June 21, 1938. R. J. KILLGORE 2,121,202

ROTARY BIT

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Fig. 1.

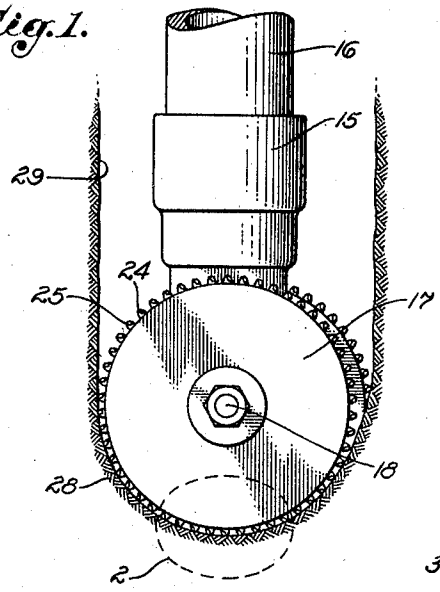


Fig. 4.

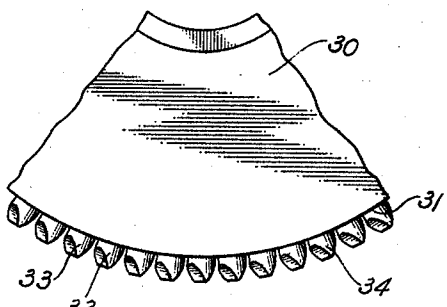


Fig. 5.

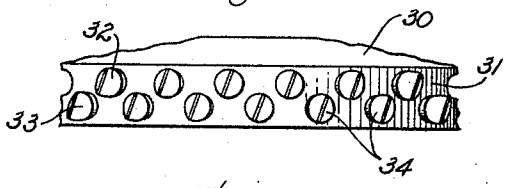


Fig. 2.

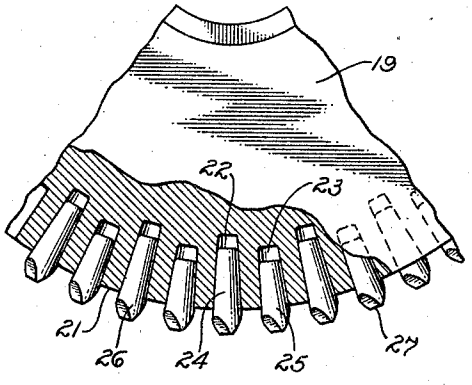


Fig. 6.

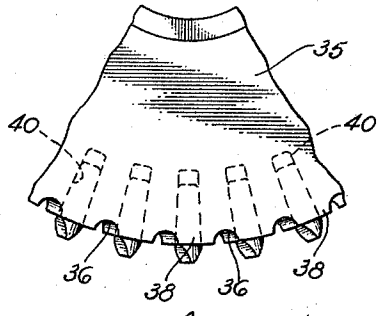


Fig. 3.

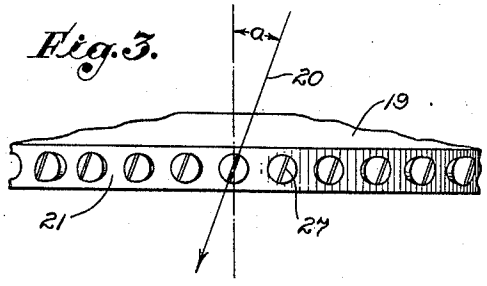
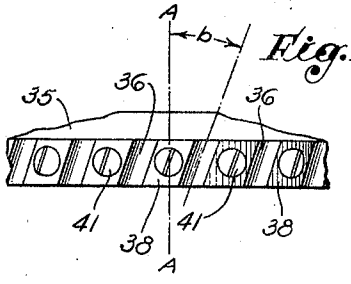


Fig. 7.



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June 21, 1938. R. J. KILLGORE 2,121,202

ROTARY BIT

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Fig. 8.

