WELL DRILLING TOOL

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This invention relates to well drilling tools and relates more particularly to well bits for use in the rotary method of well drilling. A general object of this invention is to provide a practical, effective, rotary well drilling tool that facilitates the testing and surveying of the well as well as drilling operations progress.

This application is a continuation in part of our co-pending application, Serial No. 214,234, entitled "Well bit," now Patent No. 2,179,010, granted Nov. 7, 1939.

Rotary well drilling bits have been introduced having openings for receiving surveying instruments, and the like, to permit the making of well surveys and well tests without the necessity of withdrawing the bits and drilling strings from the wells. A bit of the class just mentioned usually has a central vertical opening of substantial diameter for passing the surveying instrument. It is necessary to arrange a removable core receiving barrel or a removable core destroying device in this opening to cut away the core as the drilling progresses, so that the surveying instrument may be entered through the opening in the bit. In employing a bit of the class referred to it is necessary to remove the core barrel or the core destroying device from the bit when a survey is to be made. Following the surveying operation it is necessary to lower or run the core barrel or core destroying device down through the drilling string to its position in the bit. These operations are time consuming and, therefore, expensive.

Another object of this invention is to provide a rotary well drilling bit having a central longitudinal opening for the reception of surveying tools and other objects and embodying a core cutting means that is retractable to allow a surveying instrument or other object to be received in or passed through the said opening when the tool is in the well.

Another object of this invention is to provide a drilling tool of the character mentioned in which the retractable core cutting means need not be withdrawn or removed from the bit when the bit is in the well and may constitute a permanent element of the bit.

Another object of this invention is to provide a drilling bit of the character mentioned embodying a core cutting means that is automatically retracted by a surveying tool, sample taker, or other object run through the bit and that is automatically restored to its active core cutting condition upon the withdrawal of the tool or object so that the drilling operations may be immediately resumed.

Another object of this invention is to provide a well bit of the character mentioned embodying simple, dependable core cutting elements that bodily shift between their retracted positions and their active positions.

A further object of the invention is to provide a well bit of the character mentioned that requires no special handling or control, being operable in the same manner as a typical rotary well drilling bit.

The various objects and features of our invention will be fully understood from the following detailed description of typical preferred forms and applications of the invention, throughout which description reference is made to the accompanying drawing, in which:

Fig. 1 is a side elevation of a rotary well bit embodying the present invention. Fig. 2 is an enlarged bottom view of the bit shown in Fig. 1. Fig. 3 is an enlarged fragmentary vertical detailed sectional view taken as indicated by line 3—3 on Fig. 1. Fig. 4 is a view similar to Fig. 3 showing another form of the invention, and Fig. 5 is a fragmentary view similar to Fig. 3 showing still another form of the invention.

The present invention may be embodied in well drilling bits of various types and constructions. In the following detailed description we will describe three forms of the invention embodied in drag type rotary bits. It is to be understood that the invention is not to be construed as limited or restricted to the specific forms or applications herein disclosed. Further, it is to be understood that where reference is made herein to surveying instruments, sample takers, surveying operations and sample taking operations, it is contemplated that such references are to be construed as meaning the various instruments, tools and operations that may be employed for determining, testing and recording the various conditions in a well, such as temperature conditions, directional conditions, earth formation conditions, pressure conditions, etc.

