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J. H. HOWARD ET AL

2,068,327

DISK BIT

Filed April 27, 1935

FIG. 1

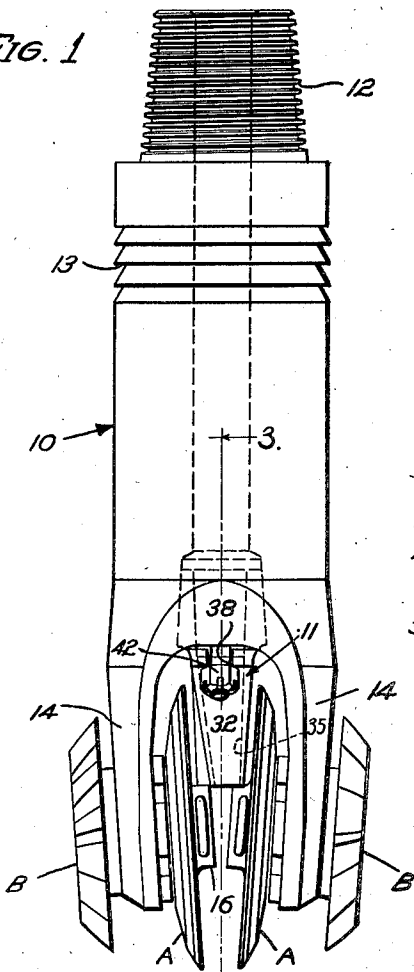


FIG. 3

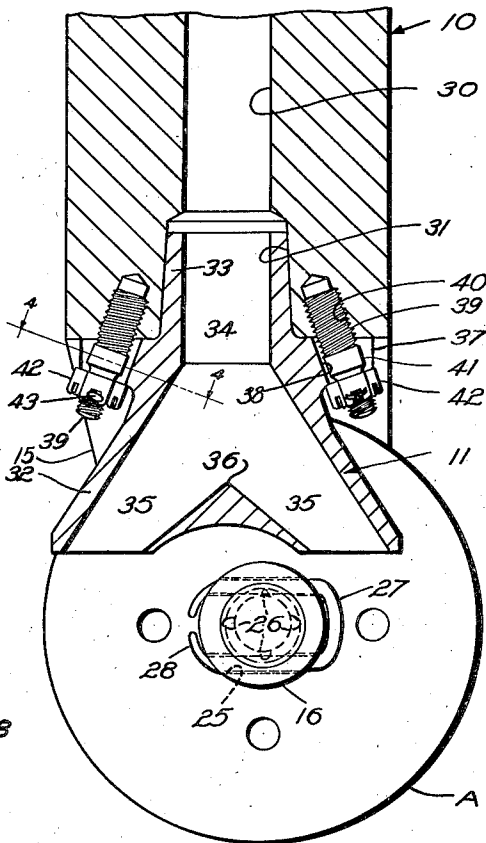


FIG. 2

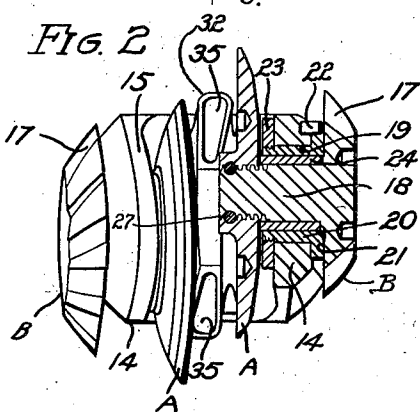
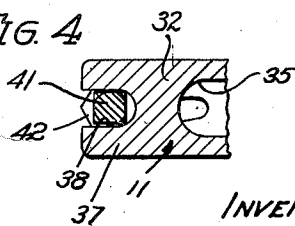


FIG. 4



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## UNITED STATES PATENT OFFICE

2,068,327

## DISK BIT

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Application April 27, 1935, Serial No. 18,547

10 Claims. (Cl. 255—71)

This invention relates to a well drilling bit and relates more particularly to a disk bit for use in the rotary method of well drilling.

Bits having rotatable disk cutters have been employed for some time in the rotary method of deep well drilling. Disk bits have proven very satisfactory except that they have a tendency to "ball up" or become encumbered with mud and cuttings so that their efficiency is sometimes greatly impaired. During operation the cutters of such bits drag mud and cuttings up into the crotch of the bit and a ball or mass of the mud and cutting accumulates which often becomes so large and heavy that it prevents the disk cutters from rotating.

