

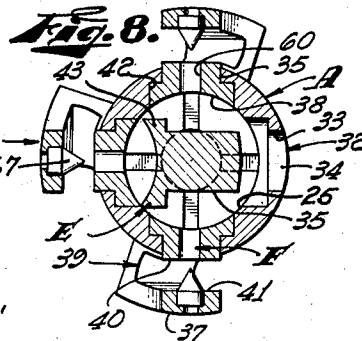
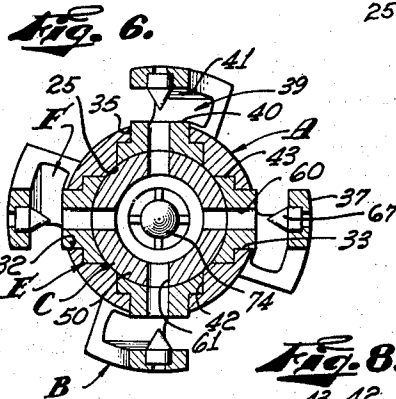
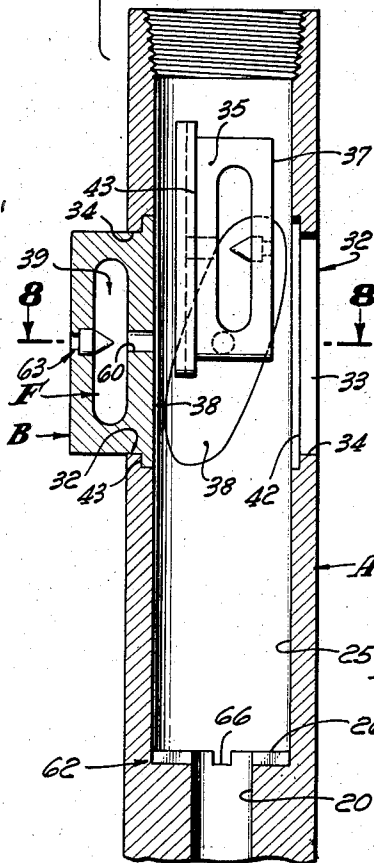
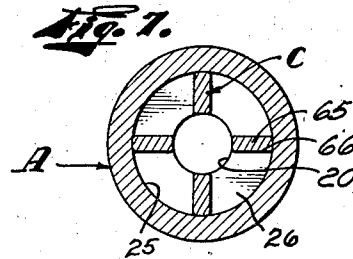
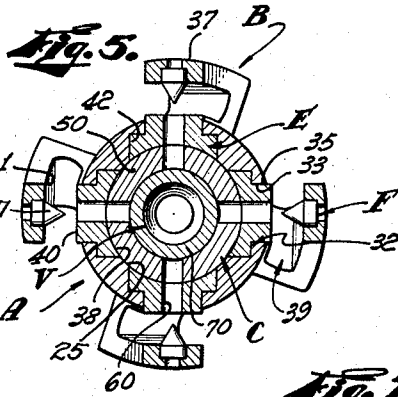
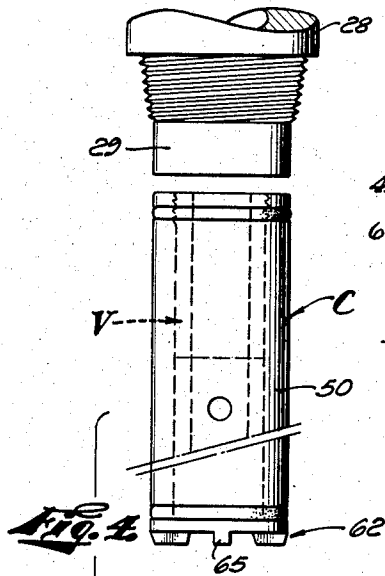
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C. J. CARR ET AL
SELF-CLEANING REAMER

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2 Sheets-Sheet 2



INVENTORS.
CHARLES J. CARR
ERWIN BURNS

BY

George C. Maxwell

AGENT.

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SELF-CLEANING REAMER

Charles J. Carr, Long Beach, and Erwin Burns,
Los Angeles, Calif.

Application October 14, 1957, Serial No. 689,932

12 Claims. (Cl. 255-73)

This invention has to do with a reamer for use in a well and is more particularly concerned with a reamer having removable cutters and valve controlled flushing means to clean the cutters thereof.

In many situations, while drilling a well, the bore of the well, due to the rock formation and due to the caking of circulating mud therein, is uneven and becomes undergaged to the extent that withdrawal of the bit at the lower end of the drilling string and/or lowering of the well casing therein, is impeded.

