May 10, 1955 E. B. WILLIAMS, JR 2,708,103

COMBINATION DRILL AND CORE BIT

Filed March 31, 1951 4 Sheets-Sheet 1

Fig. 1.

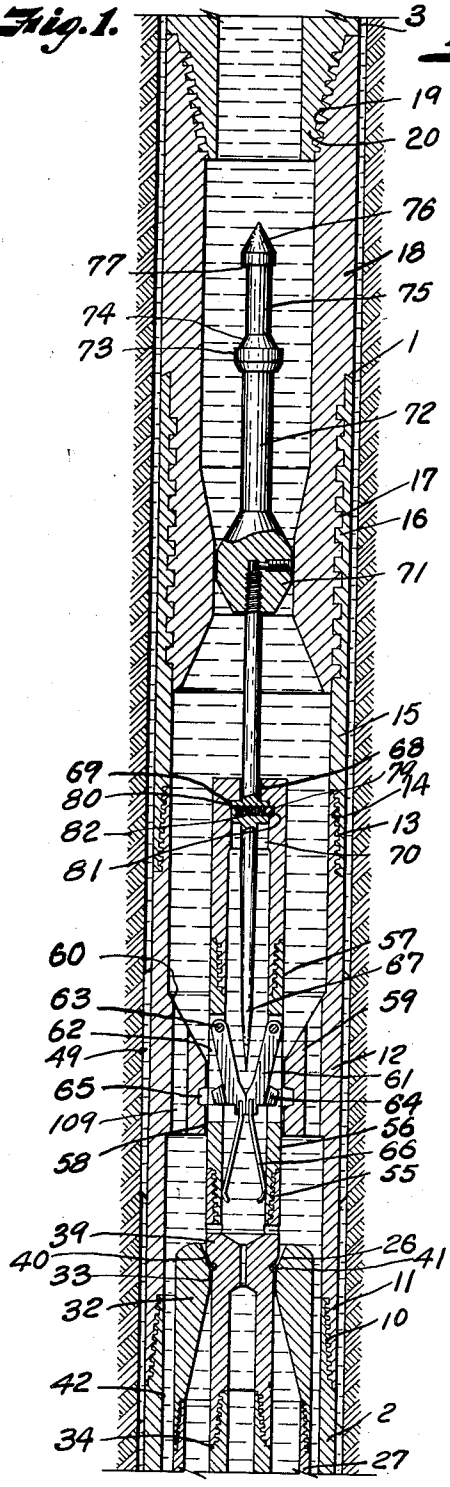
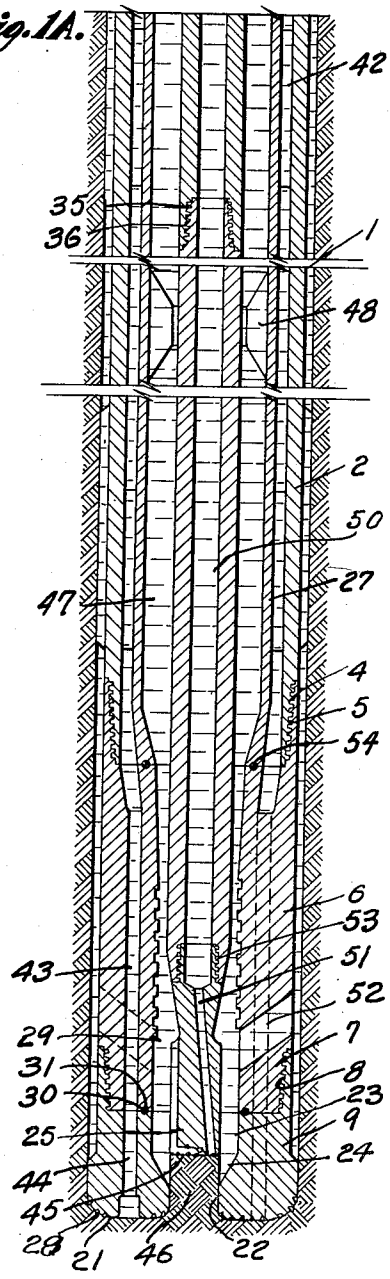


Fig. 1A.



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Filed March 31, 1951 4 Sheets-Sheet 2

Fig. 2.

