United States Patent [19]

Fowler et al.

[11] **3,845,830**

[45] **Nov. 5, 1974**

[54] **METHOD FOR MAKING HIGH PENETRATION RATE DRILL BITS AND TWO BITS MADE THEREBY**

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[22] Filed: **Feb. 22, 1973**

[21] Appl. No.: **334,828**

[52] **U.S. Cl.** **175/404,** 175/327

[51] **Int. Cl.** **E21b 9/16**

[58] **Field of Search** 175/404, 403, 331, 329, 175/330

[56] **References Cited**

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Primary Examiner—John E. Murtagh
Assistant Examiner—Richard E. Favreau
Attorney, Agent, or Firm—Thomas H. Whaley; C. G. Ries

[57] **ABSTRACT**

A method for forming a drill bit for drilling through either consolidated or unconsolidated sedimentary sections comprises (1) forming a recess in the bottom cutting surface of the drill bit, and (2) shaping the recessed cutting surface into a continuous non-cylindrical surface of revolution having a height to radius ratio of substantially three to one. Two other methods are disclosed. A preferred drill bit made by the method has a conical recess, and another has a paraboloidal recess, each recess having a vertex and a plurality of exit transverse passages. The exit passages have spaced apart inlet openings around their vertex, one modification having the openings spaced from each other around its vertex and another having the openings tangent to each other around its vertex for forming a very efficient and high penetration rate drill bit.

