May 9, 1933. W. L. FOSTER 1,908,594

UNDERREAMER

Filed July 10, 1929

Fig. 1

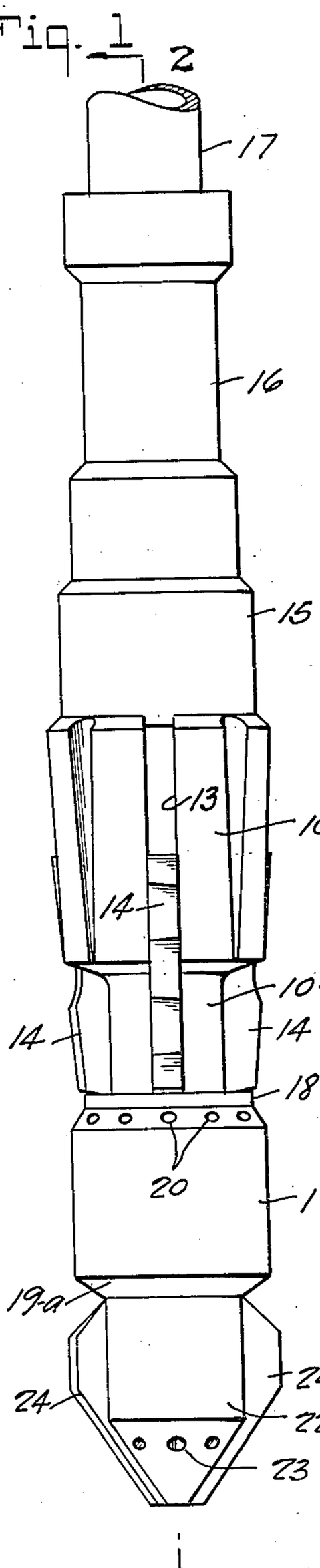


Fig. 2

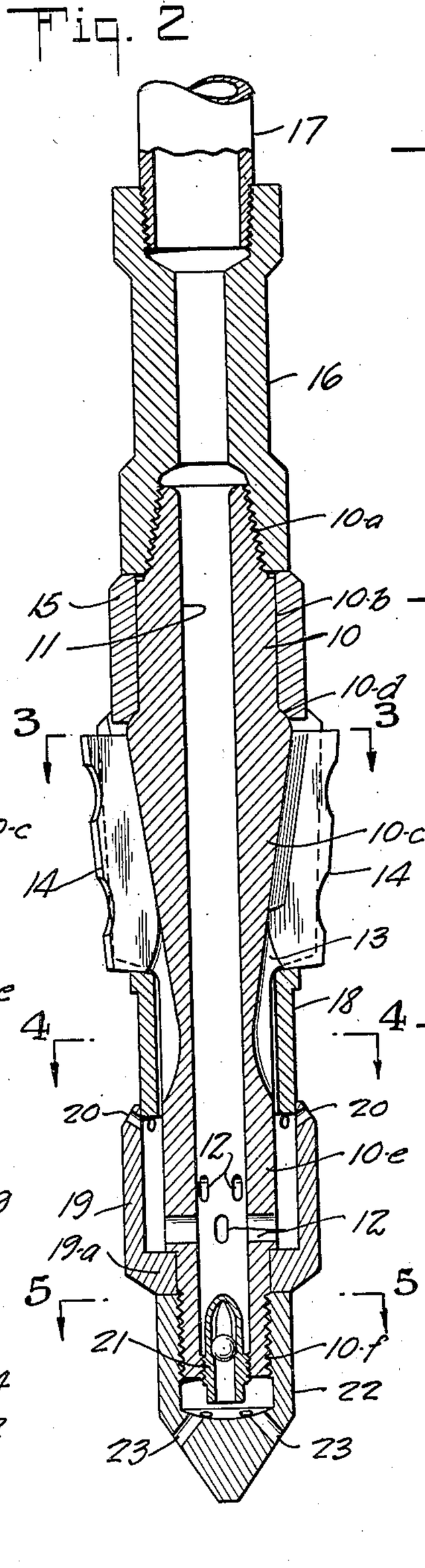


Fig. 3

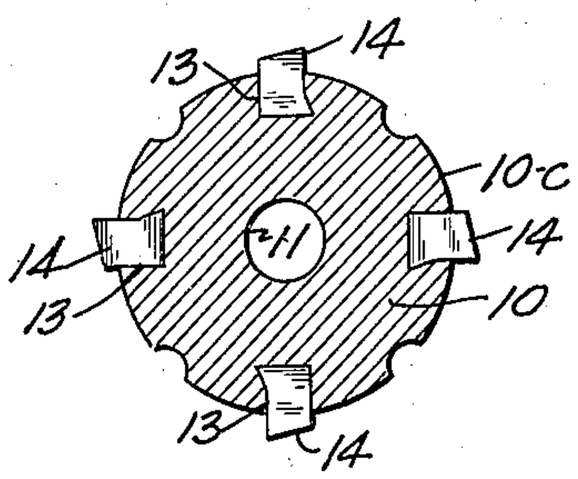


Fig. 4

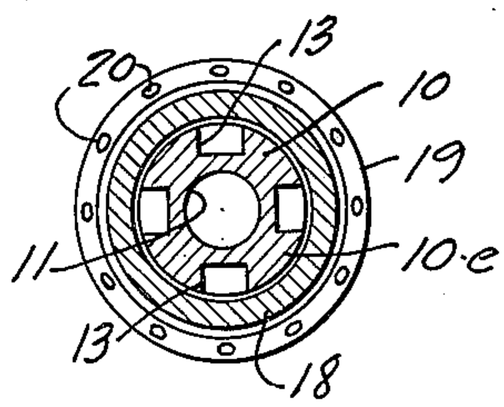
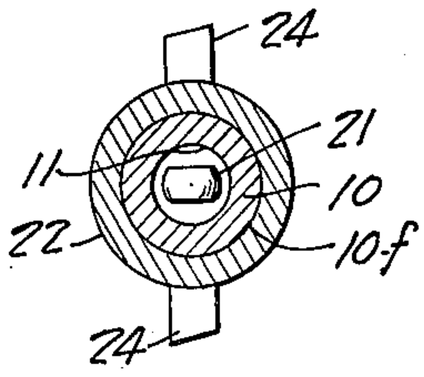


Fig. 5



INVENTOR
Walter L. Foster

BY Westall and Wallace
ATTORNEYS

Patented May 9, 1933 1,908,594

UNITED STATES PATENT OFFICE

WALTER L. FOSTER, OF WHITTIER, CALIFORNIA, ASSIGNOR TO JOHN GRANT, OF LOS ANGELES, CALIFORNIA

UNDERREAMER

Application filed July 10, 1929. Serial No. 377,117.

This invention relates to collapsible underreamers and pertains more especially to a collapsible underreamer having hydraulic means to expand the cutters.

The objects of this invention are to provide an underreamer of the character described having any or all of the following features:—novel hydraulic motor means for expanding the cutters; hydraulic motor means in which the circulation and wash liquid for the cutters is controlled by the hydraulic motor means; means to admit fluid to the drill pipe string during lowering of the underreamer; and structure whereby a compact, sturdy, strong underreamer construction is obtained.

These objects together with other objects and corresponding accomplishments are obtained by means of the embodiment of my invention illustrated in the accompanying drawing, in which:—

Fig. 1 is a side elevation of a complete underreamer with the cutters collapsed, a fragment of the drill string being shown; Fig. 2 is a section as seen on the line 2—2 of Fig. 1, the cutters being shown in elevation in expanded position; and Figs. 3, 4 and 5 are sections as seen on the lines correspondingly numbered in Fig. 2.