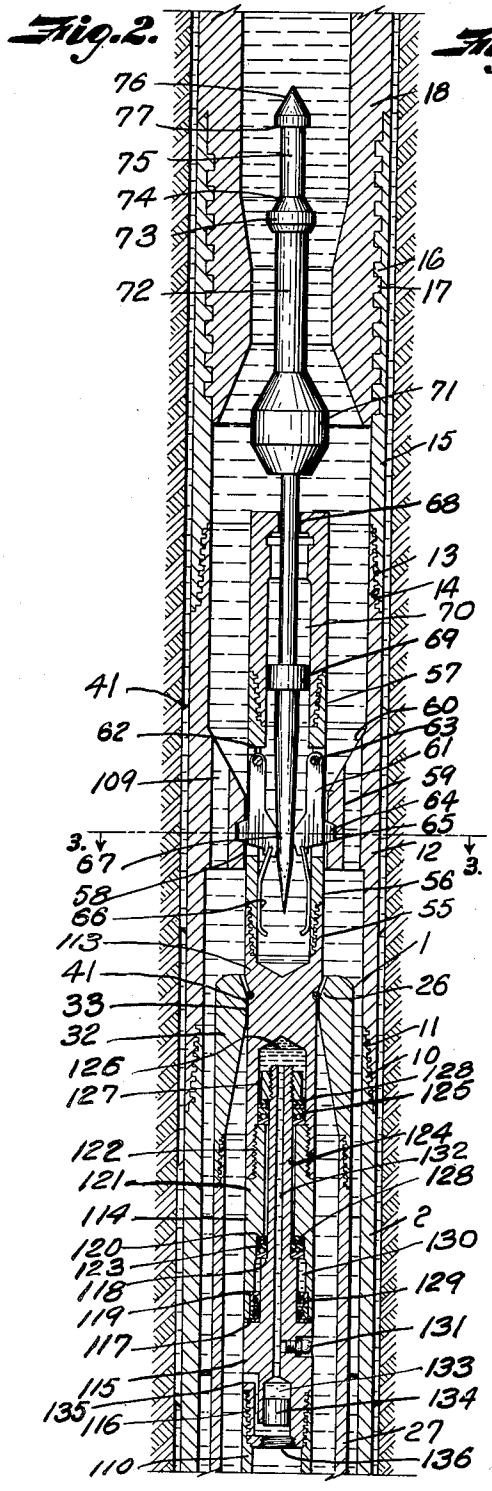
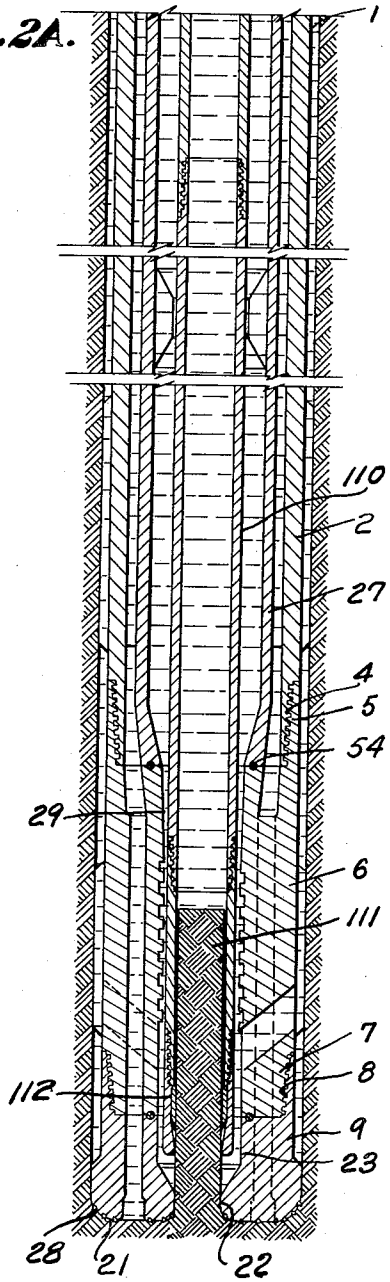


Fig. 2A.



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COMBINATION DRILL AND CORE BIT

Filed March 31, 1951 4 Sheets-Sheet 3

Fig. 3.

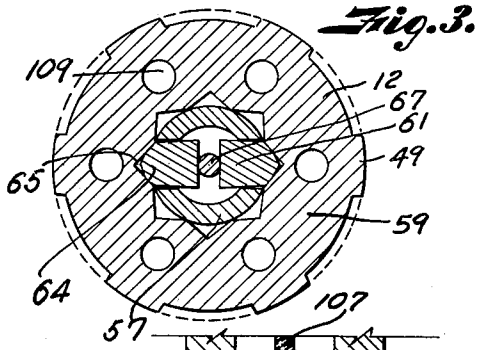


Fig. 4.

