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2,879,037

ROCK DRILL BIT

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FIG. 1

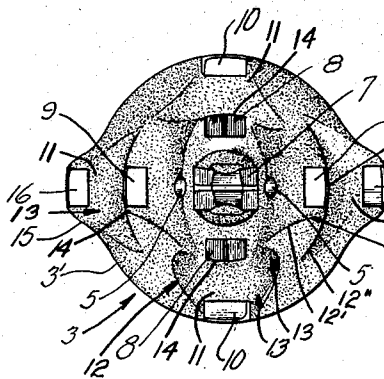


FIG. 3

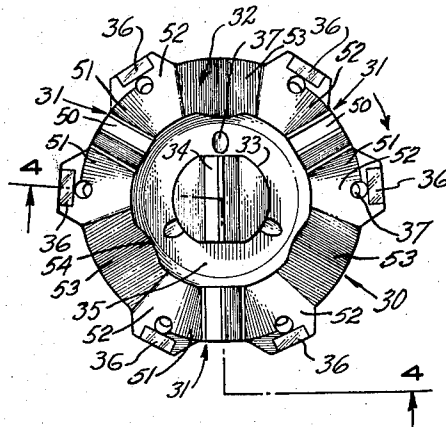


FIG. 2

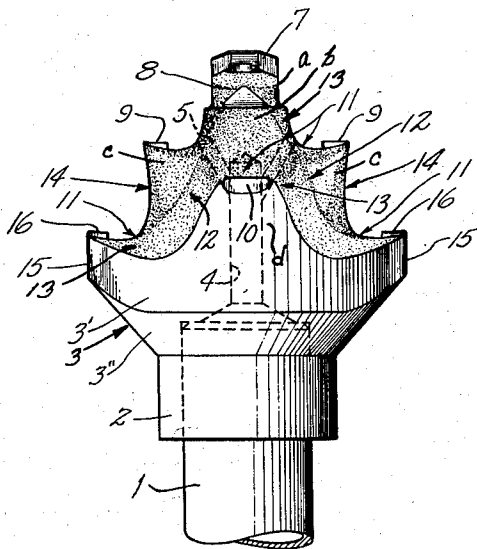


FIG. 4

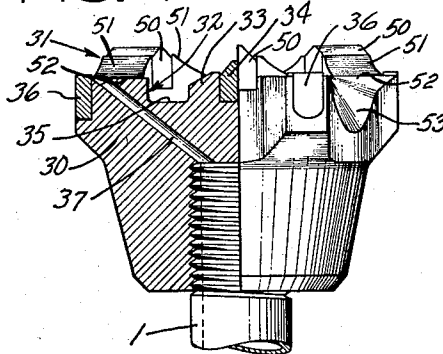


FIG. 6

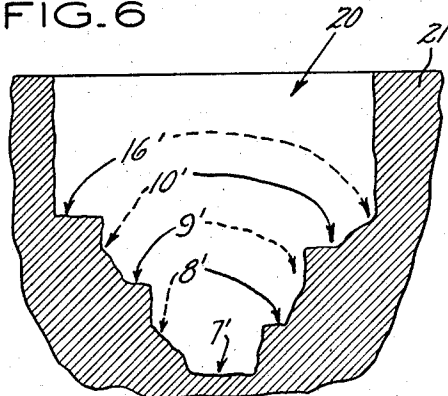
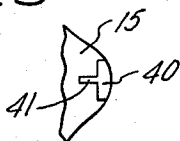


FIG. 5



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1

2,879,037

ROCK DRILL BIT

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3 Claims. (Cl. 255-64)

This invention relates to rock drill bits and particularly to bits of the drill hammer type in which a drill steel is percussively driven by a pneumatic hammer and rotated by increments according to the size and type of hammer.

A primary object of the invention is to provide a drill bit of inexpensive construction and capable of drilling a hole through rock and stone at a faster rate than any other form of rock drill bit now known to me.

Another object is to provide a bit which requires less force in the drilling operation and thus enables the use of hammer and drill steel equipment of a lighter construction for a given size of hole to be drilled.

Another object is to provide a rock drill bit, all the striking surfaces of which are formed to fracture the stone rather than pulverize the same and in the construction thereof to provide a bit which will continue to remain efficient through long periods of operation without the necessity of grinding down the surfaces to "sharpen" the same.

Another object is to provide a rock bit with an arrangement of a plurality of localized striking surfaces so that in the manufacture of the bit hardened inserts of comparatively expensive materials such as carbide inserts may be used in a more economical manner. By concentrating each of the striking surfaces of the bit into a small area on the bit face, inserts of carbide can be more economically formed so as to use a minimum of expensive material in comparison with prior bit constructions.

Another object of the invention is to provide a bit having a plurality of localized striking surfaces so located as to permit their convenient and ready accessibility for grinding and dressing operations for repair and "sharpening" purposes. An ordinary grinding wheel can be utilized to grind the surfaces of a bit of the present invention, whereas conventional bits most widely in use at the present time require special grinding wheel equipment.

The above and other specific objects and advantages of the invention will be discussed in the following description.

In the drawings,

Fig. 1 is a face view of a rock drill bit embodying the invention;

Fig. 2 is a side elevation of the bit shown by Fig. 1;

Fig. 3 is a face view of another embodiment of a bit constructed according to the invention;

Fig. 4 is a side elevation partially in section of the bit, taken on line 4-4 of Fig. 3;

Fig. 5 is a detail view showing a special form of carbide insert to provide a striking surface; and

Fig. 6 is a schematic view to illustrate the operation of a new bit.

Broadly the novel features of the new bit are based on the concept that in drilling holes in rock formations the greatest efficiency in removal of the rock is realized by chipping or spalling the stone rather than by pulver-

2

izing it. It will be readily recognized that a rock bit continually removing sizable chips and bits of stone will form a hole through rock with greater efficiency than a bit which acts in the drilling operation to produce an appreciable amount of pulverized dust together with chips. In prior art rock drills it is common knowledge that conventional bits have a short life, produce large amounts of pulverized dust in operation, and require frequent replacement for a new bit. It has been observed that such prior bits while formed to chip or spall rock formations in the initial formation of a hole to be drilled in a rock immediately meet with greater resistance once an entrance is made and the bit is positioned in the entrance cavity.

Insofar as I am aware, the difficulty has not heretofore been recognized nor has the problem been solved inadvertently or otherwise, although many and various attempts have been made to improve the construction of this type of drill bit and the useful life thereof. Basically the problem is one of constructing the bit so that a striking surface or surfaces thereof can take advantage of the spalling action while the bit is embedded in the hole being drilled. I have found that prior rock drill bits universally become "locked" in the hole being drilled so that a pulverizing action is necessary to advance the formation of the hole. Thus the speed of drilling is impeded and the dulling and wearing action increased on surfaces performing the pulverizing operation.

A bit constructed according to the present invention is formed to maintain an "unlocked" condition at all times and thus to continually spall the rock. The novel arrangement of striking surfaces and formation of the bit body in the areas between said surfaces and otherwise adjacent to said surfaces provides voids into which chips may be continually sheared or fractured. The voids so-called form interconnected passages into which chips can be expelled by the striking surfaces and through which the chips can then be passed rearwardly of the bit. The hammering surfaces at all times will then be free to hit with effective and efficient striking blows, progressively chipping off the rock, without a trapping or bottoming of the force thereof. In other words as each blow is struck it is delivered vertically. The force of the blow results in a plurality of individual fractures directed angularly of the vertical and a plurality of chips to be knocked off along the lines of fracture into the "void" areas. The chips can then be blown away from the bottom of the hole and any further interference with the striking surfaces is eliminated. Were it not for the interconnection of the voids to form paths for rapid chip removal and for the progressive chipping away of the rock along a plurality of edges formed by the action of the bit in the hole being made, the main force of the blows delivered by the striking surfaces would be transmitted into the solid body of the rock where it would be largely absorbed and be ineffective to fracture and chip off small bits of the rock in the shortest possible time. The force of the bit would then be "trapped" by the rock and absorbed without achieving the beneficial result desired which is to remove the rock.

The invention thus resides in the novel arrangement and relationship of the plurality of striking surfaces of the bit.

In the drawings (Figs. 1 and 2) a form of rock drill bit is disclosed in which drill steel is indicated at 1 with the inner socketed end 2 of a drill body 3 fixed to the steel. As indicated at 4 a central passage is provided with branches at 5 leading to the working face of the bit for conducting air under pressure to the bottom of the hole and so as to blow the drillings removed by the bit back out of the cavity being formed.

The body 3 of the bit is formed with a generally cylindrical base section as at 3'. Rearwardly of the base the inner end section 2 is of a reduced diameter. Forwardly of the base section the body is reduced circumferentially and provided with sets of longitudinally spaced stepped striking surfaces as will be explained below. The individual striking surfaces of each set are provided in the forward face of lobed portions and circumferentially spaced from each other. Each individual surface of each set is also in circumferentially spaced relation to each surface of the next adjacent longitudinally spaced set of surfaces. In appearance the forward body portion is thus somewhat conical in formation with the spaced lobed portions providing a knobbed effect. On the axis of the bit as shown by Fig. 1 a forward central striking surface is provided as a pilot cutter at 7. Preferably the forwardly projecting cutter 7 comprises an insert blade of carbide material set into a cylindrical projection at *a* of the body. The pilot 7 as shown by Figs. 1 and 2 is an insert of a generally conventional type with the cutting blade edge angularly relieved at each end (Fig. 2). In transverse cross section the shape corresponds to that of the conventional carbide cutter blade such as the insert, for example, at 50 in Fig. 3 or 4.

Also forwardly facing on the bit body are sets of striking surfaces at 8, 9, and 10. Preferably such surfaces are provided by carbide inserts set into the body of the bit as indicated. The striking surfaces are to be more specifically understood as the working surfaces of the inserts which deliver the impact of the blows. These surfaces in the form of Figs. 1 and 2 are arranged in pairs. A striking surface of each set is located in diametrically opposed relation to the other surface of the set and at the same radial spacing from the center blade or surface at 7. As will be apparent from Fig. 1 the outer edges of each pair of corresponding surfaces 8, 9, or 10 may thus define or lie at the edge of a circle, the center of which is on the bit axis. Each circle will thus be concentric with a circle similarly defined by each of the other pairs of surfaces. Accordingly, within the boundaries of two such adjacent circles lies an annular area and in such area one set or pair of striking surfaces is disposed. The inner boundary of the innermost annular area in which surfaces 8 may lie is defined by the base of the projection *a* in the end of which the blade 7 is fixed. As above mentioned the sets of striking surfaces are longitudinally spaced (Fig. 2). Set 8 is first of all rearwardly stepped from the blade edge of pilot 7, set 9 is rearwardly stepped from set 8, and set 10 is rearwardly stepped from set 9. From Fig. 1 it will also be noted that the surfaces of each set are circumferentially spaced from the surfaces lying within an adjacent annular area as above defined.

In Fig. 1 the surfaces 8 rearwardly stepped with respect to the center cutter 7 are diametrically located with the edge of the cutter blades 8 set at right angles to the edge of the cutter blade 7. As will be latter apparent the blade 8 may also be in the form of flattened striking surfaces as are the surfaces 9 and 10. With relation to surfaces 8 the diametrically opposed surfaces 9 are set at 90° with the surfaces 10 radially aligned with blades 8 and at 90° to the surfaces 9. As will also be later apparent the surfaces of each set need not be at 90° to those of an adjacent set. A series of two or three or more surfaces as 8, or 9, or 10 may be arranged within the annular areas as above defined. Each of the surfaces, however, are circumferentially spaced from the forwardly or rearwardly stepped striking surfaces of an adjacent annular area. Thus each surface 8, 9, or 10 is longitudinally or circumferentially spaced with respect to any one of the others on the face of the bit. And it will be noted the body of the bit is rearwardly relieved or cut away in the areas adjacent to each of the striking surfaces. Relieved adjacent areas are indicated

for example, by the arrows at 11, (inwardly of the surfaces) and at 12 and 13 (at each side).

Each striking surface as will later be more specifically described, is designed to deliver a localized blow to knock a chip from the hole being drilled. The surfaces adjacent thereto and relieved or cut away at 11, 12 and 13 result in providing the "voids" previously mentioned as adjacent each striking surface. The formation of such relieved surfaces as at 11, 12, and 13 also provides the knobbed or lobed portion of the bit body in which a carbide insert striking surface is set. Such lobes are indicated by the letters *b*, *c*, and *d*. More specifically with reference to Fig. 2, for example, the lobe *c* is a knobbed portion or projection having an outermost edge wall 14 disposed longitudinally of the bit axis and at the top edge of which the outer edge of the striking surface 9 is positioned. Along its topmost or foremost edge the lobe wall at 11 is directed toward the axis of the bit, curved rearwardly of the axis to a slight degree, and then upwardly to merge with the body portion from which the base of the projection *a* extends. (It may be noted from Fig. 1 that this upward curvature terminates at a more closely spaced position relative to the bit axis than does the outer edge of surface 8.) With further reference to Fig. 2 the outer wall 14 is circumferentially of the near end edge of insert 9 curved inwardly (of the bit axis) to form the relieved surface at 12 (Fig. 2). Contour shading in Fig. 1 is indicated at 12' and 12''. At 12' the contour is at a forward location longitudinally of the bit axis. This relieved surface 12 (Fig. 2) merges with a similarly relieved surface at 13 inwardly directed (of the bit axis) from the outer edge of the circumferentially adjacent lobe *d*. It should be noted (Fig. 1) the corresponding relieved surface 13 adjacent striking surface 8 also merges with the surface 12 of the lobe *c* and the surface 13 of lobe *d*.

On the periphery of the base portion 3' are located a plurality of radially extending knobbed portions or lobes 15 integrally formed with the body and having forwardly facing striking surfaces as the carbide inserts at 16. In Figs. 1 and 2 a pair of lobed portions is shown at diametrically opposite sides of the bit body. As shown by Fig. 2 the surface 13 at the right of the insert 16 at the left side of Fig. 2 is relieved and merges with the surface 12 adjacent the lobe of the striking surface 10. It will also be seen that the surfaces 16 are longitudinally spaced rearwardly of the surface 10.

The striking surfaces 16 define between their outer edges the diameter of the hole to be drilled and may be termed the "gauging" lobes. These gauging members are longitudinally spaced rearwardly of the outside striking surfaces 10 and, positioned as shown, serve to maintain the bit in "unlocked" condition during the drilling operation. The action of the bit of Figs. 1 and 2, will now be specifically described.

In Fig. 6 a hole 20 is indicated in a rock 21 with the stepped formation at the bottom of a cavity indicated by the ledging at 16', 10', 9', 8' and the bottom pilot hole 7', all as formed by the correspondingly numbered lobed striking surfaces.

As previously described the drill steel actuates the bit percussively and rotating the bit between strokes. The number of strokes for each complete revolution of the bit is a matter of the hammer operation and design. Different arrangements are provided in various hammers. Some hammers, for example, rotate the bit one complete revolution every six blows. And, in Fig. 1 the new bit, for example, is for drilling a two and one-half inch hole and may be used with a drill hammer having approximately sixteen strokes per revolution. As will be realized the circumferential spacing between lobes and amount of step-back between surfaces is to a large extent governed by the operating characteristics of the drill hammer on which the bit is to be used. The sixteen stroke hammer

5

for use with the two and one-half inch bit has a thrust of about $\frac{1}{32}$ inch with the lobed surfaces at 16 on the periphery of the bit thus advancing peripherally about a quarter of an inch between successive strokes. Inasmuch as each surface of the bit is designed to progressively chip away at a small shelf of rock and to shear off fragments thereof as it advances in a circular path, it will further be realized that with different hammers the number of lobes and the dimensions thereof are preferably designed to be consistent with the amount of thrust and the number of blows delivered for each complete revolution of the bit.

As a further refinement the location of the hammering surfaces with respect to the distance thereof from the bit axis may be affected by the type of rock which is to be drilled. As an example it has been observed that hard granite formations tend to fracture at an angle of 45° . Thus the localized chipping surfaces of the lobed carbide inserts can be gauged for particular efficiency in drilling in granite. By taking advantage of such factors as the angle of fracture in particular stone formations superior efficiency may be built into the bit. The fact that the new bit continually provides voids (to be particularly explained) into which stone chips can be cracked off means that relatively large chips can be popped inwardly at all times and thus a minimum of pulverized dust will be produced.

Referring now to Fig. 6, the bottom of the cavity is formed more or less in conical cup shaped fashion. The wall surface thereof is characterized by a plurality of concentrically formed stepped annular ledges or ridges extending upwardly from the center outwardly. The view of Fig. 6 is intended to show the conformation of the extreme edges of the hole on a vertical section line and assuming the bit of Fig. 1 to have been rotating clockwise therein and removed from the cavity with the radially aligned inserts 16 and 9 in the plane of said vertical section. Accordingly, at the left side of the hole the carbides 16 and 9 would be about to strike the ledges indicated by the full line arrows 16' and 9', while the partially chipped out portions, indicated by dotted arrows at 10' and 8' respectively, would have been formed by the inserts 10 and 8 proceeding at a 90° position clockwise thereof.

At the other side of the hole the edge pattern of course alternates with that just described. It will be realized that the more prominent ledge formations as shown by full line arrows 16' and 9' at the left hand side (and at 8' and 10' by the full line arrows pointing to the right hand side) are exaggerated to more clearly illustrate the action of the lobed striking surfaces. In any rock formation the chips dislodged are of an infinite variety and shape. However, for purposes of illustration it can be seen that as the bit rotates (clockwise) each lobed striking surface with the exception of the center 7 hits a wall surface where the adjacent surface inwardly thereof has been previously chipped away (by the lobe at a 90° clockwise position and in the adjacent inner concentric annular area in which the striking surface is longitudinally spaced forwardly thereof). Thus a blow delivered for example by insert 16 at the left outside ledge (at 16' where the inner vertical ledge wall of which has been previously chipped off to form a corner at substantially 90° as shown and by the clockwise positioned striker 10) will cause a stone chip to be knocked inwardly and downwardly or toward the viewer as in Fig. 6. The resulting ledge formation at that localized ledge area will thus take the form of the area indicated by the dotted arrows 16' at the right hand side of the hole. It will be seen (Fig. 1 and Fig. 2) that the relieved portions of the body of the bit afford void spaces in immediately adjacent relation to each of the lobed striking surfaces.

The voids more specifically are spaces into which chips can be freely deflected when a blow is delivered, these spaces being provided by the contour of the bit body

6

section around the carbide striking surfaces. As above stated a striker surface 16 will chip off stone from the full line arrow ledge 16' inwardly and downwardly or toward the viewer as in Fig. 6. This particular chip can be deflected inwardly of the bit axis and downwardly of the hole since as seen from Fig. 2, the wall of the radially and inwardly spaced lobe c (of striker 9) is spaced far enough to offer no resistance to chip separation. In this connection, viewing Fig. 6, it will be noted the inclined rock surface indicated by dotted line arrow 10' represents at its top and bottom points the radial spacing of wall 14 of striker 9 from the corner of the ledge at 16'. The downward direction is permitted since the aforesaid inclined rock surface 10' is also spaced from the wall 14 of striker 9. The chip can also be deflected toward the viewer since it will be understood the counterclockwise ledge rock surface adjacent the ledge section shown by the full line arrow 16' has by the previous blow been chipped off to an inclined surface similar to the dotted line arrow right hand ledge contour at 16'. The chip when deflected in a counterclockwise direction can also chip off in a direction upwardly of the hole since the counterclockwise edge of the lobe 15 is directed towards the axis of the bit and provides the space for escape of the chip in that direction. The blows of the striker surfaces are thus enabled to direct fracture lines for spalling off chips towards previously chipped rock surfaces in the immediate area where no portion of the bit body will be in contact with those rock surfaces to absorb the impact. Were the force of the blows blocked by the bit body it would tend to absorb the impact and "bottom" the force of the blows, i. e. tend to direct the impact of the blows into the body of the rock away from the hole being drilled. It will be further realized that the inwardly directed areas 11, 12, and 13 adjacent lobes d, c and b afford a chipping action of strikers 10, 9, and 8 similar to that just described for the "gauging" lobes 16 and in which the chips can be deflected into void spaces adjacent the striker surfaces.

In Figs. 3 and 4 another form of rock drill bit embodying the invention is also shown. In this form which may be particularly adapted, for example, for the larger type of bit of 5, 6 or 7 inches in diameter, the central portion is reversely stepped with respect to an annular ring of striker blades. And the outside gauging members are also rearwardly stepped with respect to said blades. The bit body portion is indicated by the numeral 30; a plurality of pilot lobed striking surfaces are indicated by numerals 31 and are arranged on an outer annular ring area indicated by the arrow 32; a central lobed projection is at 33 with center blade at 34 stepped rearwardly of the lobed surfaces 31; an intermediate inner annular ring area at 35 is recessed rearwardly of lobed portion 33 and the ring 32; and bit gauging members at 36 are arranged in pairs, one at each side of the members 31. The members 36 are stepped rearwardly of the lobes 31. The location and relative positioning of the lobed striking surfaces are designed for operation, for example, with a hammer rig having approximately a one inch thrust with about 7 or 8 strokes for each complete revolution.

In this form of the bit the piloting strikers are the members 31. Preferably they are formed with bladed inserts 50 of carbide material or diamond impregnated carbide to give as hard a striking surface as possible. The lobes 31 at each side of the blade insert 50 are rearwardly of the bit axis relieved as indicated at 51 with the position at 52 adjacent thereto being at a position longitudinally of the axis approximately equal to that of the gauging members 36. Between the portions 52 of adjacent striker areas the annular ring area is further rearwardly relieved as by the "scooped" passageways indicated at 53. It will also be realized that the drill steel and bit body of this larger size bit is of a more massive character and that the blows delivered by the hammers is of a correspondingly heavier nature. At the inner side

of the ring 32 a void space will be created by the rearwardly stepped annular ring area 35. At the outer side of the ring 32 a void space will be created by the rearwardly stepped members 36 allowing chips to be fractured outwardly and rearwardly by reason of the gauging members progressively clearing the area at the extreme edge of the hole. The gauging members may hammer chips inwardly into the relieved area as at 51 and 52 adjacent blades 31, while at the center the bladed insert 34 may crack large chips into the recessed void of the area at 35. The areas 35 and 32 merge at their adjacent edges where the inner edge of passages 52 intersect the outer edge of area 35 as at 54 and permit the drillings to be removed outwardly of the bit body and thus back through the drilled hole. The passages for compressed air to convey the drillings away from the face of the bit are indicated at 37.

It will be readily appreciated from the above description of the two forms of drill bit that the force of the hammer blows delivered by the lobed strikers of either bit is received in such a way as to permit the cracking off or chipping process to take place efficiently at all times. In respect of the bit of Figs. 1 and 2 it will be evident the chips can be deflected inwardly of the axis of the bit or annularly of the particular striking surface with the sole exception of the center or pilot cutter 7. The chips of the center cutter can be dislodged outwardly and annularly of the axis. In respect of the bit of Figs. 3 and 4 chips can be dislodged by the pilot cutters 31 in all directions: at either side of the radially directed bladed edges of insert blades 50; outwardly of the outside ends between gauging members 36; and inwardly of the inner ends into the area 35. The gauging members 36 can deflect chips inwardly of the bit axis while the center blade can deflect chips outwardly of the axis.

It will be seen that by progressively chipping the stone away by a sequence of relatively small hammer blows and continually providing void spaces into which the chips can be deflected the bit may remain "unlocked" during the entire drilling operation. Because the force of the hammer blows is never exerted in a direction leading into a solid body portion of the rock being drilled a minimum of pulverizing action takes place and the striking surfaces never encounter a "dead" shock. To clarify the action of the bits embodying the present invention it can be said that the blow delivered by each of the striker lobes is comparable to that of a stone hammer manually directed against the extreme edge of a piece of rock and tending to shear the edge. This is in contrast to prior rock drill bits which attempt during their operation to pound the body of the rock directly and deliver the force of the blow in the direction of the solid body of the stone formation. Such prior bits are thus directly pulverizing the stone, become dull in a short while and bottom or "lock" in the cavity being drilled.

It should be noted further and with special reference to Fig. 2, that if any wear occurs on the surfaces of the bit face at the lobed areas, dressing operations may be accomplished with an ordinary disc grinding wheel. Each projecting lobe can be directly presented to an abrasive wheel to true up the lobes as desired.

It will also be appreciated that each of the carbide inserts in wearing down more or less uniformly serve to preserve automatically the same relative spacing longi-

tudinally between the same. Thus in operation the bit will serve to perform in an efficient manner during its entire useful life. As previously explained the cutter bladed inserts 8 may also be flat surfaced, and in this event only the cutter blade 7 will require intermittent dressing operations to remain in a "sharpened" condition.

It has also been found in the form of Figs. 1 and 2 that the force of the blow delivered by a lobed portion is principally along its outer edge and inwardly thereof centrally of the lobes. Accordingly, a saving in the expense of carbide insert material may also be made in designing a T-shaped member for embedding in the lobed portion. This is shown in Fig. 5 wherein the cross head 40 of the T is along the arcuate edge of a lobe and the post 41 thereof is positioned radially of the bit. Thus a plurality of T-shaped inserts can be advantageously used and the expense of construction considerably lessened by using a minimum of carbide or diamond impregnated carbide material.

What is claimed is:

1. A rock drill bit of the type that is percussively struck against a rock and intermittently rotated to form a hole in the rock, said drill comprising a body portion at the forward end of the bit, a pilot cutter formed on the forwardmost end of said body portion in symmetrical fashion with respect to the axis of said bit, a plurality of carbide inserts formed as gauging strikers and supported by the body portion concentrically of the bit axis and set back rearwardly from said pilot cutter and a plurality of groups of further carbide inserts forming intermediate strikers, each group arranged concentrically of the bit axis and disposed longitudinally of the bit axis in progressively raised fashion from the gauging strikers and terminating short of the pilot cutter and in radial sense arranged progressively inwardly of the gauging strikers, the carbide inserts of each group of intermediate strikers being angularly spaced from the carbide inserts of the next adjacent group and all of said carbide inserts being supported on lobe-like portions of the body portion, said lobe-like portions being relieved radially inwardly in either direction angularly spaced from the carbide inserts thereon with respect to the striking surfaces, said lobes further being rearwardly of the carbide inserts in either direction angularly spaced therefrom and also rearwardly relieved on the radii extending to the inserts.

2. A rock drill as in claim 1 wherein each group comprises two diametrically opposed carbide inserts.

3. A rock drill as in claim 2 wherein the carbide inserts of each group are angularly spaced 90° from the carbide inserts of the next adjacent group.

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