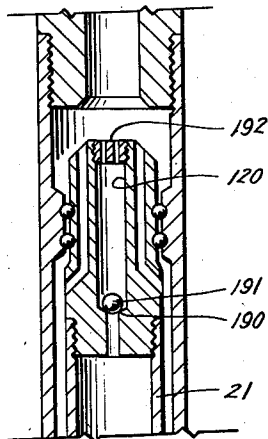
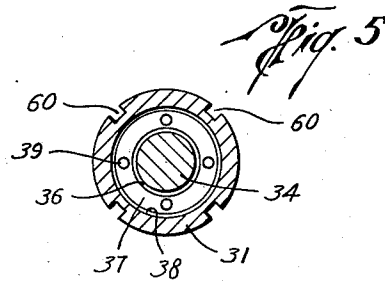


Fig. 6



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CORE DRILLING APPARATUS

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9 Claims. (Cl. 255-72)

This invention pertains to core drilling, especially in connection with oil and gas wells, and more particularly to core drilling with diamond bits or other bits of a like nature which are particularly vulnerable to damage on encountering pieces of steel or similar junk in the hole being drilled, so that it is desirable to provide means to clean the hole of such junk in advance of the commencement of actual drilling operations. One type of apparatus for so cleaning the hole that has been proposed incorporates a permanent magnet in the core barrel plug. This invention particularly concerns an improved core drilling apparatus of the foregoing type.

It is an object of the invention to provide a core drilling apparatus of the foregoing type that will more effectively clean the hole when run into the hole being drilled.

A further object of the invention is to provide such an apparatus which will be less subject to damage.

Another object of the invention is to provide an improved magnetic device forming an element of apparatus of the foregoing type which will more effectively attract junk, be itself less subject to damage, and which will be adaptable to use with a variety of makes of core barrels and core bits.

A problem that has heretofore existed in such apparatus is the prevention of the short circuiting of the magnet through the core barrel sleeve. To prevent such short circuiting it has been proposed to insulate the magnet from the core barrel sleeve with non-magnetic material, but this increases the air gap or reduces the size of the magnet that can be used, either of which greatly reduces the effectiveness of the tool, and at the same time the use of non-ferrous metal for the exterior of the plug makes it subject to wear as it runs up and down inside the core barrel sleeve and to damage when it is removed. According to the invention these difficulties are overcome by the use of a plug having a concentric construction in which there is a central core or bar of magnetic material and an outer sleeve or housing of magnetic material which are connected together at the top by a bridge or head of magnetic material, the permanent magnetic flux traveling axially of the core and across the head and through the housing parallel to the axis thereof. Since the only poles and air gap are at the lower end of the plug, it is not short circuited by the core barrel sleeve and there is no need for a non-magnetic insulating shell.

Another problem that has existed in such apparatus is the prevention of damage to the brittle permanent magnet material. According to the invention the central core of the plug is made of permanent magnet material, while the head and outer housing are made of mild steel. Across the bottom of the plug is provided a steel pole plate to protect the lower end of the permanent magnet core. The plate incorporates a ring shaped portion of non-magnetic material to prevent closure of the magnetic circuit so that the plug will exert a hold on any magnetic material contacting the plate. The width of this ring or "air gap" can be made small enough so that

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the permanent magnet will not lose strength, yet large enough to give the magnet great holding power.

A further problem that has been encountered with magnetic core barrel plugs is the attainment of the correct positioning of the plug relative to the lower end of the core bit. Since such bits are of variable axial extent, it would be necessary to provide a different plug for use with each bit except that according to the invention an adjustment in the plug support is provided which makes it possible to use a single plug with a variety of lengths of core bits and core barrels. It should be emphasized that the proper positioning of the plug is very important, for if the plug is too high inside the core bit it cannot so easily contact junk, and if the plug extends much below the bit it will receive the full weight of the drill string.

A related problem encountered with magnetic core barrel plugs is maintenance of the plug in the selected position. As the apparatus is lowered into a hole the hydrostatic pressure below the plug exceeds the pressure within the core barrel sleeve. It is necessary to provide fluid passages by-passing the plug in order that drilling mud and other well fluid can enter the core barrel and balance the external hydrostatic pressure with the magnetic circuit of the plug according to the invention, this is accomplished by providing holes in the pole plate and in the head which connect with the annular air space between the central core and the housing.