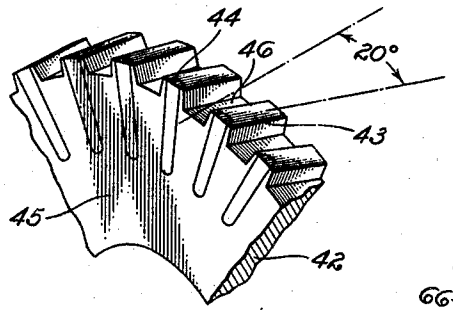


Fig. 10.

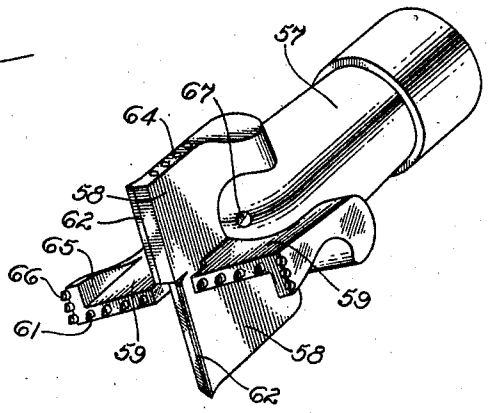


Fig. 9.

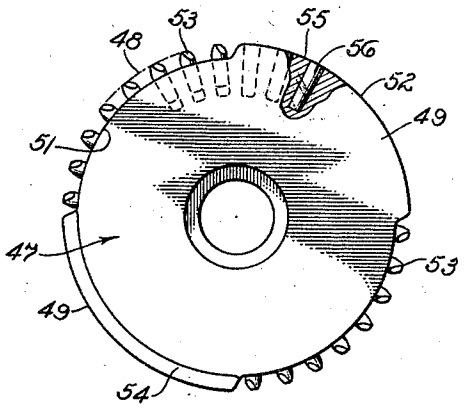


Fig. 11.

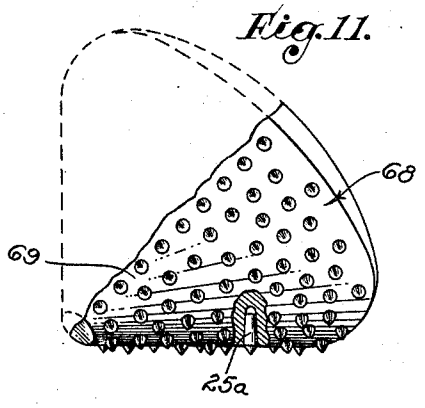
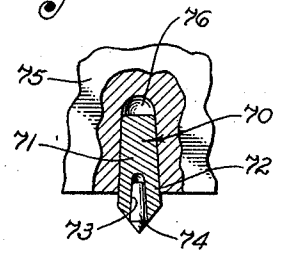


Fig. 12.



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Patented June 21, 1938 2,121,202

UNITED STATES PATENT OFFICE

2,121,202

ROTARY BIT

Robert J. Killgore, Los Nietos, Calif.

Application March 19, 1935, Serial No. 11,801

2 Claims. (Cl. 255—71)

My invention relates to rotary drill bits, and relates in particular to a rotary bit especially adapted for the drilling of formations which are of a character too hard or tough for efficient drilling with ordinary drag type drill bits and are not sufficiently brittle to be readily disintegrated by roller type bits.

We find that in certain fields formations are encountered which are of the character of shale and appear to be somewhat rubbery in nature so that they resist penetration of the cutting edges of drag type and disc bits, with the result that the bits have a tendency to slide over the surface and wear away without accomplishing any appreciable downward advance. Likewise, these formations do not chip and shatter when operated upon by roller type bits, with the result that drilling progress is retarded.

An object of my present invention is to provide a rotary bit having teeth on the cutting members thereof which will penetrate this type of formation and also harder and softer formations, these teeth being produced on the cutters of the bit in a new manner.

