

Nov. 29, 1955

P. B. BROWN
DRILLING BIT

2,725,216

Filed July 20, 1951

4 Sheets-Sheet 1

FIG. 1

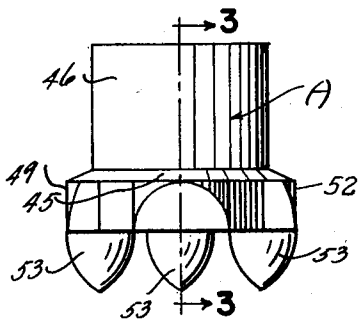


FIG. 4

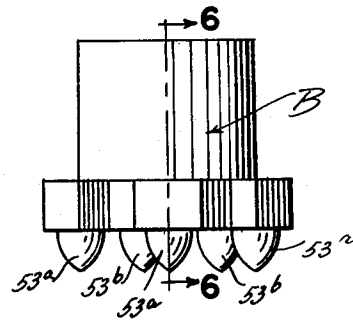


FIG. 2

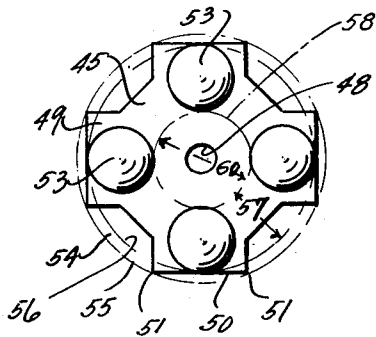


FIG. 5

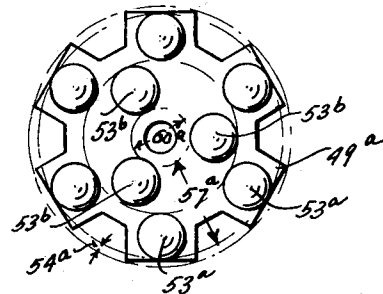


FIG. 3

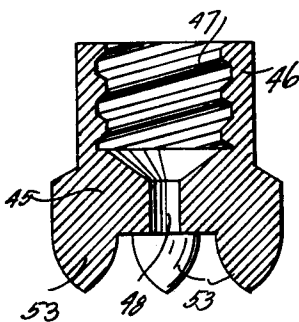
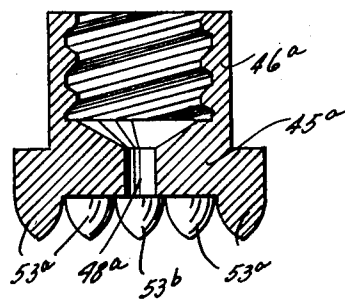


