United States Patent

[11] 3,536,150

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[21] Appl. No. 757,705
[22] Filed Sept. 5, 1968
[45] Patented Oct. 27, 1970

[54] **ROTARY-PERCUSSION DRILL BIT**
13 Claims, 10 Drawing Figs.

[52] U.S. Cl. 175/263, 175/410, 175/412
[51] Int. Cl. E21b 9/26, E21c 13/00
[50] Field of Search .... 175/263, 410—420

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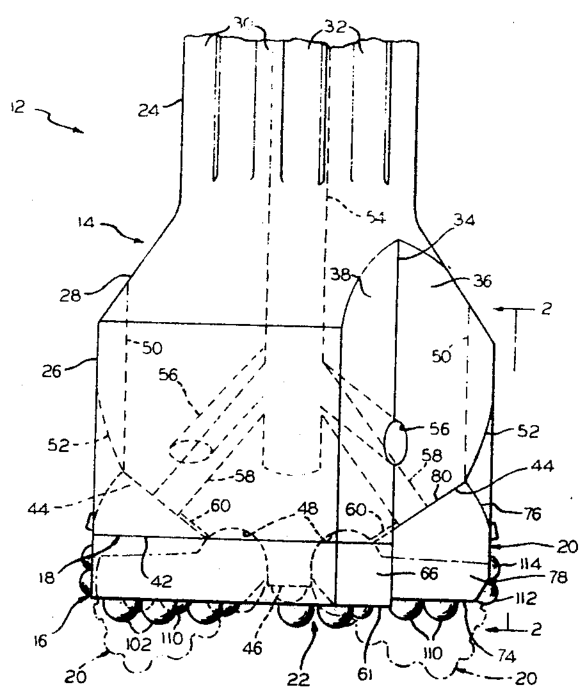
ABSTRACT: A rotary percussion drill bit includes a bit body, head sections fixed on one end of the body, and a pair of hammer members pivotally mounted on the body end between the head sections and providing a working face therewith. The head sections and the hammer members are provided with wear-resistant inserts or teeth, and the hammer member inserts determine the bit gauge. Upon impacting the bit, the head section inserts penetrate the bottom of a hole being drilled in a formation. The hammer members are swung outwardly to cause their inserts to fracture lands remaining from prior penetration by the head section inserts and to fracture the side wall of the hole being drilled. The hammer members advantageously are mounted for lateral movement, for producing increased lateral striking force upon impact. Upon raising the bit, the hammer members swing out of binding engagement with the side wall. Fluid passages in the bit body terminate at seats for the hammer members on the end of the body.



