

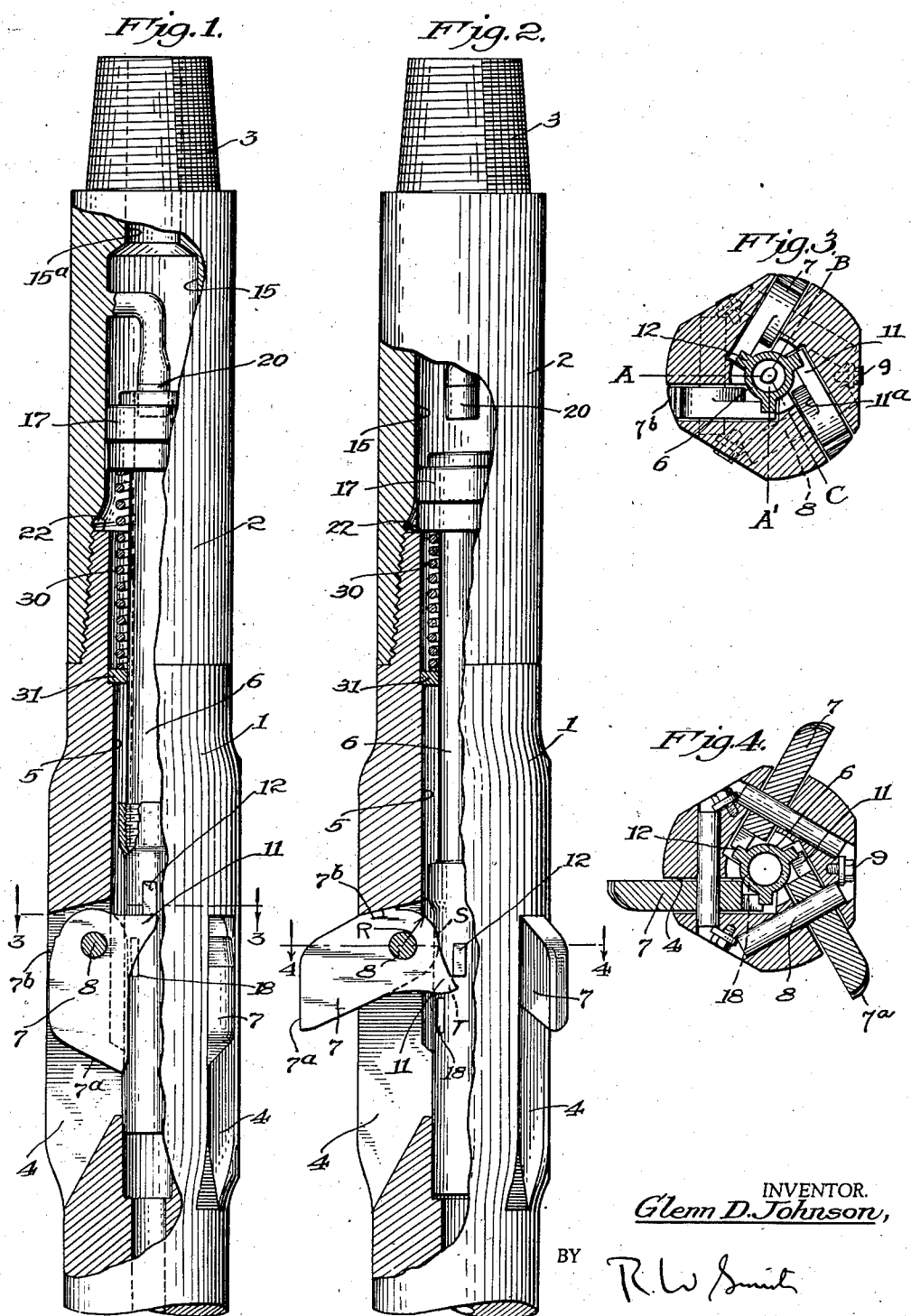
May 10, 1938.

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2,116,898

EXPANSIBLE CUTTER TOOL

Filed Nov. 30, 1936



UNITED STATES PATENT OFFICE

2,116,898

EXPANSIBLE CUTTER TOOL

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Application November 30, 1936, Serial No. 113,297

11 Claims. (Cl. 255-76)

This invention relates to expansible cutter tools and is particularly applicable to well drilling tools for enlarging the bore of a well, the invention being illustrated and described in connection with that type of tool wherein an expansible cutter scrapes the wall of the well bore.

