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WELL TOOL CONSTRUCTION

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Fig. 1

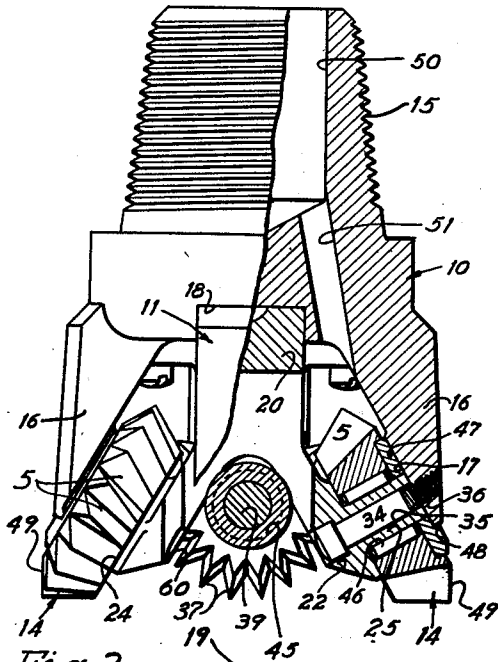


Fig. 2

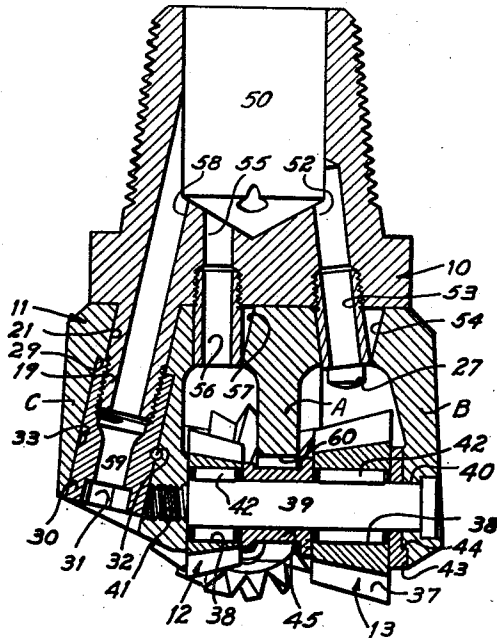


Fig. 3

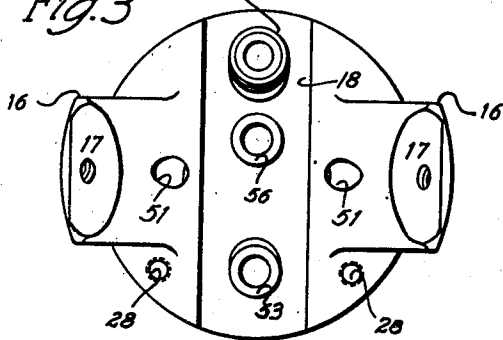


Fig. 4

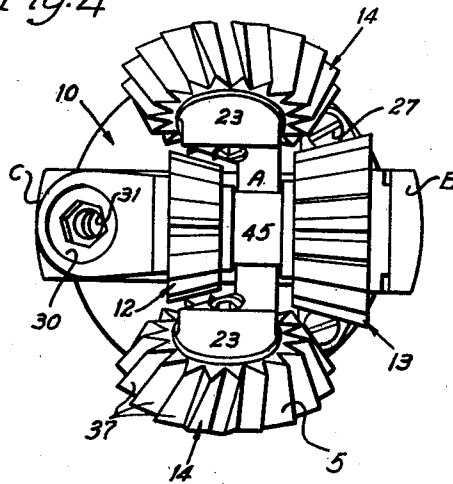
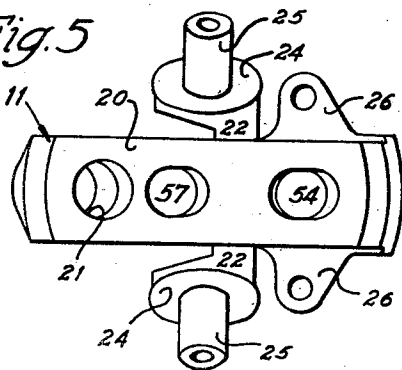


Fig. 5



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WELL TOOL CONSTRUCTION

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15 Claims. (Cl. 255—71)

This invention has to do with well drilling tools and has particular reference to a well drilling bit construction. A general object of the present invention is to provide a well tool construction wherein the active parts or cutters of the tool from elements of a simple, inexpensive and readily replaceable unit.