A further object of the invention is to provide a rotary drill having a cutter member with openings facing the formation to be penetrated, and hard metal inserts carried in these openings in such a manner that breakage thereof will not readily occur. In the preferred practice of the invention the openings are tapered inwardly, and the hard metal inserts are likewise tapered so that when they are placed in the openings they will be held under radial compression by the surrounding metal. Furthermore, it is preferable when severe operating conditions are encountered to make the inserts of such length relative to the depth of the openings that the inserts will not bottom in the openings but will be held in place by the gripping action of the surrounding metal wall.

A further object of the invention is to provide a rotary disc bit having cutter discs formed of a tough metal, such discs having hard metal inserts supported in the periphery thereof in the manner described in the preceding paragraph.

A further object of the invention is to provide a disc for a rotary bit having a combined digging and scraping action. This disc is characterized by having the periphery thereof divided into consecutive portions which are alternately provided with teeth for penetration of the formation so as to scratch the same and curved cutting blades for scraping from the bottom of the hole the particles of the formation which have been loosened by the teeth.

It is a further object of the invention to provide a disc cutter for a rotary bit having teeth in the periphery thereof formed between notches which are disposed at an angle relative to the face of the disc, the angle of such notches corresponding to the angle of drag of the periphery of the disc relative to the formation during the operation of the disc bit in its customary manner.

A further object of the invention is to provide a rotary cutter for a bit having hard metal inserts placed therein, the outer ends of such hard metal inserts being shaped to wedge form at angles relative to the axis of rotation of the cutter.

A further object of the invention is to provide a cutter for a rotary bit having a large quantity of hard metal supported in position to reinforce or produce the cutting edge. In the practice of my invention the bodies of hard metal are of large size, and in the ordinary use of the invention the placing of hard metal on a cutter of definite size gives such cutter a greater quantity of hard metal than is ordinarily placed on the cutter in the ordinary practice of hard-facing rotary cutters with either particles of hard metal or facings of welded material embodying a powdered or granulated hard metal.

A further object of the invention is to provide a rotary cutter having hard metal bodies carried therein which are cast in the openings or recesses of the cutter body.

Further objects and advantages of the invention will be made evident throughout the following part of the specification.

Referring to the drawings, which are for illustrative purposes only,

Fig. 1 is a side view of a rotary disc bit embodying my present invention.

Fig. 2 is a fragmentary, partly sectioned detail to enlarged scale showing the lower portion of a disc cutter included within the area circumscribed by the dotted line 2 of Fig. 1.

Fig. 3 is a view looking upwardly toward the lower edge of Fig. 2.

Fig. 4 is a view similar to Fig. 2, showing the lower portion of a rotary disc cutter having multiple rows of inserts forming teeth on the periphery thereof.

Fig. 5 is a fragmentary view looking upwardly toward the lower edge of Fig. 4.

Fig. 6 is a fragmentary view showing the lower portion of a disc bit having teeth formed in the periphery thereof by notches, said teeth being

provided with cutting reinforcement in the form of hard metal inserts.

Fig. 7 is a view looking upwardly at the lower edge of Fig. 6.

Fig. 8 is a fragmentary perspective view showing another manner of forming a toothed cutter of the character shown in Figs. 6 and 7.

Fig. 9 is a face view of a combination scraping and digging disc.

Fig. 10 is a perspective view of a drag type bit embodying the principles of my invention.

Fig. 11 is a view of a roller type rotary drill cutter of the character used on cone roller rock bits.

Fig. 12 is an enlarged fragmentary sectional view showing a type of insert which may be employed in the cutter shown in Fig. 11 and in other of the cutters disclosed where such cutters are to be used in extremely hard formations.

Although my invention is useful in the various types of rotary cutters hereinafter to be described, it is of especial utility in disc bits of the character shown in Fig. 1 wherein a bit body **15**, adapted to be secured to the lower end of a drilling string **16**, supports cutter discs **17** which are adapted to rotate on bearing members **18** carried by the lower portion of the bit body **15**.