Referring with more particularity to the drawing, the underreamer comprises a mandrel body 10 having a threaded pin 10*a* at its upper end, and enlarged cylindrical portion 10*b* below the pin meeting a tapered portion 10*c*. A shoulder 10*d* is formed at the juncture of the cylindrical portion and the tapered portion of the mandrel. At the lower end is a reduced cylindrical portion 10*e* and a further reduced portion 10*f* which is threaded. Extending lengthwise through the mandrel is a circulation passage 11 threaded at its extreme lower end to receive a valve cage. In the wall of the mandrel at the reduced portion 10*e* are wash water passages 12. In the tapered portion 10*c* are grooves 13 which are undercut to receive blade cutters and form cutter ways. There are four of these ways shown to accommodate four blades, although more or less blades may be used. The cutter blades are marked 14 and may be inserted in position from the shoulder end of the mandrel. Resting upon the shoulder 10*d* is a retaining ring 15 which is a slip-on fit. This ring retains the cutters against displacement. The ring is locked in position by a tubular extension 16 which is mounted upon the pin 10*a* of the mandrel and has a bore forming an extension of the circulation passage. A fragment of the drill pipe string is marked 17.

Slidably mounted over the cylindrical lower end 10*e* of the mandrel is a ring piston 18 of such length as to be reciprocable in a displacement chamber formed by a tubular shell 19. Clearance is provided between the bore of piston 18 and the stem 10*e*.