In many instances deep wells such as oil wells and gas wells are located a great many miles from transportation facilities and from machine shops making it extremely difficult, inconvenient and time consuming to replace and repair the worn parts, cutters, etc., of the well drilling tools employed in drilling the wells.

Another object of this invention is to provide a well bit in which all of the cutting parts or cutters are carried by or embodied in a compact conveniently portable unit that may be easily and quickly removed and replaced by a replacement unit. The cutter carrying unit of the present invention may be replaced by simple common tools at the derrick and the replacement unit is such that it may be easily transported to a well in a remote inaccessible region thus adapting the bit for the drilling of wells in such regions.

Another object of this invention is to provide a well bit of the character mentioned in which the cutters are easily detached following the removal of the cutter carrying unit whereby the cutters and their bearing parts may be individually replaced if necessary.

Another object of this invention is to provide a well bit of the character mentioned in which the cutters are dependably carried by the replaceable unit for efficient operation without rendering the unit complicated or expensive of manufacture.

Another object of this invention is to provide a well bit of the character mentioned involving novel and dependable means for removably securing the detachable cutter carrier to the shank.

Another object of this invention is to provide a well bit of the character mentioned in which the cutter carrier of the replaceable unit is simple and inexpensive of manufacture.

Another object of this invention is to provide a well bit of the character mentioned that embodies readily replaceable chokes or nozzles for discharging the circulation fluid, one of which constitutes a securing member for assisting in securing the cutter carrying unit to the shank.

A further object of this invention is to provide a roller type well bit of the character mentioned in which the circulation fluid is discharged downwardly adjacent the bottom of the well bore to

erode the formation and thus assist in the drilling action.

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

Fig. 1 is a side elevation of a bit embodying the construction of the present invention with a portion broken away to appear in central vertical cross section. Fig. 2 is a central longitudinal detailed sectional view of the bit taken in a plane at right angles to the plane of sectioning of Fig. 1. Fig. 3 is a bottom elevational view of the shank with the cutter carrying unit removed. Fig. 4 is a bottom elevation of the bit showing it in the same rotative position as in Fig. 2, and Fig. 5 is a top elevational view of the carrier of the replaceable unit removed from the shank.

The well bit provided by this invention includes generally, a shank 10 and a replaceable cutter carrying unit on the shank comprising a carrier 11 removably attached to the shank 10, inner cutters 12 and 13 on the carrier 11 and outer cutters 14 on the carrier 11.

The shank 10 is shaped and formed to effectively receive and support the carrier 11. The shank 10 is adapted to be connected with a drilling string and is provided at its upper end with means for facilitating its connection with the string. In the particular form of the invention illustrated in the drawing the connecting means is in the form of a tapered screw threaded pin 15 projecting from the upper end of the shank. The portion of the shank 10 immediately below the pin 15 may be cylindrical while the lower end of the shank is formed and provided with parts to receive and carry the carrier 11. Two integral legs 16 project downwardly and outwardly from the lower end of the shank 10. The legs 16 are diametrically opposite and their inner sides are inclined downwardly and outwardly. Finished bosses or bearing surfaces 17 are preferably provided on the inner sides of the legs 16. In accordance with the invention a diametric groove or slot 18 is provided in the lower end of the shank 10. The slot 18 may extend from one side to the other of the shank and its outer ends are preferably spaced substantially 90° between the diametrically opposite legs 16. The slot 18 may have flat vertical side walls and a flat horizontal upper wall. A downwardly and outwardly inclined boss or stud 19 projects from the upper wall of the slot 18 adjacent one end of the slot.