As a result of the above, it is common practice to provide one or more reaming tools in the drilling string above the bit, which tools serve to smooth the well bore out and to ream and bring the bore out to gauge.

Heretofore, reaming tools of the class herein referred to have been in the nature of subs engageable at the ends of the drill collars or at any other desired point along the drilling string to which they are related and are provided with rigid, radially outwardly projecting circumferentially spaced cutters. The cutters of the ordinary reamer are simple blade-like elements fixed to the exterior of the body of the tool as by welding, or the like, with the result that when the cutters become worn, the tool is either disposed of or must be taken to a shop and rebuilt, as by cutting off the worn cutters and fix new cutters in their place.

It also frequently happens that the cuttings made by the bit and the reamers and/or the circulating fluid or drilling mud, pack on and between the cutters of the ordinary reamer, rendering the cutters ineffective and cutting off circulation of fluid in the well with resulting freezing and packing of the drill string in the well.

The cutters of the ordinary tool of the class referred to above, are elongate, imperforate, blade-like members fixed to the body to project outwardly therefrom and substantially longitudinally of the drilling string. The cutters being imperforate and disposed as set forth above, act like paddles in the drilling mud in the annulus between the string and the well bore and make it necessary to apply considerable torque to the drill string to overcome the resistance of the cutters in the mud during the drilling operation.

This application is being filed as a continuation-in-part of the Charles J. Carr and Erwin Burns application for Letters Patent entitled "Self-Cleaning Collapsible Reamer," Serial No. 617,200, filed October 19, 1956.

It is an object of the present invention to provide a reaming tool of the general character referred to having a plurality of circumferentially spaced, radially outwardly projecting cutters, which cutters can be easily and conveniently replaced when they have become worn and without the necessity of cutting or otherwise reworking and rebuilding it.

Another object of our invention is to provide a reamer of the character referred to having blade-like cutters with elongate slot-like apertures extending therethrough, which apertures pass drilling mud as the reamer is rotated, there-

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by reducing the torque required to rotate the reamer in the mud.

Still another object of the present invention is to provide a reamer of the character referred to above, having ports in the cutters and communicating with the interior of the tool and adapted to direct circulating fluid into the apertures in the cutters and to flush and clean the cutters and the portions of the tool between the cutters.

A further object of the present invention is to provide a valve means within the body and adapted to control the flow of fluid through the ports.

Still another object of our invention is to provide fluid directing means in the apertures in the cutters and adapted to direct fluid issuing from the ports in the cutters throughout the apertures therein.

It is an object of this invention to provide a reamer of the character referred to having few parts, a reamer which is easy to service, and a reamer which is both easy and economical of manufacture and which is both highly effective and dependable in operation.

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

Fig. 1 is an elevational view of the reamer provided by the present invention and showing it engaged in a well structure.

Fig. 2 is a longitudinal transverse sectional view of the reamer shown in Fig. 1 and taken substantially as indicated by line 2-2 on Fig. 1.

Fig. 3 is a view similar to Fig. 2 and showing the reamer in another position.

Fig. 4 is an exploded view of the reamer construction that we provide.

Fig. 5 is a transverse sectional view of the reamer that we provide and taken as indicated by line 5-5 on Fig. 2.

Fig. 6 is a transverse sectional view similar to Fig. 5 and taken as indicated by line 6-6 on Fig. 3.

Fig. 7 is a transverse sectional view taken as indicated by line 7-7 on Fig. 2.

Fig. 8 is a transverse sectional view taken as indicated by line 8-8 on Fig. 4.

Fig. 9 is an enlarged detailed sectional view of a portion of one of the cutters.

Fig. 10 is a sectional view of a portion of the construction that we provide and showing another form of cutter engaged therein.

In Fig. 1 of the drawings, we have shown our new reamer construction engaged in a drilling string S extending into a well bore W. The string S is shown as extending through a suitable casing X in the well to extend below the lower terminal end thereof.

The drilling string S is shown as including an elongate drill collar 10 and a typical roller bit 13. The drill collar 10 is shown as having a central longitudinal flow passage 11 extending longitudinally therethrough, and as having a threaded socket 12 entering it from its lower end. The roller bit 13 is adapted to be related to the lower end of the drill collar 10 and includes a vertically disposed collar 14, cutters 15 rotatably carried by the body at the lower end thereof, a threaded pin 16 projecting upwardly from the upper end of the body and adapted to be engaged in the socket 12 in the drill collar 10, and a central longitudinal flow passage 17 extending through the body and pin and adapted to conduct circulating fluid handled by the drilling string, through the bit and into the well bore.