A general object of this invention is to provide a disk bit for use in the rotary method of well drilling embodying means employing and directing the circulation fluid in a manner to prevent cuttings and mud from interfering with its operation, thus greatly improving the drilling speed and the efficiency of the bit.

Another object of this invention is to provide a disk bit that includes a novel fluid discharge device or nozzle that directs the circulation fluid against the cutting edge portions of the principal disk cutters to keep the cutters free of accumulations of mud and to prevent the "balling up" of the bit.

Another object of the invention is to provide a disk bit in which the circulation fluid under pressure is discharged against the peripheral portions of the cutters at points as close as practicable to the bottom of the well bore to maintain an effective turbulence and agitation at the bottom of the bore as well as to flush the cutters.

Another object of the invention is to provide a disk bit that includes a particularly effective and long wearing replaceable fluid discharge nipple or nozzle for directing the fluid against the disk cutters and into the bottom portion of the well bore.

Another object of this invention is to provide a disk bit of the character mentioned in which the fluid discharge nozzle is dependably secured in position without the danger or possibility of fluid leaking between it and the shank to erode or cut away the shank.

A further object of this invention is to provide a disk bit of the character mentioned in which the fluid discharge nozzle may be very easily and quickly replaced when worn.

This application is a continuation in part of

our co-pending application, Serial No. 723,894, entitled Rotary disk bit.

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 the invention, throughout which description reference is made to the accompanying drawing, in which:

Fig. 1 is a side elevation of the bit provided by this invention. Fig. 2 is a bottom view or elevation of the bit with a portion in transverse cross section to illustrate the rotatable mounting of one pair of cutters. Fig. 3 is an enlarged vertical detailed sectional view taken substantially as indicated by line 3—3 on Fig. 1 and Fig. 4 is an enlarged transverse detailed sectional view taken substantially as indicated by line 4—4 on Fig. 3.

The well tool or bit provided by this invention includes, generally, a body or shank 10, two pairs of cutters A and B mounted on the shank 10 for rotation in unison, and means 11 for directing circulation fluid against the cutters A to flush the cutters free of mud and cuttings and to maintain a suitable turbulence in the lower portion of the well bore.

The shank 10 is adapted to be connected with the lower end of a well drilling string to be operated in a well bore. The body or shank 10 is an elongate member whose upper major portion is substantially cylindrical. A screw threaded pin 12 may be provided on the upper end of the shank 10 to facilitate the connection of the shank with a drill collar or other part of the well drilling string. Wickers 13 may be provided on the shank 10 so that the bit may be readily engaged by a fishing tool in the event that it is stuck or lost in the well. A pair of spaced legs 14 project downwardly from the lower end of the shank 10. Each leg 14 carries a pair of cutters A and B. The leading sides or edges of the legs 14, relative to the direction of rotation of the bit, may be vertical while the trailing edges 15 of the legs are preferably inclined downwardly and forwardly. The legs 14 are downwardly convergent each having flat substantially parallel inner and outer surfaces inclined downwardly and inwardly relative to the longitudinal axis of the shank 10.

The cutters of the bit are arranged in two pairs each pair comprising an inner cutter A and an outer cutter B. The cutters A and B of each pair are mounted and connected to rotate in unison. The cutters A and B are in the nature of disk cutters. The inner cutters A are the

principal cutters of the bit for drilling the well bore while the outer cutters B are reaming cutters and in addition to reaming or cutting the bore to size the outer cutters B operate to cause rotation of the inner cutters A.

The inner cutters A are disposed adjacent the inner sides of the legs 14 and project downwardly and forwardly from the legs. The inner cutters A may have plain untoothed peripheries or cutting edges and flat inner surfaces. Bosses 16 are provided on the inner sides of the inner cutters A. The outer cutters B are arranged at the outer sides of the legs 14 and are smaller in diameter than the inner cutters A to trail the cutters A in their engagement with the earth formation. Peripheral cutting parts or teeth 17 are provided on the outer cutters B. The teeth 17 are preferably pitched or spiralled and have bevelled active edges for properly contacting the wall of the well bore.