13 Claims, 4 Drawing Figures

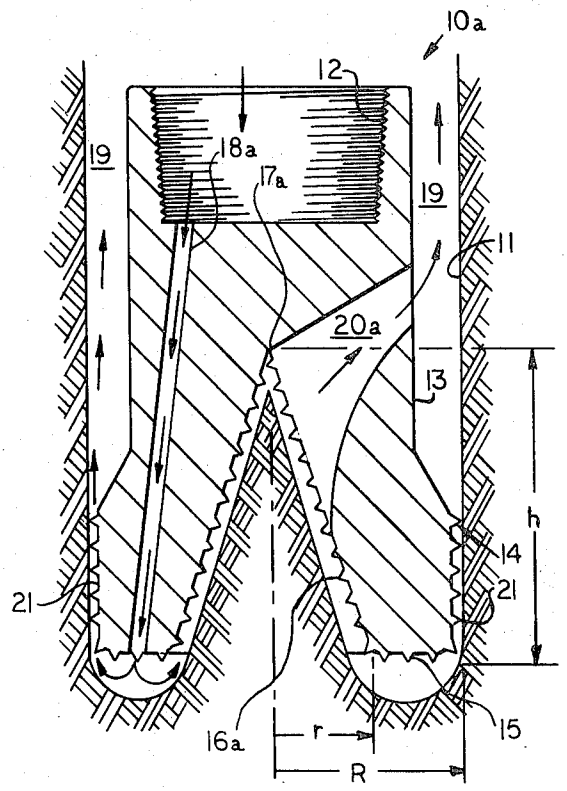


Fig-2

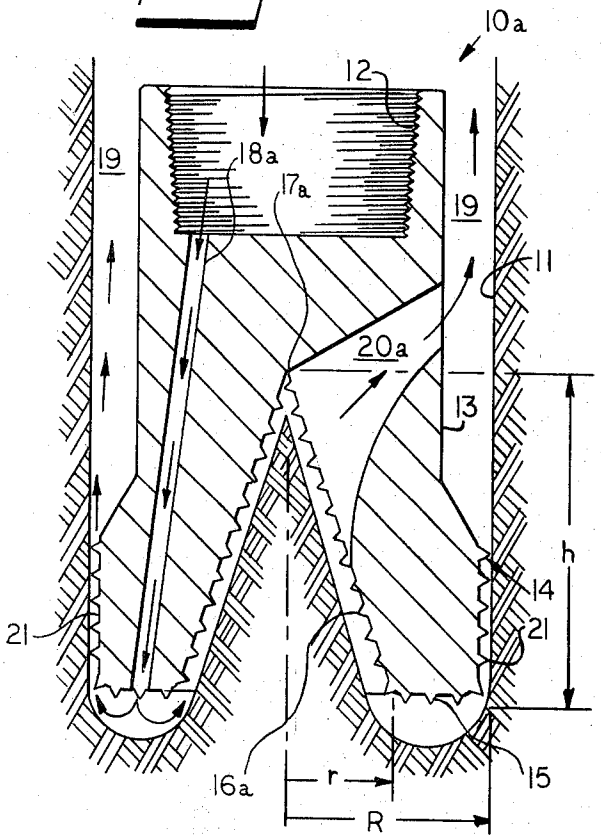
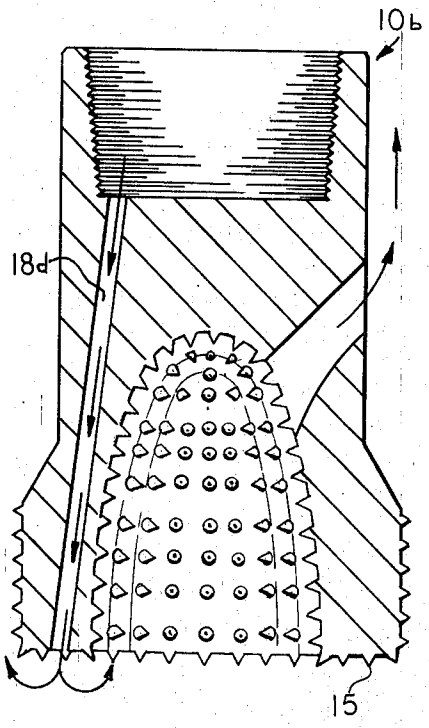


Fig-4



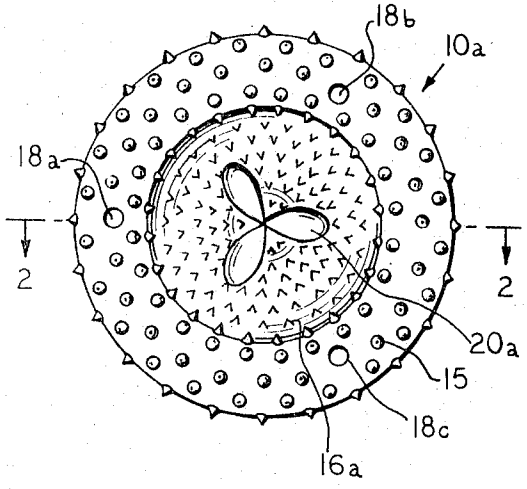


Fig-1

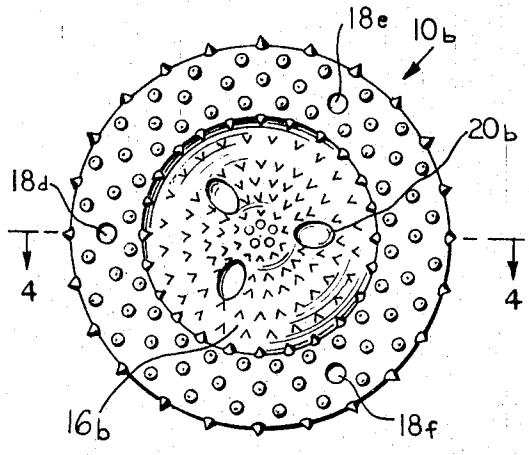


Fig-3

METHOD FOR MAKING HIGH PENETRATION RATE DRILL BITS AND TWO BITS MADE THEREBY

BACKGROUND OF THE INVENTION

While drilling wells, such as wells for the recovery of petroleum from subsurface petroleum containing formations, the better the design of the drill bit the faster the well can be drilled and accordingly the costs reduced. Many different types of drill bits have been designed and built, all in quest of the optimum fastest drilling drill bit.

