

April 7, 1942.

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2,278,780

CORE TAKING APPARATUS

Filed Jan. 20, 1940

2 Sheets-Sheet 1

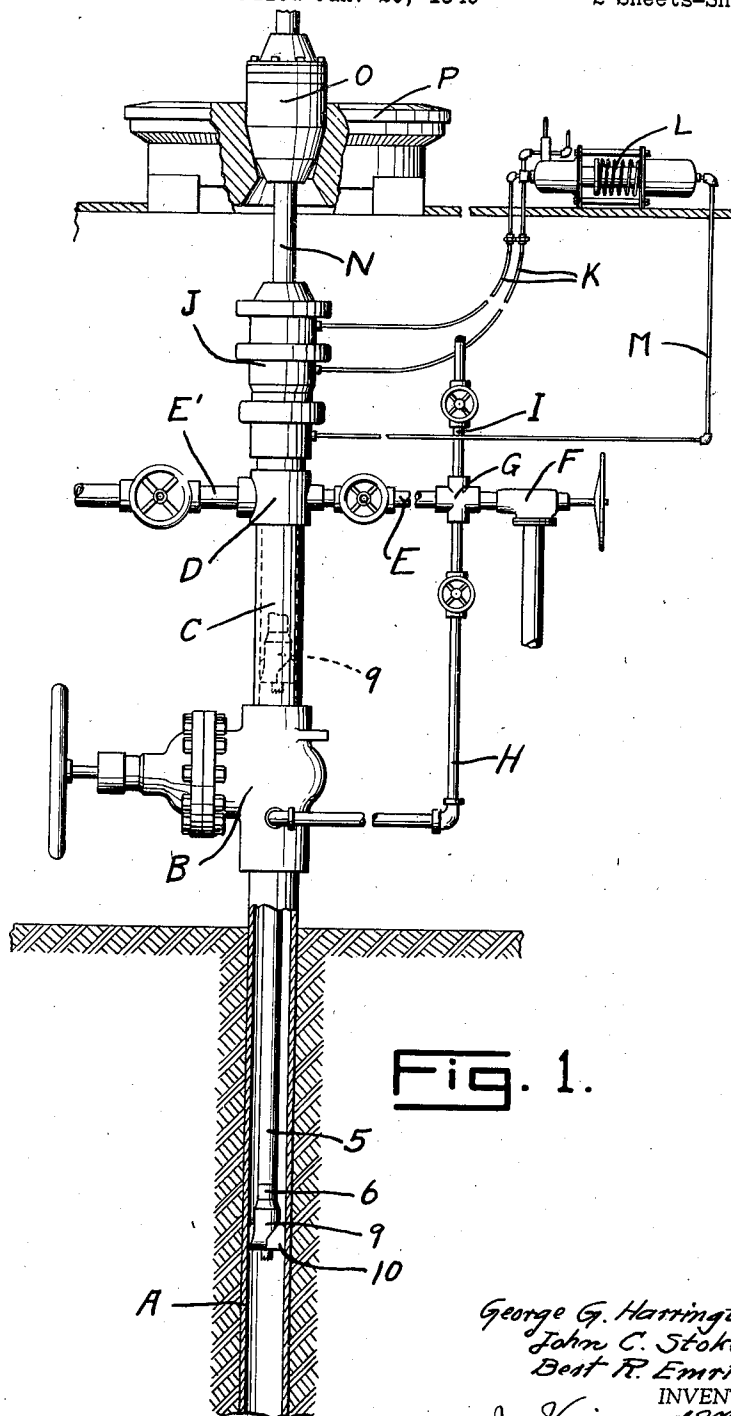


Fig. 1.