An axle 18 projects from the inner side of each outer cutter B. The axles 18 are rigid with the cutters B and are preferably integral with the cutters, as illustrated in Fig. 2 of the drawing. The axles 18 extend through transverse openings 19 in the legs 14 to project from the inner sides of the legs to carry the cutters A. The longitudinal axes of the openings 19 are inclined downwardly and outwardly being substantially normal with the side surfaces of the legs 14. The openings 19 in the legs 14 are axially offset forwardly with respect to one another relative to the direction of rotation of the bit.

Bearings 20 are arranged in the openings 19 and have flanges 21 on their outer ends which bear on the outer sides of the legs 14. Dowel pins 22 cooperate with the flanges 21 to hold the bearings 20 against rotation. Nuts 23 are threaded on the inner ends of the bearings 20 and are adapted to clamp against the inner surfaces of the legs 14. Hardened wear taking bushings 24 may be force-fitted on the axles 18 to operate in the bearings 20. The principal cutters or inner cutters A are threaded on the inner ends of the axles 18 to bear against the ends of the bushings 24. Means is provided for removably locking the cutters A on the axles 18 to prevent unthreading and displacement of the cutters. Parallel tangential openings 25 are provided in the bosses 16 and openings or notches 26 are provided in the axles to register or communicate with the openings 25. Substantially U-shaped lock members 27 are inserted in the openings 25 to cooperate with the notches 26 for the purpose of locking the cutters A against unthreading from the axles 18. The ends 28 of the side parts of the members 27 may be bent over to prevent displacement of the lock members from the openings 25. The cutters A and B mounted as just described project downwardly from the lower ends of the legs 14 and forwardly from the leading edges of the legs 14 and are pitched or toed downwardly and inwardly with respect to the longitudinal axis of the drill.

The means 11 is an important feature of the present invention and assures the effective rapid operation of the bit by maintaining the cutters free of accumulations of mud and by preventing the "balling up" of the bit and the accumulation of heavy mud in the bottom of the well bore. In accordance with the invention a central longitudinal opening or fluid passage 30 is provided in the shank 10. The upper end of the passage

30 is adapted to communicate with the opening or passage in the well drilling string. In accordance with the invention an enlargement or socket 31 is provided in the lower end of the passage 30. The socket 31 may be round in transverse cross section and is tapered having downwardly and outwardly inclined walls.

The fluid handling means 11 includes a novel nipple or nozzle 32. The nozzle 32 is provided to carry or conduct the circulation fluid as close as practicable to the bottom of the well bore and direct a stream of the fluid against the peripheral portion of each inner cutter A to flush the cutters and maintain a turbulence in the bottom of the bore. The nozzle 32 has a tapered shank or stem 33 adapted to fit the socket 31. The nozzle 32 is transversely enlarged or widened and projects downwardly between the upper portions of the cutters A. In practice the lower end of the nozzle 32 may be in or adjacent the plane of the upper parts of the bosses 16. The nozzle 32 has a fluid passage 34 which extends downwardly through the stem 33 and then divides into two branches 35. The branches 35 extend downwardly and outwardly and discharge at the lower end of the nozzle 32 to direct the circulation fluid against the inner surfaces of the cutters A adjacent the peripheries of the cutters. The branch passages or branches 35 are pitched and shaped to direct the streams of fluid past the bosses 16 and downwardly and outwardly and laterally toward the inner faces of the cutters A to impinge against the peripheral portions of the cutters adjacent the bottom of the well bore. As clearly illustrated in Fig. 1 of the drawing one wall of each branch 35 is inclined laterally toward a cutter A to direct the fluid against the inner side of the inclined or inwardly toed cutter. The outer side or exterior of the nozzle 32 may follow, generally, the direction and configuration of the branches 35 and its side surfaces have suitable clearance with the inner surfaces of the cutters A. The lower walls of the passages or branches 25 converge upwardly and inwardly to join at a point or edge 36 which is effective in dividing the main downwardly flowing column of fluid into two branches or streams which pass out through the branches 35.