The conventional core bit has been modified as in U.S. Pat. No. 1,867,024 wherein the core is first formed while drilling and a "blade" added to break up the core. In U.S. Pat. No. 2,626,780, a conical secondary cutting bit is added to an annular bit and mounted internally of the annular coring head drill bit for rotating relative thereto, it having a separate shaft and turbine blades for being rotated. U.S. Pat. No. 3,055,443 shows another coring drill bit with additional rotatable cutters for grinding up the core first formed. U.S. Pat. No. 3,215,215 is a typical diamond bit with a small recess in the center bottom with a "crow's foot" in the bottom recess wherein the larger portion of the bottom cutting area is on the outer annular portion, leaving the smaller cutting area in the recessed center portion. All of these designs are complicated with a plurality of different parts and/or surfaces to form the complete drill bit. All are thus much more expensive to manufacture and maintain than a single integral surfaced drill bit. Reliability and ease of assembly are lost when one or more additional moving parts are added to a drill bit.

OBJECTS OF THE INVENTION

Accordingly, a primary object of this invention is to provide reliable and simple methods for forming drill bits having a high penetration rate of drilling through either consolidated or unconsolidated sedimentary sections.

Another primary object of this invention is to provide high penetration rate drill bits by the new methods.

A further object of this invention is to provide drill bits that are easy to operate, are of simple configuration, are economical to build and assemble, and are of greater efficiency for drilling through the various sedimentary sections.

Other objects and various advantages of the disclosed methods of making a drill bit and drill bits made by the disclosed methods or by other methods will be apparent from the following detailed description, together with the accompanying drawings, submitted for purposes of illustration only and not intended to define the scope of the invention, reference being had for that purpose to the subjoined claims.

BRIEF DESCRIPTION OF THE DRAWING

The drawing diagrammatically illustrate by way of example, not by way of limitation, a few forms or mechanisms made by the methods of the invention wherein like reference numerals have been employed to indicate similar parts in the several views in which:

FIG. 1 is a schematic bottom view of one embodiment of the invention;

FIG. 2 is a vertical section at 2—2 on FIG. 1;

FIG. 3 is a schematic bottom view of a second embodiment of the invention; and

FIG. 4 is a vertical section at 4—4 on FIG. 3.

DESCRIPTION OF THE INVENTION

The invention disclosed herein, the scope of which being defined in the appended claims, is not limited in its application to the details of construction and arrangement of parts shown and described resulting from the disclosed methods, since the invention comprises other methods and is capable of providing other embodiments formed by other methods and of being practiced or carried out in various other ways. Also, it is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation. Further, many modifications and variations of the invention as hereinbefore set forth will occur to those skilled in the art. Therefore, all such modifications and variations which are within the spirit and scope of the invention herein are included and only such limitations should be imposed as are indicated in the appended claims.

DESCRIPTION OF THE METHODS

This invention comprises a few methods for forming high penetration rate drill bits and a few drill bits made by the disclosed methods or by other methods.

The basic method of the invention for forming high penetration rate drill bits wherein the outer periphery of the drill bit bottom cutting surface is substantially round and has a radius of curvature comprises the steps of:

1. forming a recess in the bottom cutting surface of the drill bit, and

2. shaping the bottom cutting surface recess to a continuous non-cylindrical surface of revolution having a height to radius ratio of substantially three-to-one.

While the FIG. 1 modification may be made by various methods, including one by hand, the second step of the above method may be modified to read:

2. shaping the drill bit bottom non-cylindrical surface of revolution into a conical shape.

While the FIG. 3 modification may be made by other methods, as by hand, the second step of the above method may be modified to read:

2. shaping the drill bit bottom non-cylindrical surface of revolution into a paraboloidal shape.

Another method for forming high penetrable rate drill bits comprises the steps of,

1. forming a recess in the center of the bottom cutting surface of the drill bit continuous with a peripheral portion of the bottom surface around the recess,

2. shaping an annulus on the peripheral portion of the drill bit bottom cutting surface of a particular area, and

3. shaping the surface of the recess internally of the annulus into a cutting surface area substantially greater than the cutting surface area of the annulus for forming a higher penetration rate drill bit.

