Feb. 6, 1951

P. BIGGS

2,540,385

CORE DRILLING

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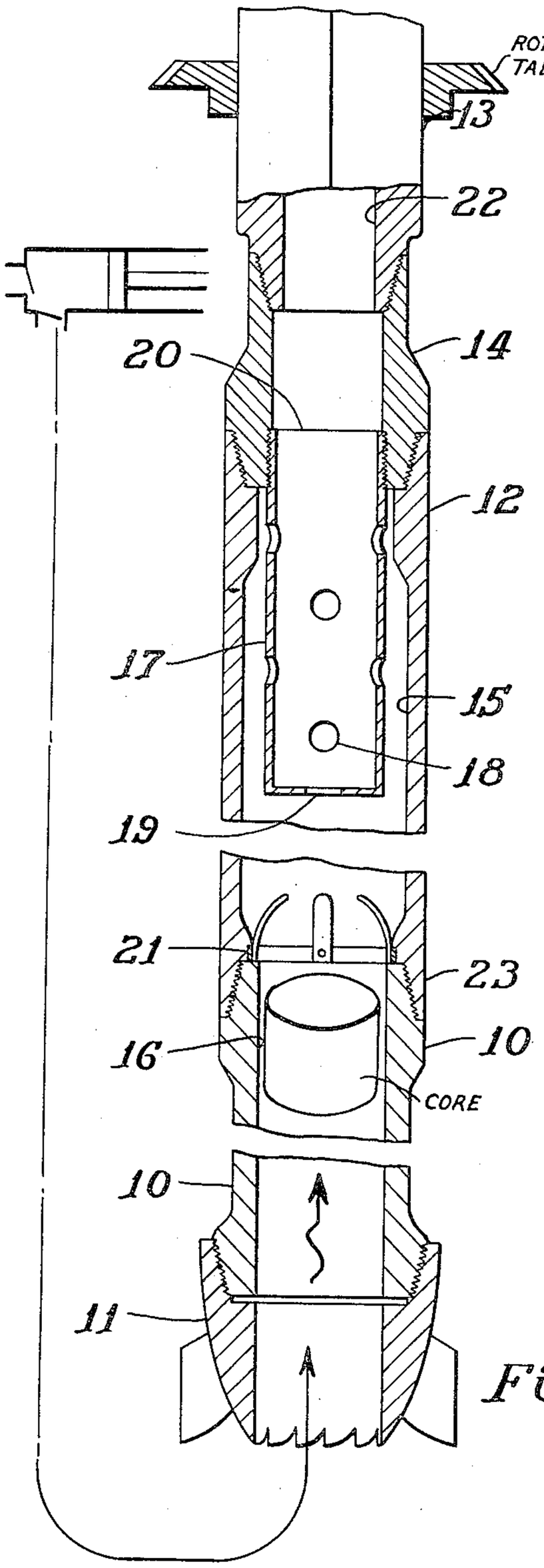

