April 14, 1959 C. J. CARR ET AL 2,882,019

SELF-CLEANING COLLAPSIBLE REAMER

Filed Oct. 19, 1956

FIG. 1.

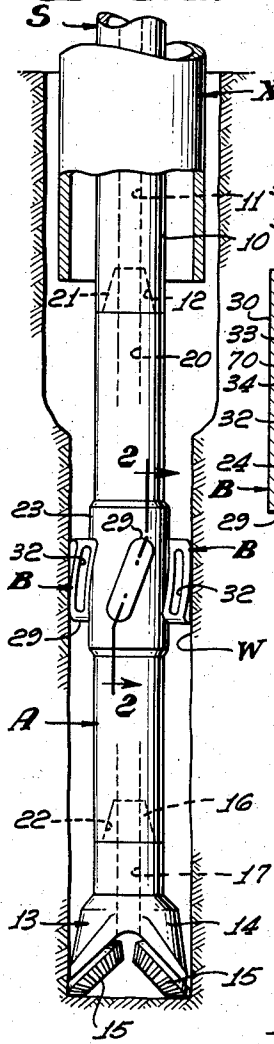


FIG. 2.

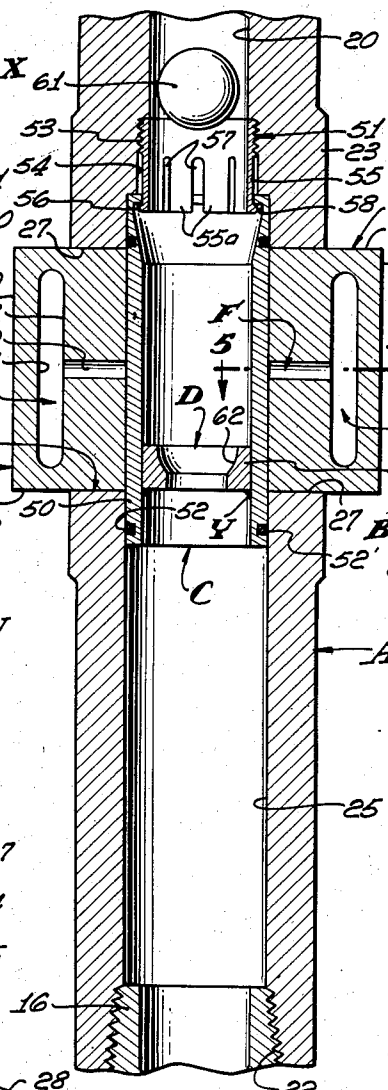


FIG. 3.

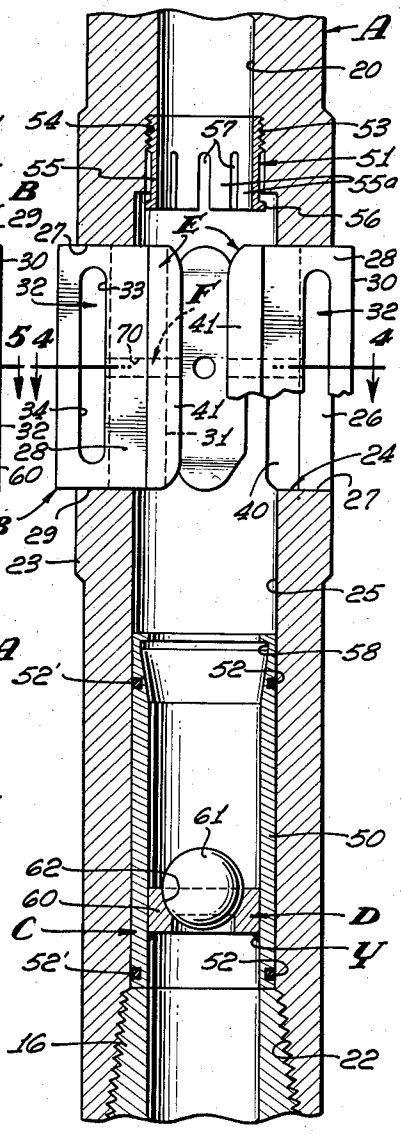


FIG. 4.