Other objects and advantages of the invention will appear from the following description of a preferred embodiment of the invention, reference being had to the accompanying drawings wherein:

Figure 1 is a vertical section through a core drilling apparatus according to the invention showing the apparatus as it is run into the hole;

Figure 2 is a vertical section through the apparatus showing the position of the parts as a core is being drilled;

Figure 3 is a vertical section through the magnetic plug portion of the apparatus, to a larger scale than Figures 1 and 2;

Figures 4 and 5 are sections taken on lines 4-4 and 5-5 of Figure 3; and

Figure 6 shows a vertical section showing modified form of the core barrel part of the apparatus.

Referring now to Figure 1, there is shown the lower end of a drill string 10 to which is connected a core drilling apparatus generally known in the art as a core barrel and comprising an outer core barrel tube 11 screwed at its upper end to a sub 12 connected to the drill string and its lower end to a short tubular section 13 having spaced stabilizing vertical ribs inside such as 14, 15. To the lower end of stabilizer section 13 is screwed a diamond core bit 16. The inside of the lower end of the stabilizer section is tapered inwardly at 17 to provide support for the inner portion of the bit adjacent the central passage 18 therethrough.

Inside outer core barrel tube 11 and radially spaced therefrom is inner core barrel tube 21, which is screwed at its upper end to mandrel 22 which is rotatably mounted inside tube 11 on ball bearings such as 23. Passages such as 24 through the mandrel provide communication between the upper and lower parts of tube 11 outside tube 21. Passage 20 through the center of the mandrel provides communication between the inside of tube 21 and drill string 10.

To the lower end of tube 21 is screwed an inwardly tapering rigid support 25 for the core catcher ring 26 which is a resilient split ring having a grooved or roughened internal surface to engage a core and an outer tapered surface to seat on support 25 so as to contract and grab the core when wedged down against support 25 by the pull of a core thereon. The outer surface of

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support 25 is radially spaced from the inner surface of stabilizer section 13 so as to provide space for fluid circulation therebetween. Stabilizing ribs 14, 15 bear against the outside of support 25 to maintain the inner tube 21 concentric with outer tube 11 and bit opening 18 so that a core can be received within tube 11.

Centrally disposed at the lower end of the apparatus is a magnetic plug 30. Details of the plug are best seen in Figures 3-5. The lower part of the plug comprises a cylindrical housing 31 of mild steel to the upper end of which is welded a head 32 of similar material which is recessed at 33 to receive one end of a cylindrical permanent bar magnet 34. The magnet is axially magnetized to provide one pole at its upper end and another pole at its lower end. In the lower end of the housing is screwed a pole plate 35 comprising a central steel disc 36, a brass ring 37, and an outer steel ring 38, all welded together into one unit. The width of the brass ring provides the "air gap" of the magnetic circuit and is chosen so as to be small enough to prevent the bar magnet from losing its strength, yet large enough to cause junk contacting the pole plate to be held firmly. The steel portions of the pole plate are of magnetic conductive material as are the housing, head, and welds, and also the bar magnet, but all of these parts except for the bar magnet are strong and tough and shock resistant and provide a protection for the relatively brittle bar magnet.

The pole plate is provided with a plurality of holes such as 39 and the head is provided with a number of holes such as 40 which together with the annular space 41 between the bar magnet and the housing provide a means for the passage of fluid through the plug connecting the parts of inner core barrel tube 21 above and below the plug.

The pole plate is provided with a recess 42 to receive and support and center the lower end of magnet 34 which is thus held securely between the pole plate and the head.

Supporting structure for plug 30 is provided to enable it to be adjustably retained within the lower end of the inner core barrel tube 21 as described hereinafter. In the upper surface of the head 32 of the plug 30 is screwed a threaded stud 50 which is welded in place at 51. A cap 52 has a central threaded aperture 53 which is screwed onto stud 50 and locked in place by nut 54. A cotter pin 55 positively prevents separation of the parts.

The cap 52 has a depending skirt 56, the lower edge of which extends around and below the upper end of housing 31, the latter being reduced slightly at its upper end as indicated at 57. Holes such as 58 through the upper part of the cap permit free flow of fluid passed through the cap. A plurality of channels such as 59, 60 cut in the sides of the cap and the housing 31 (see Figures 4 and 5) provide additional means to by-pass fluid past the magnetic plug.

As shown in Figure 1, the lower edge 70 of the cap skirt forms a shoulder by which means it supports the magnetic plug in the core barrel on the core catcher ring 26. The outer diameter of the skirt is slightly larger than the smallest inner diameter of the tapered support 25 so that even if the core catcher ring should break and fall out, the magnet plug will be retained. By means of the stud 50 and the threaded aperture 53 in the upper part of cap 52 the plug support means including skirt 56 is adjustably connected to the plug 30. By adjusting cap 52 on stud 50, the position of the lower edge 70 of the cap skirt can be adjusted relative to the magnet housing 31 and pole plate 35 so as to place the lower end of the magnet plug just above the lower face of the core bit 16 as shown.