The nozzle 32 is removable and the invention provides simple and particularly effective means for removably attaching the nozzle to the shank 10. Projections or lugs 37 project from opposite sides of the nozzle 32 at the lower end of the shank 10. The lugs 37 each have an opening or slot 38. Pins or studs 39 are threaded into downwardly and outwardly inclined openings 40 in the lower end of the shank 10 and project from the lower end of the shank. When the stem 33 is inserted in the socket 31 to position the nozzle 32 on the shank the slots 37 receive the projecting portions of the studs 39. In accordance with the invention the studs 39 have squared or polygonal portions 41 which occupy or are disposed within the slots 38. The slots 38 are proportioned to readily pass the studs 39 but the polygonal portions 41 are proportioned so that they cannot turn in the slots. The polygonal portions 41 of the studs 39 cooperate with the walls of the slots 37 to prevent turning of the studs and thus prevent unthreading and loss of the studs. Nuts 42 are threaded on the outer portions of the studs 39 and cooperate with the lugs 37 to urge the nozzle stem 33 into the socket 31 and to secure or attach the nozzle to the shank 10. The tapered stem 33 urged up-

wardly into the tapered socket 31 tightly seals with the wall of the socket to prevent the leakage of fluid from the socket. Cotter pins or keys 43 may be employed to lock the nuts 42 on the studs 39.

In the operation of the bit the drilling string is rotated and fed downwardly in the usual manner. The principal cutters or inner cutters A act on the formation at the bottom of the well bore to drill into the formation while the outer cutters B engage the side wall of the bore adjacent its bottom to ream the bore to size and to positively cause rotation of the principal cutters A. Rotary mud or circulation fluid is continuously passed downwardly through the drilling string under pressure to discharge from the nozzle 32.

The passages or branches 35 of the nozzle 32 direct the fluid under pressure downwardly and outwardly against the inner sides of the cutters A adjacent the cutting edges of the cutters to flush the cutters free of mud and cuttings. The nozzle 32 conducts the fluid to a point adjacent the bottom of the well bore so that it is effective in maintaining a turbulence in the bottom of the bore. In addition to flushing the cutters and maintaining a turbulence in the bottom of the bore the circulation fluid under pressure issuing from the nozzle 32 may have a hydraulic action in washing away the formation and thus aid the cutters in the drilling operation. The fluid under pressure discharging from the branches 35 of the nozzle 32 prevents the mud and cuttings from accumulating on the cutters A and thus prevents the bit from "balling up". As the cutters A are maintained free of accumulations of mud and cuttings they are rapid and efficient in their cutting action and are long wearing. As the mud is prevented from accumulating on the cutters A it does not form a mass or ball in the crotch of the bit and cannot interfere with the free efficient operation of the bit.

The nuts 42 threaded on the studs 39 urge the nozzle stem 33 into the socket 31 to maintain a tight sealing contact between the nozzle and the shank to prevent the leakage of the fluid under pressure from around the stem 33. Thus the fluid under pressure cannot erode or cut away the shank around the nozzle. The studs 39 are locked against unthreading from the openings 40 by the cooperation of the polygonal portions 41 with the slots 38 and the nuts 42 are locked on the studs by the keys 43 so that the nozzle 32 is dependably attached to and retained on the shank 10. The nozzle 32 may be easily and quickly detached from the shank 10 when it becomes worn. To remove the nozzle 32 the keys 43 are withdrawn and the nuts 42 are unthreaded from the studs 39 whereupon the nozzle 32 may be jarred and its stem 33 removed from the socket 31. It will be apparent how a new or replacement nozzle may be readily attached to the shank 10. The removal and replacement of the nozzles does not in any way wear or deface the shank 10 to allow or permit the leakage of fluid under pressure from around the nozzle. Heretofore it has been the common practice to thread jets and nozzles directly in openings in the shanks of the bits. The repeated removal and replacement of the jets and nozzles causes wear and defacement of the threads of the shank and results in loosening of the jets and nozzles and the leakage of fluid. In the present invention

the attaching means is independent of the stem 33 which seals with the shank and repeated replacement of the nozzle does not injure the shank 10 to cause the leakage of fluid or the loosening of the replacement nozzle.

Having described only a typical 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 modifications or variations that may appear to those skilled in the art or fall within the scope of the following claims:

Having described our invention, we claim:

1. A well bit including a shank, spaced legs on the lower end of the shank, spaced rotatable disk cutters at the inner sides of the legs, there being a fluid passage in the shank, and a nozzle at the lower end of the passage projecting downwardly between the cutters, the nozzle having branches each located and formed to direct a stream of fluid downwardly and laterally outwardly toward a cutter to impinge against the same adjacent the bottom of the well bore.