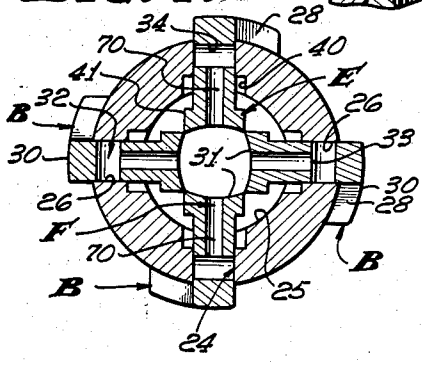
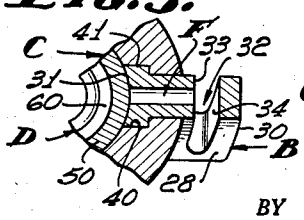


FIG. 5.



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SELF-CLEANING COLLAPSIBLE REAMER

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5 Claims. (Cl. 255—73)

This invention has to do with a reamer for use in a well, and is more particularly concerned with a collapsible reamer having retractable cutters and fluid circulating and flushing means.

In many instances, while drilling a well, the drilling bit becomes worn out to a degree that the well bore produced thereby is undergauged. It also frequently happens that the bore of the well, due to the rock formation and/or the speed at which the well is being drilled, will be uneven and rough and to the extent that withdrawal of the drilling string and/or lowering of a 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, which tools serve to smooth the well bore and to ream and bring it out to gauge.

Heretofore, reaming tools of the class herein referred to have been in the nature of subs engaged at the ends of the drill collar, or at any other desired point along the drilling string, and are provided with rigid, radially outwardly projecting, circumferentially spaced cutters. It has been found that when the drilling string is being withdrawn from the well, the cutters of the ordinary or conventional reamers drag along and scar or cave in the well bore and also frequently catch and become hung up in the well bore or on the lower terminal end of the well casing that has been lowered into the well. It also frequently happens that the cuttings made by the reamer and the drilling bit combine with the circulating fluid, or drilling mud, and pack between the cutters, rendering the cutters ineffective, cutting off circulation of fluid in the well and freezing or packing the drill string in the well.

The cutters of the ordinary reaming tool of the class referred to are elongate, imperforate blade-like projections extending substantially longitudinally of the drilling string and the well bore. The cutters being 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 considerably greater torque on the drilling 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 application for Letters Patent entitled "Reamer," Serial No. 533,543, now patent Number 2,834,578, filed September 12, 1955.

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 released so as to shift radially inward when the reamer becomes packed or hung up in the well, or when the drilling string is being pulled from the well.

Another object of the present invention is to provide a reamer of the character referred to wherein the cutter blades are normally maintained in operating position by a longitudinally shiftable member, which member is adapted to be operated or shifted out of engagement with

the cutters by interrupting the flow of circulating fluid through the reamer.

A further object of the present invention is to provide a reamer of the character referred to having blade-like cutters with elongate slot-like openings extending therethrough, which openings pass the drilling mud, as the reamer is rotated, to flush and keep the reamers clean and to reduce the torque required to rotate the reamer in the mud.

A further object of our invention is to provide a flushing means related to each cutter and adapted to flush and clean the cutters when the longitudinally shiftable member is operated and the cutters are free to shift radially inwardly.

Still another object of the present invention is to provide a reamer of the general character referred to having cutters that can be easily and quickly replaced.

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

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

Fig. 1 is a view illustrating a reamer embodying the present invention and carried by a drilling string and located in a well bore. Fig. 2 is an enlarged longitudinal detailed sectional view of the reamer that we provide, it being a view taken substantially as indicated by line 2—2 on Fig. 1. Fig. 3 is a view similar to Fig. 2 but showing the device in an actuated position and the cutters therein being shown in elevation. A portion of one of the cutters illustrated in Fig. 3 is broken away to better illustrate the body construction of our reamer. Fig. 4 is a transverse sectional view taken as indicated by line 4—4 on Fig. 3. Fig. 5 is a transverse sectional view of a portion of our reamer, it being a view taken as indicated by line 5—5 on Fig. 2.

In Fig. 1 of the drawings, we have illustrated 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 beyond 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 flow passage **11** extending longitudinally therethrough and as having a threaded socket **12** entering it from its lower end. The roller bit **13** is related to the lower end of the drill collar **10** and includes, a vertically disposed body **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 the pin and adapted to conduct fluid handled by the drilling string, through the drill 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 shiftably carried by the body to project radially outwardly therefrom, stop means E on the cutters and engageable with the body to prevent excessive outward movement and displacement of the cutters in the body, retaining means C carried by the body to releasably engage the stop means E on the cutters and to hold the cutters in working position, actuating means D related to the retaining means and adapted to shift the retaining means out of engagement with the cutters to allow the cutters to shift radially inwardly in

the body, and flushing means F adapted to direct fluid within the drill string through the cutters and into the well bore after the means C has been actuated.