The reamer provided by the present invention is shown engaged in the string S to occur between the drill collar 10 and the bit 13. The reamer is shown as including a body A, a plurality of cutters B releasably engaged in

the body to project radially outwardly therefrom, and to engage the well bore, stop means E on the cutters and engageable with the body to prevent outward shifting and displacement of the cutters from the body, retaining means C carried by the body to releasably engage the cutters and hold them in working position in the body, flushing means F adapted to direct fluid from within the drill string through the retaining means C, cutters B and into the well bore, and valve means V carried by the retaining means and adapted to control the flow of fluid to the flushing means F.

The body A that we provide is an elongate vertically disposed tubular member having a central longitudinal flow passage 20 extending therethrough. In practice, the reamer body is in the nature of a sub engaged in the drill string S to occur between the drill collar 10 and the bit 13 and is provided with a threaded socket 22 entering it from its lower terminal end and adapted to receive the threaded pin 16 of the rotary bit 13.

In the particular case illustrated, the body A is shown provided with an enlarged elongate cylindrical bore 25 entering it from its upper end. The bore 25 is concentric with the flow passage 20 and terminates in the body at a point spaced above the lower terminal end thereof and establishes an upwardly facing shoulder 26. The bore 25 is adapted to accommodate the retaining means C and the valve means V in a manner that will herein-after be described.

The upper end portion of the bore 25 is threaded as at 27 and is adapted to threadedly receive a sub-like insert 28. The insert 28 has a depending skirt-like portion 29 depending from its bottom end and slidably entering the bore 25 in the body to terminate therein in opposed spaced relationship to the shoulder 26. The upper or top end of the insert 28 is provided with a threaded pin extension 30, which pin is adapted to be engaged in the socket 12 in the lower end of the drill collar 10 and to couple the tool thereto. The insert 28 is further provided with a central longitudinal flow passage 31, which passage establishes open uninterrupted communication between the body A of the reamer and the flow passage 11 in the drill collar 10.

The body A that we provide is further provided with a plurality of circumferentially spaced elongate slot-like openings 32 adapted to slidably receive and support the cutters B. The openings 32 extend through the wall of the body between the shoulder 26 in the body and the lower terminal end of the insert 28 and establish open communication with the bore 25 therein. The openings 32 are shown as having straight, flat, parallel side walls 33 and rounded ends 34. In the preferred carrying out of the invention, the openings 32 are pitched or inclined relative to the longitudinal axis of the body and so that the cutters engaged therein and carried by the body are pitched or inclined, as clearly illustrated in Fig. 1 of the drawings.

In certain figures of the drawings, the cutters are shown extending parallel with the body A for the purpose of better illustrating the construction that we provide.

The cutters B that we provide, are simple, straight, bar-like parts with straight, flat, parallel sides 35 and rounded ends 36. The said sides and ends of the cutters are adapted to establish sliding engagement with the side and end walls 33 and 34 of the openings 32 in the body A. The cutters B are further provided with outer faces 37 adapted to establish flat engagement with the well bore W when the reamer is in operation and curved inner faces 38 adapted to normally occur concentric and flush with the bore 25 in the body.

In addition to the above, each cutter B is provided with an elongate longitudinal slot-like aperture 39 extending from one side thereof to the other, and adapted to freely pass drilling mud in the well, when the reamer is rotated.

The openings 39 in the cutters B extend longitudinally

and transverse of the cutters and establish flat, opposing, longitudinally disposed inner and outer faces 40 and 41, which faces cooperate with the flushing means F in a manner that will hereinafter be described.

With the above construction, that is, by the provision of the slot-like apertures in the cutters, it will be apparent that when the reamer is in operation and is rotated in the well, the drilling mud in the well is free to pass through the apertures 39 in the cutters, with the result that the torque required to turn the reamer and the drill string, in the well, is materially reduced.

Still further, it will be apparent that as a result of the flow of drilling mud through the apertures 39 in the cutters, the reamer is not subject to becoming loaded or packed, or the length of time required to load and pack the reamer, as it is operated, is greatly extended or increased.

The stop means E that we provide is adapted to limit outward movement of the cutters in the body A and is shown as including an elongate recess 42 in the bore 25 of the body, along or adjacent each side wall 26 and around the end walls 27 of the openings 24 therein, and stop flanges 43 projecting laterally from the sides and ends of the cutters, adjacent the inner faces 31 thereof. The flanges 43 are adapted to engage and seat in the recesses 42, as clearly illustrated throughout the drawings.

The retaining means C provided by the present invention and adapted to normally hold the cutters in fixed working position in the body and out and into engagement with the well bore W is shown as including an elongate tubular retaining sleeve 50 slidably engaged in the bore 25 of the body A to occur between the shoulder 26 at the lower end of the bore and the lower end of the skirt 29 on the insert 28 engaged in the upper end of the bore.