Fig. 1

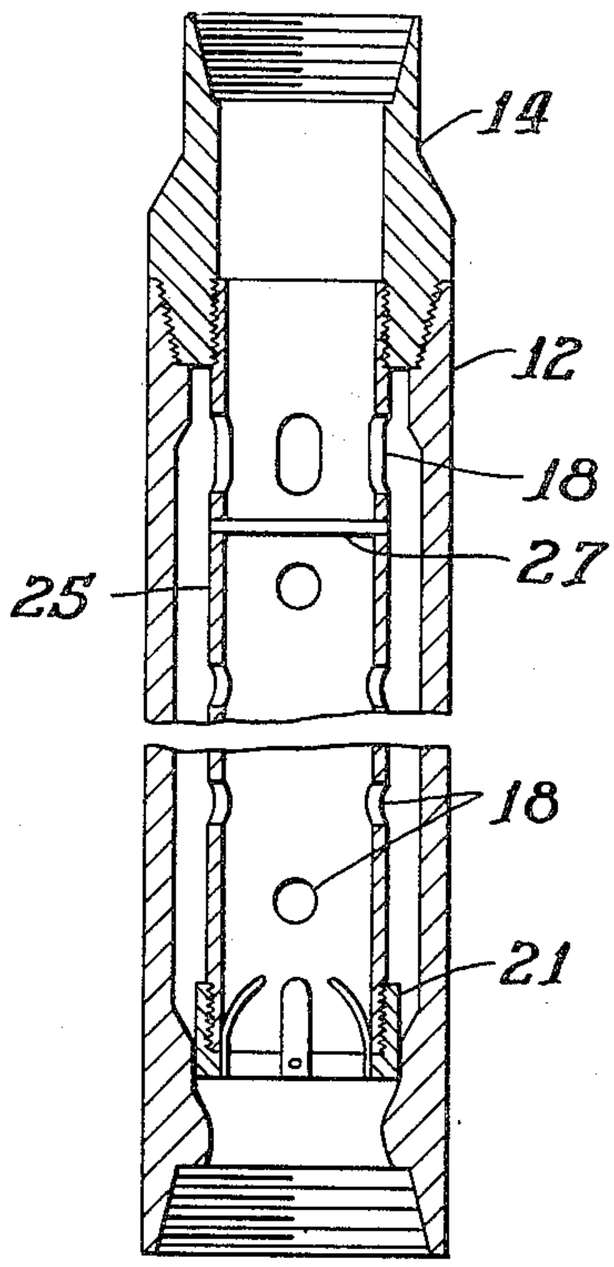

Fig. 2

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CORE DRILLING

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9 Claims. (Cl. 255—1.4)

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This invention pertains generally to the art of sampling formations by coring. More particularly, it deals with an improvement in the art of sampling formations at the bottom of a hole by circulating cores from such formations to the surface in the drilling fluid.

In the art of sampling deep subterranean formations by circulating cores to the surface in the drilling fluid two general methods have been practiced. In the first a core barrel has been pumped to the bottom by direct circulation and held in position contiguous to the drill bit by the pressure of the drilling fluid. That is, the constricted ports around the core barrel cause a pressure drop in the drilling fluid sufficient to hold the barrel in position at the bit to receive the cores as they are cut. When the barrel is full of cuttings or cores, the circulation of the fluid is reversed; i. e., the fluid is circulated downward in the well and upward in the drill stem, and the barrel containing the cuttings or cores is circulated to the surface in the drilling fluid. This method of coring has many advantages over previous methods of coring in which all of the drill pipe had to be retracted in order to recover a core. However, many of the limitations of the earlier methods are retained in this method in that the washing action of the drilling fluid tends to dissipate the core and a recovery as low as 10 to 30 per cent is not uncommon, especially where the formation cored is relatively porous. The use of this method also is limited in that in order to remove the core from the drill pipe drilling must be halted, the drill pipe must be raised, the kelly removed, and means provided at the surface for catching the barrel and for circulating the drilling fluid back to the settling pit as it rises out of the drill stem during the time that the core is being pumped to the surface. This method is also of limited application in that the core must be recovered in a core barrel, which must of necessity be located contiguous to the bit.

The above-described method has been improved by completely eliminating the use of a core barrel and circulating the core fragments to the surface through the drill string as they are cut by reverse circulation of the drilling fluid. Under this improved method the recovery is substantially improved. For example, it is not uncommon to obtain a core recovery of 97 to 100 per cent in porous formations which under previous methods gave a recovery of less than 50 per cent. This improved process has, however, not received wide application in the art in that

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standard drilling apparatus commonly employed in rotary drilling cannot be adapted to this method without major changes. For example, in a standard drilling rig it is not uncommon to use 4½" drill pipe with a kelly which has an internal diameter of only 2–3". In order that cores may be circulated to the surface under this type of operation the drill pipe, kelly, swivel, etc., must have essentially identical inside diameters. That is, in order that the core will be lifted by the drilling fluid a core must be cut which will practically fill the drill pipe, kelly, etc., and obviously no internal diameter in the path can be less than the diameter of the core. A core having a diameter appreciably smaller than the internal diameter of the drill pipe will tend to be bypassed by the drilling fluid and cores will be lodged in the drill pipe, shutting off the circulation of the drilling fluid. This obviously necessitates either using a second string of drill pipe having an internal diameter substantially equivalent to the internal diameter of the kelly or increasing the size of the kelly so that its internal diameter is substantially equal to the internal diameter of the standard drill pipe. Changes of this nature require major expenditures and a great decrease in drilling efficiency.

I have overcome the disadvantages inherent in the above-mentioned coring processes and by my improvement standard drilling rigs used in ordinary drilling can be readily and quickly adapted to a reverse-circulation coring rig. My invention, therefore, comprises the location of a suitable core catcher in a drill string at or near the lower end of the kelly. Thus cores having a diameter substantially equivalent to the internal diameter of the standard drill pipe may be cut, floated substantially to the surface in the drilling fluid, and caught in a core barrel so that the core can be readily removed without removing all of the drill string from the well.

It is therefore an object of this invention to provide a novel apparatus to facilitate the recovery of samples of a formation from the bottom of a drilling well. It is another object of this invention to provide a means for adapting a standard drilling rig so that it may be used for sampling formations by reverse-circulation coring. A still further object of this invention is to provide a core catcher which may be located in a drill string near the surface and which will catch cores as they are being pumped to the surface in the drilling fluid without materially affecting the flow of drilling fluid through the drill pipe. Other objects and advantages of this

invention will become apparent as a description thereof proceeds.