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 engageable in the drill string S to occur between the drill collar and the bit **13**, and is provided with a threaded pin extension **21** at its upper terminal end adapted to be engaged in the socket **12** in the lower end of the drill collar **10**, and 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 a slightly enlarged central portion **23**. The central portion is shown provided with a plurality of circumferentially spaced elongate slot-like openings **24** adapted to slidably receive and support the cutters B. The body A is shown as further including an enlarged bore **25** entering the body from the lower end thereof and extending upwardly through the said central portion **23** of the body and adapted to accommodate the retaining means C for the cutters.

The slot-like openings **24** in the body A, adapted to receive the cutters B, extend through the wall of the body to establish open communication with the bore therein and having straight flat parallel side walls **26** and rounded end walls **27**. In the preferred carrying out of the invention, the openings **24** are pitched or inclined relative to the longitudinal axis of the body and so that the cutters carried thereby are pitched or inclined as clearly illustrated in Fig. 1 of the drawings.

In Figs. 2 and 3 of the drawings, the cutters B are shown extending parallel with the body A for the purpose of better illustrating the construction of the device.

The cutters B that we provide are simple, straight bar-like parts with straight flat parallel sides **28** and rounded ends **29**, which sides and ends are adapted to establish sliding engagement with the side and end walls **26** and **27** of the openings **24** in the body. The cutters B are further provided with curved outer faces **30** adapted to establish flat engagement with the well bore W when the reamer is in operation and curved inner faces **31** adapted to normally occur concentric and flush with the bore **25** in the body A.

In addition to the above, each cutter B is provided with an elongate longitudinal slot-like openings **32**, extending from one side **28** thereof to the other and adapted to freely pass the drilling mud in the well when the reamer is rotated therein.

The openings **32** in the cutters B, extending longitudinally and transverse of the cutters, establish flat, opposing, longitudinally disposed, inner and outer faces **33** and **34**, which faces cooperate with the flushing means F in a manner that will be hereinafter described.

With the above construction, that is, by the provision of the slot-like openings in the cutters, it will be apparent that when the reamer is in operation, and is rotated in the well, the drilling mud is free to pass through the openings **32** in the cutters with the result that less torque is required to turn the reamer and the drill string.

Still further, it will be apparent that as a result of the flow of drilling mud through the openings **32** 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 B in the body A, and is shown as including an elongate recess **40** in the bore of the body, along or adjacent each side wall **26** of the openings **24** therein, and stop flanges **41** projecting laterally from the sides of the cutters adjacent the inner faces **31** thereof and adapted to engage and seat in the recesses **40** as clearly illustrated in the drawings.

The retaining means C provided by the present invention and adapted to normally hold the cutters B out, and in engagement with the well bore W, is shown as including an elongate tubular sleeve **50** slidably engaged in the bore **25** of the body, and a latch sleeve **51** carried by the body and engaged in the sleeve to normally prevent shifting of the sleeve in the body.

The sleeve **50** is a simple straight tubular member of substantially greater longitudinal extent than the openings **24** in the body A so that when it is positioned in the upper portion of the bore in the body, as illustrated in Fig. 2 of the drawings, it slidably engages and overlies the inner faces **31** of the cutters and holds the flanges **41** on the cutters in seated engagement in the recesses **40** in the body and thereby preventing inward movement of the cutters in the body. In the case illustrated, the inside diameter of the sleeve **50** is slightly larger 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 **52** about their outer periphery and in which suitable sealing rings **52'** are engaged. The sealing rings **52'** are adapted to seal between the bore in the body and the sleeve to normally prevent the circulating fluid from within the reamer from flowing therebetween past the cutters and into the well bore.

The latch sleeve **51** holding the sleeve **50** in the upper portion of the bore **25** in the body is an elongate vertically disposed tubular member, the inside diameter of which corresponds to the diameter of the flow passage **20**, and the outside diameter of which corresponds with the inside diameter of the sleeve **50**. The latch sleeve **51** has an upper threaded portion **53** threadedly engaged in a suitable counter bore **54** continuing upwardly in the body A from the upper end of the bore **25**, and a lower portion **55** depending into the bore **25**. The lower portion **55** is adapted to slidably enter the upper end of the sleeve **50** and is provided with a radially outwardly projecting rib **56** at its lower ends, and a plurality of vertically disposed notches **57** entering it from its lower end and establishing a plurality of resilient fingers **55a**. The rib or ribs **56** at the lower ends of the fingers **55a** enter a suitable annular groove **58** provided in the bore of the sleeve **50** at the upper portion thereof and yieldingly hold the sleeve in an up, or unactuated position, as clearly illustrated in Fig. 2 of the drawings.