The boss or stud 19 is preferably integral with the shank 10.

The cutter carrying unit of the bit is an important element or feature of the invention. The unit carries or embodies all of the cutters of the bit and is such that it may be easily and quickly replaced whereby the bit may be readily reconditioned for further use after its original cutters, etc. have become worn. The replaceable cutter carrying unit is relatively compact so that it may be transported or shipped to remote regions to recondition a worn bit. The carrier 11 which forms the body or principal element of the replaceable cutter carrying unit is an integral spider-like member adapted to be attached to the lower end of the shank 10. The carrier 11 includes an elongate transversely or horizontally extending part 20 of substantially rectangular cross section adapted to fit in and cooperate with the slot 18. The upper surface of the part 20 is adapted to cooperate with the upper wall of the slot 18 to receive the downward pressures from the shank while the opposite sides of the part 20 cooperate with the side walls of the slot to receive the rotative or turning thrusts from the shank.

Three integral projections A, B and C project downwardly from the part 20 and constitute cutter carrying parts of the carrier 11. The projection A is adjacent and at one side of the central vertical axis of the bit, the projection B is spaced outwardly from the projection A at the same side of the said axis, while the projection C is spaced outwardly from the projection A and is disposed at the opposite side of the said axis from the projections A and B. The projection C is relatively thick and has a downwardly and outwardly inclined opening 21 for receiving the stud 19. A notch 60 having downwardly and outwardly inclined walls is provided in the lower end of the inner projection A. Integral legs or wings 22 project downwardly and outwardly from the lower end of the projection A and have substantially disc shaped bosses 23 on their lower portions presenting outwardly facing surfaces 24 which are substantially parallel with the surfaces 17 of the legs 16. The inner sides of the wings 22 are inclined and form the walls of the notch 60. Cylindrical bearing studs or pins 25 project upwardly and outwardly from the surfaces 24 at right angles thereto and their outer ends are adapted to bear on the surfaces 17 of the legs 16. The pins 25 are preferably integral with the bosses 23.

The invention provides novel dependable means for removably attaching the carrier 11 to the shank 10. Integral lugs 26 project laterally from opposite sides of the carrier part 20 to bear against or be adjacent the lower end of the shank 10. The lugs 26 are located at the opposite side of the central vertical axis of the bit relative to the stud 19. Studs or screws 27 are passed through openings in the lugs 26 and are threaded into openings 28 in the lower end of the shank 10 to attach or assist in securing the carrier 11 to the shank. The opening 21 in the carrier 11 receiving the stud 19 enters the projection C from its lower end and has a downwardly facing shoulder 29 on its wall spaced above the lower end of the stud 19. A member 30 is passed into the lower end of the opening 21 and is threaded on the stud 19 to bear upwardly against the shoulder 29 and thus assist in attaching the carrier 11 to the shank 10. A polygonal socket 31 in the lower end of the mem-

ber 30 is adapted to receive a tool for turning or threading the member. The member 30 may be locked in place by a pin 32 passed through a transverse opening in the projection C and co-operation with an annular groove 33 in the member 30. In addition to assisting in securing the carrier 11 to the shank 10 the member 30 serves two other very important functions which will be hereinafter described.

The means for removably attaching the carrier 11 to the shank 10 includes in addition to the screws 27 and the member 30 studs or screws 34 passed through longitudinal openings 35 in the bearing pins 25 and threaded into openings 36 in the legs 16. The heads of the screws 34 are counter-sunk in the inner sides of the bosses 23 and the threaded outer ends of the screws 34 may be peened at the outer sides of the legs 16 to lock the screws 34 against unthreading. The screws 27 and 34 and the member 30 securely and dependably attach the cutter carrier 11 to the shank 10. It is to be noted that the screws 27 and 34 and the member 30 may be easily engaged and turned by simple common tools.

