

July 7, 1953

M. D. INGRAM
ROCK DRILLING BIT

2,644,671

Filed March 4, 1947

7 Sheets-Sheet 1

Fig. 1

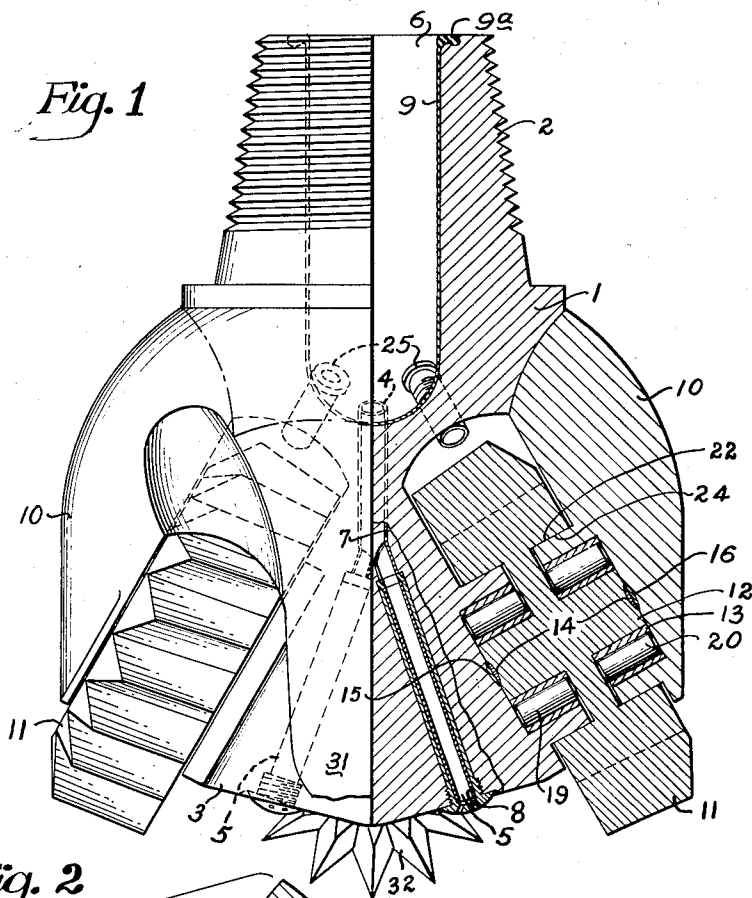
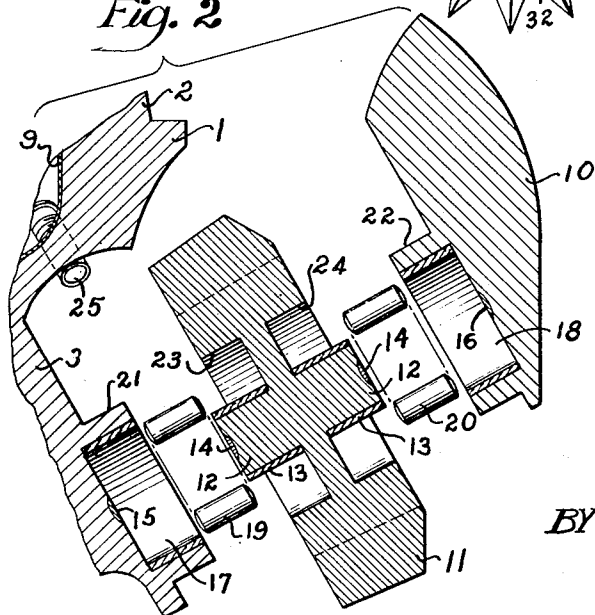


Fig. 2



Inventor
Martell D. Ingram.
BY *Wayland D. Keith*
HIS AGENT.