Another method for forming a drill bit having a high penetration rate comprises the steps of,

1. forming a recess in the center of the bottom cutting surface of the drill bit continuous with a peripheral portion of the bottom surface around the recess,

2. forming drilling fluid exit transverse passages in the bottom cutting surface recess leaving a non-cutting surface area for the fluid exits, and

3. forming the remaining bottom cutting surface area to be the major cutting surface area relative to the non-cutting surface area for forming a high penetration rate drill bit.

DESCRIPTION OF THE DRILL BITS

FIGS. 1 – 4 schematically disclose two drill bits **10***a*, **10***b* that could be made by the methods set forth above, or by hand, for forming a drill bit having a very high penetration rate of cutting for drilling the well bore **11** as compared to the convention bits described above in the "Background of the Invention".

CONICALLY RECESSED DRILL BIT OF FIG. 2

Drill bit **10***a*, FIGS. **1** and **2**, comprises a shank **12** for fastening as with screw threads onto a drill collar at the bottom of a drill string and the main body **13** of the bit including one continuous cutting surface **14**. FIG. **2** is a section at **2—2** on FIG. **1**. The drill bit body is shaped basically to provide a continuous non-cylindrical surface of revolution cutting surface **14** comprising an annular cutting surface portion **15** and a conical recessed cutting surface portion **16***a* having a vertex **17***a* and height *h* above the annular cutting surface portion. The drill bit also has three drilling fluid entrance passages **18***a* – **18***c*, FIG. **1**, for supplying drilling fluid or mud externally of the bit for carrying rock chips up and out of the well bore **11** in the annular space **19** between the wall of the well bore and the outer surface of the drill bit, and for supplying drilling fluid internally for the full length of the recess to its vertex and to three contiguous openings to exhaust or exit passages **20***a* to the annular space **19**.

One of the features of this drill bit **10***a* is that the contour of the cutting surface is so designed and shaped that the conical cutting surface portion **16***a* is the major cutting surface and the remaining annular cutting surface portion **15** is the minor cutting surface.

A third cutting surface portion **21**, FIG. **2**, is utilized comprising an external annular extension of the outer peripheral edge of the annular cutting surface portion **15**.

To obtain and to maintain or insure that the recessed or conical cutting surface portion **16***a* is the major cutting surface relative to the smaller annular cutting surface, for a drill bit having an annulus radius R, FIG. **2**, equal to the conical base radius *r*, then all heights *h* must be greater than three times radius *r*, which then provides that the area Ac of the conical cutting surface will be greater than the area A*a* of the annulus as seen thus:

R = Major radius of annulus,

r = Radius of conical base,

$Aa = \pi (R^2 - r^2)$ = Area of annular cutting surface **15**,

$Ac = \pi r \sqrt{r^2+h^2}$ = Area of conical cutting surface **16***a*,

$\therefore Ac > Aa$ for $R = 2r$ and $h > 3r$.

This may explain the superior results deemed due to the elongated conical recessed drill bit.

The continuous cutting surface **14** comprises an abrasive-resisting material, such as diamonds, metal carbides as tungsten carbide, boron carbide, titanium carbide, titanium tungsten carbide, columbium-tantalum-titanium carbide, metal alloys, or cemented carbides and the like.

PARABOLOIDAL RECESSED DRILL BIT OF FIG. 4

FIGS. **3** and **4** disclose, schematically, a modified drill bit **10***b* having a very high penetration rate for drilling through either consolidated or unconsolidated sedimentary sections, depending on which sedimentary section that the abrasive surface is designed for. FIG. **4** is a section through FIG. **3** at **4—4**.

Drill bit **10***b*, FIG. **4**, is similar to drill bit **10***a*, FIG. **2**, with a few exceptions. The cutting surface comprises instead a paraboloidal recessed cutting surface portion **16***b* continuous with its annular cutting surface portion **15**. The vertex **17***b* of the deep recess is thus a paraboloid of revolution with three transverse exit passages **20***b* with spaced apart entrances adjacent the vertex **17***b*. The remaining elements of the drill bit **10***b* are similar to the corresponding elements of drill bit **10***a*.