The inner cutters 12 and 13 are carried by the carrier 11 to act on the inner portion of the bottom wall of the well bore. The cutters 12 and 13 are frusto-conical roller cutters having inclined peripheries provided with cutting parts or teeth 37. Each cutter 12 and 13 has a central longitudinal opening 38. The cutter 12 is supported for rotation between the projection A and the projection C to act on the formation at or adjacent the center of the bottom wall of the well bore while the cutter 13 is supported for rotation between the projection A and the projection B to have a path of action on the formation surrounding and overlapping the path of the cutter 12.

In accordance with the invention a single removable means or member rotatably supports the two cutters 12 and 13. A pin 39 is passed through a substantially horizontal opening 40 in the projection B and is threaded into an opening 41 in the lower portion of the projection C. The pin 39 passes through the openings 38 in the cutters 12 and 13 and roller bearings 42 may be provided in the openings 38 to support the cutters on the pin. The opening 41 joins the opening 19 and the inner end of the pin 39 may be grooved or shaped for engagement by the member 30 whereby the member holds the pin against turning. Thus the member 30 operates as a lock member to prevent displacement of the pin 39. A thrust washer 43 is arranged on the pin 39 between the outer end of the cutter 13 and the inner surface of the projection B. The washer 43 has shouldered engagement with the projection B at 44 which holds it against rotation. The pin 39 extends through the notch 60 and a spacer 45 is arranged on the pin to properly space the two cutters 12 and 13. The spacer 45 preferably has clearance with the walls of the notch 60. With this construction it is unnecessary to provide an opening in the projection A which is aligned with the openings 40 and 41 and it is not necessary to accurately finish the lower end of the projection A. The frusto-conical inner cutters 12 and 13 are rotatably supported on the pin 39 to have their smallest ends facing inwardly or toward the central vertical axis of the bit. The cutters 12 and 13 project downwardly beyond the lower ends of the projections A, B and C so that their inclined cutting teeth 37 may act on the formation at the bottom of the well bore.

The outer cutters 14 are provided to act on the outer portion of the well bore and trim or ream the well to gauge. The cutters 14 are substantially frusto-conical having inclined peripheries provided with cutting parts or teeth 5. The teeth 5 are preferably spiralled and the teeth of one cutter 12 may be spiralled in a right-hand direction while the teeth of the other cutter may be spiralled in a lefthand direction so that the teeth of the two cutters cannot track in their engagement with the earth formation. The outer roller cutters 14 are rotatably supported on the bearing pins 25 between the bosses 23 and the legs 16 to rotate about downwardly and inwardly inclined axes. Roller bearings 46 may rotatably mount the cutters 14 on the bearing pins 25. Thrust washers 47 are provided on the pins 34 at the outer ends of the cutters 14 to bear on the surfaces 17 of the legs 16. The washers 47 have shouldered engagement with the legs 16 at 48, which engagement holds them against turning. The outer corners 49 of the teeth 5 are preferably bevelled to be substantially vertical as they come into engagement with the formation at the bottom of the well.

The invention provides means for flushing the cutters 12, 13 and 14 and for directing a stream of circulation fluid against the bottom of the well. A socket or opening 50 enters the shank 10 from the upper end of its pin 15. Ports 51 extend downwardly and outwardly through the shank 10 from the lower end of the opening 50 to discharge streams of circulation fluid against the outer cutters 14 to effectively flush the cutters. A port 52 extends downwardly from the opening 50 and a replaceable nozzle or choke 53 is threaded into its lower end. The choke 53 projects from the upper wall of the slot 18 and is received by an opening 54 in the carrier part 20. The choke 53 discharges a stream of circulation fluid downwardly against the cutter 13. A port 55 extends downwardly from the lower end of the opening 50 and a replaceable choke 56 is threaded in the lower end of the port 55 to project from the upper wall of the slot 18. An opening 57 in the carrier part 20 receives or passes the choke 56 so that the choke is adapted to discharge a stream of circulation fluid downwardly against the inner cutters 12. The openings 54 and 55 are shaped to readily receive the chokes 53 and 56 when the carrier 11 is arranged on the shank 10 to have its opening 21 receive the inclined stud 19.