The retaining sleeve 50 is a simple, straight, tubular member of substantially greater longitudinal extent than the slot-like openings 32 in the body, so that when it is positioned in the body in the manner illustrated in the drawings, it engages and overlies the inner faces 38 of the cutters B and holds the flanges 43 on the cutters in seated engagement in the recesses 42 in the body and thereby prevents inward movement of the cutters in the body.

In the case illustrated, the inside diameter of the sleeve 50 is slightly less than the flow passage 20 in the body A.

The upper and lower end portions of the sleeve 50 extend beyond the ends of the cutters B and are provided with annular grooves 51 about their outer periphery and in which suitable sealing rings 52 are engaged. The sealing rings 52 are adapted to seal between the bore 25 in the body and the sleeve 60 and prevent the circulating fluid within the reamer from flowing therebetween, past the cutters and into the well bore.

It will be apparent from the above, that when the insert 28 is disengaged from the body A and the retaining sleeve 50 of the means C is removed from engagement in the bore 25, the cutters B can be shifted radially inwardly into the bore 25 and then withdrawn from engagement therein, as for the purpose of replacement, as clearly illustrated in Figs. 4 and 8 of the drawings.

The flushing means F that we provide is adapted to wash away and free any mud and the like that might cake or become packed onto the reamer between the adjacent cutters or in the apertures 39 in the cutters. The means F is shown as involving a suitable straight port 60 in each cutter, which port extends between the inner face 38 of the cutter and the inner face 40 of the apertures 39 provided in the cutter, and ports 61 in the retaining sleeve 50 of the means C to register with the ports 60 in the cutters and establishing open communication with the said ports 60 and the interior of the body A.

The means F is shown as further including indexing means 62 adapted to position the sleeve 50 in the bore 25 of the body so that the ports 60 and 61 are in register

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with each other, and deflecting means 63 adapted to deflect the stream of fluid issuing from the ports 60 in the cutters through the apertures 39 in the cutters.

The indexing means 62 of the means F is shown as involving, a plurality of upwardly opening circumferentially spaced notches 65 in the upwardly facing shoulder 26 at the bottom of the bore 25 in the body A and a plurality of circumferentially spaced lugs 66 depending from the lower end of the retaining sleeve 50 and engageable in the notches. The lugs 66 are arranged so that when they are engaged in the notches 65, the ports 61 in the retaining sleeve register with the ports 60 in the cutter.

The deflecting means 63 of the flushing means F is shown as including, a cone-shaped deflector 67 on the outer face 41 in the apertures 39 of each cutter. The deflectors 67 are in axial alignment with and oppose the ports 60 in the cutters. The deflectors 67 are, in the preferred carrying out of the invention, in the nature of insert pins, press-fitted into socket openings 68 provided in the faces 41 in the cutter apertures 39 and are such that they can be easily removed and replaced, as circumstances require.

With the above relationship of parts, it will be apparent that when fluid issuing from the ports 60 in the cutters B impinges upon the deflectors 67 it is suitably deflected through and out of the apertures 39 in the cutters and in such a manner as to effectively engage and wash any matter, caked or packed on and about the cutters, as clearly illustrated in Fig. 9 of the drawings.

In practice, the shape of the deflectors 67 can be changed as circumstances require and in a manner to vary the flow pattern of the fluid as it impinges thereon, without departing from the spirit of this invention.

The valve means V that we provide to control the flow of fluid through the flushing means F is shown as involving generally, a valve sleeve 70 slidably engaged in the retaining sleeve 50, an annular seating ring 71 having an upwardly facing concave seat 72 fixed in the valve sleeve, a compression spring 73 normally yieldingly urging the valve sleeve upwardly in the retaining sleeve, a spacer sleeve 80 engaged in the retaining sleeve and limiting vertical movement of the valve sleeve therein, and a valve member 74 adapted to be introduced into the drilling string S at the upper or top end of the well and adapted to fall or be carried by the drilling fluid into sealing engagement with the seat ring 71.

The valve 70 is a straight, cylindrical member having a central flow passage 75 extending therethrough and is slidably engaged in the bore 76 of the retaining sleeve 50. The valve sleeve 70 is shown provided with a pair of longitudinally spaced, radially outwardly opening annular grooves 77 adapted to normally occur above and below the ports 61 in the retaining sleeve 50 and in which suitable sealing rings 78 are engaged. The sealing rings 78 are adapted to establish sealing engagement between the retaining sleeve and the valve sleeve at opposite sides of the ports 61 in the retaining sleeve and thereby normally prevent the flow of fluid within the reamer from flowing between the said retaining sleeve and valve sleeve and out through the ports 61 of the flushing means F.

