Nov. 12, 1940. C. F. BAKER 2,221,392

CORE CATCHER

Filed Dec. 14, 1938 2 Sheets-Sheet 1

Fig. 1.

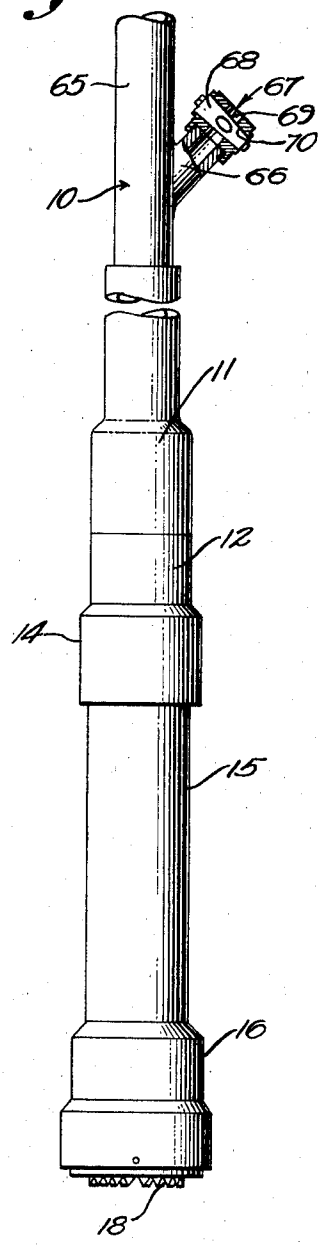


Fig. 4.

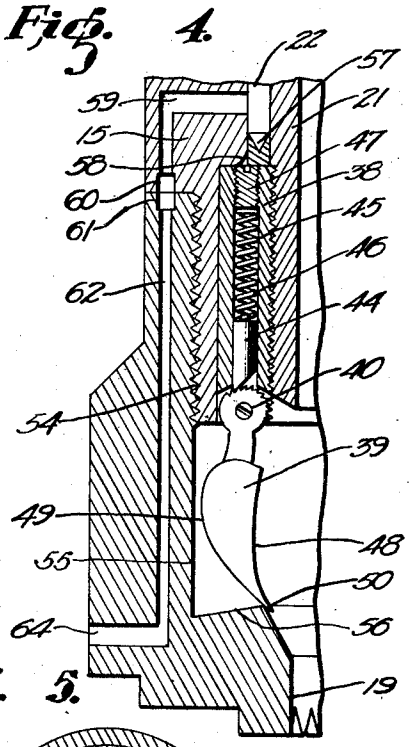


Fig. 5.

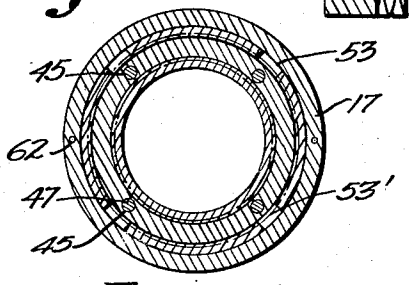
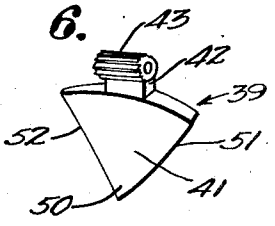


Fig. 6.



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Fig. 2.