FIG. 6



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FIG. 7

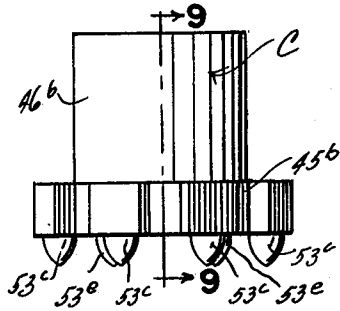


FIG. 10

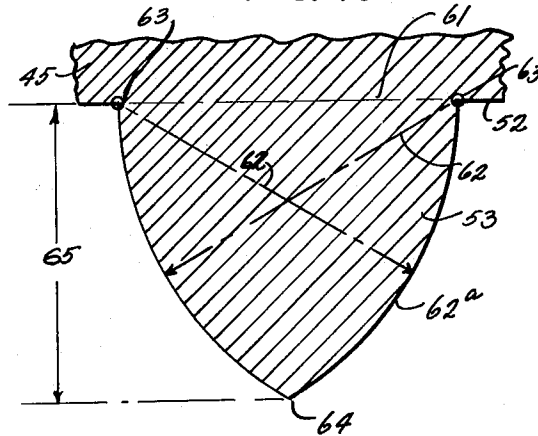


FIG. 8

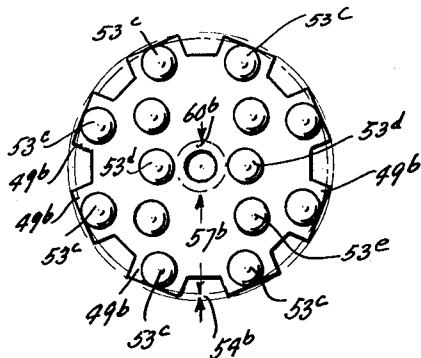


FIG. 11

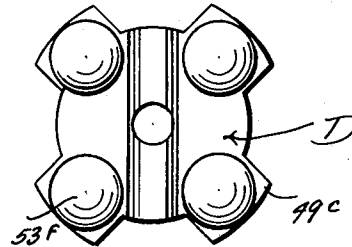


FIG. 9

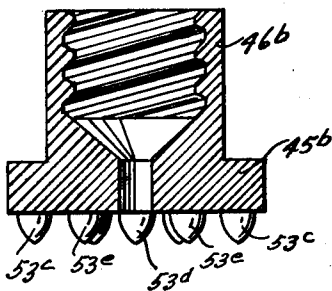
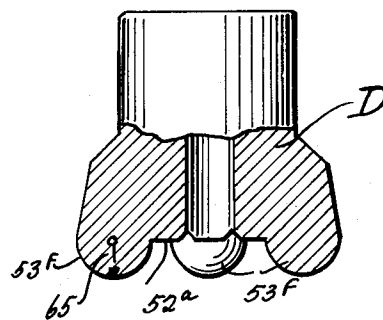


FIG. 12



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FIG. 28

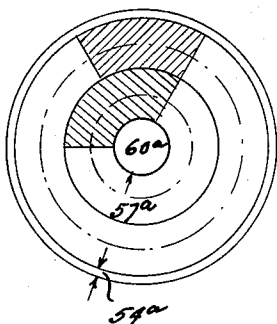


FIG. 29

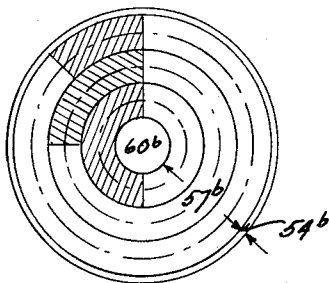


FIG. 30

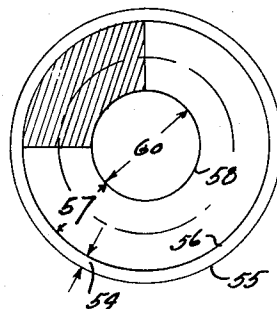


FIG. 31

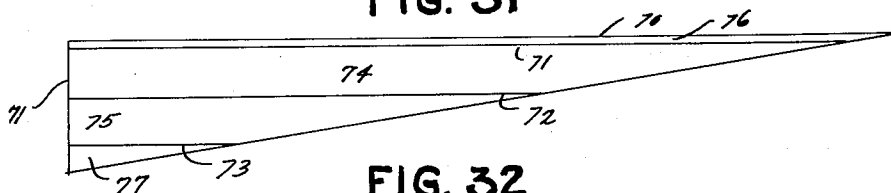


FIG. 32

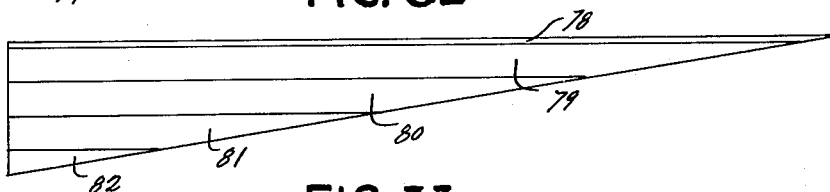


FIG. 33

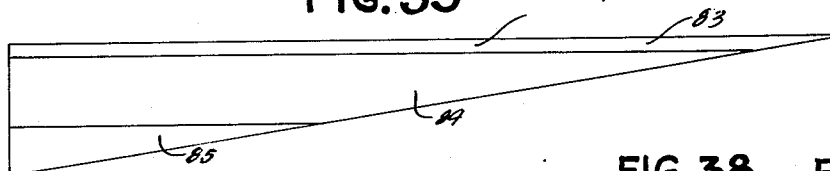


FIG. 35

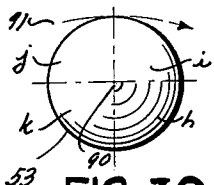


FIG. 36



FIG. 37

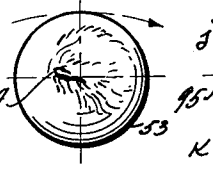


FIG. 38

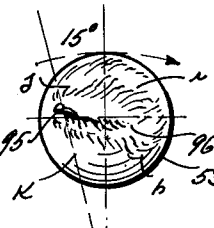


FIG. 34

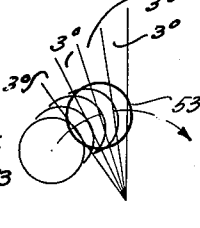


FIG. 39

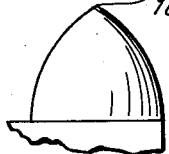


FIG. 40



FIG. 41



FIG. 42



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2,725,216

DRILLING BIT

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Application July 20, 1951, Serial No. 237,799