The seat ring 71 is a simple annular metal member and in the preferred carrying out of the invention is fixed in the lower end of the flow passage 75 of the valve sleeve 70 as by welding w.

The compression spring 75 is a simple helical compression spring and is engaged in the bore 76 of the retaining sleeve 50 to occur between the lower end of the valve sleeve 60 and a radially inwardly projecting flange 79 provided in the retaining sleeve 50 at or adjacent the lower terminal end thereof.

The spacer sleeve 80 that we provide is a simple, tubular member threadedly engaged in the upper end of the retaining sleeve 50 as at 81, and has a tubular extension

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82 depending into the bore 76 of the retaining sleeve 50 to terminate at a point spaced above the ports 61 in the retaining sleeve.

With the above relationship of parts, it will be apparent that the spring 73 normally yieldingly urges the valve sleeve 70 upwardly and into engagement with the lower end of the spacer sleeve 80 and where it overlies the ports 61 in the retaining sleeve, as clearly illustrated in Figs. 2 and 5 of the drawings.

The valve member 74 is an elongate vertically disposed member having a spherically curved enlargement 85 at its lower end and adapted to be engaged in the concave seat 72 in the seat ring 71, a spear head 86 at its upper end and adapted to be engaged by a suitable overshot fishing tool 86', insertable into the well as by means of a cable 87 when it is desired to remove the valve member and allow the valve sleeve to return to its unactuated position, and a plurality of longitudinally and circumferentially spaced stabilizers 88 intermediate its ends and adapted to maintain the member in proper position in the valve sleeve 70 to be engaged by the fishing tool 86'.

In practice, the spear head 86 on the valve member 74 and the fishing tool 86' can vary widely in form and construction. For the above reasons, we will dispense with further detailed description of the spear head and the fishing tool construction illustrated in the drawings.

It is to be understood that in practice, when it is not necessary that the valve sleeve be returned to its unactuated position, once it has been actuated or opened, the valve member 74 could be in the form of a simple check ball.

With the structure set forth above, it will be apparent that when the valve member 74 is placed in the well string and seats on the seat ring 71, the flow of fluid through the drilling string is shut off and the load of the column of drilling fluid in the string above the valve member shifts the valve sleeve downwardly in the bore 76 of the retaining sleeve, against the resistance of the spring 73 and out of engagement over the ports 60 and 61.

After the sleeve has been actuated or shifted in the manner set forth above, and the flow of circulating fluid through the ports 60 and 61 has cleaned the exterior of the reamer, the fishing tool 86' at the end of the cable 87 can be lowered into the drilling string to engage and retrieve the valve member 74. After the valve member 74 is retrieved in the manner set forth above, the spring 73 urges the valve sleeve upwardly to its unactuated position whereupon the flow of fluid through the ports 60 and 61 is shut off and normal drilling operating can be continued.

In practice, suitable roller cutters B', such as is illustrated in Fig. 10 of the drawings, can be used, in place of or substituted for the blade-like cutters B described above, without affecting the novelty of the invention. The roller cutters B' illustrated in the drawings are somewhat similar to the blade-like cutters B, except that the outer portion of the blade-like portion 90 thereof is provided with a radially outwardly opening recess 39' intermediate its ends, which recess freely receives a roller cutting member 91. The cutting member 91 is fluted, that is, it is provided with a plurality of longitudinally disposed cutting teeth and is rotatably supported and carried in the recess 39' by means of a suitable shaft 92 which is fixed to and extends between the ends of the blade-like portion 90 of the cutter.

In the case illustrated, the cutting member 91 is provided with an annular radially outwardly projecting and outwardly divergent deflecting flange 63' intermediate its ends, which flange occurs opposite the part 60' in the blade portion 90 of the cutter and is adapted to direct the fluid issuing from its said port in a manner to effectively clean the construction.

Having described only typical preferred forms and

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

Having described our invention, we claim:

1. A reamer of the character referred to including, an elongate tubular body engageable in a drilling string, a plurality of apertured cutters carried by the body to project radially outwardly therefrom, an elongate retaining sleeve engaged in the body to occur radially inwardly of and adjacent the cutters, flushing means adapted to clean the cutters and including ports in the retaining sleeve and ports in the cutters and establishing open communication between the interior of the body and the apertures in the cutters, and valve means controlling the flow of fluid in the reamer out through the ports and including a valve sleeve slidably engaged in the retaining sleeve to normally overlie the ports therein, a seat ring in the valve sleeve and a valve member engageable in the reamer through the drilling string and adapted to seat on the ring to shut off the flow of fluid through the valve sleeve and urge it downwardly in the retaining sleeve.