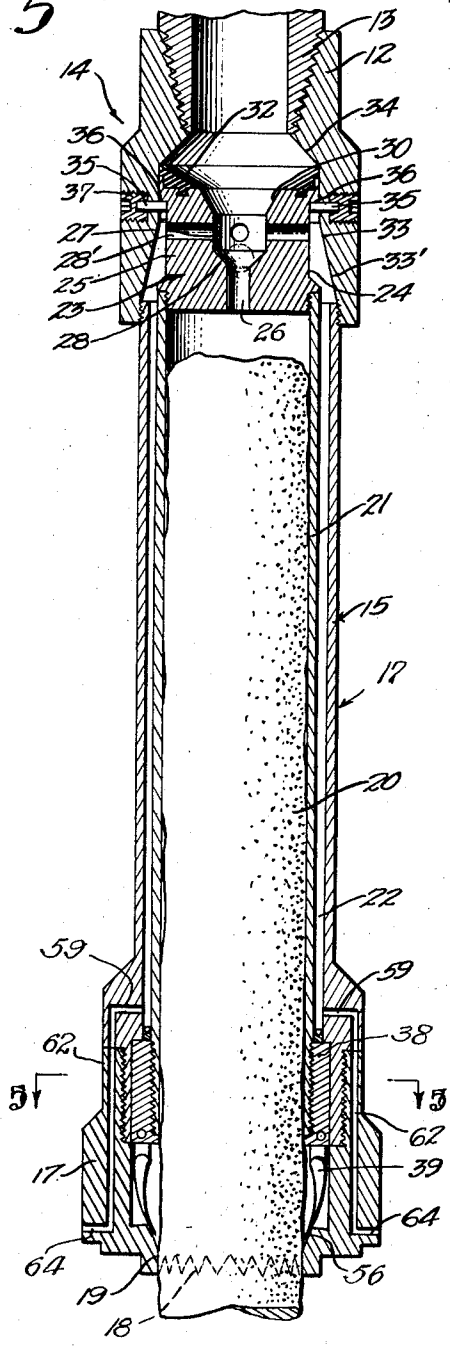
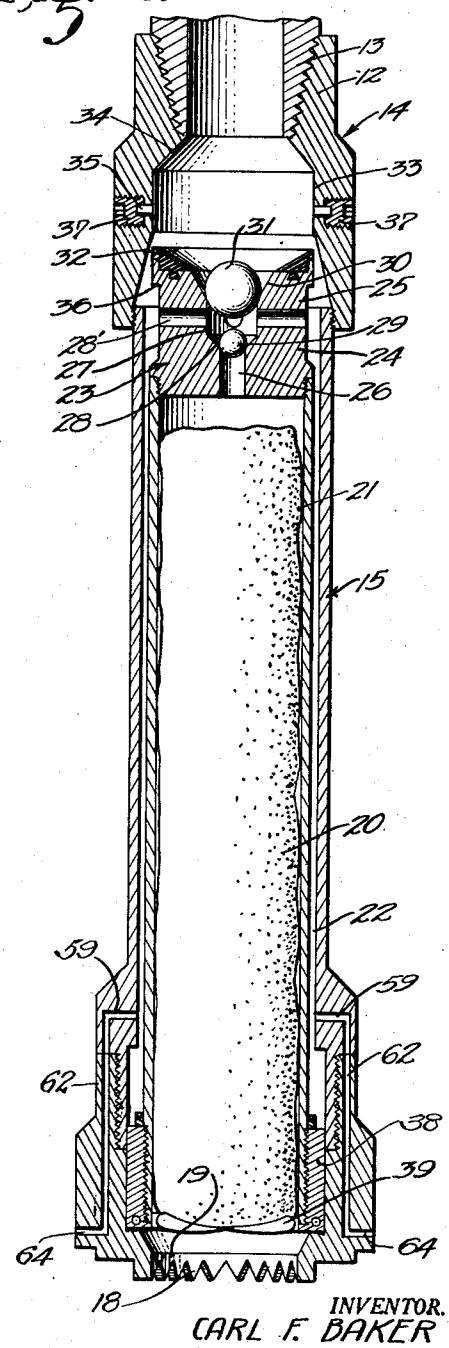


Fig. 3.



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CORE CATCHER

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Application December 14, 1938, Serial No. 245,687

10 Claims. (Cl. 255—72)

This invention relates to well drilling tools and particularly pertains to a core catcher of the type generally indicated in my co-pending application entitled "Core catcher" filed the 25th day of April, 1936, and bearing Serial Number 76,476, now Patent No. 2,152,341, granted March 28, 1939.