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2 Sheets-Sheet 2

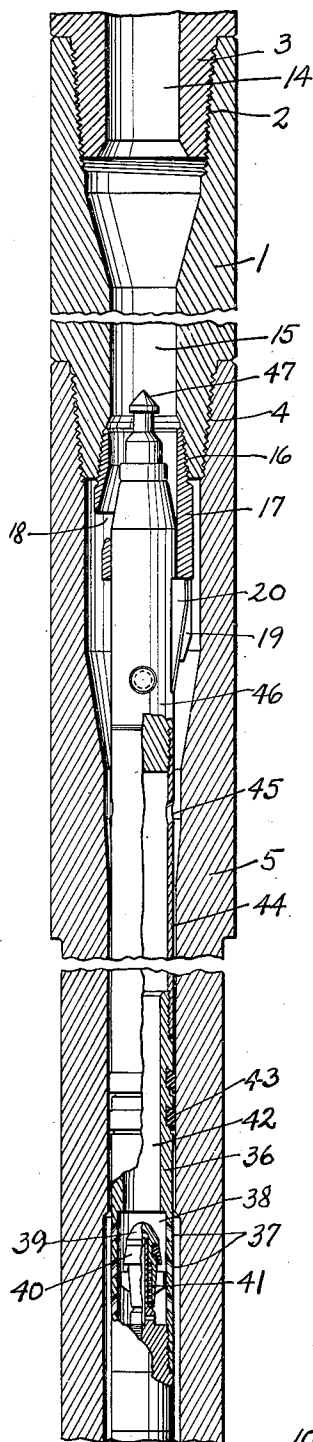


Fig. 2.

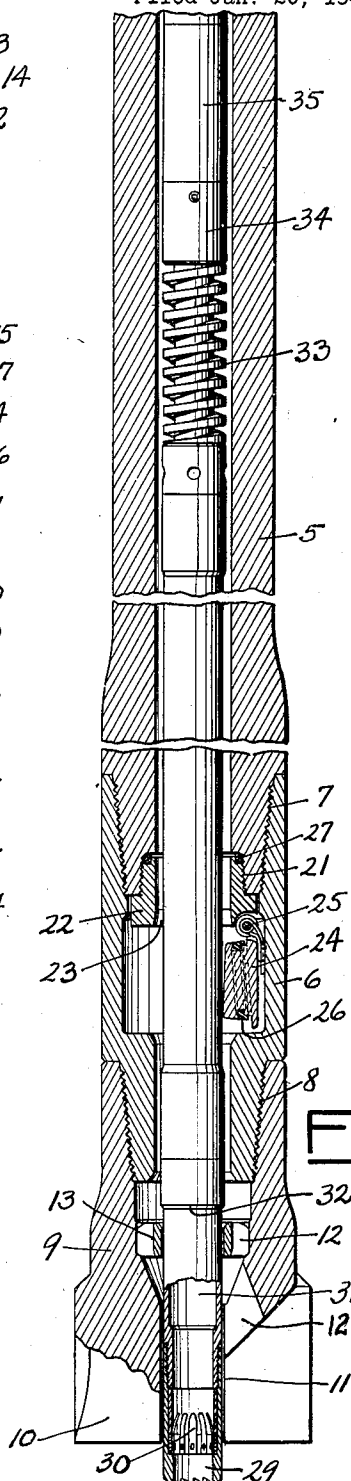


Fig. 3.

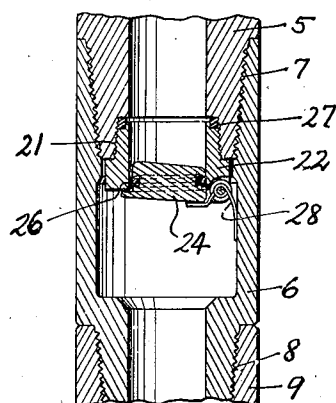


Fig. 4.

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## UNITED STATES PATENT OFFICE

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## CORE TAKING APPARATUS

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5 Claims. (Cl. 255—72)

This invention relates in general to drilling apparatus for drilling of wells, or the like, and particularly to so-called "pressure drilling." It has for its general object the provision of a means whereby various tools and instruments may be inserted into or removed from a well while the well is maintained under pressure without permitting the pressure to escape from the well through the drill stem.

Pressure drilling, or drilling under controlled pressure, is accomplished by using a packer or stuffing box on the drill stem directly under the rotary table. Where formation pressures are such that it is impossible to overcome them by the weight of the fluid which may be pumped into the well, it is also necessary to have a gate valve in the casing through which the drilling is being done at a point low enough below the stuffing box to form a lubricating chamber in order that the drill pipe may be withdrawn from the well without losing control of the pressure at the surface of the well.

When it is desired to withdraw the drill pipe from the well to change bits or for other purposes, the drill pipe is pulled up high enough so that the bit is above the master gate but with the stuffing box still effective to control the pressure, and the master gate is closed which allows the stuffing box to be removed so the drill pipe may be finally withdrawn from the casing. In putting the pipe back in the hole the reverse procedure, of course, is required.