It is an object of the invention to expand a cutter by relative longitudinal movement of a mandrel, and to provide an improved operating connection between the mandrel and the cutter so arranged and of such size as to insure adequate strength and at the same time provide for appreciable expansion and permit complete contraction of the cutter within the body of the tool without unduly increasing the diameter of said body.

It is a further object of the invention to provide a plurality of circumferentially spaced cutters with an operating connection between the mandrel and each cutter, and with the cutters laterally offset from radii of the mandrel whereby a side of each of the cutters may partially overlie the periphery of the mandrel to permit the cutters and their operating connections being of adequate size while adapted for reception within restricted space in the body.

It is a still further object of the invention to particularly adapt the improved operating connection for embodiment in a tool wherein the mandrel may be operated, and a washing medium may be circulated through the tool in accordance with usual practice as hereinafter described.

Further objects of the invention will be readily understood from the following description of the accompanying drawing, in which:

Fig. 1 is a side elevation of the tool, partly in axial section and showing the cutters contracted.

Fig. 2 is a similar view showing the cutters expanded.

Figs. 3 and 4 are transverse sections on the lines 3-3 and 4-4 of Figs. 1 and 2 respectively.

The invention is illustrated in connection with an expansible cutter tool for scraping the wall of a well bore, and in the illustrated embodiment of the invention the tool has three cutters equidistantly circumferentially spaced. The cutters are mounted on a body 1 which is adapted for incorporation in a usual drill string, preferably by means of a sub 2 which is threaded to the upper end of the body 1 and which has a threaded connection 3 at its upper end, with the lower end of the body 1 also having a usual threaded connection (not shown).

The cutters are mounted in slots 4 which are formed in the body 1 and which communicate

with an axial bore 5 of the body. These slots, which in the illustrated embodiment of the invention are three in number to accommodate the three cutters, are respectively parallel to three equidistantly circumferentially spaced radii A-O, B-O and C-O of the body 1, and are equidistantly laterally offset from said radii in the same circumferential direction as shown at Figs. 3 and 4, whereby the area of communication between each slot and the bore 5 extends beyond both sides of that radius of the body lying perpendicular to the radius to which the slot is parallel. For example, the slot 4 which is parallel to the radius A-O, communicates with the bore 5 at both sides of the radius A'-O which is perpendicular to the radius A-O.

A mandrel 6 is slidable in the bore 5 and an operating connection is provided between the mandrel and each of the cutters for expanding the latter, with each operating connection occupying the space where the slot 4 for the corresponding cutter communicates with the bore 5.

As an instance of this arrangement the cutters are shown as pivoted cutters 7, adapted for swinging movement to expanded position, and may be pivoted on pins 8 which extend across the slots 4 and which may be removably held in place as shown at 9. The cutters being mounted in the laterally offset slots 4, are thus similarly laterally offset with relation to radii A-O, B-O and C-O, and when contracted are contained within the slots 4 as shown at Fig. 1, and when expanded swing outwardly and upwardly to the position shown at Fig. 2, with their cutting edges 7a adapted to scrape the wall of a well bore when the tool is rotated.

Lugs 11 project from the bearing ends 7c of the cutters and are received in the portions of the slots 4 which communicate with the bore 5, the lugs being preferably cut away at one side as shown at 11a so as to clear the mandrel 6; and due to the laterally offset arrangement of the cutters with relation to radii of the body 1, the bearing ends 7c of the cutters may be of such radius R as to slightly overlie the periphery of the mandrel 6 as shown at S (Fig. 2), while still clearing the mandrel as shown at Figs. 3 and 4, and the lugs 11 may be of such size as to appreciably overlie the periphery of the mandrel as shown at T (Fig. 2), while still clearing the mandrel as shown at Figs. 3 and 4. Consequently the cutters may have a relatively large bearing radius R and their lugs 11 may be of relatively large size, insuring desired strength for the cutters, while still adapting the cutters

for complete contraction within the body 1 without unduly increasing the diameter of the body.