7 Claims. (Cl. 255—64)

This invention relates to improvements in bit constructions for the drilling of rock, ore and other hard formations.

The primary object of this invention is the provision of a rotary impact type rock drilling bit; the drilling parts of which, whether they are referred to as points, lugs, teeth, nobs or bit portions are scientifically and mathematically shaped and arranged for fast and economical drilling.

In the ordinary chisel type bit, used in impact hand drilling thru rock and like hard formations, or the double chisel type cross bit, used in rotary-impact machine drilling, fresh surface contact is obtained at each blow through rotation of the bit. The contact of the chisel edge in the ordinary bit is a straight line. The force of the blow is not distributed along this straight line in proportion to the area to be removed, nor is provision made for the additional work the outside edge of the bit must be doing in abrading. Using a two inch bit, the path traveled by the outside edge of the bit is 6.28 inches, and at the center there is no travel at all. It is common knowledge that in drilling some rocks a dull bit of this sort is better than a sharp bit. In the drilling of rock thru the use of an impact rotary-bit three applications of force seem to be involved, that is, the rock is removed by (1) abrasion, (2) shattering, and (3) severing, chipping or free breaking. I have provided a bit which is self sharpening and designed with a much smaller contact area for the purpose of accentuating the force of the blow in order to get better initial penetration per blow than with the ordinary bit. In the bit of this invention the points, lugs or drilling teeth are mathematically designed and placed for the maximum rock penetration through a shattering action confined to the precise area needed; a large portion of the rock being left for free breakage.

A further object of this invention is the provision of a drilling bit having a drilling point, bit portion or drilling lug mathematically shaped to permit of the same maintaining a sharp drilling apex contact located in the proper area not withstanding the self sharpening feature, for the performance of maximum drilling penetration; the drilling points having a semi-spherical shape or substantially a semi-spherical shape with the curvature of the outer side walls in the mathematical shape of a Gothic arch.

A further object of this invention is the provision of a rotary impact type of drill for drilling of rock or hard formations, which is scientifically formed with bit projections shaped to produce a maximum coarseness of cutting with extremely deep blow penetrations.

A further object of this invention is the provision of an improved drill bit of the rotary impact type adapted for the drilling of hard rock and ore formations, having an improved bit point construction to take care of abrasion, shattering and free breakage of the rock, so as to produce a maximum drilling penetration in a pre-determined time, with economy of operation and bit maintenance.

Other objects and advantages of this invention will be

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apparent during the course of the following detail description.

In the accompanying drawings, forming a part of this specification, and wherein similar reference characters designate corresponding parts throughout the several views.

Figure 1 is a side elevation of one form of bit.

Figure 2 is a bottom plan view of the bit of Figure 1, showing the rock penetrating points, lugs, teeth or bit portions.

Figure 3 is a vertical cross sectional view taken substantially on the line 3—3 of Figure 1.

Figure 4 is a side elevation of another form of bit, showing the principal features of the form of bit of Figure 1, but embodying a different arrangement of rock drilling points.

Figure 5 is a bottom plan view of the bit of Figure 4.

Figure 6 is a vertical, cross-sectional view taken through the bit of Figure 4.

Figure 7 is side elevation of another form of bit, showing a different arrangement of drilling point contacts.

Figure 8 is a bottom plan view of the bit of Figure 7 showing the drilling point arrangement.

Figure 9 is a vertical cross sectional view taken substantially on the line 9—9 of Figure 7.

Figure 10 is an enlarged fragmentary view of one of the drilling lugs or points of the drilling bit shown in Figures 1 to 9 inclusive, designating the mathematical construction thereof including the outer side wall curvature of the points in what may be conveniently referred to as a Gothic half sphere; the side walls being struck from radii in the form of a Gothic arch.