It is common practice in well drilling and particularly when drilling oil wells to drill ahead of the hole within which the casing is to be set and to cut and extract a core so that the character of the geological formation being penetrated may be ascertained, as well as the slope of the strata of the formation. This is accomplished by the use of a core barrel mounted at the lower end of a drill-string and within which a core projects as it is cut. The cutters in such instances produce a circular kerf so that the resulting core is cylindrical. This type of cutter does not, however, sever the core at the bottom of the kerf, and it is then necessary to pull or break the core from the uncut formation and to thereafter hold the core within the core barrel so that it may be withdrawn from the well for examination.

Various mechanical devices have been provided to act as core catchers but these in most instances have been uncertain in their operation, and it is, therefore, the principal object of the present invention to provide an efficient core barrel and core catcher which may be manipulated by the flow of drilling fluid through the drill-string supporting the core, and will act to sever the core, entrap it within the core barrel and also establish a condition which will serve as a signal to the operator at the top of a well that the core has been cut and severed and may be withdrawn from the well without further operations.

The present invention contemplates the provision of a core barrel having a plurality of cutting segments at the bottom thereof in addition to the usual core drill, and which segments may be hydraulically controlled from the top of the well to cause them to impinge against the sides of the cut core and to sever the core from the formation, the structure also acting under responsive hydraulic pressure to entrap the core and to insure that it will be held within the core barrel and withdrawn from the well.

The invention is illustrated by way of example in the accompanying drawings, in which:

Figure 1 is a view in elevation showing the complete core barrel with which the present invention is concerned.

Fig. 2 is an enlarged view in longitudinal section showing the core barrel during the core cutting operation.

Fig. 3 is a similar view to Fig. 2 showing the core barrel in longitudinal section with the parts in their entrapping position.

Fig. 4 is an enlarged fragmentary view in longitudinal section showing one of the core casing elements and the means associated therewith.

Fig. 5 is a view in transverse section through the structure as seen on the lines 5—5 of Fig. 4.

Fig. 6 is a view in perspective showing one of the core severing and retaining elements.

Referring more particularly to the drawings, 10 indicates a drill-string at the lower end of which is formed a fitting 11 including a box 12 to receive a threaded pin 13. The box 12 is part of a holder-sub 14 which is internally threaded at its lower end to receive the main housing 15. This housing is tubular and cylindrical. It is upset at its lower end as indicated at 16 and is threaded into a shoe 17. The upper end of the main housing 15 is threaded into the skirt of the holder-sub 14. Extending downwardly from the under face of the shoe 17 is a cutter 18, which is formed with a central opening 19 therethrough to receive a core 20.

Mounted within the housing 15 is an inner core barrel 21. This core barrel is cylindrical and tubular and is interposed between the core 20 and the outer housing 15. The outer diameter of the inner core barrel is sufficiently less than the inner diameter of the housing 15 so as to cause an annular fluid circulating space 22 to occur between the two walls. This permits circulation of drilling fluid through the drill-string in a manner and for a purpose to be hereinafter set forth.

The upper end of the inner core barrel is connected with a shearing head assembly 23. This assembly includes a cylindrical body member 24 having a threaded extension at its lower end to receive the upper end of the inner barrel 21. The overall diameter of the body member 24 is less than the inner diameter of the housing 15 and is formed intermediate its length with a portion of restricted diameter indicated at 25, which provides an additional fluid space and creates shoulders at its opposite ends against which fluid pressure may be exerted. Formed centrally of the body member 24 of the shearing head assembly is a lower fluid duct 26 communicating with a counter-bore 27, the counter-bore being formed at its lower end with a tapered ball seat 28 upon which a circulation deflector ball 29 may seat, as will be hereinafter explained. Extending radially from the counter-bore 27 are a plurality of fluid deflector ducts 28' which extend entirely through

the side wall of the body member 24. At the upper end of the counter-bore 27 a tapered valve seat 30 is formed. This seat receives the core catcher control ball 31. Keyed to the upper face of the body member 24 of the shearing head assembly is an inner barrel rubber packing 32 which tapers downwardly and inwardly to the valve seat 30. This seat normally fits within the bore 33 of the holder-sub 14 and in its uppermost position bears against the downwardly and outwardly face 34 formed at the point of juncture of the bore 33 and the threaded central opening of the sub to receive the pin of the drill pipe.