In addition to the packer and master gate there is, of course, a multitude of other control valves and control manifolds required to complete the pressure drilling set up. However, this invention is not concerned with the arrangement of details of this set up. The one important valve which must be contained in the drill pipe while pressure drilling is progressing is a back pressure valve. It is absolutely necessary to have such a valve to prevent upflow through the drill stem when connections are being made or when the pipe is being withdrawn from the hole.

In general, controlled pressure drilling, is done where the formation pressure is so high that it cannot easily be controlled by the weight of the column of mud or fluid in the hole; or in some cases it is desirable to drill under controlled pressure because it may be more economical than buying the necessary weighting material to make the mud column heavy enough to overcome the formation pressure. Other times in "drilling in" wells it is desirable to keep the pressure on the producing formations just as low

as possible and in some cases use oil or water for circulating fluid to keep from mudding off the producing formations. Usually in this last case it is necessary to use controlled pressure drilling.

Another possibly very important use of pressure drilling would be in drilling through heaving formations. It has been found that in some heaving formations the only way they can be penetrated is by producing much higher pressure against them than can be obtained with the column of fluid. In drilling these heaving formations pressure at the top of the well is often maintained as high as 1000 to 2000 pounds per square inch. It is also absolutely necessary in drilling of heaving formations with a pressure drilling system that the pressure be constantly maintained at a high enough figure to keep the formation from heaving in while drilling or while the drill stem is out of the hole. Running the drill stem in the hole or pulling it out of the hole under these conditions of high pressure is extremely laborious and difficult. In some cases the difficulty is so great that it is practically impossible, or at least impractical, to make the necessary extra round trips to core the formation being drilled or to make other very desirable surveys or tests. It can, therefore, be seen that a satisfactory means of doing the coring or making such other surveys or tests without removing the drill stem in the case of pressure drilling is highly desirable and is of much greater value as respects saving of time and hazards of losing the well than in ordinary drilling which is not being done under controlled pressure.

With the present equipment available for use with pressure drilling when it is desired to run a core barrel, instrument, or other object in or out of the drill pipe by use of the wire line, a lubricator chamber at the top of the drill pipe similar to that which is used in the casing is necessary to get the tool in or out of the drill pipe without the loss of pressure or loss of control of flow of the fluid, and in addition to this so called lubricator chamber it is necessary to have and to use a packer on the wire line to keep from losing pressure while the line is being run in or out of the hole. While in the past this system has been used to some extent, it has been found extremely difficult to satisfactorily pack the wire line under high pressure and consequently with the use of the wire line packer and the other equipment required at the top of the drill stem a considerable hazard is involved due

to possible loss of control of the pressure at the top of the well.

With the use of the apparatus herewith disclosed and described many of the difficulties and hazards encountered in drilling under controlled pressure will be easily overcome, particularly in coring or running other testing devices in and out of the drill stem.

It is an object of this invention to provide a wire line apparatus whereby a core may be taken or other tests or surveys made or operations performed while drilling under heavy gas pressure by the same procedure heretofore employed in performing such operations while drilling where there is no pressure or where the pressure is fully compensated for by heavy mud.

It is an object of this invention to provide an apparatus of the wire line type, which may be employed in connection with coring or other operations, where drilling is being conducted under pressure.

It is a further object of this invention to provide a device of the type set forth, in which it will be impossible for the pressure in a well being drilled to blow out through the drill stem.

Another object of this invention is to provide an apparatus of the type set forth in which it will be possible to open the drill stem, both for the purpose of inserting a core barrel or other tool or instrument to be lowered through the drill stem, and also for the purpose of retrieving the same and bringing it back to the surface after the desired function has been performed thereby.

Other objects and advantages of this invention will more fully appear in the following description taken in connection with the accompanying drawings, it being understood that the embodiment therein set forth is by way of illustration and example, only, and is not intended to, in any way, limit the scope of this invention.

In the following specification and claims, the term "tool" will be used to designate any tool, instrument or the like, adapted to be passed down through the drill stem to perform a desired operation at the bottom of the hole, and then retrieved. It will be understood also, that while a core barrel is used as the specific illustration of this invention in the drawings and following description, this invention is not limited to a core barrel but is applicable as well to surveying instruments and various other tools and instruments.