The shell 19 has its inner wall spaced from the cylindrical portion 10*e* so as to form an annular displacement chamber for the piston 18 to operate in. The shell has an inturned portion 19*a* forming a lower head for the displacement chamber and adjacent its upper end are wash ports 20 designed to direct wash water upwardly and clean the cutter blades. The cutter blades rest against the upper end of the piston so that when the blades are in expanded position and the piston resting thereagainst, the lower end of the piston will be clear of the wash ports 20. Mounted in the lower end of the circulation passage is a valve cage 21 having a valve therein arranged to prevent outflow of circulation fluid. A pilot bit cap 22 is threaded upon the lower end of the mandrel, and holds the shell 19 in position. A chamber is formed in the cap and ducts 23 connect the chamber with the exterior of the bit. Pilot blades 24 complete the pilot bit cap. The shell and piston constitute a motor for urging the blades 14 into expanded position and also act as a valve to control the wash water ports 20. The assemblage of the parts is obvious from an inspection of the drawing. In the operation of the underreamer, before circulation fluid is introduced into the circulation line to the underreamer, the piston and blade tend to maintain themselves in collapsed position by gravity. The underreamer is lowered in the well hole, and fluid in the hole, may enter the ports 23 and pass upwardly

into the circulation passage and from thence into the drill pipe string, thereby preventing collapse of the drill pipe string. When the underreamer has been positioned where it is desired to cut, circulation is started. This causes the closure of the valve in cage 21, and the circulation fluid passes into the displacement chamber below the piston. The pressure causes elevation of the piston and expansion of the blades 14. When the blades have reached their fully expanded position, the lower end of the piston clears the wash ports 20, and wash water may pass upwardly. When it is desired to collapse the bit, circulation is stopped and the blades and pistons will drop by gravitative action. However, should the blades stick in expanded position, elevation of the underreamer causing the blades to abut the bottom of the casing shoe ordinarily used in oil well, will cause the blades to be moved downwardly. The clearance between piston 18 and the stem previously mentioned will permit the fluid in the drill pipe to drain out when the piston is down and cutters are collapsed, obviating the difficulty of pulling a wet string.

What I claim is:—

1. A collapsible underreamer comprising a mandrel having a sloping cutter engaging surface, cutters slidably mounted for longitudinal movement on said mandrel to expanded and contracted positions, said mandrel having a shoulder at the upper ends of said cutters, a retaining ring mounted on said mandrel and supported on said shoulder, a lock member forming an extension of said mandrel threaded thereto and holding said retaining ring in position, a barrel shell on the lower end of said mandrel providing therewith an annular displacement chamber, water ports in said mandrel communicating with said chamber, and a ring piston reciprocably mounted in said chamber and over said mandrel engaged with said cutters to expand the latter and disposed so that its lower end clears and opens said ports when said piston is in cutter expanding position.

2. A collapsible underreamer comprising a mandrel having a sloping surface, a cutter slidably accommodated on said surface for longitudinal movement thereon to expanded and contracted positions, an annular displacement chamber about said mandrel, water passages in said mandrel communicating with said chamber adjacent the inner end of the latter, wash ports in the wall of said chamber adjacent its outer end, and a ring piston reciprocably mounted in said chamber and over said mandrel to urge said cutter to expanded position and disposed so that its lower end clears and opens said ports when said piston is in cutter expanding position.

3. A collapsible underreamer comprising a mandrel having cutter ways, cutters slidably accommodated in said ways for longitudinal movement on said mandrel to expanded and contracted positions, a displacement chamber about said mandrel, water passages in said mandrel communicating with said chamber adjacent the inner end of the latter, wash ports in the outer wall of said chamber adjacent its outer end, and a ring piston reciprocably mounted in said chamber and over said mandrel to urge said cutters to expanded position and disposed so that its lower end clears and opens said ports when said piston is in cutter expanding position.

4. A collapsible underreamer comprising a mandrel having sloping cutter ways, cutters slidably accommodated in said ways for longitudinal movement on said mandrel to expanded and contracted positions, a barrel shell on said mandrel providing therewith an annular displacement chamber, water passages in said mandrel communicating with said chamber adjacent the inner end of the latter, wash ports in said shell adjacent the outer end, and a ring actuator reciprocably mounted in said chamber and over said mandrel, engaged with said cutters to expand the latter and disposed so that its lower end clears and opens said ports when said actuator is in cutter expanding position.

5. A collapsible underreamer comprising a mandrel having sloping cutter grooves, cutters slidably mounted in said grooves by dove tail connections for longitudinal movement on said mandrel to expanded and contracted positions, a barrel shell on said mandrel below said cutters providing therewith an annular displacement chamber, water passages in said mandrel opening to said chamber adjacent the inner end of the latter, wash ports in said shell adjacent the outer end, and a ring actuator reciprocably mounted in said chamber and over said mandrel engaged with said cutters to expand the latter and disposed so that its lower end clears and opens said ports when said actuator is in cutter expanding position.