July 7, 1953

M. D. INGRAM
ROCK DRILLING BIT

2,644,671

Filed March 4, 1947

7 Sheets-Sheet 2

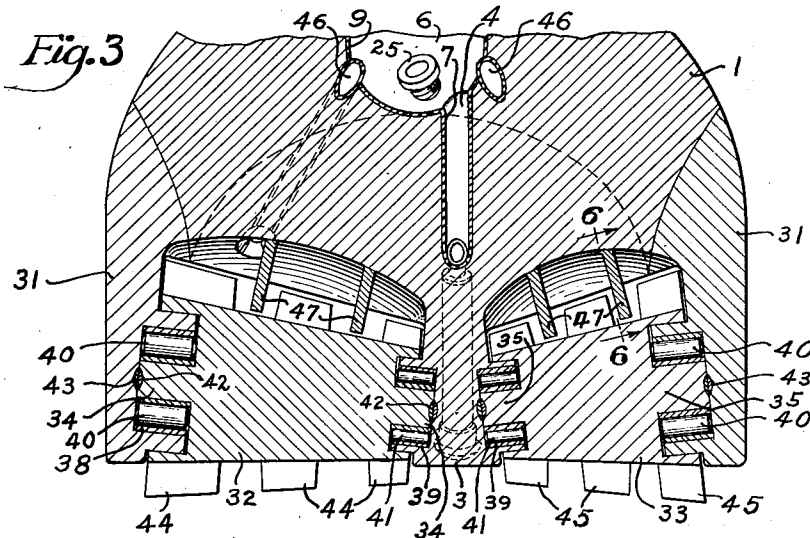


Fig. 4

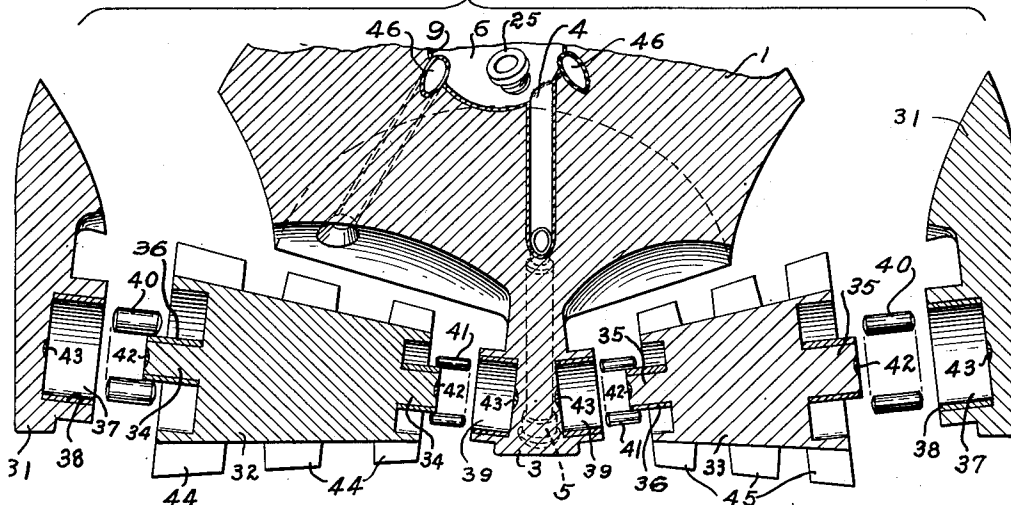


Fig. 5

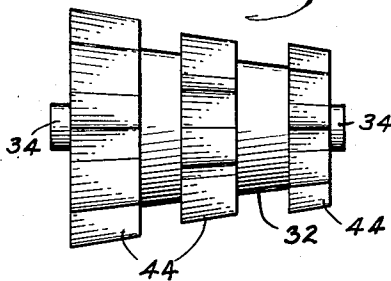
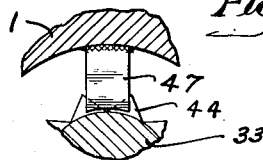


Fig. 6



Inventor
Martell D. Ingram
BY
Wayland D. Keith
HIS AGENT.

July 7, 1953

M. D. INGRAM
ROCK DRILLING BIT

2,644,671

Filed March 4, 1947

7 Sheets-Sheet 3

Fig. 7

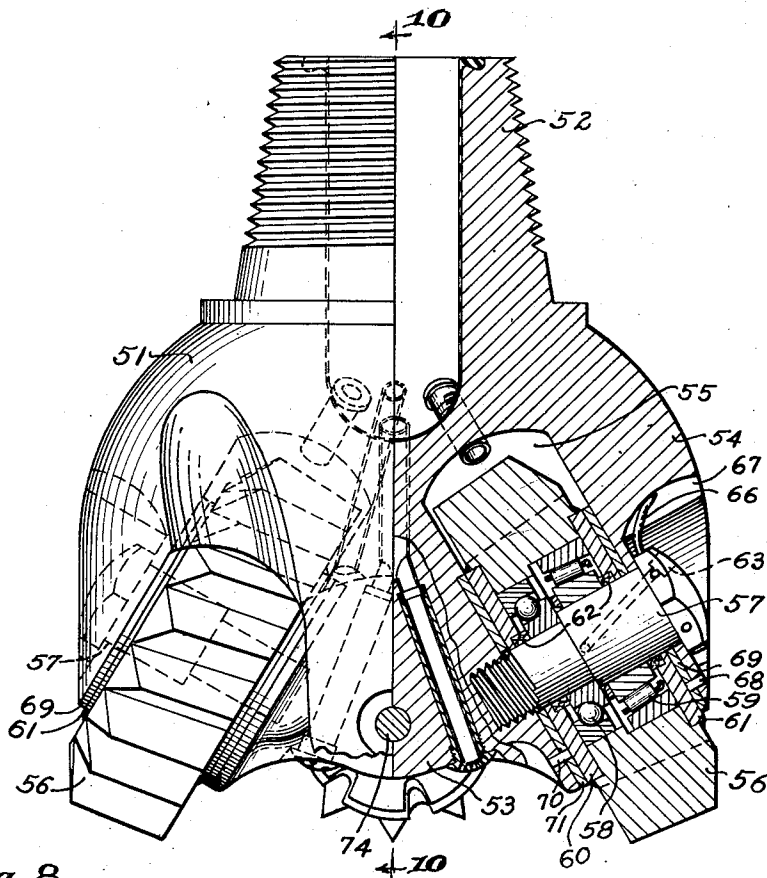


Fig. 8

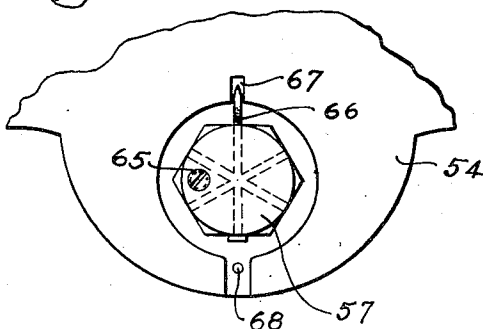
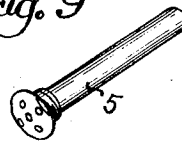


Fig. 9



Inventor
Martell D. Ingram
BY *Wayland D. Keith*
HIS AGENT.

July 7, 1953

M. D. INGRAM
ROCK DRILLING BIT

2,644,671

Filed March 4, 1947

7 Sheets-Sheet 4

Fig. 10

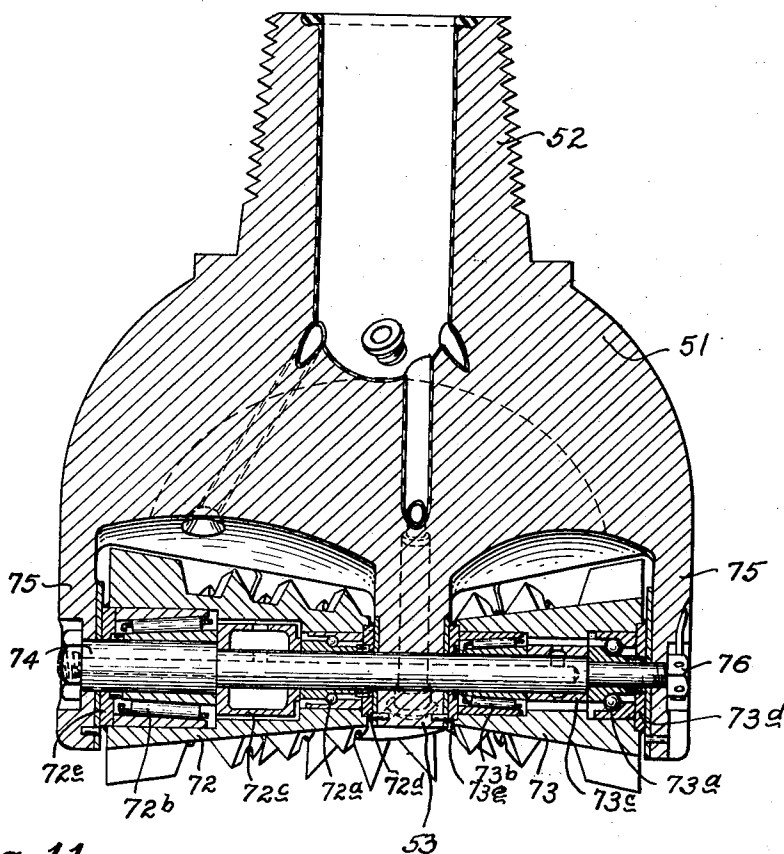
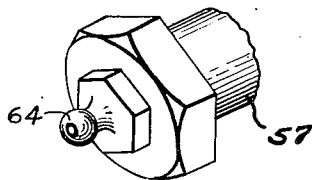


Fig. 11



Inventor
Martell D. Ingram
BY **Wayland D. Keith**
HIS AGENT.

