

April 15, 1952

H. W. WALLACE

2,593,229

DRILL BIT

Filed Nov. 14, 1947

2 SHEETS—SHEET 1

Fig. 1

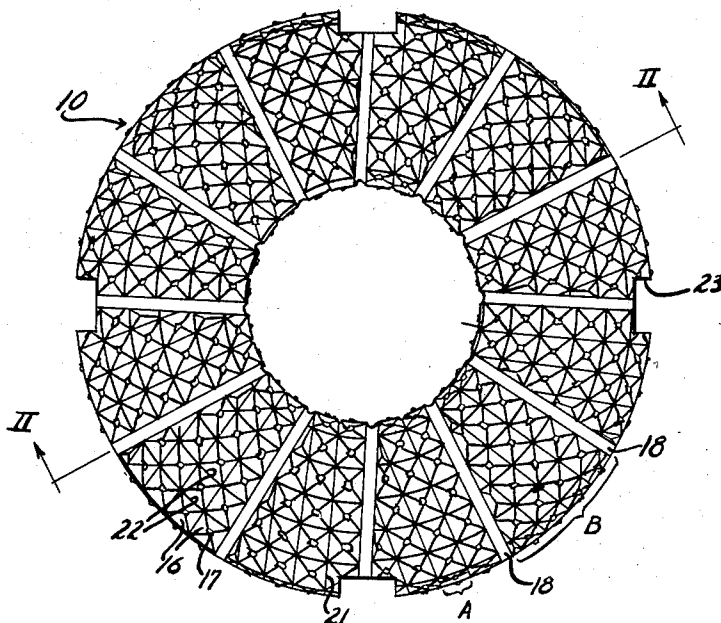


Fig. 2

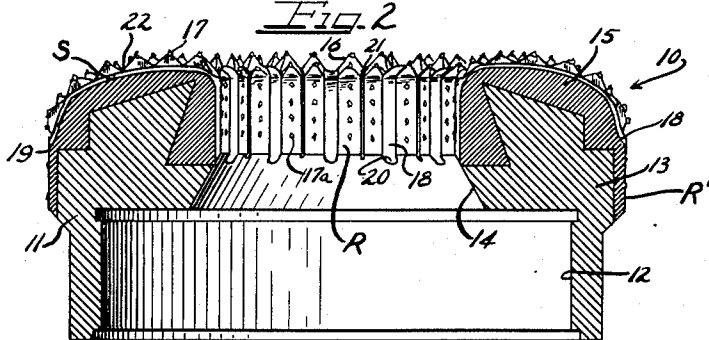


Fig. 3

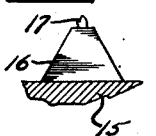
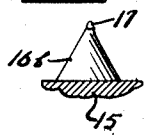


Fig. 4



Fig. 5



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2 SHEETS—SHEET 2

Fig. 6

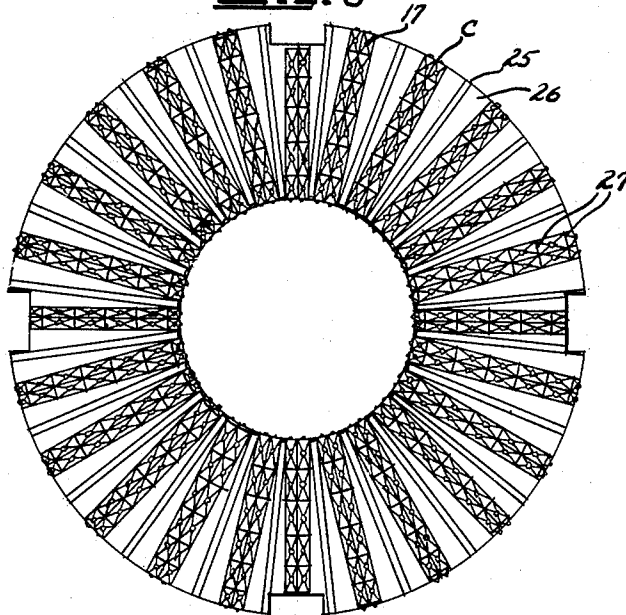
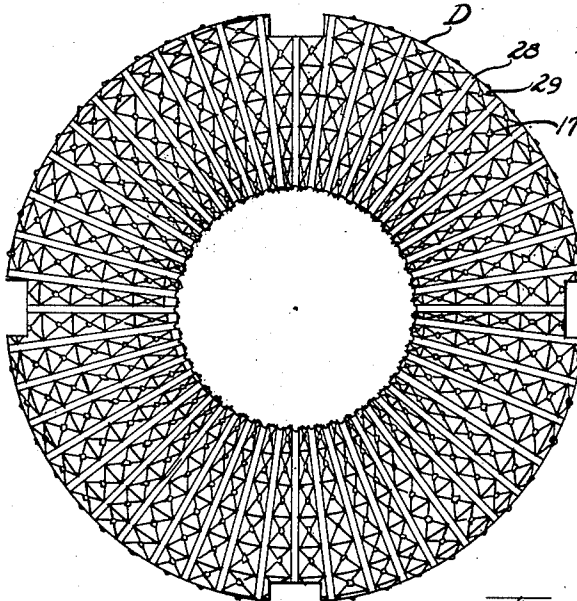