6. A collapsible underreamer comprising a mandrel having sloping cutter ways, cutters slidably mounted by dove tail connections in said ways for longitudinal movement on said mandrel to expanded and contracted positions, said mandrel having a shoulder at the upper ends of its ways, a retaining ring mounted on said mandrel and supported on said shoulder, a lock member forming an extension of said mandrel threaded thereto and holding said retaining ring in position, a detachable barrel shell on the lower end of said mandrel providing therewith an annular displacement chamber, water passages in said mandrel communicating with said chamber adjacent the inner end of the latter, wash ports in said shell adjacent its outer end, and a ring piston reciprocably mounted in said chamber and over said mandrel engaged with said cutters to expand the latter and disposed so that its lower end clears and opens said

ports when said piston is in cutter expanding position.

7. A collapsible underreamer comprising a mandrel having a sloping surface, a cutter slidably accommodated on said surface for longitudinal movement thereon to expanded and contracted positions, an annular displacement chamber about said mandrel, a circulation passage extending within said mandrel, a check to prevent outflow of water from said circulation passage, water passages in said mandrel connecting said chamber adjacent the inner end of the latter with said circulation passage, wash ports in the wall of said chamber adjacent its outer end, and a ring piston reciprocably mounted in said chamber and over said mandrel to urge said cutter to expanded position and disposed so that its lower end clears and opens said ports when said piston is in cutter expanding position.

8. A collapsible underreamer comprising a mandrel having cutter ways, cutters slidably accommodated in said ways for longitudinal movement on said mandrel to expanded and contracted positions, a displacement chamber about said mandrel, a circulation passage extending the length of said mandrel, a check to prevent outflow of water from the lower end of said circulation passage, water passages in said mandrel connecting said chamber adjacent the inner end of the latter, with said circulation passage, wash ports in the outer wall of said chamber adjacent its outer end, a ring piston reciprocably mounted in said chamber and over said mandrel to urge said cutters to expanded position and disposed so that its lower end clears and opens said ports when said piston is in cutter expanding position, and a pilot bit cap mounted over the end of said mandrel and check.

9. A collapsible underreamer comprising a mandrel having sloping cutter ways, cutters slidably accommodated in said ways for longitudinal movement on said mandrel to expanded and contracted positions, a barrel shell on said mandrel providing therewith an annular displacement chamber, a circulation passage extending the length of said mandrel, a check to prevent outflow of water from the lower end of said circulation passage, water passages in said mandrel connecting said chamber adjacent the inner end of the latter with said circulation passage, wash ports in said shell adjacent the outer end, a ring actuator reciprocably mounted in said chamber and over said mandrel engaged with said cutters to expand the latter and disposed so that its lower end clears and opens said ports when said actuator is in cutter expanding position, and a pilot bit cap mounted over the end of said mandrel and check.

10. A collapsible underreamer comprising a mandrel having sloping cutter grooves, cutters slidably mounted in said grooves by dove tail connections for longitudinal movement on said mandrel to expanded and contracted positions, a barrel shell on said mandrel below said cutters providing therewith an annular displacement chamber, a circulation passage extending the length of said mandrel, a check to prevent outflow of water from the lower end of said circulation passage, water passages in said mandrel opening to said chamber adjacent the inner end of the latter, and connected with said circulation passage, wash ports in said shell adjacent the outer end, a ring actuator reciprocably mounted in said chamber and over said mandrel engaged with said cutters to expand the latter and disposed so that its lower end clears and opens said ports when said actuator is in cutter expanding position, and a pilot bit cap mounted over the end of said mandrel and check.

11. A collapsible underreamer comprising a mandrel having sloping cutter ways, cutters slidably mounted by dove tail connections in said ways for longitudinal movement on said mandrel to expanded and contracted positions, said mandrel having a shoulder at the upper ends of its ways, a retaining ring mounted on said mandrel and supported on said shoulder, a lock member forming an extension of said mandrel threaded thereto and holding said retaining ring in position, a detachable barrel shell on the lower end of said mandrel providing therewith an annular displacement chamber, a circulation passage extending the length of said mandrel, a check to prevent outflow of water from the lower end of said circulation passage, water passages in said mandrel communicating with said chamber adjacent the inner end of the latter and with said circulation passage, wash ports in said shell adjacent its outer end, a ring piston reciprocally mounted in said chamber and over said mandrel engaged with said cutters to expand the latter and disposed so that its lower end clears and opens said ports when said actuator is in cutter expanding position, and a pilot bit cap threaded on said mandrel over said check.

In witness that I claim the foregoing I have hereunto subscribed my name this 29th day of June, 1929.

WALTER L. FOSTER.