The actuating means D related to the retaining means C and adapted to shift the retaining means out of engagement with the cutters B and thereby permit the cutters to shift radially inwardly into the body, includes, an annular seat ring **60** in the sleeve **50** and a spherical valve member or ball **61** adapted to be introduced into the drill string 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 ring **60**. The ring **60** is a simple annular ring-like part fixed in the sleeve **50** as by welding Y or the like, and has an upwardly facing spherically curved seat **62** adapted to accommodate and seal with the ball **61**. In the case under consideration, the ball **61** is a simple steel ball.

With the structure set forth above, it will be apparent that when the ball **61** is placed in the drill string and seats on the ring **60**, the flow of fluid through the drilling string is shut-off, and that upon the application of sufficient fluid pressure upon the column of fluid in the string above the ball, as by means of a suitable pump at the top of the well, the ribs **56** on the latch sleeve **51** and engaged in the groove **58** are urged out of engagement with the groove, and the sleeve **50** is free to shift downwardly in the bore **25** and out of engagement with the cutters B. In the particular case illustrated, excessive downward movement of the sleeve **50** in the bore **25** of the body A is prevented by the upper terminal end of the pin **16**

of the bit 13, which pin is engaged in the socket opening 22 in the bottom end of the body A and serves to establish an upwardly facing stop shoulder 62 at the lower end of the bore 25.

After the sleeve 50 has been actuated or shifted in the manner set forth above, and the pressure exerted upon the column of fluid in the string S is released, the cutters B are free to shift radially inwardly into the body, as clearly illustrated in Fig. 3 of the drawings. In practice, engagement of the cutters on the well bore, well tubing, or any other obstruction that might occur in the well is sufficient to shift the cutter radially inwardly into the body in the manner desired. However, if it is desired to retract all of the cutters as far as possible, reversed flow of fluid in the well string can be temporarily established, which flow of fluid will draw the cutters inwardly as desired.

The flushing means F that we provide is adapted to wash away and free any mud and the like that might pack onto the reamer, between and adjacent the cutters, or in the openings 32 in the cutter so that the cutters are free to shift relative to the body when the reamer is actuated for withdrawal from the well.

The means F is shown as involving a simple straight port 70 in each cutter B, which ports extend between the inner faces 31 of the cutters B and the inner faces 33 of the openings 32 provided in the cutters, to establish open communication therebetween.

With the relationship of parts set forth above, it will be apparent that when the reamer is in operation, the sleeve 50 overlies the ports 70 in the cutters B and prevents the flow of drilling mud handled by the string 10 from flowing therethrough. It will be further apparent that when the reamer is actuated, that is, when the flow of fluid through the reamer body is interrupted by the valve member 61 and the sleeve 50 is shifted downwardly in the body and out of engagement with the cutters, the ports 70 in the cutters are opened and the flow of mud is directed outwardly therethrough. The flow of drilling fluid or mud outwardly through the ports 70 in the cutters B cuts through or blows out any mud packed in the openings 32 of the cutters whereupon it impinges upon the outer faces 34 of the notches 32 and is dispersed in all directions to cut and wash away mud packed on the other portions of the reamer construction.

In addition to the foregoing, the means F also serves as a drain permitting the fluid in the drill string to flow outwardly through the ports 70 and into the well bore as the string is pulled or drawn from the well.

In practice, several ports 70 could, if desired, be provided in each cutter B, the angles at which they are disposed relative to the cutter, and their position in the cutters could be varied to obtain any desired flushing action.

It is to be understood that, in practice, the reamer that we provide could, if desired, be placed at any point along the drilling string S and that the particular arrangement shown and described above is only typical of one arrangement and relationship of parts that can be employed in carrying out the present invention.

Throughout the drawings we have shown our reamer as having four cutters. It is to be understood, however, that, in practice, the number of cutters provided can vary widely as circumstances require.

It will be apparent from the foregoing description, that the reamer provided by the present invention involves a minimum of parts making it easy and economical of manufacture, and is such that it is both effective and dependable in operation.