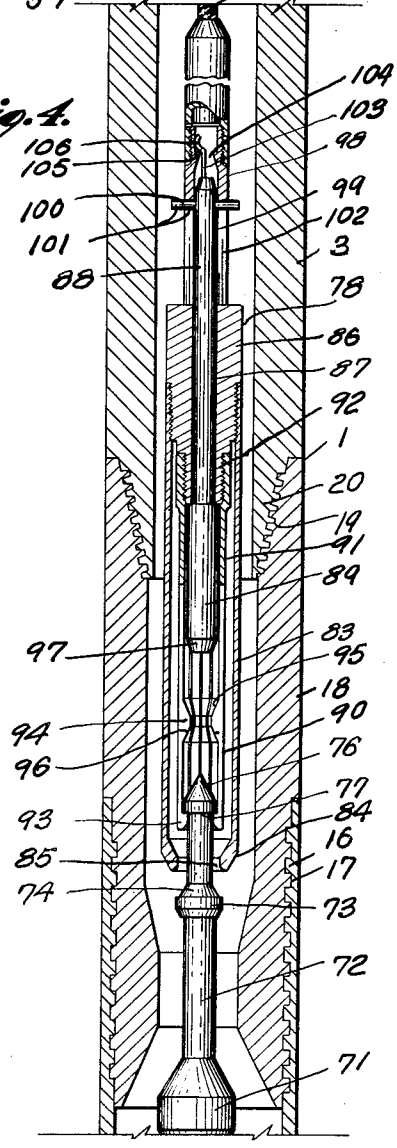
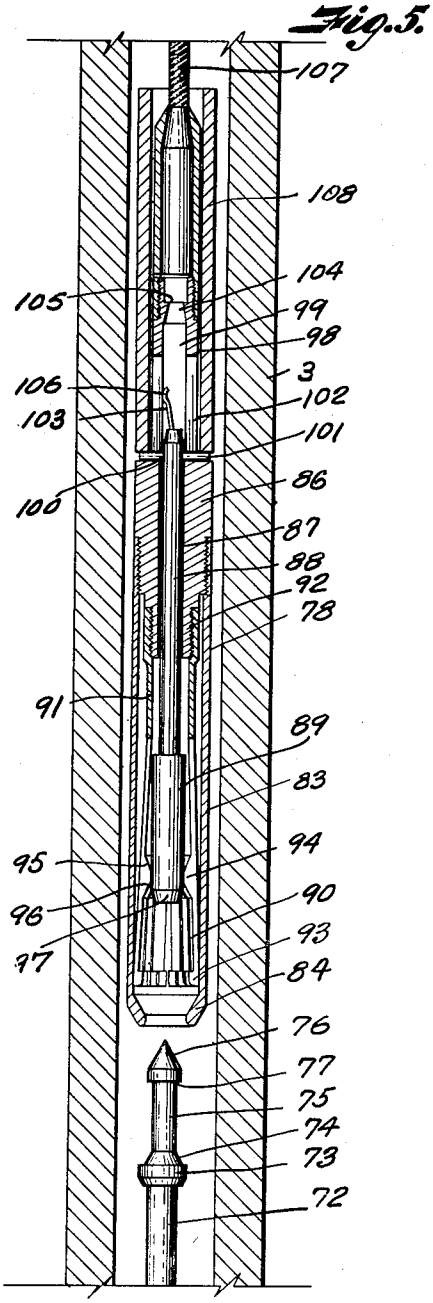


Fig. 5.



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Filed March 31, 1951 4 Sheets-Sheet 4

Fig. 6.

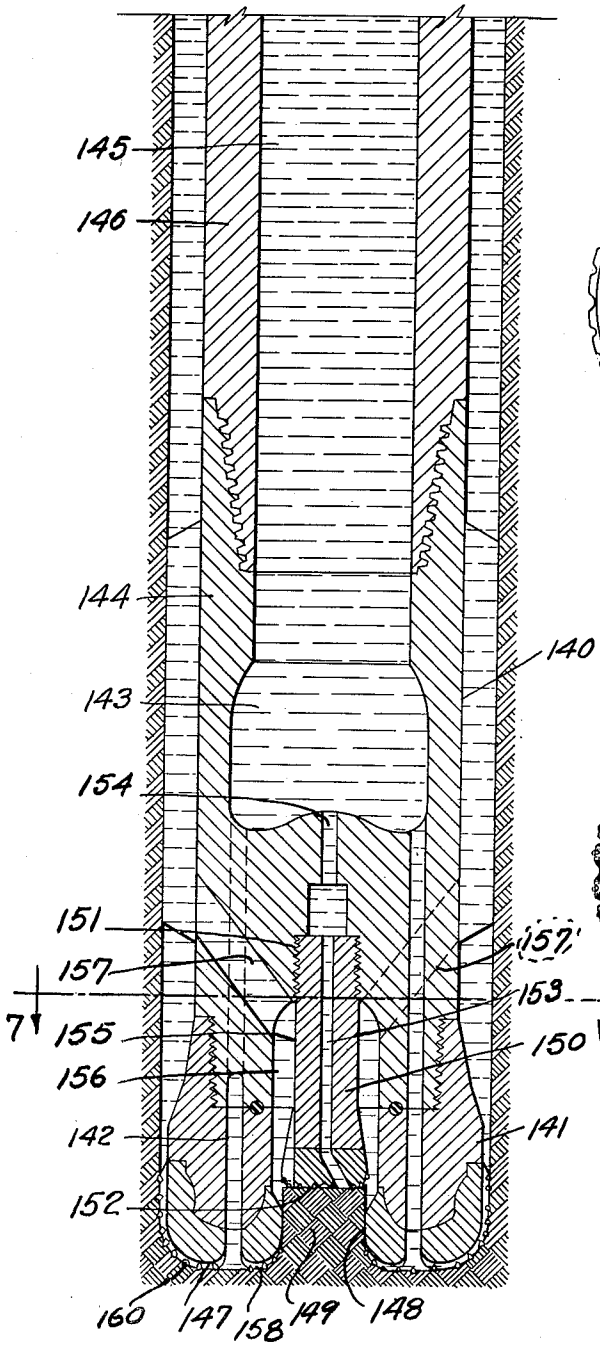


Fig. 7.

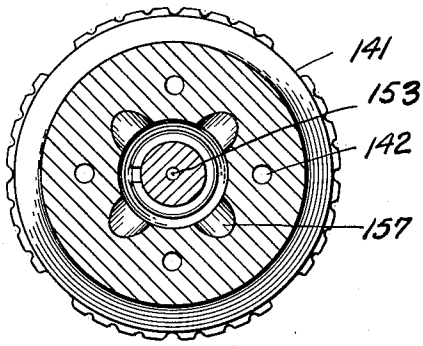
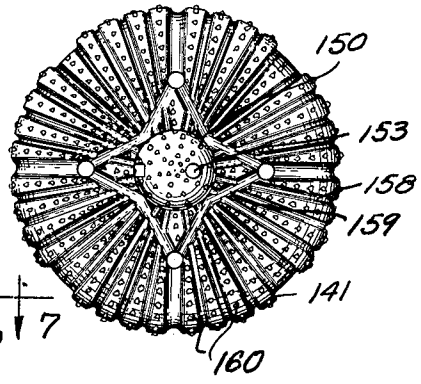


Fig. 8.