2. A reamer of the character referred to including, an elongate tubular body engageable in a drilling string, a plurality of apertured cutters carried by the body to project radially outwardly therefrom, an elongate retaining sleeve engaged in the body to occur radially inwardly of and adjacent the cutters, flushing means adapted to clean the cutters and including ports in the retaining sleeve and ports in the cutters and establishing open communication between the interior of the body and the apertures in the cutters, valve means in the retaining sleeve and controlling the flow of fluid in the reamer out through the ports, and fluid directing means in the cutters to direct the fluid issuing from the ports and including fluid directing pins carried by the cutters to project into the apertures therein and opposing the ports therein.

3. A reamer of the character referred to including, an elongate tubular body engageable in a drilling string, a plurality of apertured cutters carried by the body to project radially outwardly therefrom, an elongate retaining sleeve engaged in the body to occur radially inwardly of and adjacent the cutters, flushing means adapted to clean the cutters and including ports in the retaining sleeve and ports in the cutters and establishing open communication between the interior of the body and the apertures in the cutters, valve means controlling the flow of fluid in the reamer out through the ports and including a valve sleeve slidably engaged in the retaining sleeve to normally overlie the ports therein, a seat ring in the valve sleeve and a valve member engageable in the reamer through the drilling string and adapted to seat on the ring, and fluid directing means in the cutters to direct the fluid issuing from the ports and including fluid directing pins carried by the cutters to project into the apertures therein and opposing the ports therein.

4. A reamer of the character referred to including, an elongate vertically disposed body engageable in a drilling string and having a central longitudinal flow passage extending therethrough, an enlarged bore entering the body from its upper end and terminating therein to define an upwardly disposed shoulder, a plurality of elongate slot-like openings in the body and communicating with the bore therein, elongate recesses in the bore and surrounding the openings, an elongate cutter with inner and outer faces and slidably engaged in each opening to normally project radially outwardly therefrom, each cutter having an elongate slot-like opening extending longitudinally thereof and from one side thereof to the other and having opposed inner and outer faces, a port in each cutter extending between the inner face thereof and the inner face of the slot-like opening therein, lateral stop flanges on the cutters adjacent the inner faces thereof and

adapted to normally engage and seat in the recesses, a retaining sleeve slidably engaged in the bore in the body to normally overlie the openings and the inner surfaces of the cutters, an insert engageable in the upper end of the body and engaging and holding the retaining sleeve engaged therein and adapted to connect with the drilling string, above the reamer, said retaining sleeve having ports therein, indexing means related to the retaining sleeve and the body to position the retaining sleeve in the body with the ports therein in register with the ports in the cutters, and valve means carried by the retaining sleeve and adapted to control the flow of fluid in the reamer through the ports.

5. A reamer of the character referred to including, an elongate vertically disposed body engageable in a drilling string and having a central longitudinal flow passage extending therethrough, an enlarged bore entering the body from its upper end and terminating therein to define an upwardly disposed shoulder, a plurality of elongate slot-like openings in the body and communicating with the bore therein, elongate recesses in the bore and surrounding the openings, an elongate cutter with inner and outer faces and slidably engaged in each opening to normally project radially outwardly therefrom, each cutter having an elongate slot-like opening extending longitudinally thereof and from one side thereof to the other and having opposed inner and outer faces, a port in each cutter extending between the inner face thereof and the inner face of the slot-like opening therein, lateral stop flanges on the cutters adjacent the inner faces thereof and adapted to normally engage and seat in the recesses, a retaining sleeve slidably engaged in the bore in the body to normally overlie the openings and the inner surfaces of the cutters, an insert engageable in the upper end of the body and engaging and holding the retaining sleeve engaged therein and adapted to connect with the drilling string, above the reamer, said retaining sleeve having ports therein, indexing means related to the retaining sleeve and the body to position the retaining sleeve in the body with the ports therein in register with the ports in the cutters, and valve means carried by the retaining sleeve and adapted to control the flow of fluid in the reamer through the ports, and including, a valve sleeve, slidably engaged in the retaining sleeve, a spacer sleeve engaged in the upper end of the valve sleeve and limiting upward movement of the valve sleeve therein, a seat flange on the lower end of the retaining sleeve, a compression spring between said seat flange and the bottom of the valve sleeve and normally yieldingly urging the valve sleeve upwardly into engagement with the spacer sleeve where it overlies the ports with retaining sleeve, an annular seat ring in the valve sleeve, and a valve element insertable into the structure from the top of the well to seat on the seat ring and to thereby shut off flow through the ring and cause it to shift downwardly in the retaining sleeve against the resistance of the spring and from engagement over the ports therein.