By reference to Fig. 2 of the drawings it will be seen that under normal conditions shear pins 35 are held by the sub 14 and that they project inwardly from the wall of the bore 33 to extend into the restricted portion 25 of the body member of the shearing head assembly. This restricted portion 25 forms an upper shoulder 36 upon which the shearing head assembly and the inner core barrel hang when seated and by which they are held until the pins are sheared off. Shear pin holders 37 are threaded into radial bores in the skirt of the sub 14 and may be removed to facilitate in inserting new shear pins when the device is to be used again.

The lower end of the inner barrel 15 is shown in detail in Figs. 2, 3 and 4. Here it will be seen that a cylindrical sleeve 38 is threaded onto the outer surface of the lower end of the barrel and circumscribes the same. This sleeve carries a plurality of core cutting and core catching elements 39 which depend from the lower end of the sleeve 38 and are pivoted to swing radially thereof upon pivot pins 40. The combined core cutting and core catching elements 39 are segmental in shape as shown particularly in Fig. 6. Here it will be seen that they have a triangular shaped segment 41 from the circumferential edge of which a centrally disposed lug 42 projects. Carried by this lug is a cylindrical bearing portion 43 through which the pin 40 extends. A portion of the cylindrical surface of this bearing member is formed with longitudinally extending and circumferentially arranged ratchet teeth. These ratchet teeth are engaged by dogs 44 which reciprocate within longitudinally extending bores 45 formed within the body of the sleeve 38. Springs 46 yieldably hold the dogs in their lowermost positions. The upper ends of the bores 45 are fitted with threaded plugs 47 by which the springs are held in position.

By reference particularly to Fig. 4 of the drawings, it will be seen that the segmental member has a concaved front face 48 and a convex back face 49, the two faces define a tapered body portion which terminates in an end point 50, and since the sides of the segment are defined by the radial faces 51 and 52 it will be seen that if the core catchers are swung to a substantially horizontal aligned position, as shown in Fig. 3 of the drawings, the points 50 of the segments will converge at the longitudinal center of the core catcher and the side faces 51 and 52 of the segment will abut against each other so that the set of segments will combine to form a closure for the lower end of the inner barrel 21 and will at the same time entrap the core therein. Attention is also directed to the fact that as the core catching elements 39 move to their closed position from their inactive position that the points of the core catchers will act as cutters and will sever the core from the formation in which it occurs.

The core catching segments 39 are moved to their closed positions by relative movement of the inner barrel 21 and the shoe 17, as well as by a sliding movement within the housing 15. The housing 15 at its lower end is formed with a plurality of longitudinally extending keyways 53 which receive keys 53'. This permits longitudinal movement of the parts without relative rotation. The upper end of the shoe 17 is formed with an internally threaded bore 54 which receives the lower threaded end of the main housing 15. A continuing portion 55 of this bore accommodates the core catching members 39 when these members are in their inactive and vertically disposed positions. At the bottom of the bore 55 a shoulder 56 occurs against which the back arcuate face 49 of each of the core catching segments 39 rests. Thus, as the inner barrel 21 with its sleeve 38 moves downwardly the core catching elements 39 are forced to swing outwardly as they engage the shoulder 56 and as they move from their vertical to their horizontal positions. This swinging action takes place on the pins 40 and as the swinging takes place the dogs 44 engage the ratchet teeth 43 and hold the segments 39 in the position to which they have been swung. If this position is the full horizontal position of the segments it will be evident that the segments will be locked and that the core 20 will be entrapped therein. The inner barrel is designed to receive its force for downward movement by hydraulic action of the fluid entrapped within the housing 15 in a manner hereinafter to be described.

In order to pack the inner cylinder with relation to the barrel at the time of the initial downward movement of the barrel an annular packing ring 57 is mounted around the inner housing 21 and against the upper face of the sleeve 38. This packing forms a seal between the outer circumferential face of the inner barrel 21 and the inner face of the housing 15. In order to facilitate the entry of this packing into the space 22 which occurs between the housing and the inner barrel a curved face 58 is formed on the shoulder of the housing, as particularly shown in Fig. 4 of the drawings.