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United States Patent Office 2,708,103 Patented May 10, 1955

2,708,103

COMBINATION DRILL AND CORE BIT

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Application March 31, 1951, Serial No. 218,644

7 Claims. (Cl. 255—72)

This invention relates to an apparatus for forming a borehole in an earth formation, and more particularly to a combination rotary drill and core bit, the principal object of the invention being to provide a drill bit with an annular drilling face encircling a removable drilling core section that has a drilling face located at a higher level than the annular drilling face to form a pilot or core progressively with formation of a borehole when the drill bit is in operation.

Further objects of the invention are to provide the bit with transverse passages extending across the annular drilling face and into the recess which receives the pilot or core for admitting a drilling fluid in cooling relation with the annular drilling face and for conducting cuttings from the drilling face to the axial recess and from the axial recess through radial ports in the body of the bit so that the cuttings are carried to the top of the borehole circumferentially of the drill pipe; to provide for removal and replacement of the core drilling element of the bit; to provide for removal of the core drilling element by way of the drill pipe while the bit is within the borehole; to provide for insertion of a core barrel by way of the drill pipe to take a core; to provide for removal of the core through the drill pipe; to provide a simple and positive latch mechanism for retaining the axial drilling core element and core barrel in position within the body of the drill bit; to provide a simple means for releasing the core drilling element of the bit or core barrel when they are to be removed and replaced one by the other; and to provide the core barrel with a lubricated swivel having the pressure of the drilling fluid acting thereon for preventing loss of lubricant and dilution by the drilling fluid.

In accomplishing these and other objects of the invention, I have provided improved structure, the preferred forms of which are illustrated in the accompanying drawings, wherein:

Figs. 1 and 1A are vertical sections through the upper and lower portions of a combination drill and core bit having a construction in accordance with the present invention, the drill bit being shown in connection with a string of drill pipe and in the bottom of a borehole formed thereby, the retaining latch being released and showing the latch operating device in retracted position.

Figs. 2 and 2A are similar sections but showing the core barrel in place within the drill bit and connected thereto by the latching mechanism.

Fig. 3 is a horizonal section through the body of the drill bit on the line 3—3 of Fig. 2, showing the latch members in engaged position.

Fig. 4 is a section showing the wire line tool engaged with the overshot spear of the core drilling element by which the core drilling element is lowered through the drill pipe into position within the body of the drill bit or is removed therefrom.

Fig. 5 is a similar section showing the wire line device released from engagement with the overshot spear.

Fig. 6 is a vertical section through a modified form of drill bit.

Fig. 7 is a cross-section through the modified form of drill bit on the line 7—7 of Fig. 6.

Fig. 8 is an end view of the drilling face of the bit illustrated in Fig. 6.

Referring more in detail to the drawings:

1 designates a drill bit constructed in accordance with the present invention and which includes an outer barrel 2 substantially conforming in diameter with a drill pipe 3 on which the drill bit is mounted. The barrel 2 has a threaded lower end 4 that is connected with an internally threaded box 5 of a coupling 6, also preferably conforming to the outer diameter of the barrel 2. The lower end of the bit coupling is provided with a threaded pin 7 engaged in a threaded socket 8 of a bit head 9. The upper end of the barrel 2 has a threaded pin end 10 threadedly connected with the box end 11 of a lock coupling 12, which is connected at its upper end by a threaded pin 13 with the internally threaded box 14 of a safety joint 15 having threads 16 connected with internal threads 17 of a coupling 18, the threads 16 being of opposite hand to the threads of the drill pipe so that the roation of the drill pipe may be used to effect uncoupling of the drill pipe from the drill bit should the drill bit become lodged in the borehole.

The coupling 18 is provided with a box end 19 that connects with the pin 20 of the lowermost tool joint of the drill pipe 3. The bit head 9 includes an annular drilling face 21 encircling an axial core receiving bore or recess 22 that is formed within the bit head and which connects with a counterbore 23 through a flaring portion 24. The counterbore 23 forms an annular flow passageway about a core drilling section 25 of the bit and which is carried coaxially of the outer shell from a tapered seat 26 provided on the upper end of an inner barrel 27, as later described. The drilling face 21 has water courses extending thereacross into the bore 22. The drilling face is provided between the water courses with diamonds 28.

The coupling 6 has an axial passageway 29 forming an upward continuation of the counterbore 23. A leak-tight seal is provided between the lower end of the inner barrel and the coupling 6 by means of an O-ring 30 seated in grooves 31 as shown in Fig. 1A. The upper end of the inner barrel carries a collar 32, having an axial opening 33 for passing a core tube 34, the core tube also being formed of a string of pipe suitably connected together by pin and box joints 35 and 36. The opening 33 is encircled by the seat 26 and tapers to the inner diameter of the inner barrel. Mounted on the upper end of the tube 34 is a head 39 having a tapered shoulder 40 engaging the seat and carrying an O-ring 41 to form a fluid-tight joint therewith, as best shown in Fig. 1. The inner barrel is of smaller outer diameter than the inner diameter of the outer barrel to form an annular downflow passageway 42 between the inner and outer barrels to connect with a circular series of ports 43 that are provided within the collar 6, and which connect with corresponding ports or passageways 44 in the bit head, as best shown in Fig. 1A.