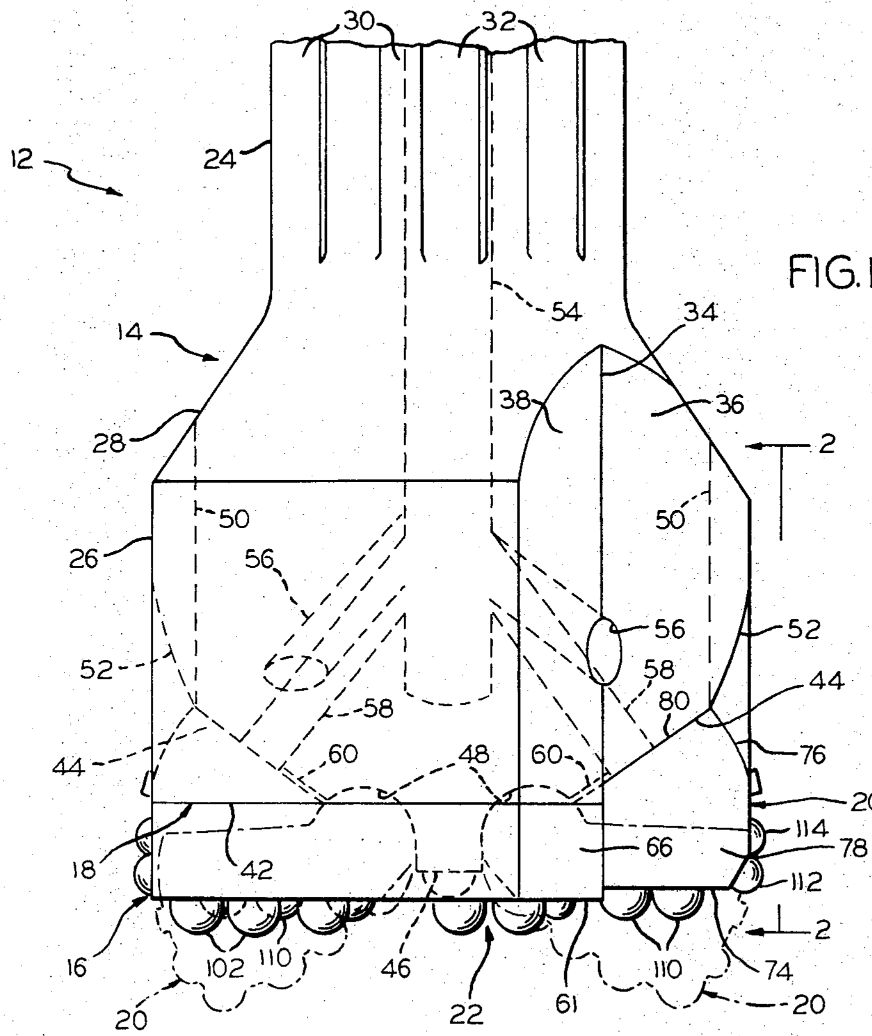


FIG.1

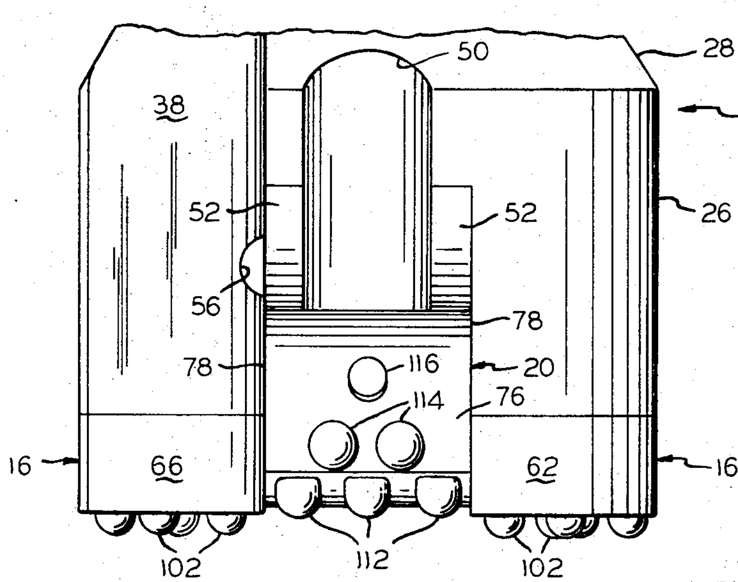


FIG.2

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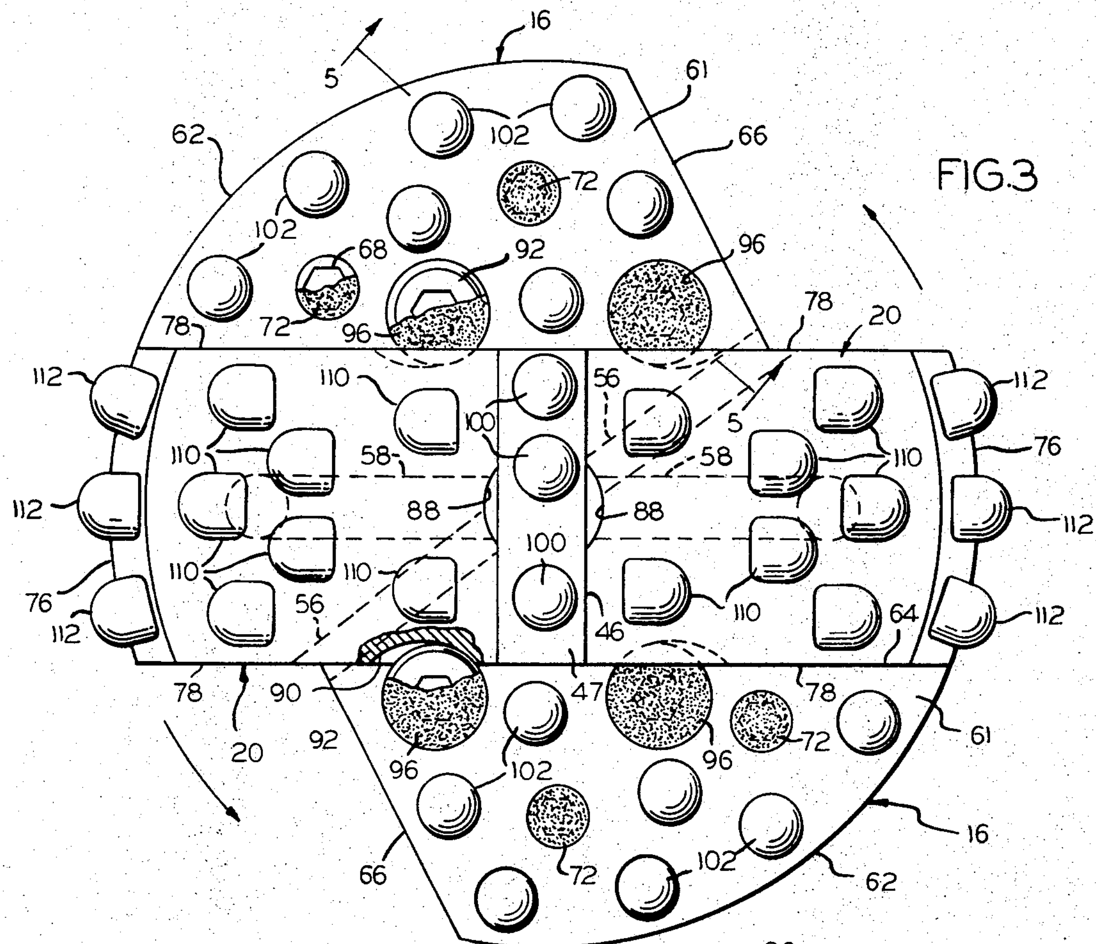