The well bit of the present invention illustrated in Figs. 1, 2 and 3 of the drawing, may be said to comprise, generally, a bit body 10 having a central longitudinal opening 11 for receiving or passing an object, cutting means 12 on the body 10 for cutting the well bore to gauge and retractable means 13 for cutting or breaking away the central portion of the earth formation. The body 10 of the bit illustrated in Figs. 1 to 3, inclusive, of the drawing, is in the nature
of an elongate stem or shank. The lower major portion of the bit body 10 is cylindrical and of uniform diameter while the upper portion 14 of the body is enlarged and tapered downwardly and inwardly. Means is provided at the upper end of the body 10 for facilitating its connection with a well drilling string. In the typical case illustrated a tapered screw threaded socket 15 is provided in the upper portion of the body 10 to receive a correspondingly shaped pin on the lower end of the string. The opening 11 extends downwardly through the body 10 from the socket 15 to the lower end of the body. The opening 11 serves to handle or conduct the circulating fluid and is proportioned to receive or pass the surveying instrument. In accordance with the invention the opening 11 has a substantial diameter to readily receive or pass the surveying instrument. Means are provided in the body 10 to assist in locating and supporting the surveying instrument. An annular flange 16 is provided at the wall of the opening 11. The flange 16 is spaced below the socket 15. The lower portion of the opening 11 is reduced in diameter to receive the instrument with suitable clearance and to form an upwardly facing shoulder. The flange 16 and the reduced lower portion of the opening 11 are provided to center and locate the surveying instrument in the body 10 of the bit.

The cutting means 12 is provided to cut away the earth formation and form the well bore. The present invention is not primarily concerned with the character of the cutting means embodied in the bit and contemplates the employment of cutting means and elements of various nature. In the form of the invention being described the cutting means 12 includes two cutting blades 18 on the lower end portion of the body 10 and a set of spaced cutting blades 18 on the upper enlarged body portion 14. The cutting blades 18 may be termed pilot blades and operate to form an annular cut in the earth formation to receive the lower portion of the shank 10 with suitable clearance. The blades 18 project downwardly and outwardly from the lower end of the body 10 and have upwardly and inwardly inclined lower cutting edges and substantially vertical reaming edges. The inner edges 23 of the blades 18 are in substantially immediate adjacent the central vertical axis is vertical. The blades 18 are operable to enlarge the well bore to receive the drilling string with substantial clearance and thus provide for the return flow of circulation fluid through the well bore.

The means 13 is an important feature of the invention. The means 13 operates to remove or cut away the core of earth formation and in accordance with the invention is retractable to allow a surveying instrument, sample taker, or other object to be received in or pass through the body opening 11. The means 13 includes one or more shiftable core breaking or core cutting dogs 24. In the form of the invention illustrated in Figs. 1, 2 and 3 there are two dogs 24. It is preferred to locate the core breaking means 13 adjacent the lower end of the bit body 10 and in the construction illustrated the means 13 is provided below the shoulder 9 on the wall of the opening 11. The body 10 is constructed or formed to accommodate the means 13. Two substantially diametrically opposite slots or openings 26 are provided in the lower portion of the body 10. The openings 26 may be positioned as found most practical. In the form illustrated the openings 26 are adjacent the forward sides of the guide blades 19 where the body wall has substantial thickness. The openings 26 are vertically elongated and have flat parallel side walls. The upper and lower walls of the openings 26 are straight and substantially parallel. The outer sides of the openings 26 are open to the well bore and the inner sides of the openings are in communication with the longitudinal body opening 11.

A core cutting dog 24 is provided in each lateral opening 26. The dogs 24 may be flat plate-like parts whose opposite side surfaces shiftable bear on the side walls of the openings 26. In accordance with the invention the dogs 24 are adapted to bodily shift in their respective openings 26. The side surfaces of the dogs 24 shiftably bear on the side walls of the openings 26 and the upper edges of the dogs are adapted to bear against the upper walls of the openings. The dogs 24 are guided for movement between the projecting active positions, illustrated, and retracted positions where they are clear of the opening 11. Each dog 24 is provided with a downwardly and outwardly sloping slot 27 receiving or passing a pin 28 carried by the body 10. The pins 28 are flatsided to cooperate with the side walls of the slots 21 and are fixed in openings in the body 10 to extend through the openings 26 and the slots 27. The cooperation of the slots 21 and the pins 28 guides the dogs 24 for downward and outward movement from their active positions to their retracted positions and the engagement of the pins with the ends of the slots limits the travel of the dogs. The upper inner 60 corners of the dogs 24 are bevelled off to have downwardly and inwardly sloping faces 28. The faces 28 are engageable by a surveying tool, sample taker, or other object run down through the opening 11 and the engagement of the object 65 with the faces 28 causes downward and outward shifting of the dogs 24.

The lower edges 30 of the dogs 24 are adapted to cooperate with the core of earth formation to cut the same away. The cutting edges 30 are to be straight and horizontal, as stated above, and if desired or necessary may be sharpened. As best illustrated in Fig. 3 of the drawing the dogs 24 may be proportioned to have their inner edges immediately adjacent the central vertical axis 76.
of the opening 11 when the dogs are in their fully projected positions. When the dogs 24 are in their projected active positions where they bear against the upper walls of the openings 26 there are spaces of substantial capacity under the dogs allowing free circulation of fluid through the openings 26.

The invention includes means for returning the dogs 24 to their active projecting positions following the withdrawal of the surveying tool or object from the opening 11. A spring means is associated with each dog 24 to urge the dog inwardly to its active cutting position. In the construction illustrated leaf springs 31 are secured to the body 10 by screws 32 and extend into the openings 26 for engagement with the dogs 24. The springs 31 slope downwardly and inwardly and have cooperation with the lower rear corners of the dogs 24. The springs 31 normally hold the dogs 24 in the positions illustrated in the drawing where they are operable to cut away the core. The springs 31 yieldable to permit the downward and outward retraction of the dogs 24 by an object lowered through the opening 11.

In the operation of the bit illustrated in Figs. 1, 2, and 3 of the drawing the body 10 is connected with the lower end of a rotary well drilling string and the string is rotated and fed downwardly in the well in the usual manner. The cutting blades 17 assisted by the blades 18 make an annular cut in the bottom of the well leaving a central upstanding core of earth formation. The blades 18 enlarge this annular cut to form a bore which freely receives the drilling string.

The upstanding core is destroyed or drilled away by the dogs 24. The cutting edges 30 of the dogs 24 engage the upper end of the core and drill the core away. The engagement of the upper walls of the openings 28 with the upper edges of the dogs 24 transmits the downward feed pressures from the body 10 to the dogs 24. It will be observed that the engagement of the dogs 24 with the core serves to maintain the dogs 24 in their active cutting positions so long as the drilling operation continues.

Circulation fluid is pumped down through the bit and out through the openings 26 to carry away the cuttings from the surface and flush the dogs 24.

When a surveying instrument, sample-taker, or other object is to be lowered into the well the rotary drilling operations are suspended and the bit may be raised from the bottom of the hole. The instrument or object is run down through the drilling string and passes through or into the opening 11. In most instances the object or tool will pass through the opening 11 to protrude from the lower end of the bit. As described above, the flange 16 and the reduced lower portion of the opening 11 centralize the surveying instrument or object and the instrument may be supported on the flange 16. When the object or instrument is moving downwardly in the opening 11 its lower end contacts the faces 29 of the dogs 24. This engagement causes the dogs 24 to move downwardly and outwardly and the downwardly moving object or instrument retracts the dogs to positions clear of the opening 11. The dogs 24 do not interfere with the movement of the surveying tool or object through the opening 11.

When the survey, test or sample has been taken the object or surveying tool is withdrawn upwardly through the opening 11 and the drilling string. Upon removal of the object or surveying instrument the springs 31 automatically shift the dogs 24 upwardly and outwardly by the active positions illustrated in the drawing conditioning the dogs 24 for further operation. The tool may then be operated as above to continue the drilling operations.

The form of the invention illustrated in Fig. 4 of the drawing includes a body 10 provided with a central longitudinal opening 11 through which the surveying instrument is received. A spring 31 is provided to receive an object or surveying instrument and carrying cutting means 20 for making an annular cut in the earth formation. The body 10 is further provided with one or more lateral openings 28. In the case illustrated there is one lateral opening 28. The opening 28 extends horizontally or laterally through the thick wall at the lower end part of the body 10 and is open at the outer side of the body. The opening 28 is provided to shieldably receive a core cutting dog 24. The opening 28 may have flat parallel side walls and have flat parallel side walls and extending at substantially right angles to the longitudinal axis of the opening 11. The dog 24 is shaped to bodily shift in the opening 28 being provided with side surfaces for bearing on the side walls of the opening 28 and flat upper and lower end for bearing on the upper and lower walls of the opening. The dog 24 is shiftable between a position where it projects into the opening 11 to cut away the core of earth formation and a position where it is retracted from the opening 11. The lower edge of the dog 24 may be bevelled or sharpened to effectively cut away the core. The inner corner of the dog 24 is cut away to provide a downwardly and inwardly sloping face 29 that is engageable by an object run down through the opening 11. The movement of the dog 24 is limited by a pin 22 carried by the body 10.

Spring means is provided for yielding the dog 24 in its active core cutting position and for automatically restoring the dog to its active position following retraction. A spring 31 is secured to the body 10 by a screw 32 or the like and projects into the opening 28 for engagement with the dog 24. The spring 31 is designed to bear inwardly against the outer side of the dog 24 and is adapted to shift the dog 24 from its retracted position to its fully active position.

The operation of the structure shown in Fig. 4 of the drawing is substantially the same as that of the previously described form of the invention. During the drilling operation the dog 24 projects inwardly from the opening 28 and acts on the upper end of the core to cut away the same. When an object such as a surveying instrument, or the like, is run down through the opening 11 its lower end contacts the face 29 and this engagement retracts the dog. The dog 24 is retractable from the opening 11 to allow the object or instrument to freely pass through the opening 11. When the object or instrument is withdrawn upwardly from the opening 11 the spring 31 automatically restores the dog 24 to its active core cutting position.

The form of the invention illustrated in Fig. 5 of the drawing includes a body 10 similar to the body 10 described above. The body 10 has a central longitudinal opening 11 for handling the circulation fluid and for passing the surveying instrument, etc. One or more downwardly
and outwardly sloping lateral openings 26\(^b\) are provided in the wall of the body 10\(^a\). In the construction illustrated there is a single opening 26, but the opening 26\(^b\) slopes downwardly and outwardly from the opening 11\(^b\) to the exterior of the body 10. The opening 26\(^b\) is provided to carry a bodily shiftable core cutting dog 24\(^b\).

The dog 24\(^b\) is arranged to engage the walls of the opening 26\(^b\) to be guided by the opening. The inner surface of the dog 24\(^b\) is flat and slopes downwardly and inwardly. The lower side or edge of the dog 24\(^b\) has a sharpened cutting edge 38\(^b\) for cutting away the core. The edge 38\(^b\) slopes downwardly and outwardly. A pin 29\(^b\) carried by the body 10\(^a\) cooperates with a slot 27\(^a\) in the dog to limit the travel of the dog. Spring means is provided for yieldingly holding the dog 24\(^b\) in its active core cutting position. A plug 40\(^a\) is secured in the outer part of the opening 28\(^b\) and a spring 41\(^a\) is arranged under compression between the outer end of the dog 24\(^b\) and the plug 40. The outer part of the spring 41\(^a\) may be set in an opening 42\(^a\) in the plug to be retained in place. A port 43\(^a\) is provided in the plug 40 to permit the free flow of fluid to and from the opening 28\(^b\).

The core cutting means illustrated in Fig. 5 of the drawing operates in substantially the same manner as in the previously described forms of our invention. During the drilling operations the cutting edge 30\(^b\) acts on the upper end of the core to cut away the core. When a sample taker, surveying instrument, or the like, is run through the opening 11\(^b\) it strikes the end 29\(^b\) and forces the dog 24\(^b\) downwardly and outwardly in the opening 26\(^b\). When the surveying instrument or object is withdrawn outwardly from the opening 11\(^b\) the spring 41 restores the dog 24\(^b\) to its active core cutting position.

Having described only typical preferred forms and applications of our invention, we do not wish to be limited or restricted to the specific details hereinbefore set forth, but wish to reserve to ourselves any modifications or variations that may appear to those skilled in the art, or fall within the scope of the following claims.

Having described our invention, we claim:

1. A well drilling bit comprising a body having a vertical opening adapted to receive an object passed downwardly through the bit, cutting means on the body for cutting the outer portion of the well, and a bodily shiftable cutting element carried by the body to cut the inner portion of the well and retractable from its cutting position by said object as the object moves downwardly in the bit.

2. A well drilling bit comprising a body having a vertical opening adapted to receive an object passed downwardly through the bit, cutting means on the body for cutting the outer portion of the well, a cutting element for cutting the inner portion of the well and means slideably supporting the cutting element on the body to be retractable from its cutting position by said object.

3. A well drilling tool comprising a body having a vertical opening, cutting means on the body operable to make an annular cut in the earth formation leaving a central core of earth formation, a core cutting element shiftably supported by the body to bodily shift between a position where it is inactive and a position where it cuts away the core and is engageable by an object run down through said opening to be retracted by the object, and means for returning the element to the last named position upon removal of the said object.

4. A well drilling tool comprising a body having a vertical opening, cutting means on the body operable to make an annular cut in the earth formation leaving a central core of earth formation, a core cutting element carried by the body to bodily shift between a position where it is projected to cut away the core and where it is engaged by an object run down said opening to be retracted by the object, and spring means on the body for holding the element in the projected position and yieldable to allow retraction of the element.

5. A well drilling tool comprising a body having a longitudinal opening and a lateral opening in communication with the longitudinal opening, cutting means on the body for making an annular cut and leaving a core of earth formation, a core cutting element bodily shiftable in the lateral opening between an active position and a retracted position clear of the longitudinal opening, a sloping face on the element engageable by an object run down the longitudinal opening to cause retraction of the element, and spring means for returning the element to its active position upon removal of the object.

6. A well drilling tool comprising a body having a longitudinal opening and a lateral opening in communication with the longitudinal opening, cutting means on the body for making an annular cut and leaving a core of earth formation, a core cutting element bodily shiftable in the lateral opening between an active position and a retracted position clear of the longitudinal opening, a core cutting element bodily shiftable in the lateral opening, means guiding the element for downward and outward movement in the lateral opening, a cam face on the element engageable by an object run down the longitudinal opening to cause downward and outward retraction of the element, and a spring carried by the body urging the element upwardly and inwardly to its active position.

7. A well drilling tool comprising a body having a longitudinal opening and a lateral opening in communication with the longitudinal opening, cutting means on the body for making an annular cut and leaving a core of earth formation, a core cutting element bodily shiftable in the lateral opening, means guiding the element for downward and outward movement in the lateral opening, a spring actuating on the outer end of the element to yieldable urge the element to its active position, and a sloping inner face on the element engageable by an object run down through the longitudinal opening to cause retraction of the element.

8. A well drilling tool comprising a body having a longitudinal opening and a lateral opening in communication with the longitudinal opening, cutting means on the body for making an annular cut and leaving a core of earth formation, a core cutting element bodily shiftable in the lateral opening and sloping downwardly and outwardly, cutting means on the body for making an annular cut and leaving a core of earth formation, a core cutting element guided in said lateral opening for
movement between an active core cutting position and a retracted position clear of the longitudinal opening, and a spring acting on the outer side of the element to urge it to the active position.

10. A well drilling tool comprising a body having a longitudinal opening and a lateral opening in communication with the longitudinal opening and sloping downwardly and outwardly, cutting means on the body for making an annular cut and leaving a core of earth formation, a core cutting element guided in said lateral opening for movement between an active core cutting position and a retracted position clear of the longitudinal opening, a downwardly and inwardly inclined inner face on the element engageable by an object run down the longitudinal opening to produce retracting of the element, and a spring acting on the outer side of the element to urge it to the active position.

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