Having described only a typical preferred form and application 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 collapsible reamer of the character referred to including, an elongate body with a central longitudinal flow passage and engageable in a drilling string, a plurality of circumferentially spaced openings in the body, a plurality of cutters carried in the openings to project radially outwardly from the body, each cutter having an elongate slot-like opening extending laterally therethrough, an elongate sleeve engaged in the body and positioned radially inward of and adjacent to the cutters to prevent inward shifting of the cutters in the body, fluid pressure actuating means related to the sleeve and adapted to shift the sleeve longitudinally of the body and away from the cutters, and means adapted to clean the reamer when the sleeve is shifted, and including ports in the cutters establishing open communication between the apertures in the cutters and the flow passage in the body.

2. A collapsible reamer of the character referred to including, an elongate vertically disposed body with a central longitudinal flow passage extending therethrough, a plurality of lateral openings in the body and communicating with the flow passage, a cutter engaged in each opening in the body to project radially outwardly therefrom, each cutter having an elongate slot-like opening extending longitudinally thereof and adapted to pass the circulating fluid in the well when the reamer is rotated, a sleeve engaged in the flow passage to overlie the lateral openings in the body and hold the cutters in working position, actuating means adapted to shift the sleeve downwardly in the bore and away from said lateral openings and means adapted to clean the reamer and including, a port in each cutter establishing open communication between the slot-like opening therein and the flow passage in the body, the ports in the cutters being closed by the sleeve before the sleeve is shifted.

3. A collapsible reamer of the character referred to including, an elongate vertically disposed body with a central longitudinal flow passage extending therethrough, a threaded pin projecting from one end of the body and a threaded socket entering the other end of the body and adapted to connect with parts of a drill string, an enlarged bore entering the body from the bottom end thereof, a plurality of lateral openings in the body and communicating with the bore therein, a cutter engaged in each opening in the body to project radially outwardly therefrom and having an outer face adapted to engage a wall bore, a sleeve engaged in the bore to overlie the openings and holding the cutters in working position, fluid pressure operated actuating means adapted to shift the sleeve downwardly in the bore and away from the openings and including a seat ring in the sleeve and a valve member adapted to be dropped into engagement on the ring and means adapted to clean the reamer when the sleeve is shifted and including, a slot-like opening extending longitudinally of each cutter to extend from one side thereof to the other and having opposed inner and outer faces, a port in each cutter and establishing open communication between the slot-like opening therein and the interior of the body after the sleeve is shifted and adapted to direct a stream of fluid from within the body onto the outer face of the said slot-like opening.

4. A collapsible reamer of the character referred to including, an elongate vertically disposed body engageable in a drilling string and having a central longitudinal flow passage, a plurality of elongate slot-like openings in the body and communicating with the passage therein, an elongate cutter engaged in each opening to project radially outwardly therefrom, each cutter having an elongate slot-like opening extending longitudinally thereof and from one side thereof to the other, each cutter having a port adapted to establish open communication between the interior of the body and the slot-like opening therein, stop means limiting outward movement of the cutters in the body and including grooves in the body adjacent each side of the slot-like openings in the body and stop flanges

on the cutters and engageable in the grooves, a sleeve engaged in the passage, a latch sleeve carried by the body and engaging the sleeve to hold the sleeve up where it overlies the openings and ports in the body and in the cutters respectively and holds the cutters in operative position, and actuating means adapted to shut off flow through the sleeve and to shift it downwardly in the body out of engagement with the latch sleeve and away from the openings in the body and the ports in the cutters including, an annular seat ring in the sleeve, and a ball engageable in the drilling string and adapted to drop onto and seat on the ring.

5. A collapsible 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, a plurality of elongate slot-like openings in the body and communicating with the passage therein, elongate recesses in the passage and along the sides of the slot-like openings in the body, an elongate cutter with inner and outer faces slidably engaged in each opening to 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, laterally projecting stop flanges on the cutters adjacent the inner faces thereof and adapted to engage and seat on the recesses, a sleeve engaged in the passage to overlie the openings and the inner surfaces of the cutters in operative position, retaining means carried by the body and engaging the sleeve to hold the sleeve up where it overlies the openings in the body, and actuating means adapted to shut off flow through the sleeve and cause the sleeve to shift downwardly in the body out of engagement with the retaining means and away from the openings and the cutters and including, an annular seat ring in the sleeve, and a ball engageable in the drilling string and adapted to drop onto and seat in the ring.

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