Fig. 7



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2,593,229

DRILL BIT

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5 Claims. (Cl. 255—72)

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This invention relates to a rotary drill bit, and more particularly to a core or solid type rotary drill bit in which diamonds are set singly in protuberances formed in the drilling face of the bit.

The drill bits to which my invention pertains are used in drilling rock or other earth formations, as for instance in the drilling of oil wells. Such drill bits are removably mounted on the end of a core barrel which forms a part of the drilling shaft. As the shaft is rotated about its axis, the drill bit effects its cutting and abrading action upon the material against which it is forced by the weight of the shaft above it. In the case of a core bit, the core cut by the bit passes upwardly through the core barrel and is removed through the hollow shaft. At the same time, circulating fluid is forced downwardly through the core barrel around the core for discharge over the working face of the bit to carry away the cuttings and abraded particles.

It has heretofore been proposed to make diamond-impregnated and diamond set bits for use in earth and rock drilling operations. In some of the larger type of diamond set drill bits for use in oil well drilling operations as much as several hundred carats of diamonds have been used in a single drill bit. As a consequence of the use of such a large weight of diamonds in a single drill bit, the cost has been very high and the danger of the bit being accidentally destroyed in use has been a serious consideration.

In accordance with my present invention, I am able to use a smaller weight of diamonds for the same type and size of drill bit, and also smaller individual diamonds, and still accomplish the same effective cutting. This is accomplished by a novel and improved construction and arrangement of the drilling face of the bit. The drilling face is provided with protuberances symmetrically arranged in substantially radially extending rows and also, preferably, in spirally extending rows. Each of the protuberances is performed as an integral part of the matrix metal that constitutes the drilling face of the bit, and each protuberance is of a well-defined shape, such as pyramidal, conical, segmental spherical, or the like, to provide more or less of an apex. A single diamond, or diamond particle is set in each such apex so as to project therefrom. Instead, however, of using relatively large diamonds of a carat or over in weight, that have previously been used in drill bits of different construction, smaller diamonds of the order of from two to ten diamonds to the carat are employed. Each diamond is

properly set in the matrix metal so as to be firmly held therein, and for this purpose a matrix metal such as disclosed in the Petrie Patent No. 2,210,039 may be employed, since by the process of that patent firm adherence between the diamonds and the tungsten metal is obtained. It is also contemplated, however, that other types of matrix metal, such, for instance, as the cemented carbide type, can be used. The mound of matrix metal in which each diamond is mounted supports the diamond in a free-cutting position and enables the use of smaller diamonds by virtue of the mass of the supporting metal. This means a smaller diamond area of contact with the material being drilled and sharper individual diamonds or diamond particles. Less weight need be applied to the bit and the bit may be rotated at a slower speed and yet the bit will cut at a higher rate of penetration than diamond set bits of previous construction.

Further, by virtue of the construction and arrangement of the drilling face of the bit the circulating fluid during the drilling operation can pass freely around each individual diamond particle to insure the clearing away of the cuttings in a most effective manner and also to insure the cooling of each diamond as it engages the rock or other material to be drilled. The smaller diamonds when arranged as described with a single diamond set in the apex of each protuberance accomplish the drilling just as effectively as larger diamonds arranged as formerly and with greater economy in the use of the diamonds.

It is therefore an important object of this invention to provide a diamond set drill bit of novel and improved construction that is just as effective as more expensive drill bits that have heretofore been used.

It is a further important object of this invention to provide a drill bit having a drilling face provided with well-defined and symmetrically arranged protuberances in each of which is set a single diamond, whereby the circulating fluid used in the drilling operation is able to pass freely around each individual diamond to clear the cuttings away in a most effective manner and also to exercise a cooling effect upon each diamond as it engages the material being drilled.

Other and further important objects of this invention will be apparent from the disclosures in the specification and the accompanying drawings.

On the drawings:

Figure 1 is a top plan view of a drill bit embodying the principles of my invention.

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Figure 2 is a sectional view taken substantially along the line II—II of Figure 1.

Figures 3, 4 and 5 are enlarged fragmentary elevational views, partly in section, of different forms of protuberances that may be used in the drill bits of my invention.

Figure 6 is a top plan view of a modified form of my invention.

Figure 7 is a top plan view of a further modification of my invention.

As shown on the drawings:

In Figures 1 and 2 the reference numeral 10 indicates generally a drill bit embodying the principles of my invention. Said drill bit comprises a metal body portion 11 that is generally cylindrical in shape and that is provided with an enlarged cylindrical bore 12 and annular portion 13 having a smaller, outwardly converging bore 14. Matrix metal, indicated at 15 is suitably keyed or otherwise secured to the annular body portion 13. In accordance with principles well known in the art, the matrix metal 15 may be formed by powder metallurgy into the shape illustrated, or it may be cast into that shape. Preferably, the matrix metal is formed by placing the powdered metals in a mold, in which the diamonds have been properly set at the apices of the corresponding depressions, and the body 11 is then placed above the powdered metal in the mold and forced into the mold to compress the powder. Sufficient heat and pressure are used to complete the molding and sintering operation. As illustrated in Figure 2, the matrix metal 15 forms a drilling face comprising inner and outer substantially cylindrical reaming faces R' and R' and an annular outwardly convex intermediate face S. Said surface S is provided with protuberances 16 which are generally pyramidal in shape, and a single diamond or diamond particle 17 is set in the apex of each pyramid. Figure 3 illustrates an enlarged single pyramid of the type described. The protuberances 16 are arranged in substantially radially extending rows, such as the row A and sector-shaped groups B of such rows are separated by relatively deep water grooves 18. The water grooves 18 extend from the outer periphery R', as at 19, radially inwardly and downwardly along the inner periphery R to terminate at 20. Each of the individual rows A is also separated from the next adjacent row by a groove 21 formed between the bases of the pyramids. In addition to arranging the protuberances in the radially extending rows A, the protuberances are also arranged in arcs which are segments of circles or spirals, and which are offset radially from one group B to the next. There are thus formed arcuate grooves 22 which extend between the water grooves 18 and which serve as supplemental water grooves to conduct the circulating fluid and cuttings, or sludge, into the radial grooves 18. It will be apparent by this radially offset or spiral arrangement that circumferentially spaced diamonds 17 in adjacent groups B are on slightly different radii and consequently do not follow in exactly the same track. Practically, each diamond thus acts as a separate cutting element effecting its own cutting action along its own particular track or path. Due to the fact that each diamond is mounted singly in the apex of a protuberance, with plenty of clearance on all sides for the passage of the circulating fluid and cuttings, a much more economical use of the diamonds is possible than where the diamonds are set in the continuous surface of the matrix metal

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in closely spaced relationship and with only infrequent grooves and watercourses.

As indicated in Figure 2, the radially extending rows of diamonds continue along the inner periphery R as rows of spaced, single diamonds 17a set directly into the generally cylindrical surface of the matrix metal. In other words, the protuberances are not continued along the inner periphery R, but individually set diamonds are mounted around said inner periphery in rows lying in the same general planes as the diamonds 17 in the rows A. The diamond-set protuberances 16, however, do continue outwardly toward the outer periphery R', although not, in general, beyond said outer periphery.

At a plurality of points around the outer periphery R', the periphery is vertically recessed to provide relatively wide axially extending grooves 23. Four such grooves 23 are illustrated, but more or fewer grooves may be employed. The grooves 23 provide communication between the inner and outer peripheries along certain of the watercourses 18. These axially extending grooves 23 thus serve for the upward escape of cuttings produced during the drilling and carried along by the circulating fluid over the drilling face into the radially extending watercourses 18.

As indicated in Figure 4, instead of being pyramidal in shape, a protuberance, indicated by the reference numeral 16a, may be segmental spherical, with a diamond or diamond particle 17 mounted therein to provide an apex. In Figure 5 there is shown a conically shaped protuberance 16b having a single diamond set in the apex. The protuberances may take other regular geometrical forms; but, preferably, the pyramidal or conical form is used.