My invention will be described with reference to the drawings, in which similar reference numerals are applied to the same or corresponding parts, and in which

Figure 1 is a diagrammatic cross section of a drill string having incorporated one embodiment of my invention; and

Figure 2 is an alternate embodiment of my invention adapted to be placed in the drill string shown in Figure 1.

In Figure 1 drill pipe 10 has attached at its lower end a core bit 11 which will cut a core having a diameter slightly smaller than the internal diameter of the drill pipe 10. My core barrel 12 is located near the upper end of the drill pipe 10 and attached thereto as shown. Preferably this core barrel is located contiguous to the kelly 13, inasmuch as all of the drill string above the core barrel 12 must be removed from the well each time a core is removed from the core barrel as will be shown in greater detail hereinafter. Obviously this barrel can be placed at any position in the drill string, provided that it must always be placed below a constriction in the internal diameter of the string; but to facilitate the removal of cores it is, as indicated above, preferably placed immediately below the kelly. The core barrel 12 may be attached, for example, to the kelly 13 through an adapter 14. The core barrel 12 has an internal diameter 15 substantially greater than the drill pipe internal diameter 16. Tubular perforate means 17 is located at the upper end of core barrel 12. It comprises, for example, a tube having a multiplicity of perforations 18 in the walls and a partially closed lower end 19. The upper end 20 may be threaded for attachment to adapter 14. This tubular perforated means prevents a core from entering the constricted area above but does not impede the flow of drilling fluid.

Near the lower end of core barrel 12 a core catcher 21 is provided for retaining a sample or core in the core barrel. More particularly, core catcher 21 is adapted to permit cores having a diameter substantially equal to drill pipe internal diameter 16 to pass upward therethrough but to prevent core movement in the opposite direction. Thus when circulation of the drilling fluid upward through the drill pipe and core barrel ceases, the core but for core catcher 21 would fall through drill pipe 10 to the bottom of the well.

As indicated above, the internal diameter 15 of core barrel 12 being substantially larger than the drill pipe internal diameter 16 will permit free passage of drilling fluid around the cores which are retained in core barrel 12 by perforate means 17. Thus large-diameter cores which would not pass through the kelly 13 due to its smaller internal diameter 22 are retained in the drill string below the kelly and can be removed by merely raising the upper end of the drill pipe 10 to the surface and disconnecting the core barrel at its lower end 23.

In Figure 2 an alternative embodiment of my core barrel is shown. In this embodiment the sample or core is retained in an inner perforate core tube 25 which is adapted to retain the core at the center of the outer core barrel and thus permit free passage of the drilling fluid in the annulus 26. This inner perforate core tube 25 may be threadably attached to adapter 14 so that it may be removed from the core barrel 12 with adapter 14 and kelly 13 by disconnecting core barrel 12 at the upper end from adapter 14. A core stop 27 is located at some intermediate point in inner perforate core tube 25 and is adapted to limit the upward movement of cores therein and thus prevent a core from lodging in adapter 14 and shutting off circulation of the drilling fluid. Perforations 18 are provided both above and below this core stop 27. Near the lower end of inner perforate core tube 25 a core catcher 21 is fitted and serves the same purpose as the core catcher described in connection with Figure 1 hereof.

In operation core fragments cut from the bottom of the well while using reverse circulation of the drilling fluid are pumped up the drill pipe 10 with the fluid, and separated from the fluid in inner perforate core tube 25 for an appreciable period of time, preferably until the barrel is full of core and circulation is impeded by the lodging of cores in the constricted area of the drill pipe 10 below core barrel 12. The drill string is then lifted so that the kelly 13, adapter 14, and inner perforate core tube 25 may be disconnected from the remainder of the drill string for removal of the accumulated core from inner perforate core tube 25. By removal of core catcher 21 from the lower end of the inner perforate core tube the core can be removed for observation and filing.

While I have described my invention with reference to particular embodiments in which cores are floated to the surface in the drilling fluid as they are cut from the bottom of the well by bit 11, it will be apparent that my invention is not limited to the particular embodiments shown. For example, my core catcher is adapted to catch core barrels such as are employed in the first-described method used in the prior art. This invention is therefore to be limited only by the scope of the appended claims.

I claim:

1. In a rotary core drill apparatus in which cores are cut from the formations near the bottom of a well and pumped to the surface in the drilling fluid through the drill string the improvement comprising means in the upper end of said drill string to catch said cores and a fluid passage through said first-named means whereby the catching of a core will not materially affect the flow of said drilling fluid.