In the drawings:

Fig. 1 is a diagrammatic view partly in vertical cross section and partly in elevation showing a set up of apparatus for drilling a well under controlled pressure, or "pressure drilling."

Fig. 2 is a longitudinal cross section, through a portion of the lower end of a drill stem, including the upper end of the drill collar, and the upper end of a core barrel constructed in accordance with this invention.

Fig. 3 is a similar longitudinal cross section, forming a continuation of the lower portion of Fig. 1, and illustrating the drill collar and the main drill bit, in vertical cross section, and the core barrel in side elevation.

Fig. 4 is an enlarged, vertical cross section view of the valve located at the lower end of the drill collar, the same being illustrated in closed position.

Referring first to Fig. 1 of the drawings, there is shown more or less diagrammatically a portion of a well having a casing A therein. This casing carries on its upper end a gate valve B and above

gate valve B is a shorter section of casing C which for the purpose of this application will be termed a "lubricator section".

Secured to the upper end of the lubricator section C is a fitting D having lateral flow lines extending therefrom as shown at E and E'. One of the flow lines E leads through an adjustable flow bean or choke F to the usual slush pit. Interposed in this flow line E between the fitting D and the flow bean F is a cross G. One of the three arms of this cross is connected with the space in the casing below the gate valve by means of a pipe H and the other arm may be connected by means of a pipe I with slush pumps so that if desired slush may be pumped directly into the casing. The lines E', H and I are provided with suitable cut off valves of any well known type.

Above the fitting D there is mounted a stuffing box construction the details of which are relatively unimportant for the purposes of this description, but which is preferably of a type in which the seal is maintained by means of fluid under pressure. For this purpose pressure lines K may be provided leading from a pressure regulator L, the same being supplied with actuating pressure by means of a pressure line M. This last pressure line may, if desired, be connected with the space within the casing below the stuffing box so that the force with which the stuffing box parts are forced inwardly to form a seal will be proportional to the pressure existing within the casing.

The stuffing box just described is adapted to form a seal about a section N of the drill stem which may be a round drive joint known as the Kelly joint. This Kelly joint is driven by a suitable driving clutch or bushing such as shown at O, and this bushing in turn fits within a rotary table P of the well known type used in driving rotary well drilling tools.

It will readily be seen that with the equipment illustrated, the slush within the well may be maintained under pressure during drilling by simply closing to a greater or lesser extent the flow bean F. The slush pumps will inject the slush into the well through the drill stem under any suitable pressure, and the flow from the well will be held back by the flow bean F in any desired degree so as to maintain the required pressure within the well. When the bit illustrated at 9 has been drawn upwardly above the gate valve B and is located within the lubricator section C as illustrated in dotted lines, the gate valve B will be closed and the stuffing box J removed in order to permit removal of the bit. The difficulties of removing and inserting the drill stem under these conditions will be readily apparent and it is to avoid this necessity in so far as possible that the present invention is devised.

Referring now more specifically to Figs. 2 to 4 inclusive, the numeral 1 indicates a sub, which is threadedly connected at 2 to the lower end of a tool joint 3 on the lower end of the drill stem. To the lower end of this sub 1, there is threadedly connected at 4 the upper end of the drill collar 5. Another sub 6 is threadedly connected at 7 to the lower end of the drill collar 5, and to the lower end of this sub, there is threadedly connected at 8 the usual core bit 9 which may be of any suitable type. The core bit 9 in this instance is of the fish-tail type, having two or more blades 10, which extend substantially radially with respect to the axis of the bit. The bit is provided with an opening 11 centrally thereof, and just above this opening, it is provided with a

spider 12, in the center of which is a ring 13, adapted to receive and support a portion of the core barrel or other tool in a manner presently to be set forth. The space around the ring is adapted to serve as a mud passage when a core barrel or other tool is in place therein. Suitable passages are also provided at 12' for discharging mud adjacent the cutting blades of the bit.

Referring again to the tool joint 3 at the lower end of the drill stem, it will be noted that this tool joint is provided with a longitudinal opening centrally thereof, as shown at 14, and that this opening is continued through the sub 1, as shown at 15. The lower end of the sub 1 is formed with internal threads 16, adapted to receive a latching collar 17, which may be of any desirable type customarily used for latching down a core barrel within a drill of the type here set forth. It will be seen that this latching element 17 is provided with an opening, adapted to receive the core barrel, and that on one side, it is also provided with a flared opening in a lateral direction, as shown at 18, for the purpose of permitting the passage of mud which is pumped down through the drill stem during the operation of the drill. At its lower end, this member 17 is provided with a downwardly extending lug 19, adapted to receive the retractable latch 20, which is carried by the core barrel or other tool, and which operates in a manner that will be presently explained.