6. A reamer of the character referred to including, an elongate vertically disposed body engageable in a drilling string and having a central longitudinal flow passage extending therethrough, an enlarged bore entering the body from its upper end and terminating therein to define an upwardly disposed shoulder, a plurality of elongate slot-like openings in the body and communicating with the bore therein, elongate recesses in the bore and surrounding the openings, an elongate cutter with inner and outer faces and slidably engaged in each opening to normally project radially outwardly therefrom, each cutter having an elongate slot-like opening extending longitudinally thereof and from one side thereof to the other and having opposed inner and outer faces, a port in each cutter extending between the inner face thereof and the inner face of the slot-like opening therein, lateral stop flanges on the cutters adjacent the inner faces thereof and adapted to normally engage and seat in the recesses, a retaining

sleeve slidably engaged in the bore in the body to normally overlie the openings and the inner surfaces of the cutters, an insert engageable in the upper end of the body and engaging and holding the retaining sleeve engaged therein and adapted to connect with the drilling string, above the reamer, said retaining sleeve having ports therein, indexing means related to the retaining sleeve and the body to position the retaining sleeve in the body the ports therein in register with the ports in the cutters, and valve means carried by the retaining sleeve and adapted to control the flow of fluid in the reamer and through the ports.

7. A reamer of the character referred to including, an elongate vertically disposed body engageable in a drilling string and having a central longitudinal flow passage extending therethrough, an enlarged bore entering the body from its upper end and terminating therein to define an upwardly disposed shoulder, a plurality of elongate slot-like openings in the body and communicating with the bore therein, elongate recesses in the bore and surrounding the openings, an elongate cutter with inner and outer faces and slidably engaged in each opening to normally project radially outwardly therefrom, each cutter having an elongate slot-like opening extending longitudinally thereof and from one side thereof to the other and having opposed inner and outer faces, a port in each cutter extending between the inner face thereof and the inner face of the slot-like opening therein, an inwardly projecting deflector on the outer face of the opening in each cutter and opposing the portion thereof, lateral stop flanges on the cutters adjacent the inner faces thereof and adapted to normally engage and seat in the recesses, a retaining sleeve slidably engaged in the bore in the body to normally overlie the openings and the inner surfaces of the cutters, an insert engageable in the upper end of the body and engaging and holding the retaining sleeve engaged therein and adapted to connect with the drilling string, above the reamer, said retaining sleeve having ports therein, indexing means related to the retaining sleeve and the body to position the retaining sleeve in the body with the ports therein in register with the ports in the cutters, and valve means carried by the retaining sleeve and adapted to control the flow of fluid in the reamer and through the ports.

8. A reamer of the character referred to including, an elongate vertically disposed body engageable in a drilling string and having a central longitudinal flow passage extending therethrough, an enlarged bore entering the body from its upper end and terminating therein to define an upwardly disposed shoulder, a plurality of elongate slot-like openings in the body and communicating with the bore therein, elongate recesses in the bore and surrounding the openings, an elongate cutter with inner and outer faces and slidably engaged in each opening to normally project radially outwardly therefrom, each cutter having an elongate slot-like opening extending longitudinally thereof and from one side thereof to the other and having opposed inner and outer faces, a port in each cutter extending between the inner face thereof and the inner face of the slot-like opening therein, lateral stop flanges on the cutters adjacent the inner faces thereof and adapted to normally engage and seat in the recesses, a retaining sleeve slidably engaged in the bore in the body to normally overlie the openings and the inner surfaces of the cutters, an insert engageable in the upper end of the body and engaging and holding the retaining sleeve engaged therein and adapted to connect with the drilling string, above the reamer, said retaining sleeve having ports therein, indexing means related to the retaining sleeve and the body to position the retaining sleeve in the body with the ports therein in register with the ports in the cutters and including upwardly facing notches in the shoulder at the bottom of the bore in the body and lugs depending from the lower end of the retaining sleeve and engageable in the notches, and valve means carried by the retaining sleeve and

adapted to control the flow of fluid in the reamer and through the ports.