The main feature of this embodiment of FIG. **4**, like that of FIG. **2**, is providing a drill bit with a recessed cutting surface area comprising a continuous non-cylindrical surface of revolution of substantially greater area than the annular cutting surface area. This feature accordingly provides a high penetration rate drill bit. For a drill bit having a radius $R = 2r$ and a height *h* of the paraboloidal recess equal to $3r$, the area A*p* of the paraboloidal recess is even greater than the area Ac of the conical recess **16***a*, FIG. **2**, of the same proportions. Suitable water courses in the cutting surface **14** of both drill bits may be added as desired.

Another primary feature of both embodiments of the new drill bits of FIGS. **2** and **4** is the forming of a recessed cutting surface which is continuous with the rest of the cutting surface in which the major surface of the recess is actually cutting surface, i.e. the conical surface **16***a*, FIG. **2**, and the paraboloidal surface **16***b*, FIG. **4**, comprise the major cutting surface portions of the recess, wherein the little drilling loss resulting from the absence of abrasive surfaces in the three openings to the drilling fluid exhaust passages is minor and almost negligible.

Obviously other methods may be utilized for forming the embodiments of either FIG. **2** or FIG. **4** than those listed above, depending on the particular design requirements.

Accordingly, it will be seen that the above described methods for making drill bits and various drill bits set forth above will operate in a manner which meets each of the objects set forth hereinbefore.

While only a few methods of the invention and two mechanisms made by the methods have been disclosed, it will be evident that various other methods and modifications are possible in the arrangement and construction of the disclosed invention without departing from the scope of the invention and it is accordingly desired to comprehend within the purview of this invention such modifications as may be considered to fall within the scope of the appended claims.

We claim:

1. A method for forming a high penetration rate drill bit wherein the drill bit has a bottom cutting surface comprising the steps of,

a. forming a recess in the bottom cutting surface of the drill bit, the recess having a height and a circular base with a radius,

b. shaping the bottom cutting surface recess to a continuous non-cylindrical surface of revolution having a height to radius ratio of substantially three-to-one, and

c. shaping the drill bit bottom non-cylindrical surface of revolution into a paraboloidal shape.

2. A method for forming a high penetration rate drill bit wherein the drill bit has a bottom cutting surface comprising the steps of,

a. forming a recess in the bottom cutting surface of the drill bit, the recess having a height and a circular base with a radius,

b. shaping the bottom cutting surface recess to a continuous non-cylindrical surface of revolution having a height to radius ratio of substantially three-to-one,

c. shaping an annulus on the periphery of the drill bit bottom cutting surface of a particular area,

d. shaping the surface of the recess internally of the annulus into a cutting surface area substantially greater than the cutting surface area of the annulus for forming a higher penetration rate drill bit, and

e. shaping the drill bit bottom non-cylindrical surface of revolution into a paraboloidal shape.

3. A method for forming a high penetration rate drill bit wherein the drill bit has a bottom cutting surface comprising the steps of,

a. forming a recess in the bottom cutting surface of the drill bit, the recess having a height and a circular base with a radius,

b. shaping the bottom cutting surface recess to a continuous non-cylindrical surface of revolution having a height to radius ratio of substantially three-to-one,

c. forming drilling fluid exit transverse passages in the bottom cutting surface recess leaving non-cutting surface areas for the fluid exits,

d. forming the remaining bottom cutting surface area to be the major surface area relative to the non-cutting surface area for forming a high penetration rate drill bit, and

e. shaping the drill bit bottom non-cylindrical surface of revolution into a paraboloidal shape.

4. A method for forming a better drill bit comprising the steps of,

a. forming a cutting surface over the bottom of the drill bit in one continuous non-cylindrical surface of revolution,

b. forming an annulus on the periphery of the drill bit bottom cutting surface of a particular area,

c. forming a recess internally of the annulus having a cutting surface area substantially greater than the cutting surface area of the annulus, and

d. shaping the drill bit bottom non-cylindrical surface of revolution into a paraboloidal shape for forming a higher penetration rate drill bit.