Despite the fluid by-pass passages through and on the sides of the plug 30, the flow of well fluid and drilling mud into the upper part of the inner core barrel tube 21 as the apparatus is lowered in to the well will exert enough force to overcome the weight of the plug and tend to lift it in the tube 21. To prevent this and insure that

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the plug stays close to bit 16 where it can contact junk until it is desired to move the junk up into the core barrel, the plug support means formed by the cap skirt 56 is provided with releasable means cooperable with the core barrel to restrain upward movement of the plug therein. To form such a releasable means, the skirt 56 is reduced at its upper end to form a shoulder 71 over which is placed a thin aluminum shear ring 72 which extends beneath the lower end of the tube 21 as shown in Figure 1.

In use of the apparatus, it is assembled and run into the hole as shown in Figure 1. Circulation of mud or other drilling fluid can be accomplished by pumping the fluid down the drill string and through the apparatus both inside the inner tube 21 through the magnetic plug and between the inner tube 21 and outer tube 11 and thence out through the core bit into the hole and back up to the surface. By such fluid circulation combined with rotation of the drill string it will be possible to get the apparatus to the bottom of the hole and clean off any junk so it will make good contact with the magnetic plug as shown at 80, 81 in Figure 1. Then sufficient weight will be placed on the bit to start drilling a core 83 which will press upwardly against plug 30 and shear ring 72 forcing the plug and junk up into tube 21 on top of the core as shown in Figure 2. The junk is thus removed from the vicinity of the bit so that it is protected against damage. Any fluid trapped in tube 21 above the core can escape through passage 20.

Figure 6 shows a slightly modified form of the apparatus in which the passage 120 is provided with a shoulder seat 190 and a ball check valve 191 which prevents down flow of fluid through the inner tube 21 of the core barrel so as to protect the magnet plug from the abrasive action of the fluid. A spider plug 192 prevents the ball from escaping from passage 120 when fluid passes upwardly therethrough.

While preferred embodiments of the invention have been shown and described, many modifications thereof can be made by one skilled in the art without departing from the spirit of the invention, and it is desired to protect by Letters Patent all forms of the invention falling within the scope of the following claims.

I claim:

1. Core drilling apparatus comprising an outer tube, an inner tube mounted within and radially spaced from the outer tube, a core drill bit on the lower end of the outer tube having a central opening, core retaining means on the lower end of said inner tube, a cylindrical housing of magnetic material slidably disposed in said inner tube, a permanent bar magnet concentrically disposed within said housing, a head of magnetic material bridged across the upper ends of the permanent magnet and said housing and a pole plate bridged across the lower ends of the permanent magnet and said housing, said pole plate comprising an outer ring of magnetic material, a central disc of magnetic material, a ring of non-magnetic material disposed therebetween, a threaded stud secured to the top of said head, a cap screwed onto said stud, said cap having a depending skirt whose outer diameter is greater than the inner diameter of said core retaining means, and means to lock said cap on said stud in any desired position of adjustment of the relative positions of the lower end of said skirt and the lower end of said housing.

2. Core drilling apparatus comprising a core barrel having an outer tube, an inner tube mounted within and radially spaced from the outer tube, a core drill bit on the lower end of the outer tube having a central opening, and core retaining means on the lower end of said inner tube, and a core barrel plug including a cylindrical housing of magnetic material slidably disposed in said inner tube, a permanent bar magnet concentrically disposed within said housing, a head of magnetic material bridged across the upper ends of the permanent magnet

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and said housing and a pole plate bridged across the lower ends of the permanent magnet and said housing, said pole plate comprising an outer ring of magnetic material, a central disc of magnetic material, and a ring of non-magnetic material disposed therebetween, a threaded stud secured to the top of said head, a cap screwed onto said stud, said cap having a depending skirt whose outer diameter is greater than the inner diameter of said core retaining means, means to lock said cap on said stud in any desired position of adjustment of the relative positions of the lower end of said skirt and the lower end of said housing, and a shear ring of frangible material mounted on said cap and extending radially therefrom beneath a downwardly facing surface on the lower end of said inner tube to prevent upward movement of said plug relative to said inner tube until said ring is sheared.