FIG.3

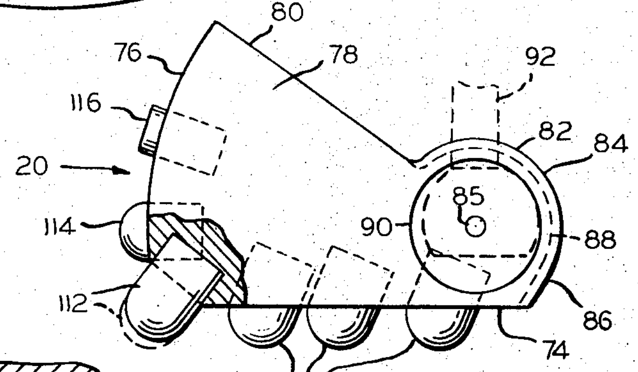

FIG.4

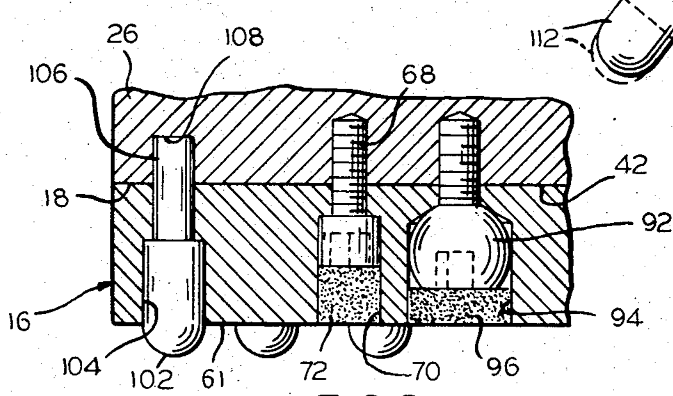

FIG.5

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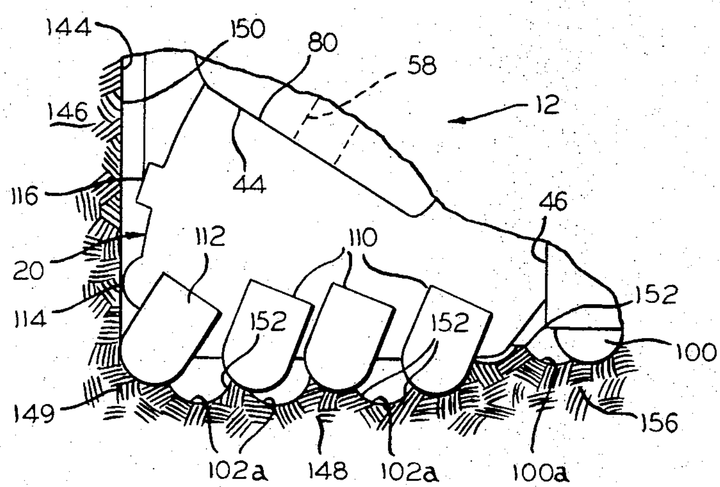

FIG.6

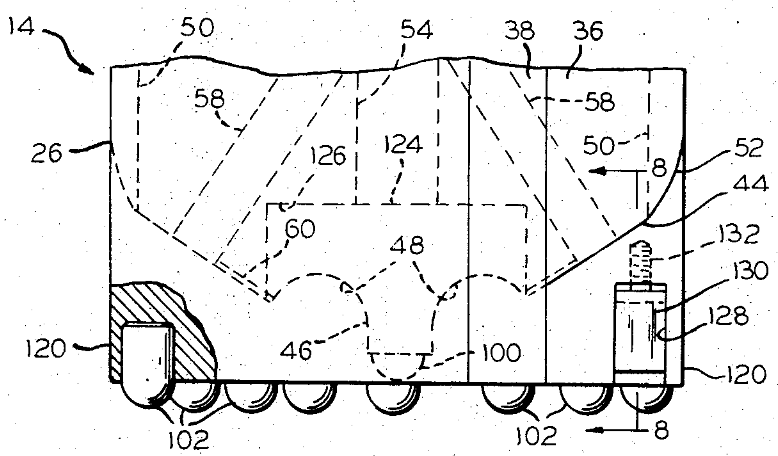

FIG.7

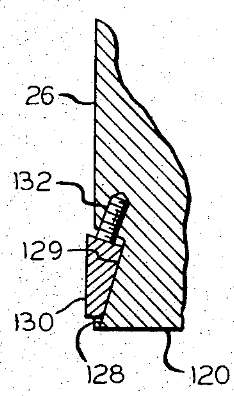

FIG.8

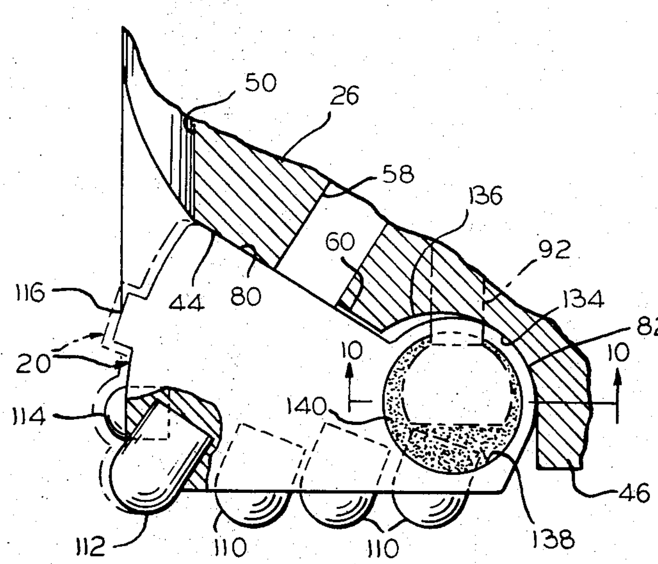

FIG.9

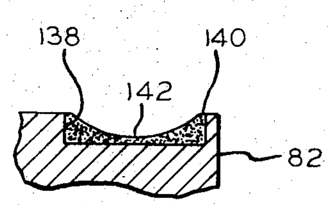

FIG.10

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ROTARY-PERCUSSION DRILL BIT

BACKGROUND OF THE INVENTION

This invention relates to earth drilling tools, more particularly, to a drill bit suitable for use with rotary percussion drilling equipment for drilling into rock formations.

The invention has particular reference to percussion drilling employing drill bits of the type referred to in my U.S. Pat. No. 3,382,940. Thus, a popular type or rotary percussion drill bit constructed to withstand large impact forces and considerable abrasive action is constructed of a solid steel body having a working face at one end of the bit, and a plurality of cylindrical inserts or teeth of wear-resistant material, which are force-fitted in openings in the bit body at the working face and project therefrom. The wear-resistant material preferably is tungsten carbide, also referred to as cemented tungsten carbide. The inserts have cylindrical body portions and hemispherical impact ends. Alternatively, if desired, other wear-resistant materials and insert configurations may be employed.