As shown in Figs. 2 and 3, the cutter discs **17** each comprise a circular body **19** of tough steel having a cylindrical circumferential face **21**. Extending inwardly from the face **21** are tapered openings **22** and **23** which carry tapered hard metal inserts **24** and **25** in such positions that the outer ends **26** thereof form radially projecting teeth. The type of hard metal employed in the inserts depends upon the character of the formation to be penetrated. For example, if the formation is relatively soft, even though gummy or rubbery as in shale, these inserts may be made from stellite or some other air-hardening alloy. An especial advantage of the construction shown in Figs. 1 to 3 is that the metal components of the disc **17** may be assembled without use of processes or treatment which will be detrimental to the grain structure of the metal or place strains therein by the unequal distribution of heat. It has been a practice to make a disc of the shape shown at **17** from a good grade of steel and to apply hard metal thereto by welding processes. Very naturally, the particles of hard metal employed and the body **19** of such disc are not benefited by the application of welding heat thereto. In my new disc **17** the openings **22** and **23** may be formed, and the body **19** may then be hardened. After the hardening operation, the inserts may be placed without application of heat which will weaken the same.

The openings **22** and **23** are respectively deeper and longer than the portions of the inserts **24** and **25** which are placed therein so that the inner ends of the inserts do not strike the bottoms of the holes or openings **22** and **23**. Accordingly, these inserts are held in place by the gripping effect of the metal of the body **19** surrounding the openings **22** and **23**, which gripping effect not only prevents inward movement of the inserts **24** and **25** but at the same time holds them under radial compression, which minimizes shattering and breakage of the inserts. It will be understood, however, that in discs **17** adapted for soft digging, where the inserts **24** and **25** are not subject to severe axial forces, the inserts may be bottomed in the openings **22** and **23**. Likewise, in the manufacture of some discs the openings and the inserts may be both made untapered or cylindrical, and such inserts may be placed in the openings while the body **19** is heated to a medium temperature, the subsequent cooling of the body **19** causing the metal walls of the openings to shrink around the inserts and securely hold them in the openings.

An additional feature of the invention resides in the forming of wedge or chisel points **27** on the outer ends **26** of the inserts **24** and **25**, these chisel points **27** being disposed, as shown in Fig. 3, at angles *a* relative to the face of the disc **17**. The angle *a* corresponds in general to the direction of movement of the periphery of the disc **17** across the formation **28**, Fig. 1, forming the bottom of the hole **29** which is being drilled, this direction of movement being indicated by the arrow **20** of Fig. 3 and ordinarily being approximately 20° relative to the axis of the disc **17**.

As shown in Fig. 2, the openings **22** and **23** are alternated, and the openings **23** are of less depth than the openings **22**, for the purpose of enabling the placing of the openings **22** and **23** relatively close together without too thin a metal wall being formed between the inner ends thereof. The inserts, placed as shown in Figs. 1 to 3, are forced into the formation **28** so that as the disc rotates with a combined revolving and sliding movement, the face of the formation is scratched up and disintegrated. Tests which I have made indicate that in shale formations such as those hereinbefore mentioned, the disc cutters **17** will drill from two to four times faster than standard disc bits and roller type bits.

Where the formation to be penetrated is of more abrasive character, the disc may be provided with a larger number of hard metal inserts. This may be accomplished as disclosed in Figs. 4 and 5, wherein I have shown a portion of a disc **30** having a relatively wide peripheral face **31** in which two rows **32** and **33** of inserts **34** are placed in staggered relation. These inserts project so as to form penetrating teeth and are sharpened on the projecting ends, as shown.

Another feature of the invention is to provide a disc cutter having peripheral teeth formed by or between peripheral notches which extend diagonally with relation to the face of the disc. In Figs. 6 and 7 I show a portion of a disc **35** having diagonal notches **36** cut therein, each notch being at an angle *b* relative to the axis A—A of the disc **35**. The angle *b* in this form of the invention is also the approximate angle of movement of the periphery of the disc relative to the formation and ordinarily is about 20° relative to the axis A—A of the disc **35**. A further feature of this form of disc is that the teeth **38** are given cutting reinforcement. In other words, the ability for these teeth to cut is reinforced by the placing of hard metal bodies in the disc **35** in such position that the hard metal bodies will be aligned with the outer portions or point portions of the teeth **38**. Accordingly, in each tooth a radial opening **40** is drilled inwardly, and a hard metal insert **41** is placed in each opening as disclosed.

As shown in Fig. 8, a disc cutter **42** may have the teeth **43** thereof reinforced for greater cutting ability by hard metal bodies **44** placed on or in the face **45** of the disc **42** by the known processes, such, for example, as welding. In the disc **42** the teeth **43** are formed between notches or slots **46** which are helical with relation to the axis of rotation of the cutter **42**, and such slots **46** are likewise formed at an angle corre-

sponding to the angle of movement of the periphery of the disc relative to the formation which is being penetrated, such angle being ordinarily 20° relative to a plane coinciding with the axis of rotation of the cutter.

In soft but rubbery formations, and in other formations also, the drilling action by roller type cutters is often retarded by the presence of the cuttings on the bottom of the hole, the roller cutter rolling upon these cuttings and therefore penetrating the formation but little. For use in formations of this character my invention provides a disc cutter **47**, such as shown in Fig. 9, having alternate digging and scraping edges **48** and **49** so that as the disc rotates on its axis, it will first present teeth to the formation to dig into and break up the surface and will then apply a scraping blade to remove the cuttings which have been formed by the digging teeth, so that the full effect of the subsequent application of digging teeth may be realized. The disc **47** is accordingly provided with alternate arcuate edges **51** and **52**, the edges **52** projecting radially beyond the edges **51** a distance substantially equal to the length of teeth **53** which are formed along the edges **51** so as to provide the disc **47** with digging segments **48**. These teeth **53** are preferably formed by use of hard metal inserts carried in openings in the disc **47** in the manner shown in Fig. 2. The scraping or blade portions **49** of the disc may be given reinforcement either as shown at **54** by the application of hard metal on the face of the disc or as shown at **55** by the placing of hard metal inserts **56** with the outer ends thereof flush with the peripheral edges **52**.

It is a feature of the invention to cast hard metal bodies, such as shown at **56** in Fig. 9, in the openings of the cutters. In this process of reinforcing the cutting edge of a rotary bit cutter, the cutter body is provided with openings and is heated. The openings are then filled with molten hard metal, such, for example, as tungsten carbide, air-hardening steels, etc., which bonds itself to the walls of the openings and therefore forms a hard metal insert which is in proper operative position and which cannot be removed from the opening in which it resides. Such inserts as shown at **44** in Fig. 8 and at **64** in Fig. 10 may be applied by use of the above set forth method of casting.

Although I have but little doubt that my invention is of greatest utility with roller types of rotary drilling bits, it must be recognized that the principles thereof may be used in what are known as "drag bits" such as, for example, fishtail bits. In Fig. 10 I show a drag bit patterned after the later types, in which a bit body **57** has a plurality of blades **58** and **59** projecting downwardly therefrom in radial relation. In drag blades of this character hard metal inserts may be mounted in such a manner that greater cutting ability or reinforcement will be given the cutting edges of the blades. Likewise, such inserts may be caused to project from the blades so as to definitely provide teeth. In Fig. 10 I show a drag bit with scraping blades **58** and digging blades **59**. The digging blades **59** have inserts **61** mounted therein after the manner disclosed in Fig. 2, so as to provide projecting digging teeth, and the blades **58** are provided with hard metal edges **62**, preferably welded in place, to act as scrapers for removing from the bottom of the hole the cuttings which have been produced by the digging action of the inserts **61**.