A by-pass fluid duct establishes communication between the space 22 and the exterior of the shoe. This includes a passageway 59 in the lower end of the outer housing and which passageway communicates with an annular groove 60 in the housing. A complementary groove 61 is cut in the upper end face of the shoe 17 and communicates with a passageway 62 which leads downwardly within the shoe and outwardly through an outlet passageway 64.

Mounted at the upper end of the drill-string 10 is a sub 65 which has a side outlet 66 therein. The sub 65 is disposed directly beneath the swivel head of the drill-string (which is not shown in the drawings). A valve housing 67 is mounted upon the extension 66 and is fitted with a rotary valve element 68. The rotary valve element has an opening 70 entirely through it and transversely of its longitudinal axis. An opening 69 is formed through the valve housing to register with the opening 70 in the valve element 68 when the element is rotated into a position of alignment therewith. The openings 69 and 70 are large enough to permit the circulation deflector ball 29 to be introduced into the structure as well as the core catcher control ball 31 when the openings 69 and 70 are in register. When the valve element 68 is rotated a quarter turn these openings will be out of register and the valve will be closed.

In operation of the core catcher structure, as

here disclosed, for the purpose of cutting and catching a core and permitting it to be withdrawn from the well the device is assembled as shown in Fig. 1, and is attached to the usual swivel and operatively supported by the rotary table. Before the structure is lowered into the well bore care is taken to place the shear pins **35** in position so that they will support the inner barrel **21** in its uppermost position, as shown in Fig. 2 of the drawings. At such a time it will be seen that the core catching segments **39** are in their retracted positions with their pivoted ends held at the top of their stroke of travel and with their lower curved ends resting against the shoulder portion **56** and clear of the central opening **19** in the bottom of the shoe **17**. With the structure thus assembled the core cutting teeth **18** are positioned to rest upon the formation at the bottom of the drilled hole so that the core **20** will be cut as indicated in Fig. 2 of the drawings.

After the structure has been lowered into the well in a cutting position, fluid may then be pumped through the drill string to wash out mud and debris from the tool prior to a cutting operation. The circulation deflector ball **29** is then introduced through the valve structure **67** into the member **65**, and will then fall through the drill-string until it seats upon the inclined seat **28** in the shear head **24**, at which time it will close the circulating passageway **26** and divert the downward circulating fluid to cause it to flow outwardly through the passageways **28'** in the shear head **23**. This fluid will then flow downwardly between the inner core barrel **21** and the outer housing **15**. When it reaches a point adjacent the lower end of the inner core barrel **21** it will flow through the passageways **59** and into passageway **62**, thereafter passing outwardly into the well bore through passageway **64**. The presence of the deflector ball **29** will therefore prevent a circulating fluid from filling into the inner core barrel **21** and will permit the barrel to receive the core **20** as it is being cut. It will also be evident that as the core travels upwardly into the barrel it will displace any fluid which has been entrapped within the inner barrel and permit this fluid to lift the deflector ball and to thereafter pass outwardly through the ducts **28'** and around the inner barrel.

When the barrel has been appropriately filled with a desired length of core it is then desirable to sever the core from the formation. This is then accomplished by dropping the core catcher control ball **31** into the drill-string by passing it through the valve **67**. The ball **31** will rest upon the tapered seat **30** in the shear head **23** and thus interrupt downward flow of circulating fluid completely. Further action of the mud pumps will force circulating fluid downwardly to produce a pressure upon the shear pins **35**, causing them to be sheared off as shown in Fig. 3 of the drawings. This releases the inner core barrel **21** from its supported position, after which the barrel will be subjected to the pressure of the hydrostatic head of drilling fluid within the drill-string plus the pump pressure. While this action is being sustained a continuous rotary driving action is produced upon the drill-string and the core barrel. The downward pressure of the fluid will tend to force the lower end of the inner barrel **21** downwardly and this in turn will cause the core catching segments **39** to bear against the shoulders **56** of the shoe **17**, thus forcing the points of the segments **39** inwardly toward the position shown in Fig. 3 of the drawings. It will be evident that as the core barrel is rotated and the segments **39** are forced inwardly they will act to sever the core and at the same time close the lower end of the inner barrel. As the segments **39** swing from their vertical positions their ratchet teeth **43** will swing beneath the dogs **44** and will be held against a reverse swinging action. Thus, at any time the severing action is interrupted the segments **39** will be locked against reverse swinging action and the core will be held thereby. In the event that the segments **39** are swung to their extreme horizontal positions, as shown in Fig. 3 of the drawings, the segments will substantially close the lower end of the inner core barrel **21**, and since the end portion of the sleeve **38** will at that time strike the shoulder **56** of the shoe **17** it will be evident that the inner core barrel cannot move downwardly any greater distance.