Figure 11 is a bottom plan view of a drilling bit wherein the contact points or lugs are of true semi-spherical shape.

Figure 12 is a side elevation, partly in section, taken through the bit of Figure 11, showing the formation of the bit points or lugs.

Figure 14 is a bottom plan view showing a modified form of rock drilling bit wherein drilling lugs or contact points have been arranged to expedite the drilling of rock at the outer circumferential wall of the bore through the use of improved contact points in an arrangement which enables the rock to be chipped as well as abraded at the normal wall abrasion ring of the bore.

Figure 15 is a vertical cross sectional view taken substantially on the line 15—15 of Figure 14.

Figure 16 is a bottom plan view of the contact point arrangement of a modified form of a bit possessing characteristics of the bit shown in the Figure 14, but with a different lug or drill point arrangement.

Figure 17 is a vertical cross sectional view taken substantially on the line 17—17 of Figure 16.

Figure 18 is a bottom plan view of a further modified form of drill bit of the types shown in Figures 14 and 16, but with a modified form of lug or drill point arrangement.

Figure 19 is a cross sectional view taken substantially on the line 19—19 of Figure 18.

Figures 20 to 23 inclusive, are fragmentary cross sectional views taken substantially on the respective lines 20—20; 21—21; 22—22 and 23—23 shown in Figures 16, 14 and 18 of the drawings.

Figure 24 is a top plan view of the bit shown in Figure 14.

Figure 25 is a top plan view of the bit shown in Figure 16.

Figure 26 is a top plan view of the bit shown in Figure 18.

Figure 27 is a cross sectional view taken thru the drill hole or bore of ore or rock formation, showing in dot and dash lines the outline of the type of drill bit shown

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in Figures 14 and 15, and showing the manner in which the rock formation will be abraided, shattered, and free broken.

Figure 28 is a diagrammatic view representing the various abrasion, shattering and free breaking areas formed by the use of the type of drill bit shown in Figure 5.

Figure 29 is a diagrammatic view representing the various abrasion, shattering and free breaking areas of the type of drill bit shown in Figure 8.

Figure 30 is a diagrammatic view representing the various abrasion, shattering and free breaking areas of the type of drill bit shown in Figure 2.

Figures 31, 32 and 33 are graphs showing the relative percentages of rock removed by abrasion, shattering and free breaking, respectively for the types of bits shown in Figures 5, 8 and 2 respectively.

Figure 34 diagrammatically represents the degree of rotation and the number of blows imposed upon one of the drilling lugs or points of the type of bit shown in Figure 2, for a bit of two inch diameter, operated under machine drilling conditions wherein the drill is struck 2000 blows per minute and rotates 50 times per minute.

Figures 35 to 38 inclusive are bottom plan views of one of the Gothic arch shaped drilling points or lugs showing progressively how the point is worn in a self sharpening manner thru continued use and maintaining the apex in the best rock shattering position.

Figures 39 to 42 inclusive are side elevational views of the bit point or lug as shown in the respective positions of Figures 35 to 38 inclusive.

In the drawings, wherein for the purpose of illustration are shown preferred and modified forms of the invention, the letters A, B, and C respectively designate the types of bit shown in Figures 1, 5, and 8 of the drawings; the letter D the drill bit shown in Figures 11 and 12 and the letters E, F, and G the types of bit shown in Figures 18, 16 and 14 of the drawings.

Referring to the bit A shown in Figures 1, 2 and 3 of the drawings, the same includes a body portion 45 having a cylindrical shaped drill rod attaching sleeve 46 which may be internally screw threaded as shown at 47 in Figure 3. The body portion 45 is provided with a central water passage 48, and is preferably provided with four laterally extending wings 49, positioned 90° apart around the circumference of the body portion 45; the same projecting laterally of the outer circumferential surface of the sleeve portion 46. The outer side faces or surfaces of the wings 49 are flat as designated at 50 in planes which are parallel for opposed wings although these surfaces 50 may be struck on an arc, with the axes of the drill bit as a center, if so desired. The wings have outermost sharp rock abrading corners 51 being formed by side and end surfaces disposed at 90° angles; although this angular arrangement may be varied if so desired.