The drilling operations involve chipping and pulverizing a rock formation, and forcing the particles upwardly and out of the formation with air and/or water under pressure. As noted in my aforesaid patent, the drill bits are expensive, and the inserts are susceptible to fracture. The bits are exposed to severe abrasive conditions, causing the sides of the bit to wear. Side wear reduces the bit gauge, which results in loss of drill hole diameter and causes the bit to bind in the hole. The inserts which determine the gauge are under the greatest load, causing them to fracture more frequently with resulting gauge loss. The bit body wears on it sides and also on its end, removing support for the working face and increasing the tendency to fracture the inserts.

SUMMARY OF THE INVENTION

The present invention provides a new and improved rotary percussion drill bit which includes a bit body for receiving and transmitting rotational and impact forces from a percussion tool, head sections fixed on one end of the body, a pair of hammer members adapted to seat on the body between the head sections and together with the head sections providing a working face on the bit, the hammer members extending transversely of the bit in diametrically opposed relation, means pivotally mounting the inner ends of the hammer members on the body end for swinging movement of the members to and from positions seated on the body end, a plurality of wear-resistant inserts mounted in the head sections and projecting therefrom at the working face, a plurality of wear-resistant inserts mounted in the hammer members and projecting therefrom at the working face, including inserts projecting laterally beyond the periphery of the remainder of the bit on opposite sides thereof when the hammer members are seated on the body end, whereby upon impacting the bit, the hammer members are swung towards the seated positions to cause the laterally projecting inserts to fracture the side wall of a hole being drilled in a formation, and upon raising the bit, the hammer members swing out of binding engagement with the side wall.

In the preferred structure, head section inserts are mounted at varying radial distances from the axis of the bit, and additional hammer member inserts are mounted at varying radial distances from the axis of the bit, whereby upon impacting the bit, the hammer member inserts are caused to fracture the lands resulting from penetration of the formation by the head section inserts.

The hammer members include surfaces making seating engagement with surfaces on the bit body end in respective planes which preferably extend angularly with respect to the bit axis and inwardly of the body towards its periphery. Certain of the laterally projecting hammer member inserts preferably extend normally to the seating surfaces of their respective hammer members.

In an advantageous embodiment, the hammer members are mounted for lateral movement as well as swinging movement, for producing increased lateral striking force upon impact.

Fluid passages are provided in the bit body which terminate at the seating surfaces on the bit body end. The passages cooperate with the hammer members for more effective chip or particle ejection.

The new drill bit is constructed to overcome various disadvantages of the prior structures and provide improvements thereover. In particular, better lateral penetration of a formation is achieved with reduced bit wear, resulting in better gauge holding ability. Bit binding is minimized. The inserts are subjected to less damaging stresses, and drilling is accomplished with minimal percussive and rotational energy.

The new drill bit also provides more effective fragmentation at the bottom of a hole, and wear on the sides and end of the bit is reduced. The construction is rugged and durable, and parts subject to wear may be replaced readily in the field.

BRIEF DESCRIPTION OF THE DRAWINGS

The attached drawings illustrate preferred embodiments of the rotary percussion drill bit of the invention, without limitation thereto. In the drawings, like elements are identified by like reference symbols in each of the views, and:

FIG. 1 is an elevational view of the working end of a drill bit according to the invention, illustrating alternate positions of hammer members thereof in broken lines;

FIG. 2 is another elevational view thereof, taken on line 2–2 of FIG. 1;

FIG. 3 is an enlarged bottom plan view thereof, with parts broken away to reveal internal structure;

FIG. 4 is an enlarged elevational view of a hammer member thereof, with a portion broken away to reveal the insert mounting;

FIG. 5 is an enlarged fragmentary cross-sectional view thereof, taken substantially on line 5–5 of FIG. 3;

FIG. 6 is a schematic fragmentary elevational view thereof, illustrating the action of the bit in a drill hole;

FIG. 7 is a fragmentary elevational view similar to FIG. 1, of another embodiment of the drill bit, with the hammer members thereof removed and a portion broken away;

FIG. 8 is a fragmentary sectional view of the embodiment of FIG. 7, taken on line 8–8 thereof;

FIG. 9 is an enlarged fragmentary sectional and elevational view of a further embodiment of the bit, with a portion broken away, illustrating mounting means for the hammer member permitting lateral movement thereof, as illustrated in broken lines; and

FIG. 10 is a fragmentary cross-sectional view of the embodiment of FIG. 9, taken on line 10–10 thereof.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the drawings, particularly FIGS. 1—5, a preferred rotary percussion drill bit 12 according to the invention includes an elongated body 14, a pair of spaced apart head sections 16 fixed on an outer end 18 of the body, and a pair of hammer members 20 pivotally mounted on the body end between the head sections and providing a working face 22 on the bit therewith.

The body 14 includes a generally cylindrical shank 24, an enlarged generally cylindrical base 26 including the outer end 18, and a generally frustoconical connecting section 28 joining the shank to the base. A plurality of longitudinally extending splines 30 alternate with grooves 32, for attachment to a drill string in turn connected to a percussion or impact tool of a standard type (not shown), as described in my aforesaid patent. Alternatively, other bit body styles may be employed, *e.g.*, the shank 24 may be threaded for attachment to a drill string. The bit body 14 is constructed of a solid block of steel, head treated to suitable hardness.

Two angular grooves 34 having sides 36 and 38 are provided on opposite sides of the bit body 14. The grooves extend longitudinally in the base 26 and the connecting section 28, and provide external air-water passageways on the body communicating with the outer end 18. The outer end of the base 26 includes two diametrically opposed spaced flat mounting surfaces 42, which lie in a plane perpendicular to the longitudinal axis of the bit and of the bit body. The outer end of the base also includes two diametrically opposed flat seating surfaces 44, disposed between the mounting surfaces 42. The seating surfaces lie in planes extending angularly with respect to the longitudinal axis of the bit and its body, and inwardly of the body towards its periphery.