The core drilling bit element 25 is supported in spaced relation with the annular drilling face 21 and has an end drilling face 45 to drill out the pilot or core 46 that is formed at the bottom of the borehole within the core opening 22 of the bit head. The outer diameter of the core tube is of smaller diameter than the inner diameter of the inner barrel to provide an annular passageway 47 therebetween and the core tube is retained in concentric relation with the inner barrel by guides 48, as best shown in Fig. 1A. The inner barrel is similarly retained in coaxial alignment with the outer barrel by vertical ribs 49. The core tube thus forms a passageway 50 for sup-

plying drilling fluid to the drilling face of the core drilling section through a port **51** that extends through the body of the core drilling section and which discharges adjacent the periphery of the drilling face thereof. The drilling fluid passes outwardly under the drilling face **45** and into the outlet passage **23** where it joins with the flow of drilling fluid from the annular drilling face and passes through lateral ports **52** that are provided within the wall of the collar **6**, as shown in Fig. 1A.

The bit section **25** is removably connected with the core tube by a threaded connection **53**. A leak-tight seal is provided between the inner barrel **27** and the coupling by an O-ring **54** as shown in Figs. 1A and 2A. In order that the core tube and core drilling element **25** carried thereby may be lowered through the drill pipe into the drill bit and removed therefrom through the drill pipe, the head **39** has an internally threaded socket **55** for engaging the threaded end **56** of a latch and spear housing **57** which extends through a guide opening **58** within an internal collar **59** that is formed on the inner side of the coupling **12** and which has a tapering upper face **60** to guide the core drilling element of the bit through the opening **58** for seating the head **39** on the seat **26**.

The latch spear housing has an outer diameter to pass freely through the opening **58** and an inner diameter to accommodate inward swinging movement of latch dogs or detents **61**, the detents **61** being pivotally mounted within slots **62** that are formed in the wall of the housing, as shown in Fig. 1. The detents are supported on pins **63** that extend transversely of the slots. The detents depend within the slots and have wedge-shaped portions or lugs **64** that extend laterally therefrom and which are adapted to engage in wedge-shaped grooves **65** that are provided within the internal flange **59**, so that the core tube is anchored in position within the drill bit. The detents are normally retained in retracted position by leaf springs **66** that are carried by the lower ends of the detents and engage the opposite diametric sides of the latch and spear housing **56**. The springs retain the detents with the lower ends thereof in abutting relation so that when the core tube and core drilling bit element carried thereby is lowered through the drill pipe the wedge-shaped lugs **64** are retained within the confines of the housing **56**. The detents are adapted to be moved into engagement with the wedge-shaped recesses **65** by means of a spear **67** that is slidably mounted within an axial opening **68** in an upward part of the latch spear housing, the spear being provided with a collar **69** that is reciprocably mounted within a bore **70** of the housing extension.

The spear extends upwardly through the opening **68** and carries a head **71**. The head **71** includes an upward stem **72** having a collar **73** that is provided with a bevelled upper face **74** encircling an upward continuation **75** of the stem and which terminates in a cone-shaped terminal **76** forming an annular shoulder **77** that is adapted to be gripped by a running-in tool **78**, later described.

The spear **67** is retained in retracted position by a ball latch **79** that is mounted in a transverse bore **80** in the collar **69**, previously described, the ball being urged into engagement with a recess **81** of the spear housing by means of a coil spring **82** having one end seated in the bottom of the transverse bore **80** and to the end bearing against the ball **79**.

The tool **78** includes a sleeve-like body **83** having a swedged lower end **84** encircling an opening **85** of sufficient diameter to pass over the terminal **76** but which is adapted to engage the collar **73**. The upper end of the sleeve **83** carries a head **86** provided with an axial bore **87**. Slidably mounted in the bore **87** is a rod **88** carrying a cylindrical plunger **89** on the lower end thereof and which is adapted to spread a plurality of gripping fingers **90** that are carried from a sleeve **91** threaded on a reduced neck **92** of the head **86**. The fingers **90** are adapted to encircle the cone terminal **76** and have hook-shaped ends **93** that are adapted to engage under the shoulder **77** thereof as best shown in Fig. 4. The fingers have cam portions **94** that extend inwardly thereof and which have upper and lower tapering portions **95** and **96** adapted to be engaged by a bevelled end **97** of the plunger **89** and the cone-shaped terminal **76** respectively.

Carried by the upper end of the head **82** is a rope socket **98** having an axial bore **99** receiving the upper end of the rod **88**. The rod **88** carries a pin **100** that extends transversely through the terminal end thereof and has laterally projecting ends **101** guidingly mounted in slots **102** that are provided in opposite sides of the rope socket. Carried on the upper end of the rod **88** is a detent in the form of a spring leaf **103** that extends through a constriction **104** in the bore **99** to form a shoulder **105** to be engaged by a hook **106** on the end of the detent **103** for holding the plunger in retracted position, as shown in Fig. 4. Connected with the socket **98** is a cable **107** by which the mechanism is lowered into or removed from the drill pipe. The detent **103** is adapted to be released from the shoulder **105** by means of a sleeve-like jar that is dropped over the wire-line **107** to drive against the projecting ends **101** of the transverse pin **100** as shown in Fig. 5.