2. In a rotary core drill apparatus in which cores are cut from the formations near the bottom of a well and pumped to the surface in the drilling fluid through the drill pipe the improvement comprising a core barrel connected to said drill pipe adjacent to the upper end thereof, said core barrel having an internal diameter substantially greater than the internal diameter of said drill pipe, perforate means within said core barrel, said perforate means being adapted to separate said cores from said drilling fluid, and means to retain said cores in said core barrel.

3. In a rotary core drill apparatus in which cores are cut from the formations near the bottom of a well and pumped to the surface in the drilling fluid through the drill pipe the improvement comprising a core barrel connected to said drill pipe adjacent to the upper end thereof, said core barrel having an internal diameter substantially greater than the internal diameter of said drill pipe, perforate means at one end of said core barrel, and core retainer means at the other end whereby said cores will be caught in said

core barrel without materially impeding the flow of drilling fluid therethrough.

4. In a rotary core drill apparatus in which cores are cut from the formations near the bottom of a well and pumped to the surface in the drilling fluid through the drill pipe the improvement comprising an enlargement in the flow channel within said drill pipe, a perforated core tube within said enlargement, means at the upper end of said core tube to prevent the passage of cores therethrough, and means at the lower end of said core tube adapted to permit said cores to enter said core tube and to prevent exit of said core, the overall diameter of said core tube being substantially smaller than the internal diameter of said enlargement, whereby said core is retained in said core tube without materially affecting the flow of drilling fluid through said drill pipe.

5. In a rotary well drilling apparatus employing a drill string, a core bit at the lower end of said drill string, said core bit being adapted to cut a core having a diameter substantially equal to the drill pipe internal diameter from the formations at the bottom of said well, a kelly having an internal diameter substantially less than said drill pipe internal diameter, a core catcher in said drill string at a substantial distance above said core bit but below any substantial restriction in the internal diameter of said drill string and a fluid passage through said core catcher whereby said cores may be pumped up said drill string with the drilling fluid, retained in said core catcher and removed from said core catcher while drilling proceeds, for observation without removing all of said drill string from said well.

6. In a rotary well drilling apparatus employing a drill string, a core bit at the lower end of said drill string, a kelly having an internal diameter substantially less than the internal diameter of said drill pipe, the improvement which comprises a core barrel adjacent said kelly and communicating at its lower end with said drill string, said core barrel comprising a resilient constriction in a lower portion thereof adapted to permit only the upward passage of the suspended core and drilling fluid, and means in the upper portion of said core barrel adapted to prevent the travel of the core while permitting the substantially unimpeded flow of the drilling fluid from said core barrel.

7. In a method of sampling formations wherein a plurality of cores are cut by a drill bit in the process of drilling the formations and the core samples are retrieved for inspection at the surface, the improvement comprising the steps of floating the individual cores upwardly within the drill pipe, entrapping a plurality of successive core samples within the uppermost portion of the drill string while permitting the drilling fluid to pass substantially unrestricted from the drill pipe, periodically terminating the drilling operation and circulation of drill fluid, and retrieving the accumulated core samples.

8. In a rotary core drill apparatus in which cores are cut from the formations near the bottom of a well and pumped to the surface in the drilling fluid through the drill string the improvement comprising a core barrel within and adjacent to the upper end of said drill string, a core tube within said core barrel, the overall diameter of said core tube being substantially smaller than the interior diameter of said core barrel whereby a fluid passage is left therebetween, means at the upper end of said core tube to prevent the passage of cores therethrough, means at the lower end of said core tube adapted to permit said cores to enter said core tube and to prevent exit of said core, and means at each end of said core barrel to permit fluid flow through said core barrel around a captured core.

9. In a rotary core drilling apparatus in which cores are cut from the formations being drilled and pumped to the surface in the drilling fluid within the drill pipe, the improvement comprising a core barrel adjacent the upper end of said drill pipe, the internal diameter of said core barrel being substantially greater than the internal diameter of said drill pipe, a resilient core retainer within said core barrel adapted to permit the flow of drilling fluid and the core thereabove, and core stop means within said core barrel and above said resilient core retainer adapted to entrap the core therebelow within said core barrel and to permit fluid flow thereabove, whereby said core is retained within said core barrel adjacent the upper end of the drill pipe without materially retarding the flow of drilling fluid through said drill pipe.

PAUL BIGGS.

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Certificate of Correction

Patent No. 2,540,385 February 6, 1951

PAUL BIGGS

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows:

Column 5, line 35, strike out the words and comma "while drilling proceeds," and insert the same after "catcher", first occurrence, line 34, same column;

and that the said Letters Patent should be read as corrected above, so that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 10th day of April, A. D. 1951.

[SEAL]

THOMAS F. MURPHY,

Assistant Commissioner of Patents.