A central bar section 46 is integral with the base 26 and has an outer work surface 47 forming part of the working face 22 on the bit. The bar section protrudes longitudinally from the base 26 beyond the base surfaces 42 and 44. Elongated sockets 48 are formed in the outer end 18 of the base and in the opposite sides of the bar section. The sockets are substantially cylindrically curved about axes lying in a plane perpendicular to the bit axis. The bar section and the sockets extend for the widths of the base seating surfaces 44, and the sockets merge into the seating surfaces.

Arcuate longitudinal grooves 50 are provided in opposite sides of the bit body 14 and terminate at the seating surfaces 44. Inwardly curved surfaces 52 are provided on the base 26, on opposite sides of the grooves 50, and they extend longitudinally to the seating surfaces 44 and laterally to the side margins thereof. The grooves 50 and the curved surfaces 52 provide auxiliary external air-water passageways on the bit body.

A cylindrical internal air-water passageway 54 extends centrally or axially in the bit body 14, for the supply of air and/or water, or other fluid. Two branch passageways 56 extend angularly outwardly therefrom and terminate at the junctions of the sides 36 and 38 of the angular grooves 34. Two additional branch passageways 58 extend angularly from the central passage and terminate at the seating surfaces 44. Small arcuate grooves 60 in the seating surfaces (see FIGS. 1 and 9) extend from the passageways 58 to the sockets 48.

The head sections 16 are flat platelike members having outlines conforming to the mounting surfaces 42 on the base 26 and planar end work surfaces 61 at the outer end of the bit and perpendicular to the bit axis. The work surfaces 61 form part of the working face 22 on the bit. The head sections have arcuate peripheral sides 62 conforming to the periphery of the base, planar inner sides 64 extending across the base and bordering the seating surfaces 44, and planar outer sides 66 extending angularly from the inner sides and coplanar with the sides 38 of the angular grooves 34 in the body. The head sections are detachably secured in fixed positions to the mounting surfaces 42 of the base, by Allen head cap screws 68 seated in corresponding recesses 70 (FIG. 5) in the sections. The screws are covered and protected by removable plugs 72 of rubber or other suitable material, which are inserted in the recesses.

The hammer members 20 are elongated wedge-shaped platelike members having planar work surfaces 74 at the outer end of the bit, work surfaces 76 curved longitudinally and laterally at the periphery of the bit, parallel planar sides 78, inclined planar seating surfaces 80, and elongated rounded inner end portions 82. The planar and curved work surfaces 74 and 76 form parts of the working face 22 on the bit. The inner end portions 82 include sections 84 which are cylindrically curved about transverse axes 85 and merge into relatively flat sections 86 adjacent the work surfaces 74. An arcuate groove 88 (FIG. 3 and 4) is milled centrally around the inner end portion 82 of each hammer member.

The hammer members 20 are mounted on the outer end 18 of the base 26 with their rounded inner end portions 82 seated in the sockets 48 and the bar section 46 interposed between the ends of the members. The axes 85 of the curved sections 84 coincide with the axes of the sockets. The hammer members extend transversely of the bit in diametrically opposed relation, with their sides 78 adjacent to the inner sides 64 of the head sections 16. One side 78 of each hammer member is coplanar with a side 36 of an angular groove 34 in the bit body. The seating surfaces 80 of the hammer members are arranged for engagement with the base seating surfaces 44 and are substantially coextensive therewith.

The inner end portions 82 of the hammer members are rotatable in the sockets 48 for swinging movement of the members to and from positions seated on the outer end 18 of the body and the base thereof. In closed positions of the hammer members, their seating surfaces 80 engage the base seating surfaces 44, as illustrated in full lines in FIG. 1. In their open positions, the respective seating surfaces are angularly separated, and the flat end sections 86 on the hammer members engage opposite sides of the bar section 46, as illustrated in phantom lines in FIG. 1. FIG. 1 illustrates the bit 12 in its vertical use position in a formation, and the latter positions of the hammer members constitute hanging positions under the force of gravity.

When the hammer members 20 are in their closed or upper positions, their curved work surfaces 76 extend to points approximately at the periphery of the base 26 of the bit body. Their planar work surfaces 74 are spaced slightly inwardly from, or are elevated above, the head section work surfaces 61. The grooves 88 on the hammer inner end portions communicate with the grooves 60 in the end of the base, which communicate with the branch passageways 58. When the hammer members are in their open or lower positions, their curved work surfaces 76 preferably are spaced inwardly from the periphery of the base 26.

A concave circular depression 90 is provided on each side of the end portion 82 of each hammer member 20. Ball head screws 92 are seated in recesses 94 (FIG. 5) in the head sections 16, on opposite sides of each hammer member. The screw heads project into the recesses 90, slightly off-center with respect thereto, to form ball joints for rotatably or pivotally securing the hammer ends in their sockets 48. As illustrated in FIGS. 3 and 4, the screw heads bear on points in the upper right hand or inner quadrant of the circle defining the recess 90, with reference to the illustration of FIG. 4. The screws 92 are covered and protected by removable rubber plugs 96.

In the illustrative embodiments, wear-resistant inserts of tungsten carbide are mounted in the head sections 16, the hammer members 20, and the bar section 46, and project therefrom at the working face 22 for penetrating a formation. Three inserts 100 are press-fitted in corresponding recesses in the bar section 46 at varying radial distances from the axis of the bit, and the inserts project from the work surface 47 of the bar section. A plurality of inserts 102 is mounted in the head sections 16 at varying radial distances from the axis of the bit, and they project from the work surfaces 61 of the head sections. The head section inserts are press-fitted in corresponding openings 104 (FIG. 5) extending inwardly from the work surfaces 61, and the inserts are arranged in the same pattern for each head section. The head section inserts are supported at their inner ends by cylindrical steel pins 106 snugly but removably received in corresponding recesses 108 in the outer end 18 of the base 26. The pins both support the inserts and secure the head sections against lateral movement on the base. The bar section inserts 100 and the head section inserts 102 are illustrated as extending with their axes parallel to the bit axis, but they or some of them may extend angularly with respect thereto.