The bottom surface 52 of the body 45 is preferably provided with four drill points or lugs 53, one bit being centrally positioned upon each wing 49 with the base of the point 53 contacting the face 50 of the wing. I do not wish to be restricted to dimensions given, but for 2 inch diameter drill bit the base of each of the bit points 53 preferably measures 1/2 inch in diameter. The dot and dash lines 55 and 56 in Figure 2, designate an area 54 called the abrasion area; the area 57 between the dot and dash circles 56 and 58 may be designated as the shattered area or ring; and the area 60 within the circle 58 is the free breaking center or area.

For the form of invention B the drill point or lug arrangement is different from the form A only because it is used for drilling a harder rock or ore formation than the drill bit A. It includes a body portion 45^a; attaching sleeve 46^a; six of the wings 49^a and a central water passageway 48^a. These parts are constructed similar to the drill bit A. Two annular series of contact or bit points are provided; the outermost series 53^a occupying the same relative positions on the wings 49^a as the bit

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lugs or contact points of the form of invention A. There is an inner annular series of contact points or lugs 53^b. The dot and dash lines show the abrasion area in Figure 5 as designated by numeral 55^a; the rock shattering area as 57^a and the free breaking area as 60^a. It is to be noted that the rock shattering is taken care of by the two annular series of lugs 53^a and 53^b in this form of drill bit.

In the form of drill bit shown at C in Figures 7, 8 and 9 the body portion 45^b; the sleeve portion 46^b and wings 49^b are formed similar in shape to the body portion, sleeve and wings of the bits of forms A and B, except that there are eight of the wings 49^b provided and three annular series of contact drilling points. The outermost series 53^c are located on the wings 49^b; the innermost annular series, comprising two in number, being designated at 53^d; the intermediate annular series constituting four in number being designated at 53^e in Figure 8. The rock abrading area for the form of bit C is designated at 54^b; the rock shattering area at 57^b; and the free breaking area at 60^b.

Referring to the mathematical construction of the contact points or lugs in the forms of bits A, B, and C, the same is shown in Figure 10. The base line of the lug, designated at 61, in dot and dash lines lie flush with the bottom surface 52 of the drill bit body 45. The convex curvature of the side walls 62^a is struck from radii 62, the centers 63 of which are located in the outer circumference of the base 61; the apex 64 being determined by the intersection of the radii 62. The diameter of the base 61 thus will be less than the height 65 of the lug from the apex 64 to the base 61. Thus, the contact point or lug is formed in the shape of a half or semi spheroid and in axial cross section in any plane of intersection being in the mathematical form of an equilateral Gothic pointed style arch. I have found that this provides the necessary mass and strength for an efficient self sharpening of the bit under continued use without the material shifting of the apex, as it recedes from the normal position of the apex 64 out of a line tangential to the axis of the bit point.

In the form of bit D, the characteristics are in the main the same as those of the bit A, except that the contact points or lugs 53^f are semi-spherical in shape and positioned on the wings 49^c in the same relation as the points for the form of invention A. It will be noted from Figure 12 that the base of the half sphere lies flush with the bottom 52^a of the drill bit D, and the lug or drill point has a single radius 65 which determines the outer convex curvature of it.

In Figures 28, 29 and 30 are graphically shown the abrasion, shattering and free breaking areas referred to in connection with the respective description of Figures 5, 8 and 2, and the same reference characters given to the latter have been used in the graphic representation of Figures 28, 29 and 30.

Straight line graphs of the various areas shown in Figures 28, 29 and 30 are respectively illustrated in Figures 31, 32 and 33. The straight line graphs are each in the form of triangles.

In the graph of Figure 31 the line 70 represents the circumference of the drill hole and the right angle vertical line 71 represents the effective radius of the bit. The lines 71 and 72 denote between them the area in which the bit point 53^a of the bit B operate, and the area between the lines 72 and 73 is that travelled by the bit points 53^b. The area 74 between the lines 71 and 72 within the triangle constitutes 59% of the total area constituting a cross section of the bore, and the area 75 constitutes 30.6% of the area of the bore. The abrasion area 76 constitutes 5.8% of the total bore area, and the free breaking area 77 constitutes 4.6%.

For the bit C the graph in Figure 32 shows the abrasion area 78 as constituting 3.0% of the total bore cross sectional arc; the outermost ring of lugs travel thru the area 79 constituting 48% of the total cross sectional area of

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the bore; the area 80 travelled over by the intermediate annular ring of lugs constitutes 31.2% of the total cross sectional area; the area 81 constitutes 15.8% of the total cross sectional area and the free breaking area 82 constitutes 2% of the total area.

For the bit A graphically represented in circular lines in Figure 30 and in straight lines in the graph of Figure 33, the abrasion area 83 constitutes 12% of the total cross sectional area of the bore hole; the lug travelling area 84 constitutes 68.4% of the total area, and the free breaking area 85 constitutes 19.5%.

In the graphs of Figures 28, 29 and 30 the dot and dash lines show the travel of the apices of the lugs, the cross sectioned areas showing how the burden upon the lugs in the various annular series of points is equalized. Referring to Figures 28 and 31, there are six of the lugs 53^a travelling through the area 74, and since this constitutes 59% of the total cross sectional area of the bore the burden upon each lug is 9.8. There are three lugs travelling in the areas 75 and since this area is 30.6%, each lug has a burden of 10.2. The ratio is substantially equal although not exactly so. Likewise referring to Figures 29 and 32, the burden ratio of each lug for the area 79, 80 and 81, arrived at in like fashion, is 6.0 for the lugs 53^b; 7.8 for the points or lugs 53^c, and 7.9 for the lugs or points 53^d.

For the bit A, each of the four lugs has a burden ratio of 4 divided into the shattering area of 68.5%, which gives 17.125% for each lug.

Figure 34 diagrammatically shows the number of blows each lug (assuming there are four 1/2 inch lugs) receives, for a two inch bit, during one revolution of the bit. The drill bit receives 2000 blows per minute, and the bit completes 50 revolutions per minute. During one blow the bit travels 9°. Therefore, it would take four blows for each lug to pass through its own base area. I am striving to establish a constant rate of drilling for each bit, independent of the nature of the rock to be drilled. That is the reason why various type bits of A, B and C have been provided, for the lugs in the multiple annular series of points receive a fewer number of blows in passing thru the lug base area. Thus, the additive effect on a complete rotation would give the desired penetration constant.

Referring to the self sharpening feature of the bit points and the manner in which each point wears as shown in Figures 35 to 42, assuming that I am using a two inch bit. That is, for drilling a 2 inch bore or drill hole. The cross sectional area of a 2 inch diameter drill hole is 3.1416 square inches. In one rotation of the bit the outside edge of the bit travels 6.2832 inches and the inside next to the water hole travels .62 inches, assuming a circle to be struck from the axis of the bit as a center and intersecting the apices of the lugs. In the case of a four lug 2 inch bit this would divide the circle designated by the area 57 in Figure 30 into an outer annular ring portion and an inner annular ring portion. The dot and dash line apex intersecting circle represents the distance the apex of each lug travels during one revolution of the bit and this is 3.92 inches. The inner edge of the point designated by the line 58 in Figure 30 travels 2.35 inches. The area of the ring from the dot and dash line apex intersecting circle and the circle 58 is .7858 square inches. The area from the dot and dash line apex intersecting circle to circle 56 is 1.1781 square inches and the distance traveled by the apex is 5.49 inches. Therefore, the wear on the bit point is greater on the outer half of the point than upon the inner half. This enables the apex of the bit to slip from the normal apex location, in the direction of the trailing side of the lug as the bit point wears. Looking at Figures 35 and 39, the same in plan and side elevation illustrate a normal Gothic half-sphere contact point. The apex is at the exact center designated at 90. The outer circumference edge of the bit is designated by the circular line 91 and the direction of rotation is also shown by the arrow head. The

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outer half of the point gets the greatest wear, as indicated at 92 in Figure 36. Here the apex has slipped to the location 93, but it still lies along a line thru the normal apex tangent to an arc struck from the axis of the bit body. The area of the bit may be conveniently divided into four 90° sectors designated as "h", "i", "j", and "k." As the wear progresses (see Figure 37) the outer circumferential portion of the bit receives the greatest wear and the apex indicated at 94 in Figure 37 has receded slightly into sector "j," but still lies along a line tangential to an arc struck from the axis of the bit body thru the normal apex of the bit point. Recession of the bit apex continues, as shown in Figure 38 where the apex is indicated at 95. Note that it has receded toward the trailing side of the bit point to a position located at an angle of 15° from the normal position of the apex. Also note the wear upon the outer side of the bit as distinguished from the wear upon the inner side of the bit.