When the head **23** is in its uppermost position it will be seen that the rubber packing ring **32** will fit within the bore **33** of the holder sub **14** around the head **23** but will permit a limited flow of fluid through the ducts **28'** until after the ball **31** has been dropped onto its seat within the head **23**. At that time the downward flow of fluid will be interrupted completely and the force of the pump pressure will be exerted against the head **23** acting to shear the pins **35**. After these pins have been sheared the head will move downwardly within the bore **33** until the upper end of the head passes out of the cylindrical bore **33** and into the undercut length **33'**. When this point is reached the circulation of fluid will be re-established through the drill string and down through the core barrel by passing around the unseated head **23** and into the space **22** between the inner core barrel and the outer housing. This will instantly produce a drop in fluid pressure and will relieve the load on the mud pumps so that the usual pressure gauge at the top of the well will indicate the pressure change and advise the operator that the core cutting operation is complete. Attention is directed to the fact that the packing ring **57** normally seals the lower end of the space between the inner barrel and the outer housing.

It will thus be seen that the core catcher structure here disclosed is simple in design, rugged in construction, and provides direct and efficient means whereby a core may be cut, severed and then withdrawn from the well without danger that it will be lost or that it will be damaged during the operation. It will also be evident that by the arrangement here shown that the performance of the core catcher may be accurately controlled from the top of the well and that the operator may know when the core severing operation has been completed.

While I have shown the preferred form of my invention as now known to me, it will be understood that various changes may be made in combination, construction and arrangement of parts by those skilled in the art, without departing from the spirit of my invention as claimed.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

1. A device of the character described comprising a sub adapted to be attached to a drill-string, a core drill and an intermediate core cutting and catching structure, said structure including an outer barrel connecting the sub with the core drill, an inner barrel reciprocating at its upper end within the sub in fluid-tight relation thereto, core cutting and retaining means carried at the lower end of the barrel and adapted to be swung upwardly toward a horizontally aligned

position when the inner barrel moves downwardly within the outer barrel, means for establishing a flow of fluid through the sub and the inner barrel, means for interrupting said flow of fluid and diverting it into the outer barrel and around the inner barrel, thereafter discharging it into the well bore, and means for interrupting said last-named flow of fluid whereby the fluid pressure will be imposed upon the upper end of the inner barrel and will force the same downwardly within the outer barrel and will coincidentally swing the core cutting and retaining means upwardly and inwardly toward a horizontal position.

2. A device of the character described comprising a sub adapted to be attached to a drill-string, a core drill and an intermediate core cutting and catching structure, said structure including an outer barrel connecting the sub with the core drill, an inner barrel reciprocating at its upper end within the sub in fluid-tight relation thereto, core cutting and retaining means carried at the lower end of the barrel and adapted to be swung upwardly toward a horizontally aligned position when the inner barrel moves downwardly within the outer barrel, means for establishing a flow of fluid through the sub and the inner barrel, means for interrupting said flow of fluid and diverting it into the outer barrel and around the inner barrel, thereafter discharging it into the well bore, means for interrupting said last-named flow of fluid whereby the fluid pressure will be imposed upon the upper end of the inner barrel and will force the same downwardly within the outer barrel and will coincidentally swing the core cutting and retaining means upwardly and inwardly toward a horizontal position, and means for locking the core cutting and retaining means with relation to the inner barrel whereby the core will be held within the inner barrel while the structure is being withdrawn from a well.