3. Core drilling apparatus comprising a core barrel having an outer tube, an inner tube mounted within and radially spaced from the outer tube, a core drill bit on the lower end of the outer tube having a central opening, and core retaining means on the lower end of said inner tube, and a core barrel plug including a cylindrical housing of magnetic material slidably disposed in said inner tube, a permanent bar magnet concentrically disposed within said housing, a head of magnetic material bridged across the upper ends of the permanent magnet and said housing and a pole plate bridged across the lower ends of the permanent magnet and said housing, said pole plate comprising an outer ring of magnetic material, a central disc of magnetic material, and a ring of non-magnetic material disposed therebetween, a threaded stud secured to the top of said head, a cap screwed onto said stud, said cap having a depending skirt whose outer diameter is greater than the inner diameter of said core retaining means, means to lock said cap on said stud in any desired position of adjustment of the relative positions of the lower end of said skirt and the lower end of said housing, and a shear ring of frangible material mounted on said cap and extending radially therefrom beneath a downwardly facing surface on the lower end of said inner tube to prevent upward movement of said plug relative to said inner tube until said ring is sheared, said cap and said head and said plate each being provided with a fluid passage therethrough.

4. Core drilling apparatus comprising a core barrel including an outer tube, a core drill bit on the lower end of said outer tube, an inner tube mounted concentrically within said outer tube and having its lower end positioned to receive a core cut by said core drill bit from the formation to be cored, and core retaining means on the lower end of said inner tube, a magnetic plug including a cylindrical housing member having an exterior diameter less than the inner diameter of said inner tube and core retaining means and slidably received therein, a bar member concentrically disposed within and spaced from said housing member, one of said members being a permanent magnet and the other of said members being of magnetic material, a head of magnetic material connected across the upper end of said housing member and magnetically contacting the upper end of said bar member, said members providing concentric opposite polarity poles at their lower ends to provide radial magnetic flux lines of increasing density progressing inwardly toward the pole at the lower end of said bar member, and means carried by said plug extending laterally outwardly therefrom and supported by one of said tubes to retain said plug within said inner tube with the concentric poles positioned adjacent said core drill bit.

5. Core drilling apparatus as recited in claim 4 wherein said bar member is the permanent magnet and said housing member is made of magnetic material.

6. Core drilling apparatus comprising a core barrel including an outer tube, a core drill bit on the lower end of

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said outer tube, an inner tube mounted concentrically within said outer tube and having its lower end positioned to receive a core cut by said core drill bit from the formation to be cored, and core retaining means on the lower end of said inner tube, a magnetic plug including a cylindrical housing of magnetic material having an exterior diameter less than the interior diameter of said inner tube and core retaining means and slidably received therein, a permanent bar magnet concentrically disposed within and spaced from said housing, and a head of magnetic material connected across the upper end of said housing and magnetically contacting the upper end of said permanent magnet, said magnet and housing providing concentric opposite polarity poles at their lower ends to provide radial magnetic flux lines of increasing density progressing inwardly toward the pole at the lower end of said magnet, means carried by said plug extending laterally outwardly therefrom and supported by one of said tubes to retain said plug within said inner tube with the concentric poles positioned adjacent said core drill bit, and longitudinally extending passages formed exteriorly of said cylindrical housing between said housing and the inner wall of said inner tube to permit fluid to flow through said inner tube past said plug.

7. A magnetic core barrel plug and a support therefor for use with a core barrel provided with upwardly facing shoulder means on the interior of the core receiving tube, said plug including a housing and a permanent magnet in said housing, said support including means extending laterally outwardly of said plug and cooperable with the shoulder means for retaining the plug thereagainst, and means adjustably connecting said plug and said laterally extending means for selective movement thereof vertically relative to said plug whereby said plug can be positioned at a desired level relative to the lower end of the core barrel.

8. A magnetic core barrel plug and a support therefor for use with a core barrel provided with upwardly and downwardly facing shoulder means on the interior of the core receiving tube, said plug including a housing and a permanent magnet in said housing, said support including means extending laterally outwardly of said plug and cooperable with the upwardly facing shoulder means for retaining the plug thereagainst, and means adjustably connecting said plug and said laterally extending means for selective movement thereof vertically relative to said plug whereby said plug can be positioned at a desired level relative to the lower end of the core barrel, and releasable means carried by said laterally extending means and cooperable with the downwardly facing shoulder means of the core barrel to restrain upward movement of said plug within the core barrel.

9. A magnetic core barrel plug and a support therefor for use with a core barrel provided with upwardly facing shoulder means on the interior of the core receiving tube, said plug including a housing and a permanent magnet in said housing, said support including means extending laterally outwardly of said plug and cooperable with the shoulder means for retaining the plug thereagainst, and means adjustably connecting said plug and said laterally extending means for selective movement thereof vertically relative to said plug whereby said plug can be positioned at a desired level relative to the lower end of the core barrel, said plug and said laterally extending means each having a fluid passage therethrough.

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