5. A high penetration rate rotary drill bit having a bottom cutting surface comprising,

a. a recess in the bottom cutting surface, said recess having a height and a circular base with a radius,

b. said bottom cutting surface recess has a continuous non-cylindrical surface of revolution shape having a height to radius ratio of substantially three-to-one, and

c. said bottom cutting surface non-cylindrical surface of revolution shape is a paraboloidal shape.

6. A high penetration rate rotary drill bit having a bottom cutting surface comprising,

a. a recess in the bottom cutting surface, said recess having a height and a circular base with a radius,

b. said bottom cutting surface recess has a continuous non-cylindrical surface of revolution shape having a height to radius ratio of substantially three-to-one, and

c. said bottom cutting surface has an annulus around said recess of a particular area,

d. the cutting surface area of the recess internally of the annulus is substantially greater than the cutting surface area of said annulus for providing a higher penetration rate drill bit, and

e. said bottom cutting surface non-cylindrical surface of revolution shape is a paraboloidal shape.

7. A drill bit comprising,

a. a drill bit having one continuous non-cylindrical surface of revolution cutting surface over the bottom thereof,

b. said cutting surface having an annulus on the periphery of the drill bit bottom covering a particular area thereof,

c. said cutting surface having a recess formed internally of the annulus,

d. said recess having a cutting surface area substantially greater than the cutting surface area of the annulus, and

e. said bottom cutting surface non-cylindrical surface of revolution shape is a paraboloidal shape for forming a higher penetration rate drill bit.

8. A drill bit as recited in claim **7** wherein,

a. said drill bit has drilling fluid exit transverse passages in said cutting surface recess area forming noncutting surface areas for exit of the drilling fluid, and

b. the remaining cutting surface area being the major cutting surface area relative to the noncutting surface area for providing a high penetration rate drill bit.

9. A drill bit as recited in claim **8** wherein,

a. said cutting surface recess area has a vertex at its highest point, and

10. A drill bit comprising,

a. a drill bit having one continuous non-cylindrical surface of revolution cutting surface over the bottom thereof,

b. said cutting surface having an annulus on the periphery of the drill bit bottom covering a particular area thereof,

c. said cutting surface having a recess formed internally of the annulus,

d. said recess having a cutting surface area substantially greater than the cutting surface area of the annulus,

e. said drill bit has drilling fluid exit transverse passages in said cutting surface recess area forming non-cutting surface areas for exit of the drilling fluid,

f. the remaining cutting surface area being the major cutting surface area relative to the non-cutting surface area,

g. said cutting surface recess area has a vertex at its highest point, and

h. said drilling fluid exit transverse passages each has spaced apart openings around said vertex of said recess area in the cutting surface for providing a high penetration rate drill bit.

11. A drill bit as recited in claim **10** wherein,

a. said spaced apart openings around said vertex area are tangent to each other.

12. A high penetration rate drill bit comprising,

a. a drill bit having one continuous noncylindrical surface of revolution cutting surface over the bottom thereof,

b. said cutting surface having therein a recess area with a vertex in the middle thereof,

c. drilling fluid exit transverse passages in said cutting surface recess area for exit of the drilling fluid, and

d. said drilling fluid exit transverse passages each has spaced apart openings around said vertex of said cutting surface recess area.

13. A drill bit as recited in claim **12** wherein,

a. said spaced apart openings around said vertex area are tangent to each other.

* * * * *

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 3,845,830

DATED : November 5, 1974

INVENTOR(S) : JOE R. FOWLER and JOHN L. BRYAN

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Claim 3, line 15, after "major" insert --bottom--.

Claim 9, after line 3 add:

--(b) said drilling fluid exit transverse passages each has contiguous openings at said vertex of said recess area in the cutting surface.--

Signed and Sealed this

twenty-ninth Day of *July 1975*

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks