

June 18, 1968

D. W. VAREL ET AL
PERCUSSION BIT

3,388,756

Filed March 29, 1965

3 Sheets-Sheet 1

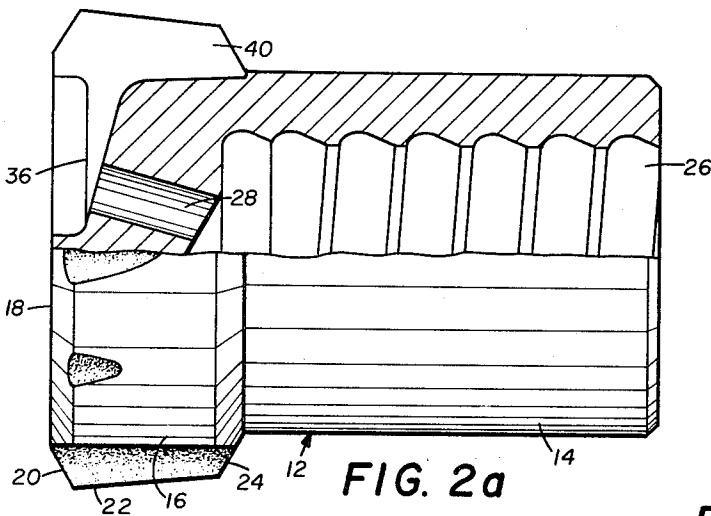


FIG. 2a

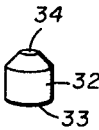


FIG. 2b

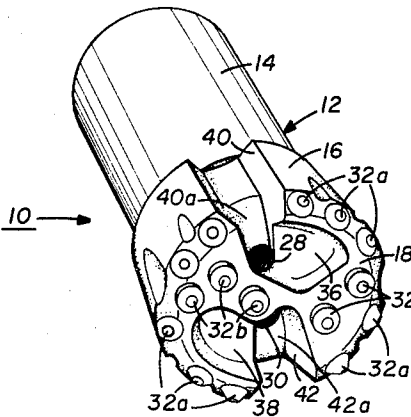


FIG. 1

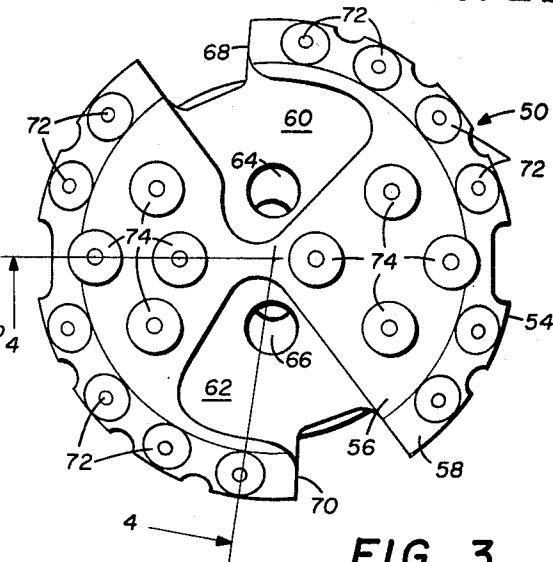


FIG. 3

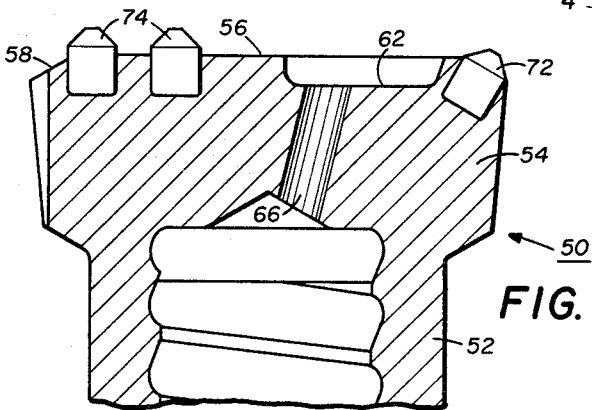


FIG. 4

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3 Sheets-Sheet 2

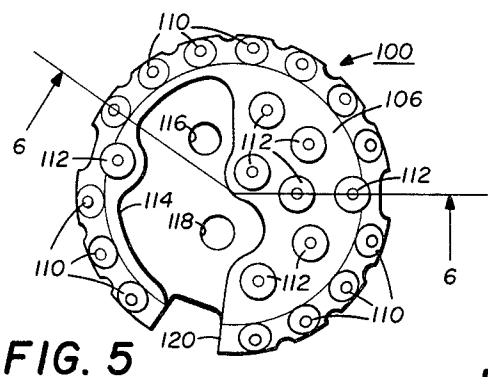


FIG. 5

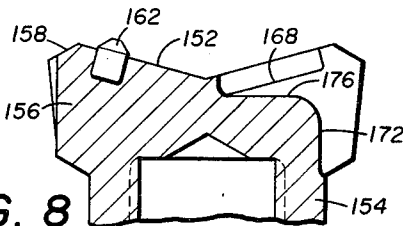


FIG. 8

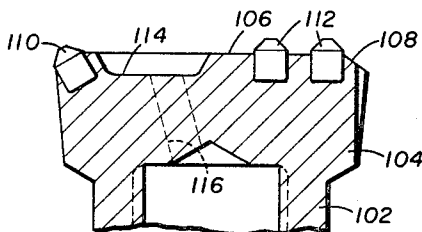


FIG. 6

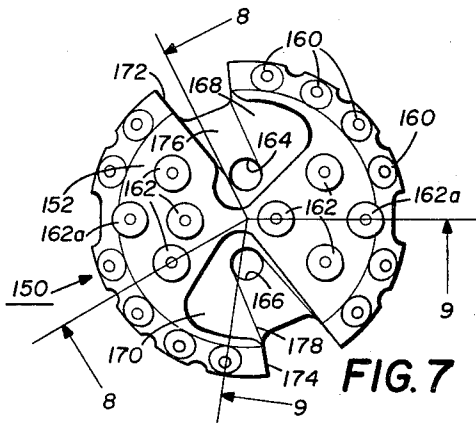


FIG. 7

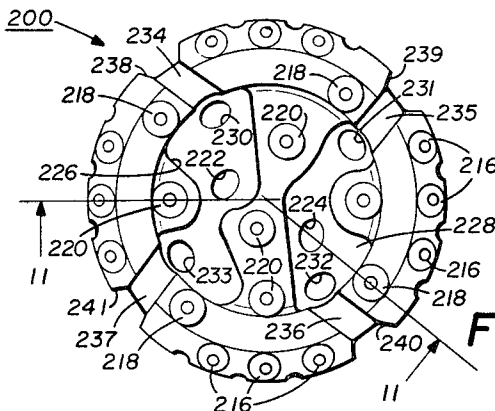


FIG. 10

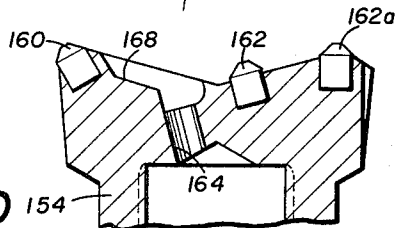


FIG. 9

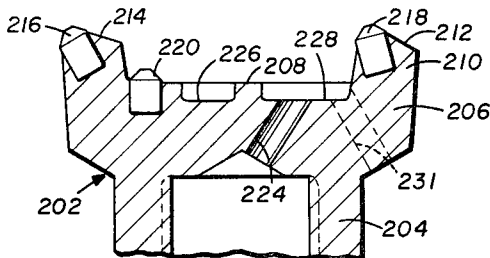


FIG. 11

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3 Sheets-Sheet 3

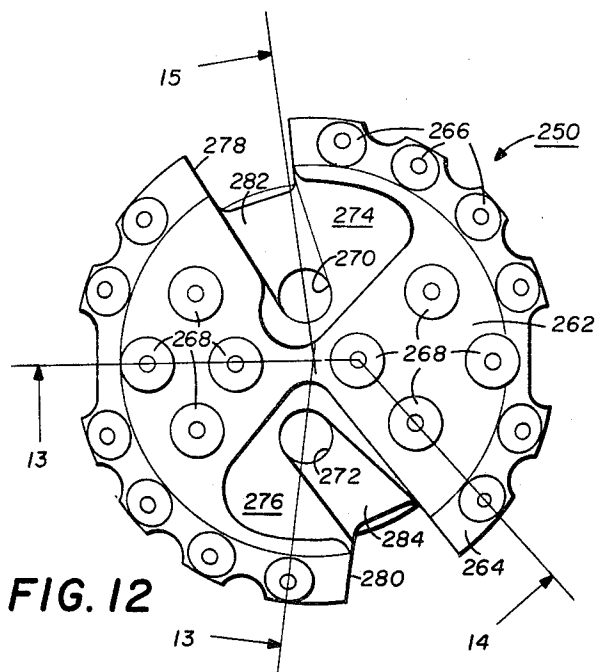


FIG. 12

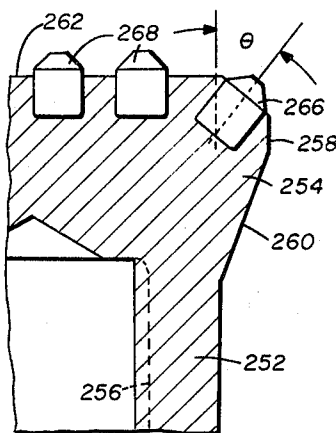


FIG. 14

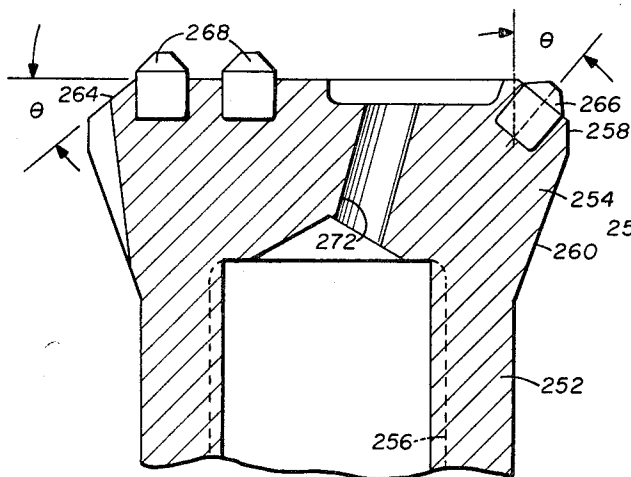


FIG. 13

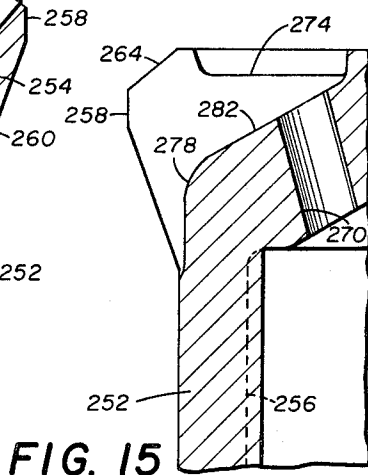


FIG. 15

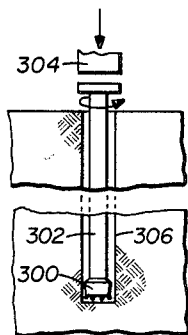


FIG. 16

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PERCUSSION BIT

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18 Claims. (Cl. 175—410)

ABSTRACT OF THE DISCLOSURE

In a carbide insert percussion bit for earth boring, the major portion of the inserts are positioned on the outward facing periphery of the bit, while a smaller number of the inserts are positioned on the bit face. The peripheral inserts are oriented at an angle greater than about 35° to the longitudinal axis of the bit. Fluid passageways are directed onto the bottom of the borehole through the body of the bit. A recess of enlarged area central to the bit face provides a standoff cavity communicating with the downward passageways and return fluid courses, which return courses are formed by grooving in the periphery of the bit or by passages through the bit body.

This invention relates to earth boring, and in particular, but not by way of limitation, relates to an improved percussion bit which needs no sharpening.

Percussion bits are widely used for drilling relatively shallow bores in hard rock and to some extent deeper holes such as oil wells in other similar formations. Perhaps the most conventional and widely used percussion bit utilizes four elongated chisel-shaped carbide inserts disposed radially and arranged to form either an X pattern or cross pattern on the face of the bit which impacts the bottom of the borehole. The shank of the bit is impacted at a relatively high rate by a pneumatic hammer or other similar mechanism and is simultaneously rotated either by rifling or by a separate rotary drive mechanism. The bit may be connected to the end of a stem or mandrel and the hammer located at the surface, or the hammer may be located immediately adjacent the bit in the borehole. The cuttings are usually transported from the borehole by a suitable fluid such as air, although water or other liquid or gas may also be used. The outer ends of the chisel-shaped inserts in the percussion bits described above become rounded at a relatively high rate with use and must be sharpened from time to time in order to continue to operate efficiently. Even so, these bits have a relatively short life in terms of hole footage cut.

Another basic problem involved in this type of drilling is the efficient removal of cuttings from the borehole by means of the fluid. If the cuttings are not quickly removed, a substantial portion of the energy will be absorbed in further grinding the cuttings. It is customary to pump compressed air down through the center of the bit so that the air will engage the bottom of the borehole and entrain the cuttings which are then carried up the annulus by the stream of air. It is customary to form large longitudinally extending grooves at spaced points around the periphery of the bit to pass the cuttings and air by the bit to the annulus.

The object of this invention is to provide an improved percussion bit having a longer useful life in terms of hole footage cut.

Another object of the invention is to provide such a bit having an increased penetration rate.

Yet another object is to provide a self-sharpening percussion bit.

A still further object of the invention is to provide a percussion bit having improved efficiency in the removal of cuttings from the borehole.

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These and other objects are accomplished by placing a number of hardened inserts in the impacting face of a softer bit body which have blunt protruding ends to engage and crush the rock. More specifically, the major portion of the inserts are placed around the outer periphery of the bit in a position to determine and maintain the gauge of the borehole while a lesser portion of the inserts are positioned toward the center of the bit face to act on the bottom of the borehole. The hardened inserts are so formed as to maintain substantially the same blunt face as they are worn and are useful until they are worn to the extent they can no longer be secured in the body because the softer bit body will be rapidly worn away by the drilling action. In order to position a maximum practical number of inserts at the periphery of the bit and still efficiently sweep the cuttings from the bottom of the borehole, one or more air courses pass generally axially through the body of the bit and are directed onto the bottom of the borehole. A standoff cavity is formed by a recess in the center portion of the face of the bit body around each fluid course and is of an enlarged area so as to extend over a major portion of the bottom of the borehole and each communicates with a return fluid course, formed either by a groove in the periphery of the bit body or by a passageway through the bit body, communicating with the annulus around the drill stem. The standoff cavity in the face of the bit continues to provide a turbulence cavity for entrainment of the cutting particles even as the blunt inserts wear off toward the face of the bit body and the soft bit body itself is worn. The periphery of the bit body is interrupted only by a passageway of minimum width so as to permit a maximum number of peripheral inserts, yet results in a high velocity fluid stream to insure that the entrained cuttings will be efficiently removed from the borehole.

In accordance with another important aspect of the invention, the inserts around the periphery of the body of the bit are positioned at an angle greater than about 35° to the longitudinal axis of the bit, and preferably at an angle of from about 40° to 50°. The reason for improved performance is not fully appreciated as of the date of this application although an increase of this angle from 30° to 40° resulted in substantially doubling the hole footage drilled by bits otherwise identical in construction, as well as a reduction in bit heating to a high degree and an increase in penetration rate.

Other aspects, objects and advantages of the invention will become apparent to those skilled in the art from the following detailed description and drawings, wherein:

FIGURE 1 is a perspective view of a percussion bit constructed in accordance with the present invention;

FIGURE 2a is a side view, partially in section, of the body of the percussion bit of FIGURE 1;

FIGURE 2b is a perspective view of an insert used in the bit of FIGURE 1;

FIGURE 3 is an end view of another percussion bit constructed in accordance with this invention showing the face of the bit which engages the bottom of the borehole;

FIGURE 4 is a sectional view taken substantially on lines 4—4 of FIGURE 3;

FIGURE 5 is an end view of another bit constructed in accordance with this invention showing the face which engages the bottom of the borehole;

FIGURE 6 is a sectional view taken substantially on lines 6—6 of FIGURE 5;

FIGURE 7 is an end view of another percussion bit constructed in accordance with the present invention showing the face which engages the bottom of the borehole;

FIGURE 8 is a sectional view taken substantially on lines 8—8 of FIGURE 7;

FIGURE 9 is a sectional view taken substantially on lines 9—9 of FIGURE 7;

FIGURE 10 is an end view of still another percussion bit constructed in accordance with the present invention showing the face which engages the bottom of the borehole;

FIGURE 11 is a sectional view taken substantially on lines 11—11 of FIGURE 10;

FIGURE 12 is an end view of another bit constructed in accordance with the present invention showing the face which engages the bottom of the borehole;

FIGURE 13 is a sectional view taken substantially on lines 13—13 of FIGURE 12;

FIGURE 14 is a sectional view taken substantially on radial line 14 of FIGURE 12;

FIGURE 15 is a sectional view taken substantially on radial line 15 of FIGURE 12; and

FIGURE 16 is a schematic illustrating the method of this invention.

Referring now to the drawings, and in particular to the perspective view of FIGURE 1, a bit constructed in accordance with this invention is indicated generally by the reference numeral 10. The bit 10 has a generally cylindrical body 12 which is illustrated in FIGURE 2a. The body 12 may be machined or otherwise formed from a high quality steel or the like and is comprised of a tubular shank portion 14 and a head portion 16. The head portion 16 has a greater diameter than the shank portion 14 and has a face comprised of a generally flat portion 18 and a peripheral conically tapered portion 20. The head 16 also has a slightly tapered cylindrical portion 22 which terminates in a steeply tapered frusto conical portion 24. The tubular shank portion 14 has internal threads 26 for connecting the bit to the mandrel or stem of the conventional hammer means used to drive the bit. Of course, external threads could be provided on the shank if desired. The mandrel or stem is also tubular and supplies fluid under pressure to the interior of the bit in the conventional manner. A pair of outlet fluid courses 28 and 30 extend from the tubular shank and emerge in the central portion of the face 18 so as to direct fluid toward the bottom of the bore being cut by the bit.

A set of hardened inserts 32a are mechanically secured in bores in the conically tapered peripheral surface 20. Each of the hardened inserts 32a is generally cylindrical in form as shown in FIGURE 2b and has a flat inner end 33 and a blunt protruding end 34. The inserts 32a may be formed from various hard carbide materials or any other similar suitable material that is substantially harder than the steel used to form the body 12. The inserts 32a may be connected to the bit using conventional mechanical press fit techniques so as to be frictionally retained in the bores formed in the body 12. The set of peripheral inserts 32a are press fitted in bores the axes of which are normal to the conically tapered peripheral face 20 and protrude radially from the bit at an angle to the longitudinal axis of the bit to determine the gauge of the bore cut by the bit. A second set of inserts 32b are secured in bores in the flat portion 18 of the face of the bit and project from the face normal to the flat portion 18. In accordance with an important aspect of the invention, it will be noted that the number of peripheral gauge inserts 32a is substantially greater than the number of interior face inserts 32b so that a greater proportion of the energy of the bit is directed toward the outer portion of the borehole. In the particular embodiment illustrated in FIGURE 1, there are twice as many peripheral gauge inserts 32a as face inserts 32b.

In accordance with another aspect of the invention, recesses 36 and 38 in the flat portion 18 of the face of the bit provide standoff cavities for purposes which will presently be described. The recesses 36 and 38 intersect the outlets of the fluid courses 28 and 30 and cover as much of the face 18 as possible consistent with adequate mechanical support for the face inserts 32b. The recesses

36 and 38 are of substantially constant depth with respect to the longitudinal axis of the bit and are preferably sufficiently deep to insure that a standoff cavity still exists after the inserts 32 and the face of the head 16 have worn down to the point there is danger that the inserts will loosen and fall from the bit body so as to utilize the full useful life of the bit. Return fluid courses are formed by longitudinal grooves 40 and 42 in the periphery of the head portion 16 which intersect the recesses 36 and 38. It will be noted that the return fluid courses interrupt only a minimum length of the periphery of the bit so as to permit the use of a maximum practical number of peripheral inserts 32a. Deepened channels 40a and 42a may be provided in the recesses 36 and 38 between the outlet fluid courses 28 and 30 and the return flow fluid courses 40 and 42 to further facilitate fluid communication between the outlet and return flow fluid courses.

It will also be noted that the recesses 36 and 38 extend from the deepened channels 40a and 42a over a substantial portion of the face of the bit so that the remaining portion of the face and the inserts generally forms a reversed S configuration. It is preferred that the bit be indexed or rotated slowly in the clockwise direction when referring to FIGURE 1 so that particles will not tend to accumulate in the shallow recesses 36 and 38 as opposed to the deeper channels 40a and 42a. The head 16 is also provided with a number of longitudinally extending grooves 43 around the periphery thereof to minimize the contact between the head of the bit and the walls of the borehole so as to reduce heating of the bit.

A borehole is cut through the formation by holding the bit 10 against the bottom of the borehole and impacting the bit at a high rate such that the blunt ends of the hardened inserts 32 will crush and spall the rock formation. The large number of inserts 32a around the periphery of the bit determine the gauge of the bore being cut while the face inserts 32b act on the face of the bore. The rock fragments are then carried from the borehole by the fluid, which is usually air, directed from the fluid courses 28 and 30 onto the bottom of the borehole. Although it is not intended to be limited by any specific theory, it is believed that the standoff cavities formed by the recesses 36 and 38 promote considerable turbulence of the air over a large portion of the bottom of the borehole which results in the entrainment of the loose rock particles. Once the particles are entrained, the return fluid courses 40 and 42 are of a smaller cross-sectional area to provide a relatively high velocity to carry the particles past the head of the bit and up through the annulus.

The bit 10 does not lose cutting efficiency with use because the hardened inserts 32 retain a somewhat rounded, but blunt end as they are worn away by use. Thus, the configuration of the inserts does not materially change and the bit does not need sharpening during its useful life. The bit continues to be useful even after the inserts have worn down past the original position of the face of the body because the softer body readily wears away to expose the blunt ends of the inserts. As the peripheral inserts 32a wear, the gauge of the bore is, of course, lessened to a small degree and the relatively soft steel forming the head portion 16 will also be worn away to conform to the reduced gauge of the borehole. However, by reason of the recesses 36 and 38, standoff cavities are maintained in which fluid turbulence and agitation can be established to efficiently entrain the particles cut from the bottom of the borehole to prevent further grinding and consequently inefficient operation. Thus the useful life of the bit is prolonged by the high ratio of peripheral inserts as compared to face inserts, by the continuing exposure of the inserts as they are worn, and by continued high cleaning efficiency as the face of the bit is worn down by use.

Referring now to FIGURES 3 and 4, another bit constructed in accordance with the present invention is indi-

cated generally by the reference numeral 50. The bit 50 is of the same type as the bit 10 and has a substantially identical shank portion 52 and head portion 54. The bit 50 also has a face with a relatively flat portion 56 with a conically tapered peripheral edge portion 58. Recessed portions 60 and 62 in the flat portion 56 form standoff cavities which in turn provide fluid communication between fluid outlet courses 64 and 66 and fluid return courses 68 and 70 formed by grooves in the periphery of the head 54. A first set of hardened inserts 72 is provided in the conically tapered peripheral face portion 58 and a lesser number of hardened inserts 74 are provided in the flat face portion 56. The inserts 72 and 74 may be substantially identical with the inserts 32 heretofore described and may be secured in the bit body in the same manner. It will be noted that there are twelve peripheral inserts 72 as compared with eight face inserts 74 to provide a ratio of approximately three peripheral gauge forming inserts to two interior face inserts. It will also be noted that the periphery of the bit is interrupted only by the relatively narrow grooves 68 and 70 which form the return fluid courses and that the cross-sectional area of the standoff areas formed by the recesses 60 and 62 are at least as great and preferably greater than the cross-sectional area of either the outlet fluid courses 64 and 66 or the return fluid courses 68 and 70. No deepened channels similar to the channels 40a and 42a are provided with a view to maintaining a minimum cross section in the return fluid course, consistent with passing the maximum sized rock particles, so that the fluid velocity through the return fluid courses 68 and 70 will be maintained at a maximum to insure that the particles are efficiently removed from the borehole once entrained by the action of the fluid directed onto the bottom of the borehole and the turbulence resulting in the standoff cavities formed by the recesses 60 and 62. This action appears to be even further enhanced as the inserts 72 and 74 are worn down and the face 56 more closely conforms to and mates with the face of the borehole. Note also that the recesses forming the standoff cavities are of sufficient depth to permit face 56 to wear away and expose the last usable portions of carbide inserts while yet leaving a recessed cavity to permit proper field action.

Referring now to FIGURES 5 and 6, another bit constructed in accordance with this invention is indicated generally by the reference numeral 100. The bit 100 is similar to the bits 10 and 50 and is also comprised of a body of relatively soft material such as steel having internally threaded, tubular shank portion 102 and a head portion 104. The head portion 104 has a flat interior face portion 106 and a conically tapered peripheral face portion 108. A set of hardened inserts 110 which determine the gauge of the borehole cut by the bit is secured in the peripheral face portion 108 as heretofore described. A number of hardened inserts 112 are disposed in the interior face portion 106 and project normal to the face 106. It will be noted that there are fourteen peripheral inserts 110 and eight face inserts 112 and that substantially all of the face inserts 112 are disposed in one-half of the flat face 106.

A recess 114 covers substantially all of the other half of the face 106 to form a standoff cavity preferably of a depth as heretofore described in connection with bits 10 and 50 so as to be useful over the life of the inserts. A pair of outlet fluid courses 116 and 118 extend from the interior of the tubular shank portion 102 and are positioned to direct fluid onto the bottom of the borehole within the standoff cavity formed by the recess 114. A single groove 120 extends longitudinally along the edge of the head 104 and is in fluid communication with the standoff cavity formed by the recess 114 to provide a single return fluid course having a minimum cross-sectional area consistent with passing the largest rock particle to be expected so as to establish a high fluid velocity by the bit head. A number of longitudinally extending peripheral

eral grooves 122 are provided in the head 104 to reduce frictional contact between the head and wall of the borehole and thus reduce heating.

It will be noted that the ratio of peripheral inserts 110 which determine the gauge of the bore substantially exceeds the number of face inserts 112 which act directly upon the bottom of the borehole. This results in a greater useful life for the bit because the inserts 110 are located at the periphery of the bit where it has been found the major portion of the drilling energy is required and where the most wear occurs. All of the hardened inserts retain a blunt working head extending from the comparatively soft body face as the comparatively soft face wears to expose originally embedded carbide insert portions. Further, by reason of the design illustrated, it is believed that the cuttings are removed from the bottom of the borehole with increased efficiency, even as the inserts are worn down and the face 106 more closely approaches and conforms to the bottom of the borehole as a result of wear. This is occasioned, it is believed, by reason of the fact that the outlet fluid courses 116 and 118 direct the fluid as a relatively high velocity jet onto the bottom of the borehole. The standoff cavity formed by the recess 114 produces a substantial amount of turbulence over approximately one-half of the bottom of the borehole. The return fluid course 120 is of a reduced cross section as compared to that of the standoff cavity so that the fluid velocity is at least maintained and probably increased to insure that the particles entrained by the turbulent air in the standoff cavity will be carried by the bit as the fluid moves longitudinally of the borehole toward the annulus. Thus, the bit 100 provides a maximum number of peripheral gauge cutting inserts, yet provides for the efficient removal of cuttings from the borehole.

Referring now to FIGURE 7, another bit constructed in accordance with the present invention is indicated generally by the reference numeral 150. The bit 150 is similar to the bit 50 heretofore described except that the bit 150 has a concave, conically tapered central face 152 rather than a flat central face as in the bit 50. The bit 150 has a steel body with a tubular shank portion 154 and an enlarged head portion 156. The face of the head portion 156 has a peripheral conical surface 158 disposed around the concave conical face 152. A plurality of peripheral inserts 160 are frictionally secured in bores in the conical surface 158 so as to be disposed at an angle to the axis of the bit and determine the gauge of the borehole as heretofore described. The face inserts 162 are positioned in substantially the same configuration as the inserts 74 except that the inserts 162 are disposed substantially normal to the concave conical face 152 as can best be seen in FIGURES 8 and 9. However, face inserts 162a are disposed generally parallel to the axis of the bit 150.

A pair of outlet fluid courses 164 and 166 communicate with the interior of the tubular shank portion 154 to direct a jet of fluid onto the central portion of the bottom of the borehole. A pair of standoff cavities are formed by recesses 168 and 170 in the conical face 152 which intersect the fluid courses 164 and 166. A pair of return fluid courses 172 and 174 extend longitudinally along the periphery of the head portion 156 and are in fluid communication with the standoff cavities formed by the recesses 168 and 170. Deepened channels 176 and 178 facilitate fluid communication between the outlet fluid courses 164 and 166 and the return fluid courses 172 and 174.

The operation of the bit 150 is substantially the same as the operation of the bit 50 heretofore described. The relatively large number of peripheral inserts 160 which determine the gauge of the bore are concentrated in the region where the most drilling energy is required and thus materially prolong the useful life of the bit. Yet the configuration of the fluid courses and standoff cavities effects the efficient removal of cuttings from the borehole while permitting a maximum number of hardened inserts to be placed around the periphery of the bit.

Referring now to FIGURE 10, still another bit constructed in accordance with the present invention is indicated generally by the reference numeral 200. The bit 200 is also comprised of a body portion indicated generally by the reference numeral 202 having a shank portion 204 and a head portion 206. The bit 200 has a relatively flat, recessed central face 208 disposed within an annular projection 210 as best seen in the sectional view of FIGURE 11. The end of the projection 210 has an outwardly facing, conically tapered, annular surface 212 concentrically disposed about an inwardly facing, conically tapered, annular surface 214.

A first set of hardened inserts 216 is frictionally retained in bores in the outwardly facing conical face 212 with the axes of the inserts 216 disposed substantially normal to the conical face 212. The set of inserts 216 thus determines the gauge of the bore cut by the bit. A second set of inserts 218 is disposed in the inwardly facing conical face 214 and the axes of the inserts are disposed generally normal to the face 214. Thus the set of inserts 218 determines an internal gauge for an annular groove which will pass the annular projection 210 and associated inserts. A third set of inserts 220 is secured in the flat central face 208 and is disposed substantially normal to the flat face.

A pair of outlet fluid courses 222 and 224 are in fluid communication with the interior of the shank portion 204 and are positioned to direct a jet of fluid downwardly against the center of the bottom of the borehole. A pair of recesses 226 and 228 in the flat central face 208 form standoff cavities and intersect the outlet fluid courses 222 and 224. Four generally longitudinally extending bores 230-233 extend radially through the head portion 206 as represented by the dotted lines 231 in FIGURE 11 so as to provide one set of return fluid courses between the standoff cavities formed by the recesses 226 and 228 and the annulus between the drill stem and the borehole. Additional return fluid courses are formed by radial grooves 234-237 in the annular projecting portion 210 and grooves 238-241 extending longitudinally along the periphery of the head portion 206.

In the operation of the bit 200, the first set of inserts 216 determines the outer gauge of the borehole, the second set of inserts 218 determines the interior gauge of the annular groove cut in the bottom of the borehole, and the central set of inserts 220 acts on the center portion of the bottom of the borehole. Fluid under pressure is directed through the outlet fluid courses 222 and 224 onto the central portion of the face of the borehole. The particles generally beneath the standoff cavities formed by the recesses 226 and 228 are agitated and entrained and pass out through the return fluid courses 230-233. A portion of the fluid also passes through the radially extending grooves 234-237 to entrain the particles lying in the annular groove cut by the first and second sets of projections 216 and 218, and the entrained particles bypass the head of the bit into the annulus through the grooves 238-241. It will be noted that the peripheral set of inserts 216 which determines the gauge of the bore exceeds the number in the second set of inserts 218 and the set of inserts 220 by a ratio of approximately four to three.

Referring now to FIGURES 12-15, another bit constructed in accordance with the present invention is indicated generally by the reference numeral 250. The bit 250 is similar to the bits heretofore described in that it is comprised of a body of relatively soft metal such as steel having a shank portion 252 and a head portion 254. The shank portion 252 is tubular and has internal threads represented by the dotted line 256 for connection to a tubular mandrel or drill stem. The head 254 has a cylindrical band 258 defining its maximum diameter and is conically tapered from the band 258 down to the shank portion 252 which is of smaller diameter. The head portion 254 has a substantially flat central face 262 disposed

normal to the axis of the bit and a peripheral, conically tapered face 264 disposed at an angle θ to the flat face 262.

A number of hardened inserts 266 similar to the inserts 32 heretofore described are disposed in bores in the face 264 with the axes of the inserts disposed normal to the face 264. Thus, the axes of the inserts 266 are disposed at the angle θ with respect to the longitudinal axis of the bit 250 and therefore with respect to the longitudinal axis of the borehole. A second set of inserts 268 is disposed in the flat face 262. As illustrated, there are twelve peripheral inserts 266 which determine the gauge of the borehole and eight face inserts 268 to provide a ratio of three to two.

In accordance with an important aspect of the invention, the angle θ is in excess of about 35°. Although the precise optimum angle θ is not known, nor is there a substantiated theory for improved results which have been obtained as of the date of this application. However, experimental data reveals that a bit wherein the angle θ is 40° will cut approximately twice as much hole in hard rock as an otherwise identical bit wherein the angle θ is 30°. By using the greater angle θ , the bit operates with less heat, cuts hole at a faster rate and has a longer useful life. At this time, the maximum useful angle is not precisely known although preliminary data indicates that an angle θ in excess of 40° also produces superior results in many formations up to the point where the angle θ is about 50°.