2. A well bit including a shank, spaced legs on the lower end of the shank, spaced rotatable disk cutters at the inner sides of the legs, there being a fluid passage in the shank, and a nozzle at the lower end of the passage projecting downwardly between the cutters to a point adjacent the axes of rotation of the cutter and having outlets directed downwardly and laterally outwardly to discharge streams of fluid downwardly and laterally toward the cutters to impinge against and flush the cutters adjacent the bottom of the well bore.

3. A well bit including a shank, spaced legs projecting from the lower end of the shank, rotatable cutters on the inner side of the legs, there being a fluid passage in the shank having an enlargement in its lower end, a nozzle projecting downwardly between the cutters, a stem on the nozzle received in the said enlargement, and means remote from the stem for removably attaching the nozzle to the shank.

4. A well bit including a shank, spaced legs projecting from the lower end of the shank, rotatable cutters on the inner side of the legs, there being a fluid passage in the shank having a tapered socket in its lower end, a nozzle projecting downwardly between the cutters, a tapered stem on the nozzle received in the socket, and means remote from the stem for urging the stem into the socket and for removably attaching the nozzle to the shank.

5. A well bit including a shank, spaced legs projecting from the lower end of the shank, rotatable cutters on the inner side of the legs, there being a fluid passage in the shank having an enlargement in its lower end, a nozzle projecting downwardly between the cutters, a stem on the nozzle received in the said enlargement, and means remote from the stem for removably attaching the nozzle to the shank, said means including a stud projecting from the shank at a point spaced from the stem, a projecting lug on the nozzle, and a nut on the stud engaging the lug.

6. A well bit including a shank, spaced legs projecting from the lower end of the shank, rotatable cutters on the inner side of the legs, there being a fluid passage in the shank having an enlargement in its lower end, a nozzle projecting downwardly between the cutters, a stem on the nozzle received in the said enlargement, and means remote from the stem for removably

- attaching the nozzle to the shank, said means including spaced studs spaced from said enlargement of the passage and projecting from the shank, nuts threaded on the studs and cooperating with the nozzle, and means locking the nuts against unthreading from the studs.
7. A well bit including a shank, spaced legs projecting from the lower end of the shank, rotatable cutters on the inner side of the legs, there being a fluid passage in the shank having an enlargement in its lower end and an opening in the lower end of the shank spaced from the fluid passage, a nozzle projecting downwardly between the cutters, a stem on the nozzle received in the said enlargement, and means attaching the nozzle to the shank including a stud threaded in said opening, a nut on the stud cooperating with the nozzle, and means preventing unthreading of the stud from its opening in the shank.
8. A well bit including a shank, spaced legs projecting from the lower end of the shank, rotatable cutters on the inner side of the legs, there being a fluid passage in the shank having an enlargement in its lower end, a nozzle projecting downwardly between the cutters, a stem on the nozzle received in the said enlargement, there being a flat walled opening in the nozzle, a stud threaded in an opening in the shank and extending through the flat walled opening, a portion of the stud cooperating with the walls of the flat walled opening to prevent unthreading of the stud, and a nut on the stud cooperating with the nozzle to attach the nozzle to the shank.
9. A well bit including a shank, spaced legs projecting from the lower end of the shank, rotatable cutters on the inner side of the legs, there being a fluid passage in the shank having a tapered socket in its lower end, a nozzle projecting downwardly between the cutters, a tapered stem on the nozzle received in the socket, and means removed from the stem for urging the stem into the socket and for removably attaching the nozzle to the shank, said means including downwardly and outwardly inclined studs projecting from the shank at points spaced from the socket, and nuts threaded on the studs cooperating with the nozzle.
10. In a well bit, a shank having a fluid passage, a discharge nozzle at the lower end of the passage, there being an opening in the shank, and a slot in the nozzle, and means for removably attaching the nozzle to the shank including a stud threaded in the opening, a portion on the stud cooperating with the slot to prevent unthreading of the stud, and a nut threaded on the stud and cooperating with the nozzle.

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