In accordance with the invention a downwardly and outwardly inclined port 58 extends through the shank 10 from the opening 50 and continues longitudinally through the stud 19. The member 30 is tubular having a longitudinal opening 59 whose upper end communicates with the port 58. The opening 59 is adapted to discharge circulation fluid downwardly and outwardly through the polygonal socket 31 so that the member 30 operates as a nozzle or choke. The circulation fluid issuing from the opening 59 discharges downwardly and outwardly adjacent the side wall of the well bore to assist in the drilling action and to provide a desirable turbulence in the lower portion of the well.

In operation of the bit the shank 10 is connected with the lower end of the drilling string and the bit is operated on the lower end of the string in the usual manner. As the bit is rotated and fed downwardly the inner cutters 12 and 13 act on and cut away the formation in the central portion of the bottom wall of the bore while the outer cutters 14 act on and cut away the forma-

tion at the outer portion of the bore and cut the bore to gauge. The cutters 12, 13 and 14 are positioned so that the bit is well balanced and has active engagement with the entire bottom wall of the well during each complete revolution. The circulation fluid pumped downwardly through the drilling string discharges from the ports 51 to flush and clean the outer cutters 14 and discharges from the chokes 56 and 53 to flush the inner cutters 12 and 13. A stream of circulation fluid under pressure is also discharged from the opening 59 and socket 31 of the member 30. This stream of fluid is discharged downwardly and outwardly adjacent the side wall of the well to assist in the drilling operation and to maintain an effective turbulence. The walls of the slot 18 cooperate with the part 20 of the carrier 11 to transmit the downward pressures and the turning forces to the carrier so that the stud 19, the screws 27 and 34 and the chokes 53 and 56 are not subjected to these forces. The screws 27 and 34 and the member 30 hold the part 20 of the carrier 11 in the slot 18 and positively prevent displacement of the carrier from the shank. The member 30 is locked against displacement by the pin 32 and the member 30 operates to lock the screw 39 against unthreading. The cutters 12, 13 and 14 are supported for free independent rotation.

When the cutters have become worn the carrier 11 may be easily and quickly detached from the shank 10 by simple tools. The screws 27 and 34 and the member 30 are easily unthreaded to permit the detachment of the carrier 11 from the shank. The chokes 53 and 56 are also easily removed for replacement when worn. If desired or found necessary the carrier 11 may be replaced by a new or replacement carrier having new cutters 12, 13 and 14. The cutters 12, 13 and 14 are mounted on the carrier 11 so that they may be easily and quickly detached from the carrier for independent replacement when worn or broken. The carrier 11 is compact and easy to transport adapting the bit for employment in the drilling of wells in remote inaccessible regions. The carrier 11 is a simple, integral part and the shank 10 is a one-piece member that is inexpensive to manufacture.

Having described only a typical preferred form and application of my invention I do not wish to be limited or restricted to the specific details herein set forth, but wish to reserve to myself any variations or modifications that may appear to those skilled in the art or fall within the scope of the following claims.

Having described my invention, I claim:

1. A well bit including a shank having a polygonal opening, and a replaceable cutter unit comprising a plurality of roller cutters, a carrier supporting the cutters for operation having a polygonal part fitting said opening whereby the carrier turns with the shank, and means removably connecting the carrier to the shank to retain the said part in the opening, there being a port in the shank for conducting circulation fluid, said means including a member threadedly connected with the body and engaging the carrier and having a fluid discharge port communicating with the port in the shank to discharge the fluid into the well.

2. A well bit including a shank having spaced depending legs, and a replaceable unit comprising a carrier detachably connected to the shank, spaced wings projecting downwardly from the carrier, pins projecting from the wings toward the legs, outer cutters rotatable on the pins,

spaced projections on the lower end of the carrier, a pin passing between the wings without contacting the same and having its opposite ends supported on the projections, and inner cutters rotatable on said pin at opposite sides of the central longitudinal axis of the bit.

3. A well bit including a shank having spaced depending legs, and a replaceable unit comprising a carrier detachably connected to the shank, spaced wings on the carrier opposing the legs, bearing pins on the wings, screws tying the pins to the legs, outer cutters rotatable on the bearing pins, spaced projections on the carrier, a pin passing between the wings without bearing on the same and supported by the projections, and inner cutters rotatable on the said pin.