The operating connections for the cutters include abutments 12 on the mandrel 6 adapted to engage the lugs 11, there being one of said abutments for each of the cutters. Each abutment projects radially of the mandrel and of the body 1, perpendicular to the radius to which the corresponding cutter is parallel. For example, the abutment 12 for the cutter which is parallel to but laterally offset from the radius A—O, projects radially as shown at A'—O. Each of the abutments 12 is thus received in the portion of the corresponding slot 4 which communicates with the bore 5, and engages the corresponding lug 11 transversely thereof and parallel to the pivotal axis of the corresponding cutter, so that when the mandrel 6 is projected downwardly from the position shown at Fig. 1 to that shown at Fig. 2, the abutments 12 engage the lugs 11 and swing the cutters to expanded position, while elevation of the mandrel to the position shown at Fig. 1 permits the cutters to swing to contracted position received completely within the body 1.

The mandrel 6 may be shifted to expand the cutters by fluid pressure in the bore of the tool, and for this purpose the sub 2 may have a bore 15a which forms a cylinder 15 for a piston 17, with the bore of the sub open at its upper end for communication with the bore of the drill string in which the tool is incorporated. The piston 17 is fixed to the upper end of the mandrel for pressure responsive downward movement in the cylinder 15 so as to downwardly shift the mandrel, and the arrangement is preferably such that pressure of a washing medium in the bore of the drill string may be utilized for operating the piston, with a part of the washing medium then preferably discharging at the expanded cutters, and the remainder of the washing medium discharging through the lower end of the bore 5.

As an instance of this arrangement the mandrel 6 may be a hollow mandrel, opening at its upper end into the cylinder 15 through the piston 17, and opening at its lower end into the bore 5; and a plurality of ports 18, one for each of the cutters 7, are preferably provided in the peripheral wall of the hollow mandrel for lateral discharge therethrough into the slots 4 immediately below the cutters. When the cutters 7 are contracted and the hollow mandrel 6 is elevated as shown at Fig. 1, a plug 20 which is supported by the sub 2 preferably extends into the upper end of the bore of the hollow mandrel so as to appreciably restrict flow through said bore and thus maintain appreciable pressure against the piston 17 for depressing the mandrel and thereby swinging the cutters toward their operative position; but by the time the piston has depressed the mandrel so as to expand the cutters, the piston will have been shifted clear of the plug 20 as shown at Fig. 2, so that the entire flow through the drill string is then directed through the bore of the mandrel for discharge of a part of said flow through the ports 18 and thence through the slots 4 just below the expanded cutters, and discharge of the remainder of the flow into the lower portion of the bore 5 and thence through the bore of that portion of the drill string which depends from the body 1, so as to maintain usual circulation.

Downward movement of the mandrel 6 is preferably terminated by the piston 17 engaging a cooperating abutment surface 22 at the upper

end of the body 1, and with the parts in this position the mandrel has preferably not yet swung the cutters to fully expanded position. However the cutters are so nearly fully expanded as to engage the wall of the well bore so that the weight of the drill string completes the swinging movement of the cutters to their fully expanded position as determined by abutment of their surfaces 7b against the upper ends of the slots 4. This final swinging movement of the cutters after downward movement of the mandrel has been arrested, spaces the lugs 11 from the abutments 12 as shown at Fig. 2, and as a result of this lost motion connection the tool may be operated with its cutters expanded, with no wear between the lugs 11 and the abutments 12.

When the cutters are to be contracted the drill string is elevated, and as a result of binding engagement of the expanded cutters with the wall of the well bore the cutters are swung toward their contracted position. Further contraction of the cutters results if the drill string is withdrawn through an upper portion of the well bore, such as a casing string, which is of smaller diameter than that defined by the expanded cutters, and during said contraction of the cutters the mandrel 6 is preferably retracted by a spring 30 so that its abutments 12 offer no obstruction to free swinging movement of the cutters. The spring is preferably mounted in the bore 5 around the mandrel 6, between the piston 17 and a supporting collar 31 which seats on a shoulder in said bore. As soon as the force tending to hold the cutters in expanded position is relieved by elevating the drill string, the spring 30 thus retracts the mandrel so that the cutters are free for contraction.

The invention thus provides for utilizing cutters of maximum size and strength while permitting their complete contraction within the body of the tool, due to the arrangement whereby the cutters are laterally offset from radii of the tool so as to in part overlie the periphery of the mandrel and thus conserve space, with the arrangement as thus described permitting a simple operating connection between the mandrel and the cutters, and also permitting operation of the mandrel and circulation of a washing medium in accordance with usual and most efficient practice.