The bit 250 also has outlet fluid courses 270 and 272 which communicate with the interior of the shank portion 252 and are positioned to direct a jet of fluid onto the central portion of the bottom of the borehole. Recesses 274 and 276 in the face 262 form standoff cavities around the outlet fluid courses 270 and 272 as heretofore described. Return fluid courses are formed by longitudinally extending grooves 278 and 280 in the periphery of the head portion 252 which provide fluid communication between the standoff cavities formed by the recesses 274 and 276 and the annulus formed between the borehole and the mandrel or drill stem. Deepened channels 282 and 284 provide a more direct communication between the outlet fluid courses 270 and 272 and the return fluid courses 278 and 280, respectively.

The operation of the bit 250 is generally the same as the operation of the bits heretofore described except that the increase in the angle θ produces superior results as previously mentioned. The peripheral inserts 262 determine the gauge of the bore being drilled and the face inserts 268 act on the bottom of the borehole. By reason of the greater number of peripheral inserts, a greater proportion of the expended drilling energy is directed to the edge of the borehole as required for the most efficient drilling and the maximum bit life. Yet the design of the fluid courses and standoff cavities efficiently removes the cuttings.

The method of the present invention is illustrated in FIGURE 16 wherein a bit 300, which may be any of the bits heretofore described, is repeatedly impacted through a mandrel 302 or other means by a hammer 304 or other means so as to produce an impact component parallel to the longitudinal axis of the bit. The bit has a first set of elongated, hardened inserts of the type heretofore described embedded therein which extend radially from the axis of the bit at an angle to the direction of impact to determine the gauge of the borehole 306, and a second set of elongated, hardened inserts embedded in the bit and extending therefrom to engage the central portion of the bottom of the borehole. The bit may also be rather slowly rotated so as to bring the inserts to bear on different parts of the bottom of the borehole and a fluid may be circulated through the bit by means of a conventional pump (not illustrated) to sweep cuttings from the borehole.

Although the peripheral face concentric to the central

face of the bits has herein been described as conically tapered, it is to be understood that this peripheral face may also be slightly convex or concave without materially altering the performance of the bit, provided the relative relationship of the inserts to the bit is not materially changed.

Although preferred embodiments of the invention have been described in detail, it is to be understood that various changes, substitutions and alterations can be made therein without departing from the spirit and scope of the invention as defined by the appended claims which are intended to constitute the sole limitations upon the scope of the invention reserved to the inventor.

What is claimed is:

1. In a percussion bit for earth boring and the like, the combination of:

a relatively soft metal body having a head portion, a tubular shank portion and a longitudinal axis, the head portion having a face disposed generally normal to the longitudinal axis,

an outlet fluid course in fluid communication with the interior of the shank and extending through the head portion for directing a jet of fluid onto the bottom of the borehole,

a recess in the face of the head portion and extending over an area of the face substantially greater than the outlet fluid course, the recess being of generally constant depth with respect to the face and not extending to the peripheral edge of the face,

a return fluid course extending longitudinally through the head and placing the recess in fluid communication with the annulus around the shank, the return fluid course having a cross-sectional area less than about three times the cross-sectional area of the outlet fluid course, and

a plurality of hardened inserts secured in the face of the head around the recess for engaging the bottom of the borehole.

2. In a percussion bit for earth boring or the like, the combination of:

a relatively soft metal body having a head portion, a tubular shank portion, and a longitudinal axis, the head portion having a face disposed generally normal to the longitudinal axis,

an outlet fluid course in fluid communication with the interior of the tubular shank and extending through the head portion for directing a jet of fluid onto the bottom of the borehole from adjacent the longitudinal axis of the body,

a recess in the face of the head portion around the outlet fluid course and extending over approximately one-fourth of the area of the face but not extending to the periphery of the face,

a longitudinally extending groove in the periphery of the head subtending less than about one-eighth of the circumference of the head in fluid communication with the recess to form a return fluid course, and

a plurality of hardened inserts secured in the body at spaced points over the remaining portion of the face of the head portion for engaging the bottom of the borehole.

3. The combination defined in claim 2 further characterized by:

a deepened channel in the recess extending between the outlet fluid course of the return fluid course, the deepened channel being of substantially the same width as the fluid courses.

4. The combination defined in claim 2 wherein:

the hardened inserts are elongated and cylindrically shaped and have a blunt end projecting from the body whereby as the inserts are worn down by usage, the face of the relatively soft body will also be worn down to expose the inserts, and

the recess is of a depth greater than the depth the face

will be worn down during the useful life of the inserts.

5. The combination defined in claim 2 wherein there are:

two outlet fluid courses disposed on generally opposite sides of the axis of the body,

a recess in the face of the head portion around each outlet fluid course, the two recesses extending over generally opposite quadrants of the face of the head portion, and

a longitudinally extending groove in the periphery of the head portion intersecting each recess to form a pair of return fluid courses disposed generally on opposite sides of the head portion.

6. The combination defined in claim 5 wherein the bit is to be rotated about the longitudinal axis and the longitudinally extending grooves are disposed at the trailing edges of the recesses.

7. In a percussion bit for earth boring or the like, the combination of:

a relatively soft metal body having a head portion, a tubular shank portion, and a longitudinal axis, the head portion having a face disposed generally normal to the longitudinal axis,

an outlet fluid course in fluid communication with the interior of the tubular shank and extending through the head portion for directing a jet of fluid onto the bottom of the borehole from adjacent the longitudinal axis of the body,

a recess in the face of the head portion around the outlet fluid course and extending over approximately one-half of the area of the face but not extending to the periphery of the face,

a longitudinally extending groove in the periphery of the head subtending less than about one-eighth of the circumference of the head in fluid communication with the recess to form a return fluid course, and

a plurality of hardened inserts secured in the body at spaced points over the remaining portion of the face of the head portion for engaging the bottom of the borehole.