A plurality of bottom inserts 110 are mounted in the hammer members 20 at varying radial distances from the axis of the bit, and they project from the planar work surfaces 74. A transverse row of three corner inserts 112 is mounted in each hammer member where the planar work surface 74 adjoins the curved work surface 76. The corner inserts 112 project outwardly from both surfaces. In the illustrative embodiment, the bottom inserts 110 project a greater distance from the work surface 74. Alternatively, the corner inserts may project beyond the bottom inserts, as illustrated in broken lines in FIG. 4. Two side inserts 114 are mounted in transverse alignment in the curved work surface 76 and project therefrom. An additional side insert 116, having a flat head, is mounted in the curved work surface above each pair of side inserts 114. The several inserts in the hammer members are press-fitted in corresponding openings in the members, as illustrated in FIG. 4 for an insert 112.

The corner inserts 112 preferably extend perpendicularly to the hammer member seating surfaces 80. The seating surfaces preferably are inclined at angles of about 35° to the planar work surfaces 74, and about 55° to the bit axis, when seated on the base seating surfaces 44. At this time, the corner inserts 112 extend at angles of about 35° to the bit axis, and the bottom inserts 110 projecting from the planar surfaces 74 preferably extend at angles of about 20° thereto. The side inserts 114 preferably are mounted with their axes in a plane including the pivotal axes 85 of the hammer members and perpendicular to the bit axis when the hammer members are seated on the base end 18. The insert arrangement is the same for each hammer member.

When the hammer members are seated on the body end, their planar work surfaces 74 are recessed a short distance from the work surfaces 61 of the head sections, or are elevated therefrom, as illustrated in FIG. 1. The bottom inserts 110 and the corner inserts 112 likewise are recessed or elevated with respect to the head section inserts 102. The corner inserts 112 and the side inserts 114 and 116 project laterally beyond the periphery of the remainder of the bit on opposite sides thereof. When the hammer members are swung out of their seated positions, as shown in phantom lines in FIG. 1, the corner inserts 112 and preferably the side inserts 114 and 116 fall within such periphery.

The work surface 47 of the bar section 46 is recessed or elevated both with respect to the planar work surfaces 74 of the hammer members and the work surfaces 61 of the head sections. The bar section inserts 100 are likewise recessed with respect to the hammer member bottom and corner inserts 110 and 112 and the head section inserts 102.

FIG. 7 illustrates alternative structural elements which may be employed individually or in combination in the new drill bit. In this embodiment, the head sections 120 are incorporated in an integral one-piece construction with the base 26. The head section inserts 102 are press-fitted into openings 122 in the head section and are completely supported thereby. The bar section 46 constitutes an integral part of a mounting member 124 removably received in a cavity 126 in the end of the base 26. The sockets 48 are formed in the mounting member. The mounting member also forms a closure for the end of the central passageway 54 in the bit.

A pocket 128 having an inclined inner surface 129 is provided in each head section 120. The pockets are adjacent to respective sides 78 of the hammer members 20, when the members are mounted on the base. A wedge-shaped wear bar 130 is received in the pocket and adjustably located by means of a set screw 132 threaded into the base 26. The wear bars serve to take up any play occasioned by wear of the hammer members, and they are held in place by the hammer members.

FIGS. 9 and 10 illustrate a modification of the structure of FIGS. 1—5, which is also applicable to the structure of FIGS. 7 and 8. Sockets 134 corresponding to the previously described sockets 48 are formed in the base 26 of the bit body, and in this case, the sockets are enlarged in the outer portions 136 thereof, corresponding to a curvature of greater radius thereat. The enlargements provide for lateral movement of the hammer members 20, as illustrated by the alternate position shown in phantom lines. Similar movement may, alternatively, be obtained by a loose fit of the rounded inner end portions 82 of the hammer members in the sockets 48 of the preceding views.

To accommodate the foregoing movement of the hammer members, cylindrical recesses 138 are provided on opposite sides of the end portions 82, and resilient circular inserts 140 having concave circular recesses 142 are mounted therein. The ball head screws 92 extend into the recesses for securing the hammer members in place. The resiliency of the inserts allows the hammer members to move laterally against the pressure of the screw heads. The inserts may be made of live rubber such as conventionally employed under abrasive conditions.

The body, head sections, hammer members, and bar section of the drill bit 12 are constructed of a nickel-content steel (*e.g.*, AHT-28), as conventionally employed for such bits. The wear bars 130 may be constructed of a wear and shock-resistant alloy, particularly a cast alloy of chromium, tungsten, columbium, and carbon in a cobalt matrix, identified as Tantung.

In manufacturing the drill bit of FIGS. 1—5, the body 14 and integral bar section 46, the head sections 16, and the hammer members 20 are formed as shown, before hardening. Similarly, the body 14 and integral head sections 120, and the mounting member 124 of FIGS. 7 and 8 are formed as shown, before hardening. Grooves, screw openings, air passageways, and insert openings also are formed before hardening.

The body is hardened by heat treatment in the usual manner, to a Rockwell C hardness of about 50. The other parts are hardened to the following Rockwell C hardness: head sections, 36; bar section, 40—45; hammer members, 40. Where the parts are integral with the body, a transition zone of hardness is provided in the body.

Engagement surfaces on the base 26, the head sections 16, and the hammer members 20 are machined after hardening. Insert openings are reamed after hardening, allowing for a force fit of about 0.0025 to 0.003 inch.

OPERATION

Referring to FIG. 6, the drill bit 12 is employed for drilling a cylindrical hole 144 in a rock formation 146. This view illustrates the action of the bit at the bottom 148, corner 149, and side wall 150 of the hole. The bit is inserted in the position illustrated in FIG. 1, and reciprocated rapidly in short strokes of about 3 to 5 inches to produce about 500 to 800 impacts per minute, with the bit rotated between impacts at about 20 r.p.m. A right hand bit is illustrated, and it is rotated in the clockwise direction, as viewed from above, or counterclockwise as viewed from below and indicated by the arrows in FIG. 3.