I claim:

1. In an expansible cutter tool, a body, a mandrel movable relative to the body, a cutter carried by the body with its inner portion overlying the periphery of the mandrel, and an operating connection between the mandrel and said overlying portion of the cutter for transversely shifting the cutting edge of the cutter by longitudinal movement of the mandrel.

2. In an expansible cutter tool, a body, a mandrel movable relative to the body, a cutter carried by the body in laterally offset relation to a radius of the body, and an operating connection between the mandrel and the cutter transversely shifting the cutting edge of the cutter by longitudinal movement of the mandrel.

3. In an expansible cutter tool, a body, a mandrel movable relative to the body, a cutter carried by the body in laterally offset relation to a radius of the body so that the inner portion of the cutter overlies the periphery of the mandrel, and an operating connection between the mandrel and said overlying portion of the cutter for transversely shifting the cutting edge of the cutter by longitudinal movement of the mandrel.

4. In an expansible cutter tool, a body, a man-

drel movable relative to the body, a cutter carried by the body, a lug at the inner portion of the cutter overlying the periphery of the mandrel, and an abutment on the mandrel for engaging the lug to transversely shift the cutting edge of the cutter by longitudinal movement of the mandrel.

5. In an expansible cutter tool, a body, a mandrel movable relative to the body, a cutter pivoted in the body with the inner portion of its bearing overlying the periphery of the mandrel, a lug at the inner portion of said bearing overlying the periphery of the mandrel, and an abutment on the mandrel for engaging the lug to swing the cutter by movement of the mandrel.

6. In an expansible cutter tool, a body having an axial bore and a slot in laterally offset relation to a radius of the body and communicating at its inner end with the axial bore, a mandrel in the axial bore, a cutter mounted in the slot with its inner portion overlying the periphery of the mandrel, and an operating connection between the mandrel and said overlying portion of the cutter for transversely shifting the cutting edge of the cutter by longitudinal movement of the mandrel.

7. In an expansible cutter tool, a body, a hollow mandrel movable relative to the body, the hollow mandrel being adapted to receive drilling fluid and having a lateral outlet for said drilling fluid, a plurality of cutters carried by the body with the inner portions of the cutters overlying the periphery of the mandrel in equi-distantly circumferentially spaced relation, and an operating connection between the mandrel and the inner portion of each of the cutters for transversely shifting the cutting edges of the cutters by longitudinal movement of the mandrel, said abutment being longitudinally above the outlet.

8. In an expansible cutter tool, a body, a mandrel movable relative to the body, a cutter carried by the body with its inner portion overlying the periphery of the mandrel, and an operating connection between the mandrel and said overlying

portion of the cutter for transversely shifting the cutting edge of the cutter by longitudinal movement of the mandrel, the mandrel being hollow and adapted for flow therethrough and discharge therefrom laterally past the cutter.

9. In an expansible cutter tool, a body, a mandrel movable relative to the body, a cutter carried by the body with its inner portion overlying the periphery of the mandrel, and an operating connection between the mandrel and said overlying portion of the cutter for transversely shifting the cutting edge of the cutter by movement of the mandrel, the cutting edge of the cutter in extended position being vertically disposed and forming a cutting edge of appreciable length, the mandrel being hollow and adapted for flow therethrough and having a port in its peripheral wall for lateral discharge therethrough adjacent the cutter.

10. In an expansible cutter tool, a body, a mandrel movable relative to the body, a cutter carried by the body with its inner portion overlying the periphery of the mandrel, an operating connection between the mandrel and said overlying portion of the cutter for transversely shifting the cutting edge of the cutter by longitudinal movement of the mandrel, and fluid pressure means for moving the mandrel.

11. In an expansible cutter tool, a body, a hollow mandrel movable relative to the body, the hollow mandrel being adapted to receive drilling fluid and having a lateral outlet for said drilling fluid, a cutter carried by the body with its inner portion overlying the periphery of the mandrel, an operating connection between the mandrel and said overlying portion of the cutter for transversely shifting the cutting edge of the cutter by movement of the mandrel, and means for limiting said movement of the mandrel, the operating connection permitting continued shifting of the cutter after said movement of the mandrel has been stopped.

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