In Figure 6 there is shown a drill bit of a similar type but with the diamond-set protuberances arranged in radially extending rows C and with each row two protuberances in width. Radially extending water grooves 25 lie between adjacent rows C of protuberances. If, as shown, the rows C are of constant width, sector-shaped portions 26 bare of protuberances are formed between adjacent rows. Said bare portions 26 are at a different level from the rows C, and, in effect, supplement the water grooves 25 in carrying away the cuttings. Thus, together with the watercourses 25, the sector-shaped portions 26 afford flow passages of increasing capacity radially outwardly of the drilling surface. The diamond set pyramidal protuberances in each of the rows C are similar to those already described, and these protuberances are arranged along spiral lines as indicated by the arcuate grooves 27 between radially adjacent protuberances.

In the further modification of this invention illustrated in Figure 7, the protuberances are arranged in radially extending, single width rows D with water grooves 28 between adjacent rows and also extending substantially radially. In this case, the width of the individual protuberances, indicated by the reference numeral 29, increases toward the outer periphery so as to substantially completely fill in the sector-shaped portions between the radially extending water grooves 28. Otherwise, the structures shown in Figures 7 and 6 are similar to that illustrated in Figures 1 and 2 and already described.

As previously indicated, all of the forms of my invention possess the common feature of well-defined, preformed protuberances, preferably tapered to provide apices, and set at each apex with a single diamond or diamond particle hav-

ing an exposed cutting portion. The more effective use of a lesser weight of diamonds and diamonds of smaller sizes is believed to be largely due to this arrangement. It also makes possible the use of a larger volume flow of circulating fluid to carry off the cuttings from each individual diamond more efficiently and thus maintain the diamond in a freer cutting condition.

As compared with a drill bit in which diamonds of a carat or over are set directly in the body of the matrix metal, rather than in spaced protuberances of the matrix metal, the drill bit of my invention with pre-formed protuberances and water grooves makes more effective use of smaller diamonds of one-half carat or less. This is largely because the smaller diamonds are sharper and remain so during their useful life, and because they are freer cutting due to the provision of pre-formed grooves forming clearances surrounding each diamond. The result is that the bits of my invention may be rotated more slowly, as for instance at from 50 to 100 R. P. M. as against over 100 R. P. M. for former type bits, and less weight need be placed on my bits, roughly one-half as much, to cause the bits to cut at a higher rate of penetration.

In bits of my invention, the diamonds accomplish the drilling solely by virtue of their cutting and abrasive action. Diamonds could not be satisfactorily used in bits where they would be subjected to percussive impacts since the shock of such impacts would shatter the relatively brittle diamonds. Consequently, the bits of my invention are of the rotary type in which the individual diamonds move only with the bit as a whole and remain in substantially continuous frictional contact with the material being drilled. Under such circumstances, the diamonds are not subjected to sudden and severe impacts. In order to distinguish from roller bits and other bits in which there is an impact action between the cutting elements and the material being drilled and in which diamonds could not be satisfactorily used, the bits to which my invention pertains are referred to in the claims as "plain rotary type drill bits." The term "diamond particle," as used in the claims, is intended to mean a whole diamond, or any integral diamond fragment.

It will, of course, be understood that various details of construction may be varied through a wide range without departing from the principles of this invention and it is, therefore, not the purpose to limit the patent granted hereon otherwise than necessitated by the scope of the appended claims.

I claim as my invention:

1. A plain rotary type drill bit having a convex

end working face provided with pyramidal protuberances arranged in substantially radially extending rows with water grooves therebetween, and a single diamond particle set in each of said protuberances to project from the apex of such protuberance.

2. A plain rotary type drill bit having a drilling face comprising inner and outer reaming faces and an intermediate convex face provided with well-defined similar protuberances each having all side faces converging to an apex, and a diamond particle set in each apex.

3. A core drill bit having a drilling face provided with pyramidal protuberances arranged in rows that extend substantially radially with radially extending water grooves therebetween and also arranged in spiral rows, and a single diamond particle set in each protuberance to project from the apex thereof.

4. A core drill bit having an annular drilling face provided with pyramidal protuberances symmetrically arranged in well-defined radially extending and spirally arranged rows and a single diamond particle set in each protuberance to project from the apex thereof.

5. A core drill bit having an annular drilling face provided with pre-formed pyramidal protuberances symmetrically arranged in well-defined radially extending and in arcuate rows, the radially extending rows being separated by water grooves and the arcuate rows providing cuttings receiving grooves therebetween, and a single diamond particle set in each protuberance to project from the apex thereof.

HARRY W. WALLACE.

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