In the side elevation shown in Figures 39 to 42 inclusive the bit is shown as always maintaining an apex contact point; the wear upon the bit taking place to provide, in addition to the point 95, a well distinguished cutting edging 96. The apex 95 is still in a position close to the tangential line above mentioned, that is, about 1/4 inches from the center of the bit body axis (in a 2 inch bit). As the outside surfacing of the bit has been worn down the bit apex lies slightly closer to the outside, and therefore, is more efficient in breaking rock. The ridging 96 is caused not only by wear due to shattering of the rock, but also to the flow of the broken chips and abrading material as the bit rotates. All of this aids in maintaining the contact point in a self sharpened condition.

Referring to the forms of bits shown in Figures 14 to 26 inclusive, it will be noted that in the types of bits A, B and C, the sharp corners 51 are responsible for abrading action upon the rock, throughout the area 54 shown in Figure 2, and as indicated in Figure 33, area 83. This abrasion is a necessary evil which cannot be entirely eliminated. However, in the bits E, F and G, this ring portion is not only removed by abrading action, but also by a breaking action thru use of contact points or lugs or nobbs inclined at an angle to the vertical, in order that the apex of the nob or lug will aid in fracturing; the side wall of the inclined contact point or nob receiving the necessary friction for abrasion. To that end, as shown for the bit E, the bottom of the body portion 100 is provided with four shattering contact points or lugs 101 of the same Gothic half sphere shape above described for the form of invention A. However, instead of wings upon the body portion 100, these contact points 101 project beyond the normal outer surfacing 102 of the body portion 100. That is, a segmental portion of each projects beyond the surface 102. Between the vertically disposed contact points 101 there are also disposed the abrading and fracturing contact points 103, the axes, designated by the dot and dash line in Figure 19, and as indicated at 105, being inclined to the vertical. The angle may vary; the important point being that the apex 105 of the inclined drill point 103 be located at a pre-determined distance (designated at 106) from the outermost curved surfacing 107 of the bit point 103. Also the inclination and positioning of the lug 103 is such that the apices thereof are disposed in a plane, designated by the dotted line 110, in Figure 19, located above a plane, designated by line 112, in which the apices 111 of the lugs or drill knobs or points 101 lie. The plane 112 lies below the plane 110 a distance designated at 113 in Figure 19. These characteristics are present in all of the forms of bits E, F and G; the main difference residing in the number of lugs provided for the various forms and the differences in degree and inclination of the lugs. By way of example in Figure 23 the angularity between the vertical lugs 101 and the inclined lugs 103 is shown as 48°.

The drill bit G is provided with an outer annular series of drill points and an inner annular series of drill points corresponding in this respect to the type of drill bit B. However, the bit G is additionally provided with the inclined abrading and fracturing drill points 103^a. Likewise in the form of invention F there are three annular series of vertically disposed drill points corresponding in this respect to the characteristics of the type of bit C above described, and additionally including the outer inclined bit portion 103^b.

The bit points 103^a and 103^b have the same characteristics, as to location and purpose, as the inclined bit points 103 for the form of invention E.

In Figure 27 has been shown a section of rock formation 119 wherein a hole 120 has been drilled by the type of bit G, shown in dot and dash lines in that figure. The two vertically disposed annular series of drill bit points or nobs are shown shattering the rock formation at 122 and the free breaking hump is shown at 121. It will be noted that the convex surfaces of the inclined lugs 103^a perform the abrading action upon the rock, and the apices of the inclined lugs, due to their positioning have a chipping or fracturing action upon this abrading ring, expediting the destruction thereof.

In lieu of the spherical and Gothic half sphere bit points or nobs above described I may use other elongated forms, such as a true conical shape.

It will be apparent from the foregoing that an improved type of bit structure has been provided embodying a radically different drilling principle than heretofore provided. The drilling will be more rapid than with the present cross head or chisel types bits, and overbreakage will be facilitated. The improved bit will save a considerable amount of energy ordinarily used in connection with cross head types of bits thru reduction of the abrading ring arc of the bore.

I have shown in my U. S. Patent 2,358,052 how it is possible in a rock drill bit to provide impact lugs which will initially penetrate the rock, in combination with means to crush or shatter other portions of the rock without major penetrating action. In the present invention there is a considerable improvement over that bit in the provision of conical shaped impact lugs in the shape of a Gothic half-sphere.