Prior to impact and with the bit raised, the hammer members 20 hang from the bit body, as shown in phantom lines in FIG. 1. Upon impacting the bit, the impact force on the base 26 is transmitted to the hammer members 20 at their rounded end portions 82. The hammer members contact the bottom 148 of the hole and are forced apart and swung upwardly and outwardly until their seating surfaces 80 engage the seating surfaces 44 on the base.

Each impact causes the bar section inserts 100 to produce indentations 100*a* (FIG. 6), and the head section inserts 102 to produce indentations 102*a*. Lands or ridges 152 remain in the formation at the bottom 148 of the hole. When the bit is next rotated and then impacted, the hammer members 20 descend on the area bearing the indentations and lands, and act to chip and fracture the lands. Thus, as the hammer members spread under the force of impact, which force is multiplied in a toggle joint action, their bottom and corner inserts 110 and 112 projecting below the planar work surfaces 74 are forced against the tops of the lands, to fracture them. Similarly, the hammer member corner and side inserts 112 and 114 projecting laterally from the curved work surfaces 76 strike the corner 149 and the side wall 150 of the hole with great lateral force, crushing and splitting the formation thereat. The corner inserts 112 fracture the shoulder remaining at the corner 149 and apply lateral force to the side wall 150. The side inserts 114 transmit a maximum force to the side wall. The several inserts are directed at angles of attack that are most effective for fracturing the formation while the forces are applied so as to minimize damaging stresses in the inserts.

When the seating surfaces 44 of the base 26 strike the surfaces 80 of the hammer members 20, an additional impact force is imparted to the hammer member inserts. At the same time, new indentations are produced by the bar section inserts 100 and the head section inserts 102, in areas adjacent to the hammer members, as seen on reference to FIG. 3.

The lateral impact forces imparted by the hammer member inserts may be accentuated by provision for lateral movement of the hammer members, as described above and illustrated with respect to FIG. 9. As the drill bit descends, and the base 26 impacts on the hammer members, a vertically downward force acts upon inclined planes corresponding to the hammer member seating surfaces 80, producing laterally directed forces as a result thereof and moving the hammer members laterally against the side wall 150.

The foregoing action causes the hammer members 20 to become tightly wedged in the bottom of the hole 144. However, the bit 12 may be raised, owing to the pivotal mounting of the hammer members, and the hammer members are then swung downwardly and inwardly, falling within the periphery of the bit, as illustrated in FIG. 1. The pressure fluid in the branch passageways 58 and the force of gravity act to move the hammer members away from the seating surfaces 44, and the upper side inserts 116 on the hammer members assist this movement by engaging the side wall 150. The action of the hammer members eliminates the binding and abrasion, and possible insert fracture, that would otherwise result, while reducing the drag and consequent power requirements.

With rotation of the bit, the bar section inserts 100 and the head section inserts 102 impact upon areas in which the lands 152 previously have been reduced by the hammer member inserts 110 and 112. Consequently, the bar section and head section inserts may function to produce new indentations in the hole bottom 148 without the interference, abrasion and wear otherwise caused by the lands. The lands tend to wear away the work surfaces 61 and 47 on the head and bar sections, reducing the support for the inserts therein and increasing the likelihood of insert fracture.

The bar section inserts 100, which are at the uppermost elevation of the several inserts, act with the remaining inserts to form a core 156 in the center of the hole bottom 148. The core acts to center the bit in the hole and provide support therefor, offsetting pressures directed towards the center of the bit. The bit balance is improved thereby, and transverse forces acting upon the connection to the bit shank 24 are relieved.

Air and/or water, or other fluid, is supplied to the central passageway 54 during drilling. With the bit raised, the fluid discharges through the branch passageways 56 leading to the angular grooves 34, and also through the branch passageways 58 leading to the seating surfaces 44. Fluid is supplied to the bottom 148 and side wall 150 of the drill hole in this manner.

As the bit descends and the hammer members 20 swing upwardly with respect to the base 26, the fluid from the branch passageways 58 is directed upwardly against the side wall in streams of increasing velocity, imparting vigorous upward movement to the mixture of fluid and rock fragments. Upward flow is facilitated by the grooves 50 and the relief surfaces 52 above the hammer members. At the same time, rock fragments are removed from between the seating surfaces 44 and 80.

When the hammer members are seated on the base, fluid is directed through the grooves 60 at the seating surfaces and through the grooves 88 in the rounded hammer ends 82, cleaning the pivot joints. With the branch passageways 58 closed by the hammer members, the full force of the fluid in the central passageway 54 is directed through the branch passageways 56, which are directed to the bottom corner 149. Cuttings are driven upwardly therefrom with increasing force, ascending along the sides of the bit and particularly in its external grooves.

The drill bit is constructed for sustaining large forces directed to the hole wall. The hammer members are mounted in cylinder and socket joints and in opposed relation against the bar section 46, to provide rugged and durable support and minimize bearing problems. Employing the wear bars 130, additional support is provided for the hammer members, should wear occur despite the force-balanced structure, as in the case of damage to some of the hammer member inserts.

The hammer members 20 serve to hold the bit gauge effectively. When the inserts are worn or broken, the hammer members may be removed by removing the ball head screws 92. The head sections 16, in the embodiment of FIGS. 1—5, also may be removed, by removing the screws 68. The inserts 102 in the head sections may be removed, by pressing them out from the undersides of the sections, and new inserts may be mounted, as described in my aforementioned patent. The head sections may be replaced on the bit base 26, with the steel pins 106 inserted in the recesses 108. After making any necessary adjustment to the wear bars 130, when employed, new hammer members may be mounted on the base, by inserting the ball head screws 92 into the hammer member recesses 90, and threading the screws into the base. Employing the mounting member 124 of FIG. 7, the bar section 46 having the inserts 100 may be removed and replaced prior to mounting the hammer members.