In Figs. 2 and 2A the core tube is removed and substituted by a core barrel **110** that is adapted to be lowered through the drill pipe and supported in position within the drill bit to receive the core **111** as shown in Fig. 2A. The barrel **110** conforms to the outer diameter of the core tube previously described, but has a substantially thinner wall to permit free entrance of the core therein. The lower end of the tube is provided with a core catcher **112** which is of conventional type so as to support the core within the barrel when the barrel is to be withdrawn as later described. The barrel **110** is carried from a head **113** corresponding with the head **39** previously described. The head **113** is connected with the latch spear housing previously described and carries a swivel **114**. The swivel includes a member **115** that is threaded in the upper end of the core barrel, as indicated at **116**, and has inwardly stepped shoulders **117** and **118** to form annular shoulders corresponding with similar shoulders **119** and **120** within a swivel member **121** that is threadedly connected with the head **113**, as indicated at **122**. Supported between the respective shoulders **118** and **120** is an antifriction bearing **123**. The member **115** has an extension **124** that extends upwardly through the member **121** and is journalled within a thrust bearing **125** that is carried within a cylindrical bore **126** that is formed within the head **113**, a collar **127** being threaded on the upper end of the extension **124** to engage the thrust bearing **125** and support the core barrel in proper position with respect to the drill bit. Suitable rubber washers **128** may be inserted between the bearings to maintain the desired fit.

The members **115** and **121** of the swivel are provided with oil seals **129** that are retained between the shoulders **117** and **119** to retain a lubricant indicated at **130**. The lubricant **130** is admitted through a pressure fitting **131** into an axial bore **132** of the member **115** which connects at its lower end with a pressure cylinder **133** in which is mounted a piston **134** to apply pressure on the body of lubricant responsive to pressure of the drilling fluid, the drilling fluid acting through a lateral port **135** against the bottom side of the piston. The lower end of the cylinder is closed by a suitable plug **136** after the piston has been inserted. The lubricant channel extends upwardly and discharges into the recess **126** from where the lubricant flows downwardly to lubricate the respective bearings.

The form of the invention shown in Fig. 6 includes a drill bit **140** that has a diamond head **141** similar to the head **9** previously described, which has a circular series of vertical ports **142** that connect with a chamber **143** in the bit coupling **144**, the chamber **143** being con-

nected with the passageway **145** through the drill pipe **146**. The bit head has an annular drilling face **147** encircling a bore or recess **148** to receive a core or pilot **149** when the bit is in use. In this form of the invention the core or pilot is drilled away by a core bit element **150** that is threaded within a socket **151** of the bit coupling **144**. The bit element **150** has a drilling face **152** substantially conforming to the drilling face of the core drilling element previously described and is provided with a water course **153** that connects with the chamber **143** through a port **154**. The shank **155** of the core drilling element of the bit is encircled by a passageway **156** from which the drilling fluid and cuttings are discharged through upwardly and outwardly directed ports **157** similar to the corresponding ports of the bit previously described. The drilling face **147** may be provided with radial water courses **158** that connect with the outlet of the ports **142** through connecting channels **159** which also connect with the recess **148**, as best shown in Fig. 8. The core drilling element, as well as the face portion of the annular drilling face are provided with diamonds or other abrading elements **160**. The abrading elements may extend upwardly around the marginal portion of the bit head to provide the desired clearance for a portion of the drilling fluid to wash upwardly together around the head of the bit while the major portion flows inwardly and then outwardly through the ports **157**. In this form of the bit the entire drilling string must be removed to effect removal and replacement of the core drilling section of the bit.

In using the apparatus for drilling a borehole, it is assembled as described and connected with the lower joint of drill pipe as shown in Figs. 1–1A. However, the spear **67** is engaged between the latches **61** so that the lugs **64** are held in engagement with the recesses **65** to provide a driving connection between the drill pipe and the inner core tube which carries the core drilling element **25**. As the drill is rotated, a hydraulic fluid is pumped under pressure, as in conventional practice, through the drill pipe, through the ports **109** and down the outer passageways **42** and **43** for discharge through the ports **44** of the drill bit. As the drill is rotated the abrassive elements **28** cut the surface of the formation and the drilling fluid, being discharged through the transverse passageways, carries the cuttings across the face of the bit to the core recess **22**. A part of the drilling fluid, however, flows outwardly across the drilling face and up the space between the wall and the borehole and the outer core barrel. The drilling fluid passing into the recess **22** flows upwardly in the passageway **29** and is discharged through the radial ports **52**, where it unites with the upflow of drilling fluid and is discharged from the top of the borehole, carrying the cuttings therewith. The fluid thus flows transversely across the annular drilling surface of the bit to keep the bit and particularly the central portion thereof in cool condition and to remove the cuttings made by the abrasive elements. Simultaneously drilling fluid is discharged under pressure through the bore **50** of the core tube to pass through the port **51** and cool the face **45** of the core drilling element **25**, which drills up the core **46** progressively with deepening of the borehole by the annular drilling face **21** of the bit.