9. A reamer of the character referred to including, an elongate vertically disposed body engageable in a drilling string and having a central longitudinal flow passage extending therethrough, an enlarged bore entering the body from its upper end and terminating therein to define an upwardly disposed shoulder, a plurality of elongate slot-like openings in the body and communicating with the bore therein, elongate recesses in the bore and surrounding the openings, an elongate cutter with inner and outer faces and slidably engaged in each opening to normally project radially outwardly therefrom, each cutter having an elongate slot-like opening extending longitudinally thereof and from one side thereof to the other and having opposed inner and outer faces, a port in each cutter extending between the inner face thereof and the inner face of the slot-like opening therein, an inwardly projecting deflector on the outer face of the opening in each cutter and opposing the port therein, lateral stop flanges on the cutters adjacent the inner faces thereof and adapted to normally engage and seat in the recesses, a retaining sleeve slidably engaged in the bore in the body to normally overlie the openings and the inner surfaces of the cutters, an insert engageable in the upper end of the body and engaging and holding the retaining sleeve engaged therein and adapted to connect with the drilling string, above the reamer, said retaining sleeve having ports therein, indexing means related to the retaining sleeve and the body to position the retaining sleeve in the body with the ports therein in register with the ports in the cutters and including upwardly facing notches in the shoulder at the bottom of the bore in the body and lugs depending from the lower end of the retaining sleeve and engageable in the notches, and valve means carried by the retaining sleeve and adapted to control the flow of fluid in the reamer and through the ports.

10. A reamer of the character referred to including, an elongate vertically disposed body engageable in a drilling string and having a central longitudinal flow passage extending therethrough, an enlarged bore entering the body from its upper end and terminating therein to define an upwardly disposed shoulder, a plurality of elongate slot-like openings in the body and communicating with the bore therein, elongate recesses in the body and surrounding the openings, an elongate cutter with inner and outer faces and slidably engaged in each opening to normally project radially outwardly therefrom, each cutter having an elongate slot-like opening extending longitudinally thereof and from one side thereof to the other and having opposed inner and outer faces, a port in each cutter extending between the inner faces thereof and the inner face of the slot-like opening therein, an inwardly projecting deflector on the outer face of the opening in each cutter and opposing the port therein, lateral stop flanges on the cutter adjacent the inner faces thereof and adapted to normally engage and seat in the recesses, a retaining sleeve slidably engaged in the bore in the body to normally overlie the openings and the inner surfaces of the cutters, an insert engageable in the upper end of the body and engaging and holding the retaining sleeve engaged therein and adapted to connect with the drilling string, occurring above the reamer, said retaining sleeve having ports therein, indexing means related to the retaining sleeve and the body to position the retaining sleeve in the body with the ports therein in register with the ports in the cutters and including upwardly facing notches in the shoulder at the bottom of the bore in the body and lugs depending from the lower end of the retaining sleeve and engageable in the notches, and valve means carried by the retaining sleeve and adapted to control the flow of fluid in the reamer and through the ports and including, a valve sleeve slidably engaged in the retaining sleeve, a spacer sleeve engaged

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in the upper end of the valve sleeve and limiting movement of the valve sleeve therein, a seat flange on the lower end of the retaining sleeve, a compression spring between said seat flange and the bottom of the valve sleeve and normally yieldingly urging the valve sleeve upwardly into engagement with the spacer sleeve where it overlies the ports with retaining sleeve, an annular seat ring in the valve sleeve, and a valve element insertable into the structure from the top of the well to seat on the seat ring and to thereby shut off flow through the ring and cause it to shift downwardly in the retaining sleeve against the resistance of the spring and from engagement over the ports therein.

11. A reamer of the character referred to including, an elongate tubular body engageable in a drilling string, a plurality of cutters having blade-like body portions carried by the body to project radially outwardly therefrom and roller cutting elements carried thereby to engage and receive a well bore, an elongate retaining sleeve engaged in the body to occur radially inwardly of and adjacent the cutters, flushing means adapted to clean the rollers and including ports in the retaining sleeve and registering ports in the body portions of the cutters, said ports establishing open communication with the inte-

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rior of the body and adapted to direct fluid from the interior of the body onto the rollers, and valve means controlling the flow of fluid in the reamer out through the ports and including a valve sleeve slidably engaged in the retaining sleeve to normally overlie the ports therein, a seat ring in the valve sleeve and a valve member engageable in the reamer through the drilling string and adapted to seat on the ring to shut off the flow of fluid through the valve sleeve and urge it downwardly in the retaining sleeve.

12. A reamer as set forth in claim 11, wherein said rollers are provided with deflecting flanges adapted to direct the fluid issuing from the ports to clean the cutters.

References Cited in the file of this patent

UNITED STATES PATENTS

1,659,327	Montgomery	Feb. 14, 1928
2,094,855	Smith	Oct. 5, 1937
2,427,052	Grant	Sept. 9, 1947

FOREIGN PATENTS

28,900	Netherlands	Feb. 15, 1933
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