The lower end of the drill collar is also internally threaded at 21 to receive a ring-shaped element 22, having a valve seat formed in the lower end thereof, as at 23, and carrying a valve element 24 hinged to one side thereof as shown at 25. The valve element 24 is, in the example illustrated, provided with a groove, which extends around its outer circumference, and in which is disposed a rubber or other sealing ring 26. This sealing ring, when the valve 24 is in its closed position, is adapted to form a perfect seal against the valve seat 23 within the ring-shaped member 22. This ring-shaped member 22 may likewise be provided with a rubber or similar sealing ring 27, to form a seal between the element 22 and the drill collar. The valve element 24 is normally urged toward its closed position by means of a spring 28. Its upper surface, as shown, is on an angle so that a descending tool would strike the valve first on the side opposite its hinge to unseat it.

The core barrel, which may be employed in accordance with this invention, is similar to that customarily employed in that it is provided, at its lower end, with a cutter head 29, and with a core catcher 30, positioned immediately above or in the cutter head 29. Above these two elements is the core barrel proper 31, into which the core is adapted to move as the entire structure is rotated in the drilling operation.

The core barrel 31 is provided on its outer surface, adjacent to the lower end, with a shoulder 32, which faces downwardly, and is adapted to seat upon the ring 13 carried in the bit head 9, which has been heretofore described.

Mounted on the upper end of the core barrel is a telescopic joint which is normally held in its extended position by means of a coil spring 33. The upper end of this coil spring bears against a solid element 34, and this is connected by means of suitable connection 35 to the lower end of a sleeve 36, having lateral openings 37

from a portion 38 of enlarged internal diameter at its lower end.

Positioned within the portion 38 is a back pressure valve 39, having a flexible sealing ring 40 surrounding it, this back pressure valve being normally spring pressed upwardly by means of a suitable spring 41. When moved upwardly, this valve is adapted to enter the bore 42 of the element 36, and to entirely close this element and prevent any upward flow therethrough. The element 36 is likewise provided with circumferential grooves in its outer surface, in which are mounted additional sealing rings 43, which are so designed as to prevent upward flow around the outside of the element 36.

Forming a continuation of the upper end of the element 36 is a sleeve-like element 44, having lateral openings 45, therein adjacent to its upper end, and being threaded at its upper end to receive the latching head 46. The latching head 46 carries the latching element 20 heretofore mentioned, and is provided with means not shown whereby this latching element 20 is normally spring-pressed outwardly, so as to engage beneath the lower edge of the latching sleeve 17. On the upper end of the latching head 46, there is carried a spear head 47, adapted to receive an overshot (not shown) for withdrawing the core barrel from the well. Suitable mechanism is provided within the latching head so that when an upward pull is exerted upon the spear head 47, the latching element 20 will be retracted so that the core barrel may be withdrawn.

The operation of the above device may be described as follows:

Let it be assumed that drilling is proceeding, with the drill stem passing through the stuffing box J at the upper end of the well, and that there is an element of well known construction known as a center bit located in the main bit 9 in the place where the core barrel is shown in Fig. 2. This center bit should be in much the same mounting as the core barrel illustrated but would be formed to cut the entire center of the hole and leave no core. In this apparatus cutter head 29 may be unscrewed and replaced with the center bit.

When it is thought desirable to take the core, the upper end of the drill stem is opened, and the pressure within the hole will, if sufficient, as soon as the center bit is released by an overshot lowered into the well in a wire line, force the center bit up through the drill collar until it has moved to a position above the valve 24. During this time the rings 43 or their equivalent will maintain a seal within the bore of the drill collar. As soon as it has moved this far, however, the valve 24 will immediately close because of the spring 28, and the pressure existing within the well, and further flow up through the drill stem will be prevented. The center bit may now be withdrawn while the drill stem is open.