When it is desired to take a core, the core drilling element **25** and its supporting tube are removed through the interior of the drill pipe. This is effected by lowering the tool **78** on the cable or wire line **107**, as shown in Fig. 4, downwardly through the drill pipe so that the sleeve or housing **83** thereof passes over the cone end **76** of the stem **72** to cause the latches **93** to engage the shoulder **77** of the cone. The core tube is then connected with the cable **107** and by withdrawing the cable the spear is disengaged from the latches so that their springs may retract them to release the core tube. The spear is then retained in retractive position by engagement of the ball latch **79**. At the same time the collar engages the internal shoulder below the opening **68** and further withdrawal lifts the core drilling tube with the core drilling element from the borehole.

The spear and latch housing carrying the spear and latch assembly is then disengaged from the head of the core tube and screwed onto the head of the core barrel by effecting engagement of the threads **55**. The spear is latched in retracted position so that the collar **69** engages the internal shoulder surrounding the opening **68**. The unit is then lowered through the drill pipe until the core barrel head **113** engages the seat **26** on the upper end of the inner barrel **27**. The core barrel is then suspended within the inner barrel and in position to receive the core **46** therein. The lowering-in tool is then disconnected from the spear and latch housing by dropping the sleeve **108** downwardly over the lowering-in cable or wire **107** to cause the sleeve to engage the projecting ends of the pin **101** and move the plunger **89** downwardly so that the coned end **97** thereof engages the cams **94** for spreading the latches **93** and freeing them from engagement with the shoulder **77**. The cable including the lowering-in tool is then free to be removed through the core barrel. The spear then drops under its own weight to cause the latches **61** to reengage their clutch engagement with the clutch coupling **12** to anchor the core barrel. The drilling operation may then proceed with the core passing into the core barrel.

When it is desired to remove the core, the lowering-in tool is again passed through the drill pipe until the latches **93** of the lowering-in tool reengage the shoulder **77**. After engagement the cable is withdrawn from the well. The initial movement raises the spear so that the springs **66** are effective in retracting the lugs **64** to release the latch connection, whereupon the entire core barrel containing the core is removed through the drill pipe. If further core is to be taken, the core barrel may be returned as previously described. However, if the drilling is to be continued without taking a core, the core tube and core drilling element are attached to the lowering-in tool and inserted through the drill pipe, as previously described.

When the core barrel is in use the pressure of the drilling fluid in the upflow passageway **29** acts through the port **135** against the lower end of the piston **134** to apply pressure on the body of lubricant and prevent infiltration of drilling fluid into the lubricant chamber.

From the foregoing it is obvious that I have provided a combination rotary drill and core bit wherein the bit is provided with ample drilling fluid to wash the cuttings from the face of the drill bit to keep the drill bit and particularly the central portion thereof in cool condition. It is also obvious that the direction of flow of drilling fluid assures positive removal of the cuttings from the central portion of the bit and about the drilling face of the core drilling element.

The drilling operation of the form of the invention shown in Fig. 6 conforms with the structure illustrated in Fig. 1–A, however, when the core drilling element **150** is to be removed it is necessary to withdraw the entire drilling string. It is obvious that the passage of drilling fluid is the same as in the first described form of drill bit.

What I claim and desire to secure by Letters Patent is:

1. In an apparatus for forming a borehole in an earth formation, a rotary member having an end provided with an annular drilling face encircling an axial core receiving recess and having longitudinal drilling fluid supply ports opening through the annular drilling face intermediate the inner and outer circumferences of said drilling face, said drilling face having passages extending thereacross from said ports inwardly to the core receiving recess and from said ports outwardly to the circumference of the rotary member for discharging the drilling fluid in cooling relation with the drilling face and for conducting cuttings

under the drilling face to said recess and borehole respectively, and said rotary member having an upward continuation of the core receiving recess to provide a passage for drilling fluid and having an outlet connected with the recess and opening through the circumference of the rotary member for creating flow of the drilling fluid and cuttings inwardly across the drilling face into the core receiving recess and through the outlet for upward flow through the borehole along with the drilling fluid and cuttings discharged circumferentially of the drilling face, and a core drill in said rotary member and having a drilling face to drill out the core, said core drill having a drilling fluid supply port opening through the drilling face thereof for discharging drilling fluid for washing core cuttings outwardly across said drilling face and directly into the core receiving recess.

2. In an apparatus for forming a borehole in an earth formation, a rotary member having an end provided with an annular drilling face encircling an axial core receiving recess and having longitudinal drilling fluid supply ports opening through the annular drilling face intermediate the inner and outer circumferences of said drilling face, said drilling face having passages extending thereacross from said ports inwardly to the core receiving recess and from said ports outwardly to the circumference of the rotary member for discharging the drilling fluid in cooling relation with the drilling face and for conducting cuttings under the drilling face to said recess and borehole respectively, said rotary member having an upward continuation of the core receiving recess to provide a passage for drilling fluid and having an outlet connected with the recess and opening through the circumference of the rotary member for creating flow of a portion of the drilling fluid and cuttings inwardly across the drilling face into the core receiving recess for discharge through said outlet for upward flow through the borehole along with the drilling fluid and cuttings discharged outwardly and circumferentially of the drilling face, and a core drill in said upward continuation of the core receiving recess and having a drilling face inset upwardly from the annular drilling face for drilling out the core progressively with its formation, said core drill having a drilling fluid supply port opening through said drilling face of the port of said core drill for discharging drilling fluid to wash the core cuttings from said drilling face into said passage and for discharge through said outlet.