Inasmuch as the head sections are subjected to less abuse than the hammer members 20, the life of the head sections often will exceed the life of the hammer members. Consequently, it may be preferable to employ the integral head sections 120 of FIG. 7. The hammer members then may be replaced while the remainder of the bit remains in service.

The invention thus provides a rotary percussion drill bit which very effectively maintains the bit gauge while reducing abrasive wear and insert fracture and loss. Drilling operations are conducted with minimal energy requirements, while lateral forces exerted against the side wall 150 are multiplied for better fragmentation in this most difficult region. The bit is ruggedly and durably constructed for withstanding the large forces exerted. The arrangement of the fluid passageways serves to clean the drill hole thoroughly with efficient utilization of wash fluid.

While several preferred embodiments of the invention have been illustrated and described, it will be apparent that various changes and modifications may be made therein within the spirit and scope of the invention. It will be apparent also that various features of the invention may be employed in other styles and types of drill bits. It is intended that all such changes, modifications, and variations be included within the scope of the appended claims.

I claim:

1. A rotary percussion drill bit which comprises:

a bit body for receiving and transmitting rotational and impact forces from a percussion tool;

head sections fixed on one end of said body;

a pair of hammer members adapted for seating on said body end between said head sections and together with the head sections providing a working face on the bit, said hammer members extending transversely of the bit in diametrically opposed relation;

means pivotally mounting the inner ends of said hammer members on said body end for swinging movement of the members to and from positions seated on said body end comprising elongated rounded inner end portions rotatably received in elongated socket means on said body end including a protruding bar section interposed between said inner ends;

a plurality of wear-resistant inserts mounted in said head sections and projecting therefrom at said working face; and

a plurality of wear-resistant inserts mounted in said hammer members and projecting therefrom at said working face, including inserts projecting laterally beyond the periphery of the remainder of the bit on opposite sides thereof when the hammer members are seated on said body end, whereby upon impacting the bit, said hammer members are swung towards said seated positions to cause said laterally projecting inserts to fracture the side wall of a hole being drilled in a formation, and upon raising the bit, said hammer members swing out of binding engagement with the side wall.

2. A drill bit as defined in claim 1 wherein said head section inserts are mounted at varying radial distances from the axis of the bit, said hammer member inserts include additional inserts mounted at varying radial distances from the axis of the bit, and said laterally projecting and additional hammer member inserts each include inserts extending angularly outwardly with respect to the bit axis when the hammer members are in said seated positions, whereby upon impacting the bit, said hammer member inserts are caused to fracture the lands resulting from penetration of said formation by said head section inserts.

3. A drill bit as defined in claim 2 including further inserts mounted in the outer ends of said hammer members and projecting laterally beyond the periphery of the remainder of the bit on opposite sides thereof with their axes in a plane including the pivotal axes of the hammer members and perpendicular to the bit axis when the hammer members are seated on said body end.

4. A drill bit as defined in claim 1 wherein said hammer members include surfaces making seating engagement with surfaces on said body end in respective planes extending angularly with respect to the bit axis and inwardly of the body towards its periphery, and said laterally projecting inserts include inserts extending perpendicularly to said seating surfaces of their respective hammer members.

5. A drill bit as defined in claim 4 wherein said planes extend at angles of about 55° to the bit axis.

6. A drill bit as defined in claim 4 wherein said means pivotally mounting said hammer member inner ends permit lateral movement of the hammer members for producing increased lateral striking force upon impacting the bit.

7. A drill bit as defined in claim 4 including fluid passages in said body terminating at said seating surfaces thereon.

8. A rotary percussion drill bit which comprises:

a bit body for receiving and transmitting rotational and impact forces from a percussion tool;

head sections fixed on one end of said body;

a pair of hammer members adapted for seating on said body end between said head sections and together with the head sections providing a working face on the bit, said hammer members extending transversely of the bit in diametrically opposed relation;

means pivotally mounting the inner ends of said hammer members on said body end for swinging movement of the members to and from positions seated on said body end comprising elongated rounded inner end portions rotatably received in elongated socket means on said body end including a protruding bar section interposed between said inner ends;

a plurality of wear-resistant inserts mounted in said head sections at varying radial distances from the axis of the bit and projecting from the head sections at said working face; and

a plurality of wear-resistant inserts mounted in said hammer members and projecting therefrom at said working face, including inserts projecting laterally beyond the periphery of the remainder of the bit on opposite sides thereof when the hammer members are seated on said body end, and additional inserts mounted at varying radial distances from the axis of the bit, whereby upon impacting the bit, said hammer members are swung towards said seated positions to cause said hammer member inserts to fracture the lands resulting from penetration of a formation being drilled by said head section inserts, and to cause said laterally projecting inserts to fracture the side wall of a hole being drilled in the formation, and upon raising the bit, said hammer members swing out of binding engagement with the side wall.

9. A drill bit as defined in claim 8 including a plurality of wear-resistant inserts mounted in said bar section at varying radial distances from the axis of the bit and projecting from the bar section at said working face, said bar section inserts being recessed with respect to said head section inserts and said additional hammer member inserts to form a central core in the formation at the bottom of the hole being drilled.

10. A drill bit defined in claim 8 wherein said hammer members include surfaces making seating engagement with surfaces on said body end in respective planes extending angularly with respect to the bit axis and inwardly of the body towards its periphery.

11. A drill bit as defined in claim 10 wherein said laterally projecting and additional hammer member inserts each include inserts extending angularly outwardly with respect to the bit axis when the hammer members are in said seated positions.

12. A drill bit as defined in claim 10 wherein said means pivotally mounting said hammer member inner ends permit lateral movement of the hammer members for producing increased lateral striking force upon impacting the bit.

13. A drill bit as defined in claim 10 including fluid passages in said body terminating at said seating surfaces thereon.