3. A device of the character described comprising a sub adapted to be attached to a drill-string, a core drill and an intermediate core cutting and catching structure, said structure including an outer barrel connecting the sub with the core drill, an inner barrel reciprocating at its upper end within the sub in fluid-tight relation thereto, core cutting and retaining means carried at the lower end of the barrel and adapted to be swung upwardly toward a horizontally aligned position when the inner barrel moves downwardly within the outer barrel, means for establishing a flow of fluid through the sub and the inner barrel, means for interrupting said flow of fluid and diverting it into the outer barrel and around the inner barrel, thereafter discharging it into the well bore, means for interrupting said last-named flow of fluid whereby the fluid pressure will be imposed upon the upper end of the inner barrel and will force the same downwardly within the outer barrel and will coincidentally swing the core cutting and retaining means upwardly and inwardly toward a horizontal position, means for locking the core cutting and retaining means with relation to the inner barrel whereby the core will be held within the inner barrel while the structure is being withdrawn from a well, and shear pins temporarily holding the inner barrel in its uppermost position and with its core cutting and retaining elements in an inoperative position.

4. In combination with a core drill and a drill-string, a core cutter and catcher interposed between the core drill and the drill-string, said core catcher comprising an outer barrel, an inner barrel longitudinally reciprocal therein and having a fluid-tight fit at its opposite end, fluid circulating ports at the upper end of the inner barrel establishing communication between the drill-string and the outer barrel, a fluid port at the upper end of the inner barrel establishing communication between the drill-string and the inner barrel, fluid outlet ports at the lower end of the outer barrel, valve means for interrupting the flow of fluid from the drill-string to the inner barrel, additional valve means for interrupting the flow of drilling fluid to the outer barrel and whereby the fluid under pressure within the drill-string will force the inner barrel downwardly within the outer barrel, and core cutting and catching means carried by the inner barrel and co-operating with the outer barrel and swinging upwardly to a horizontal plane whereby the lower end of the inner barrel will be closed to retain a core.

5. In combination with a core drill and a drill-string, a core cutter and catcher interposed between the core drill and the drill-string, said core catcher comprising an outer barrel, an inner barrel longitudinally reciprocal therein and having a fluid-tight fit at its opposite end, fluid circulating ports at the upper end of the inner barrel establishing communication between the drill-string and the outer barrel, a fluid port at the upper end of the inner barrel establishing communication between the drill-string and the inner barrel, fluid outlet ports at the lower end of the outer barrel, valve means for interrupting the flow of fluid from the drill-string to the inner barrel, additional valve means for interrupting the flow of drilling fluid to the outer barrel and whereby the fluid under pressure within the drill-string will force the inner barrel downwardly within the outer barrel, core cutting and catching means carried by the inner barrel and cooperating with the outer barrel and swinging upwardly to a horizontal plane whereby the lower end of the inner barrel will be closed to retain a core, and means for locking said retaining means in its closed position.

6. In combination with a core drill and a drill-string, a core cutter and catcher interposed between the core drill and the drill-string, said core catcher comprising an outer barrel, an inner barrel longitudinally reciprocal therein and havin a fluid-tight fit at its opposite end, fluid circulating ports at the upper end of the inner barrel establishing communication between the drill-string and the outer barrel, a fluid port at the upper end of the inner barrel establishing communication between the drill-string and the inner barrel, fluid outlet ports at the lower end of the outer barrel, valve means for interrupting the flow of fluid from the drill-string to the inner barrel, additional valve means for interrupting the flow of drilling fluid to the outer barrel and whereby the fluid under pressure within the drill-string will force the inner barrel downwardly within the outer barrel, core cutting and catching means carried by the inner barrel and co-operating with the outer barrel and swinging upwardly to a horizontal plane whereby the lower end of the inner barrel will be closed to retain a core, means for locking said retaining means in its closed position, and means for temporarily holding the inner barrel in its uppermost position with relation to the outer barrel until a sufficient force of fluid pressure is created

against the inner barrel to disengage it from the holding means.