8. In a percussion bit for earth boring or the like, the combination of:

a relatively soft metal body having a head portion, a tubular shank portion and a longitudinal axis, the head portion having a substantially flat central face disposed normal to the longitudinal axis and a tapered peripheral face disposed around the central face,

an outlet fluid course in fluid communication with the interior of the tubular shank and extending through the head portion for directing a jet of fluid onto the bottom of the borehole from the flat central face,

a recess in the flat central face around the outlet fluid course and extending over a substantially greater area of the flat central face but not over the tapered peripheral face,

a return fluid course in the head portion providing fluid communication between the recess and the annulus around the shank portion,

a first set of elongated, hardened inserts secured in the head portion and projecting from the tapered peripheral face at circumferentially spaced points to determine the gauge of the borehole, and

a second set of elongated, hardened inserts secured in the head portion and projecting from the flat face at spaced points other than the recess for acting on the bottom of the borehole.

9. The combination defined in claim 8 wherein:

the return fluid course is a groove in the periphery of the head portion intersecting the edge of the recess.

10. The combination defined in claim 8 wherein:

the return fluid course is a bore extending through the head portion.

11. In a percussion bit for earth boring or the like, the combination of:

- a relatively soft metal body having a head portion, a tubular shank portion and a longitudinal axis, the head portion having a concave, conically tapered central face around the longitudinal axis and an oppositely turned, conically tapered peripheral face concentric to the central face,
- a first set of elongated, hardened inserts secured in the head portion and projecting from the tapered peripheral face at circumferentially spaced points to determine the gauge of the bore cut by the bit,
- a second set of elongated, hardened inserts secured in the head portion and projecting at spaced points from the concave, conically tapered central face generally normal to the central face, and
- fluid course means for directing fluid onto the bottom of the borehole from the interior of the tubular shank portion and returning the fluid to the annulus around the tubular shank portion to remove cuttings from the borehole.

12. The combination defined in claim 11 wherein:

the number of inserts in the first set exceeds the number of inserts in the second set.

13. In a percussion bit for earth boring or the like, the combination of:

- a relatively soft metal body having a head portion, a tubular shank portion, and a longitudinal axis, the head portion having a substantially flat central face disposed normal to the longitudinal axis and an annular projecting portion disposed concentrically about the flat central face and projecting longitudinally beyond the flat face, the annular projecting portion having concentric inwardly and outwardly facing conically tapered annular faces,
- a first set of elongated, hardened inserts secured in the head portion and projecting from the outwardly facing annular face at circumferentially spaced points to determine the gauge of the bore cut by the bit,
- a second set of elongated, hardened inserts secured in the head portion and projecting from the inwardly facing annular face at circumferentially spaced points,
- a third set of elongated, hardened inserts secured in the head portion and projecting from the flat central face generally parallel to the axis of the body, and
- fluid course means for directing fluid from within the tubular shank portion onto the bottom of the borehole and returning the fluid to the annulus around the shank portion to remove cuttings from the borehole.

14. The combination defined in claim 13 wherein the number of inserts in the first set exceeds the number of inserts in the second and third sets combined.

15. The combination defined in claim 13 wherein the fluid course means comprises:

- an outlet fluid course communicating with the interior of the shank portion and extending through the head portion to the flat face thereof for directing a jet of fluid onto the bottom of the borehole,
- a recess in the flat central face around the outlet fluid course covering a substantially greater portion of the flat face than the outlet fluid course,
- a bore extending through the head portion between the recess and the annulus around the shank portion for providing a first return fluid course, and
- a groove extending radially across the annular projection from the recess to the periphery of the head portion and intersecting a longitudinally extending groove in the periphery of the head portion which communicates with the annulus around the shank portion to form a second return fluid course.

16. In a percussion bit for earth boring and the like, the combination of:

- a relatively soft metal body having a head portion, a tubular shank portion and a longitudinal axis,

a first set of hardened inserts secured in the periphery of the head portion and projecting radially from the head portion at an angle to the longitudinal axis of the body to engage the earth and determine the gauge of the borehole,

a second set of hardened inserts secured in the head portion and projecting from the center portion of the head portion to engage the central portion of the borehole,

the number of hardened inserts in the first set exceeding the number of hardened inserts in the second set, each hardened insert being generally cylindrical with a blunt projecting end and being frictionally retained in a bore in the head,

an outlet fluid course extending from the tubular shank portion generally longitudinally through the head portion for directing fluid onto the bottom of the borehole,

a recess in the head portion around the outlet fluid course forming a standoff cavity, the recess being of a depth greater than the thickness of the body which may be worn away during normal use of the bit so that a standoff cavity will be provided throughout the useful life of the inserts, and

a return fluid course in the head providing fluid communication between the standoff cavity and the annulus around the shank portion, the return fluid course subtending an angle substantially less than the angle subtended by the recess.

17. The combination defined in claim 16 further characterized by a deepened channel in the recess interconnecting the outlet fluid course and the return fluid course.

18. In a percussion bit for earth boring and the like, the combination of:

a relatively soft metal body having a head portion, a tubular shank portion and a longitudinal axis,

a first set of hardened inserts secured in the periphery of the head portion and projecting radially from the head portion at an angle to the longitudinal axis of the body to engage the earth and determine the gauge of the borehole,

a second set of hardened inserts secured in the head portion and projecting from the center portion of the head portion to engage the central portion of the borehole,

an outlet fluid course extending from the tubular shank portion generally longitudinally through the head portion for directing fluid onto the bottom of the borehole,

a recess in the head portion around the outlet fluid course forming a standoff cavity, the recess being of a depth greater than the thickness of the body which may be worn away during normal use of the bit so that a standoff cavity will be provided throughout the useful life of the inserts, and

a return fluid course in the head providing fluid communication between the standoff cavity and the annulus around the shank portion, the return fluid course subtending an angle substantially less than the angle subtended by the recess.

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