4. A well bit including a shank having spaced depending legs, a detachable carrier on the lower end of the shank having spaced wings opposing the legs, tubular bearing pins on the wings projecting toward the legs, outer cutters rotatable on the bearing pins, screw members extending outwardly through the tubular bearing pins and threaded into openings in the legs to connect the legs and wings, spaced projections on the lower end of the carrier, a pin passing between the wings and carried by the projections, and inner cutters rotatably supported on the pin.

5. A cutter unit for a well bit comprising a carrier having two spaced upwardly and outwardly projecting pins and spaced downwardly projecting projections spaced from the pins, cutters rotatable on the pins, a bearing pin passing transversely between said pins and supported by the projections, and cutters on the bearing pin.

6. A cutter unit for a well bit comprising an integral carrier including depending wings having outwardly projecting pins, and spaced depending projections spaced from the pins, a pin passing transversely between the wings and supported on the projections, and roller cutters rotatable on the pins.

7. A cutter unit for a well bit comprising an integral carrier including depending wings having outwardly projecting pins, and spaced depending projections, a pin passing between the wings and supported on the projections, outer roller cutters on said pins, inner roller cutters on the said pin, and a spacer carried by the pin between the said cutters and located between the wings.

8. A cutter unit for a well bit comprising an integral carrier including depending wings having outwardly projecting pins, and spaced depending projections, a pin passing between the wings and supported in an opening in one projection and threaded in an opening in the other projection, and an inner roller cutter rotatable on said pin.

9. A cutter unit for a well bit comprising an integral carrier including, a polygonal part adapted to fit an opening in the bit shank, depending wings having outwardly projecting pins, and spaced depending projections, a pin passing between the wings and supported on the projections, and roller cutters rotatable on the pins.

10. A well bit including a shank having depending legs, there being fluid ports in the shank, fluid discharge members extending from the ports and projecting from the lower end of the shank, a carrier removably attached to the lower end of the shank and having openings receiving the discharge members, parts on the carrier having pins extending outwardly to the legs, cutters rotatable on the pins, spaced projections on the carrier, a pin extending between and carried by the projections, and rotatable cutters on the pin flushed by fluid discharged from the members.

11. A well bit including a shank having fluid ports, discharge members communicating with the ports and projecting from the lower end of the shank, a removable carrier on the lower end of the shank having openings receiving the discharge members, and roller cutters carried by the carrier where they are flushed by fluid from the members.

12. A well bit including a shank having fluid ports, discharge members communicating with the ports and projecting from the lower end of the shank, a removable carrier on the lower end of the shank having openings receiving the discharge members, projections on the carrier, a removable pin extending between and carried by the projections, a part threaded on one of said members and holding the pin against displacement, and a roller cutter rotatable on the pin.

13. A well bit including a shank having fluid ports, discharge members communicating with the ports and projecting from the lower end of the shank, a removable carrier on the lower end of the shank having openings receiving the discharge members, projections on the carrier, a removable pin extending between and carried by the projections, a part threaded on one of said members connecting the carrier with the shank and holding the pin against displacement, and a roller cutter rotatable on the pin.

14. A well bit including a shank having fluid ports, discharge members communicating with the ports and projecting from the lower end of the shank, a removable carrier on the lower end of the shank having openings receiving the discharge members, projections on the carrier, a removable pin extending between and carried by the projections, a part threaded on one of said members to discharge the circulation fluid and holding the pin against displacement, and a roller cutter rotatable on the pin.

15. A well bit including a shank having fluid ports, discharge members communicating with the ports and projecting from the lower end of the shank, a removable carrier on the lower end of the shank having openings receiving the discharge members, a removable pin on the carrier, a rotatable cutter on the pin flushed by fluid discharged from one of said members, and a tubular part threaded on the other member to discharge the fluid and operating to connect the carrier to the shank and prevent displacement of the pin.

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