To assist in maintaining the gauge of the bit, hard metal inserts **64** may be placed in the edges of the blades of the drag bit. Illustrative of this, I have shown the inserts **64** in the edges of the scraping blades **58**. It will be noted also that each of the digging blades **59** has a trailing outer edge **65** in which hard metal inserts **66** are mounted in downwardly and outwardly extending diagonal relation so that the projecting ends of these inserts **66** will definitely define the largest dimension of the bit. Naturally, as these inserts **66** are worn away, the inserts **64** will assist in maintaining the gauge of the hole.

Although I have not made reference to the same, it is to be understood that all rotary bits with which the principles of my invention may be employed shall have the customary passages for drilling mud so that streams of drilling mud will be directed in such a manner as to efficiently remove the cuttings from the hole. In Fig. 10 the perspective view of the bit body **57** permits the showing of a mud discharge orifice **67** of the general character employed.

For penetration of extremely hard formations, such as rock, roller cutters of cylindrical and conical form are employed. In Fig. 11 I show a conical cutter **68** of the type employed on rock bits, these cutters comprising a body **69** of relatively tough and hard metal having a plurality of hard metal inserts **25***a* secured therein in such position that the projecting ends thereof will form teeth which will produce a grinding action on the hard material forming the bottom of the hole which is being drilled. As shown, these inserts are preferably placed in staggered relation so that they will not drag as the cutter **68** is rolled over the bottom of the hole.

Where the formations operated upon are of extremely abrasive character, the wearing away of the cutting teeth may be minimized by the use of diamond-metal points. This diamond-metal, approaching close to the natural diamond in hardness, is likewise very brittle, and in many bits is broken away from the supporting structure instead of wearing away, the result being that the expected cutting effect is not obtained. In Fig. 12 I show a composite insert **70** which may be employed under conditions such as those set forth above in this paragraph. This insert comprises a tapered body **71** of hard metal, such, for example, as one of the tough and hard, high speed, or air-hardened alloys. In the outer end **72** of the tapered body **71** a smaller tapered opening **73** is formed to receive a tapered insert **74** of diamond-metal, such, for example, as tungsten carbide, etc. In Fig. 12 I have shown a small portion **75** of a bit cutter with a tapered opening **76** therein to receive the tapered body **71**. The inner end of the opening **76** is rounded so that no sharp corners are formed wherein a crack may start. The diameter of the opening **76** is such that the insert **71** does not bottom therein, but instead the insert **71** is held by the tapered side walls of the opening **76** for exerting great radial inward pressure against the insert **71** to reinforce the metal structure thereof against shattering due to the heavy strains which may be applied during the drilling operation. The same condition is preferably produced relative to the mounting of the diamond-metal insert **74** in the tapered opening **73** of the larger insert **71** so that the diamond-metal insert **74** is securely held in cutting position and in such a manner that the tendency for the same to shatter is minimized.

Although I have herein shown and described my invention in simple and practical form, it is recognized that certain parts or elements thereof are representative of other parts, elements, or mechanisms which may be used in substantially the same manner to accomplish substantially the same results; therefore, it is to be understood that the invention is not to be limited to the details disclosed herein but is to be accorded the full scope of the following claims.

I claim as my invention:

1. A disc cutter for a disc bit of the character described, including: a circular plate having a relatively narrow peripheral edge and having inwardly tapered openings formed in the periphery thereof; and hard metal inserts disposed in said openings in such position that the walls of said plate around said tapered openings will compress said inserts radially, the outer ends of said inserts being sharpened to wedge shape and diagonal to the axis of the plate.

2. A disc cutter for a disc bit of the character described, including: a circular plate having a relatively narrow peripheral edge and having tapered openings formed in the periphery thereof; and tapered hard metal inserts disposed in said openings in such position that the walls of said plate around said tapered openings will compress said inserts radially, the outer ends of said inserts being sharpened to wedge shape and diagonal to the axis of rotation of said plate.

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