In Figs. 11 and 12 I have shown semi-spherical shaped lugs. Such will not perform their work with greatest efficiency, so far as self-sharpening and penetration are concerned, because of the flatness thereof. In the conventional percussion type rock drill with cross heads of chisel shape, the slope of the sides are at a 90° angle. Such types of drills require frequent sharpening and replacement. Equilateral triangular cross sectional shaped lugs are short lived and require frequent resharping. I have found that a lug which is conically shaped so that in any plane of intersection of its axis extending from its base to its apex is in the shape of a Gothic arch is very strong and durable and gives quicker penetration. Because of such shape it is self-sharpening to the extent pointed out in the specification and illustrated in Figs. 35 to 42 inclusive. I have also found that both endwise axially projecting drilling points and laterally inclined shattering tapered drilling points it is possible to more effectively drill rock from the standpoints of time and drilling depth. In this connection it should be noted that a rock drill is subjected to operations widely differing from drills used for penetration of the soil, etc. The latter drills are of rotary shearing and reaming types, whereas the rock drills of the percussion type are subjected to as many as 2,000 blows per minute. The degree of rotation of rock drills is not so important a factor, since the rotation of such drills occurs only about 50 times per minute. Depth of penetration and the time factor are important in a rock drill.

Various changes in shape, size, and arrangement of parts may be made in the forms of invention herein shown

and described, without departing from the spirit of the invention or the scope of the claims.

I claim:

1. A drilling bit comprising a body portion having the lower end thereof provided with laterally extending rock abrading wings, said wings having vertically extending apex pointed drilling lugs upon the bottoms each in the shape of a half spheroid and in axial cross section in any plane being in the mathematical form of an equilateral Gothic pointed style arch.

2. As an article of manufacture a drill bit comprising a body portion having means for attaching the same to a drill stem and a central water passageway opening on the bottom thereof, laterally extending material abrading wings having laterally facing sharp edges at the ends of the wings constituting the outermost portions of the sides of said wings, said body portion and wings having depending drilling extensions tapering to points at the apices thereof in the shape of a half spheroid and in axial cross section in any plane being in the mathematical form of an equilateral Gothic pointed style arch.

3. As an article of manufacture an impact drill for drilling of hard rock formations comprising a body portion having the lower end thereof provided with vertically extending drilling lugs tapering from their connection with the body portion to lower pointed apex ends, and drilling lugs upon the body portion on axes inclined to the vertical projecting laterally beyond the body portion and the vertically disposed drilling lugs but with the apices thereof located in a plane above the plane in which the apices of the vertical lugs lie, said lugs each being in the shape of a half spheroid and in axial cross section in any plane being in the mathematical form of an equilateral Gothic pointed style arch.

4. In a percussion type rock drill the combination of a body portion having a lower surface provided with endwise tapered drilling lugs the base of which lies in the plane of said lower surface of the body portion and each of which directly tapers from said lower surface in the shape of a semi-spheroid and in axial cross section in any plane being in the mathematical form of an equilateral Gothic pointed style arch.

5. In a rock drill, the combination of a body portion having fixedly connected therewith upon the bottom surface thereof and endwise extending therefrom drilling lugs each in the shape of a half spheroid which in axial cross section in any plane of intersection is in the mathematical form of an equilateral Gothic pointed style arch.

6. A rock drill as set forth in claim 5 in which there is one series of such lugs the apices of which are each located in a definite plane spaced from the body portion and a second series of such lugs the apices of which are located in a plane closer to the body portion than the plane in which the apices of the first mentioned series lie.

7. In a percussion type rock drill the combination of a drilling head having a body portion with a bottom surface provided with endwise projecting conical shaped rock penetrating lugs, the axes of which are parallel with the axis of the drill head, said body portion having a substantially central water passageway therethrough and the area surrounding said passageway at the bottom of the body portion being unobstructed between said passageway and the rock penetrating lugs, and a plurality of conical shaped rock shattering lugs fixed upon the body portion at the outer marginal portion of the body portion and having the axes thereof inclined at an angle to the axis of said body portion, the apices of the inclined lugs being disposed in a plane appreciably closer to the bottom surface of the body portion than the plane in which the apices of the first mentioned lugs lie, the inclined lugs appreciably projecting laterally beyond the outermost side surfacing of said body portion, the penetrating lugs and the rock shattering lugs being so conically formed that in any plane of axial intersection from base to apex they

are each in the mathematical form of an equilateral Gothic pointed style arch.

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