As soon as the center bit is out of the drill stem, the core barrel illustrated in the drawings is dropped in, and the drill stem is closed. The pumps are then started to force drilling mud down through the drill stem behind the core barrel, and cause it to move to the lower end of the drill stem and seat within the drilling bit as illustrated in the drawings. It will be understood that when the cutter head 29 strikes the valve 24, this force, together with the pressure of the fluid above the core barrel, will move the valve to the position shown in Fig. 2. It will be understood, however, that prior to this time,

the fact that fluid is being pumped down through the drill stem will have opened the valve 24 sufficiently to permit the passage of the fluid being pumped.

With the apparatus in position shown in Figures 1 and 2 of the drawings, the drill stem is then rotated, and the drilling continued. The drill stem will also cause the core barrel to rotate by virtue of the engagement of the latching member 20 with the lug 19. As the drilling continues, that portion of the formation in the center of the hole will not be cut, but will form a core, and the core barrel 31 will pass down thereover. After the drilling has proceeded for a sufficient distance, the drill stem will again be opened, and a wire line or cable, with an overshot thereon, will be passed into the well. At this time, it will be noted that the rings 43, and the back pressure valve 39 will prevent any upflow through the drill stem, while the cable and overshot are being lowered into engagement with the spear head 47.

An upward pull is then exerted on the spear head 47, so as to release the latching element 20, whereupon the core barrel, with the core in place, will be moved upwardly both by the pull on the cable and by the pressure existing within the well. The core catcher element 30 will operate to break off the core, and the core barrel as a whole will be moved upwardly to a position above the valve 24, whereupon this valve will snap shut in the same manner that was previously described. The same operation may be carried out with the center bit in place, except of course that no core will be taken.

With the valve 24 in closed position, the core barrel may be withdrawn from the drill stem by means of the cable and overshot without any danger of a blow out through the drill stem. It will be appreciated that during the entire time of the operation just described, any blow outs around the outside of the drill stem will be prevented by a stuffing box or blow out preventer such as shown at J in Fig. 1, located at the top of the well.

From the foregoing, it will be appreciated that a device has been provided whereby all of the objects and advantages sought by this invention may be obtained.

It will further be appreciated that by means of the device just described, it is possible to take cores or to perform other tests, surveys or operations during the drilling of a well under pressure with no more difficulty, and with substantially the same operations on the part of the operator as would be necessary if the well were not being drilled under pressure.

Having described our invention, we claim:

1. In combination, a core drill, a tool adapted to be moved into said core drill from above, and to seat within said core drill, closure means for preventing upward flow through said core drill at all times when said tool is not in place therein

thereby to prevent pressure below the core drill from acting upon said tool while it is being inserted into and removed from the well and moved down to and upwardly from the core drill, and means for preventing upward flow through said core drill when said tool is in place therein.

2. In combination, a core drill, a tool adapted to be moved into said core drill from above, and to seat within said core drill, closure means for preventing upward flow through said core drill at all times when said tool is not in place therein thereby to prevent pressure below the core drill from acting upon said tool while it is being inserted into and removed from the well and moved down to and upwardly from the core drill, and means carried by said core barrel for preventing upward flow through said core drill when said tool is in place therein.

3. In combination, a core drill, a tool adapted to be moved into said core drill from above, and to seat within said core drill, closure means for preventing upward flow through said core drill at all times when said tool is not in place therein thereby to prevent pressure below the core drill from acting upon said tool while it is being inserted into and removed from the well and moved down to and upwardly from the core drill, and a check valve carried by said tool for preventing upward flow through said core drill when said tool is in place therein.

4. In combination, a core drill, a tool adapted to be moved into said core drill from above, and to seat within said core drill, closure for preventing upward flow through said core drill at all times when said tool is not in place therein thereby to prevent pressure below the core drill from acting upon said tool while it is being inserted into and removed from the well and moved down to and upwardly from the core drill, a sleeve carried by said tool, said sleeve being open at its upper and lower ends, respectively, and a check valve within said sleeve for preventing upward flow through said core drill when said tool is in place therein.

5. In combination, a core drill, a tool adapted to be moved into said core drill from above, and to seat within said core drill, closure means for preventing upward flow through said core drill at all times when said tool is not in place therein thereby to prevent pressure below the core drill from acting upon said tool while it is being inserted into and removed from the well and moved down to and upwardly from the core drill, a sleeve carried by said tool, said sleeve being open at its upper and lower ends, respectively, means for forming a seal about said sleeve when said tool is seated within said core drill, and a check valve within said sleeve for preventing upward flow therethrough when said tool is in place in said core drill.

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