3. In an apparatus for forming a borehole in an earth formation, a substantially cylindrical rotary member having an end provided with an annular drilling face encircling an axial core receiving bore and having drilling fluid supply ports extending longitudinally through said member and discharging through the annular drilling face intermediate inner and outer circumferences thereof, said drilling face having passages extending thereacross from said ports inwardly to said bore and from said ports outwardly to the circumference of the rotary member for discharging the drilling fluid in cooling relation with the drilling face and for conducting cuttings from the drilling face to said axial bore and borehole respectively, a core member within the axial bore and of smaller diameter than the axial bore to provide an annular upward passage therearound for conducting the drilling fluid and cuttings discharged into said bore, said rotary member having an outlet opening extending from the annular upflow passage and discharging through the circumference of the rotary member, and means in the rotary member for removably retaining the core member within said bore.

4. In an apparatus for forming a borehole in an earth formation, a substantially cylindrical rotary member having an end provided with an annular drilling face encircling an axial core receiving bore and having drilling fluid supply ports extending longitudinally of the rotary member and discharging through the annular drilling face intermediate inner and outer circumferences of said drilling face, said drilling face having passages extending thereacross from said ports inwardly to said bore and from said ports outwardly to the circumference of the rotary member for discharging the drilling fluid in cooling relation with the drilling face and for conducting cuttings from the drilling face to said axial bore and borehole respectively, a core member within the axial bore and of smaller diameter than the axial bore to provide an annular upflow passage therearound for conducting the drilling fluid and cuttings discharged into said bore through said inward passages, said rotary member having an outlet opening in connection with the annular upflow passage and discharging through the circumference of said rotary member for conducting inward flow of drilling fluid and cuttings from said inward passages for upflow exteriorly of the rotary member, and means in the rotary member for removably retaining the core member within said bore with one end spaced inwardly from the annular drilling face to form a core receiving recess, said end being provided with a drilling face for drilling off the core progressively with the drilling effected by the annular drilling face when the apparatus is in use within a borehole.

5. In an apparatus for forming a borehole in an earth formation, a substantially cylindrical rotary member having an end provided with a circular drilling face encircling an axial core receiving bore and having drilling fluid supply ports extending longitiudinally of said rotary member and discharging through the circular drilling face intermediate inner and outer circumferences thereof, said drilling face having passages extending thereacross from said ports inwardly to said bore and from said ports outwardly to the circumference of the rotary member for discharging the drilling fluid both inwardly and outwardly from said ports in cooling relation with the drilling face and for conducting cuttings from said inward passages to said axial bore and through the outer passages to the borehole, a core member within the axial bore and of smaller diameter than the axial bore to provide an annular upflow passage therearound for conducting the drilling fluid and cuttings upwardly of said bore, said rotary member having an outlet opening extending from the upper end of the annular upflow passage and discharging through the circumference of the rotary member, said rotary member having a seat therein, means on the core member engaging said seat, and a latch carried by one of the members and engaging the other for removably retaining the core member on said seat within said bore with one end spaced inwardly from the annular drilling face to form a core receiving recess, said end being provided with a drilling face for driling off the core progressively with the drilling effected by the annular drilling face when the apparatus is in use within a borehole.

6. In an apparatus for forming a borehole in an earth formation, a substantially cylindrical rotary member including an outer barrel, a bit carried by the outer barrel and having a circular drilling face encircling an axial core receiving bore in said bit and having drilling fluid supply ports extending longitudinally of the bit and discharging through the circular drilling face intermediate inner and outer circumferences thereof, said drilling face having passages extending thereacross from said ports inwardly to said bore and from said ports outwardly to the circumference of the rotary member for discharging the drilling fluid in cooling relation with the drilling face and for conducting cuttings from the drilling face to said axial bore and borehole respectively, an inner barrel in the outer barrel and forming therewith a downflow passage connected with said longitudinal ports, a core member within the inner barrel and extending into said axial bore and of smaller diameter than the axial bore to provide an annular upflow passage therearound for conducting the drilling fluid and cuttings discharged into said bore, said rotary member having an outlet opening ex-

tending from the annular upflow passage and discharging through the circumference of said rotary member, and means in the rotary member for removably retaining the core member within said bore with one end spaced inwardly from the annular drilling face to form a core receiving recess, said end being provided with a drilling face for drilling off the core progressively with the drilling effected by the annular drilling face when the apparatus is in use within a borehole.

7. In an apparatus for forming a borehole in an earth formation, a substantially cylindrical rotary member including an outer barrel, a bit carried by the outer barrel and having a circular drilling face encircling an axial core receiving bore in said bit and having drilling fluid supply ports extending longitudinally through the circular drilling face intermediate outer and inner circumferences thereof, said drilling face having passages extending thereacross from said ports inwardly to said bore and from said ports outwardly to the circumference of the rotary member for discharging the drilling fluid in cooling relation with the drilling face and for conducting cuttings from the drilling face to said axial bore and borehole respectively, an inner barrel in the outer barrel and forming therewith a downflow passageway and connected

with said longitudinal ports for the supply of drilling fluid, a core member within the inner barrel and extending into said axial bore and of smaller diameter than the axial bore to provide an annular upflow passageway therearound for conducting the drilling fluid and cuttings discharged into said bore, said rotary member having an outlet opening extending from the annular upflow passage and discharging through the circumference of said rotary member, said inner barrel having a head provided with a seat for the core member, and latch means in the core member engageable with a part of the rotary member to retain the core member in engagement with said seat to support the core member and to separate the up and downflow passageways.

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