7. In combination with a core drill and a drill-string, a core cutter and catcher interposed between the core drill and the drill-string, said core catcher comprising an outer barrel, an inner barrel longitudinally reciprocal therein and having a fluid-tight fit at its opposite end, fluid circulating ports at the upper end of the inner barrel establishing communication between the drill-string and the outer barrel, a fluid port at the upper end of the inner barrel establishing communication between the drill-string and the inner barrel, fluid outlet ports at the lower end of the outer barrel, valve means for interrupting the flow of fluid from the drill-string to the inner barrel, additional valve means for interrupting the flow of drilling fluid to the outer barrel and whereby the fluid under pressure within the drill-string will force the inner barrel downwardly within the outer barrel, core cutting and catching means carried by the inner barrel and cooperating with the outer barrel and swinging upwardly to a horizontal plane whereby the lower end of the inner barrel will be closed to retain a core, and means for locking said retaining means in its closed position, said retaining means including a plurality of retaining segments mounted around the mouth of the lower end of the inner barrel and adapted when swung to their retaining position to co-operate in closing the entire lower end of the inner barrel.

8. In combination with a core drill and a drill-string, a core cutter and catcher interposed between the core drill and the drill-string, said core catcher comprising an outer barrel, an inner barrel longitudinally reciprocal therein and having a fluid-tight fit at its opposite end, fluid circulating ports at the upper end of the inner barrel establishing communication between the drill-string and the outer barrel, a fluid port at the upper end of the inner barrel establishing communication between the drill-string and the inner barrel, fluid outlet ports at the lower end of the outer barrel, valve means for interrupting the flow of fluid from the drill-string to the inner barrel, additional valve means for interrupting the flow of drilling fluid to the outer barrel and whereby the fluid under pressure within the drill-string will force the inner barrel downwardly within the outer barrel, core cutting and catching means carried by the inner barrel and co-operating with the outer barrel and swinging upwardly to a horizontal plane whereby the lower end of the inner barrel will be closed to retain a core, and means for locking said retaining means in its closed position, said retaining means including a plurality of retaining segments mounted around the mouth of the lower end of the inner barrel and adapted when swung to their retaining position to co-operate in closing the entire lower end of the inner barrel, the core retaining means being formed with cutting points at their free ends whereby a core within the inner barrel will be severed from the formation as the core catcher is rotated and the retaining means are swung toward their retaining positions.

9. In combination with a core drill and a drill string, a core cutter and catcher interposed between the core drill and the drill string, said core cutter and catcher comprising a sub connected to the drill string, an outer barrel attached thereto and depending therefrom, a core drill carried at the lower end of the outer barrel, a central cylindrical bore formed in the sub in communication with the drill string and having a counterbore portion at its lower end, a shearing head mounted to reciprocate within said central cylindrical bore and to form a fluid-tight seal therewith and being capable of movement downwardly to a position outside of the cylindrical bore and within the counterbore, a fluid duct through said head formed with superimposed valve ball seats, the lower seat being of smaller diameter than the upper seat, valve balls of appropriate diameter for each seat, the head being formed with lateral ducts lying in a plane between the two valve seats and extending outwardly through the wall of the head to establish communication with the outer barrel, an inner core barrel carried by said shearing head and extending downwardly through the outer barrel, a series of core cutting and holding elements pivoted at the lower end of the inner barrel and designed to swing upwardly and inwardly to cut off the core produced by the core drill and to substantially close the lower end of the inner barrel, means temporarily holding the shearing head and the inner barrel in its uppermost position with the core cutting and catching elements depending downwardly from their pivots, cooperating means carried at the lower end of the outer barrel and acting to swing the elements inwardly as they sever the core, and catch means carried at the lower end of the inner barrel for engaging the core cutting and catching elements and holding these elements in their upwardly swung positions.

10. Same as 9, adding the following: . . . relief ducts leading from the interior of the outer core barrel to a point of discharge adjacent the outer edge of the core drill and whereby when the shearing head has moved to its lowermost position within the counterbore of the sub fluid may pass freely downwardly around the shearing head and the inner core barrel and within the outer core barrel to thereafter discharge through the relief ducts.

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