July 7, 1953

M. D. INGRAM
ROCK DRILLING BIT

2,644,671

Filed March 4, 1947

7 Sheets-Sheet 5

Fig. 12

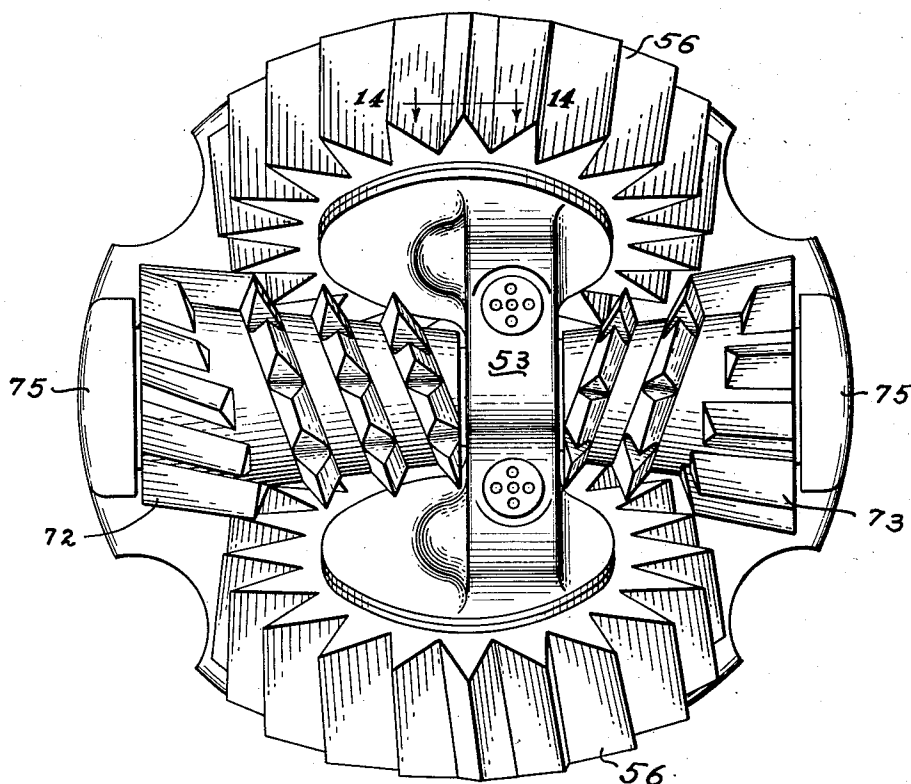


Fig. 13

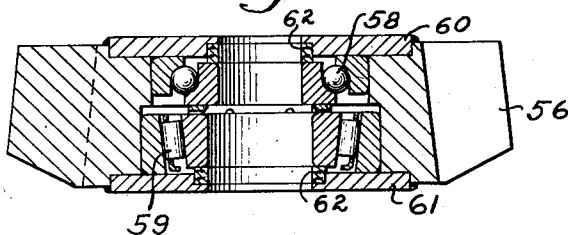


Fig. 14



Fig. 15



INVENTOR.
Martell D. Ingram
BY *Wayland Keith*
HIS AGENT.

July 7, 1953

M. D. INGRAM
ROCK DRILLING BIT

2,644,671

Filed March 4, 1947

7 Sheets-Sheet 6

Fig. 16

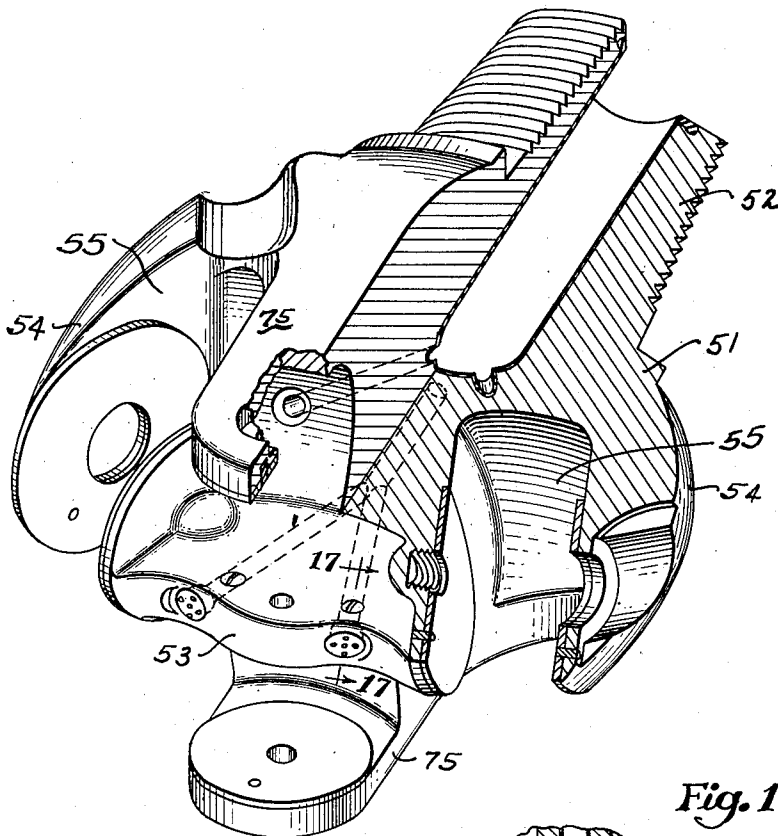


Fig. 18

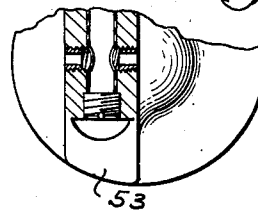
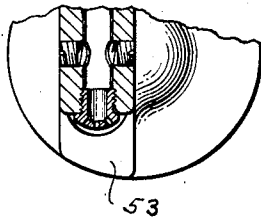


Fig. 17



INVENTOR.
Martell D. Ingram
BY
Wayland D. Keith
HIS AGENT.

July 7, 1953

M. D. INGRAM
ROCK DRILLING BIT

2,644,671

Filed March 4, 1947

7 Sheets-Sheet 7

Fig. 19

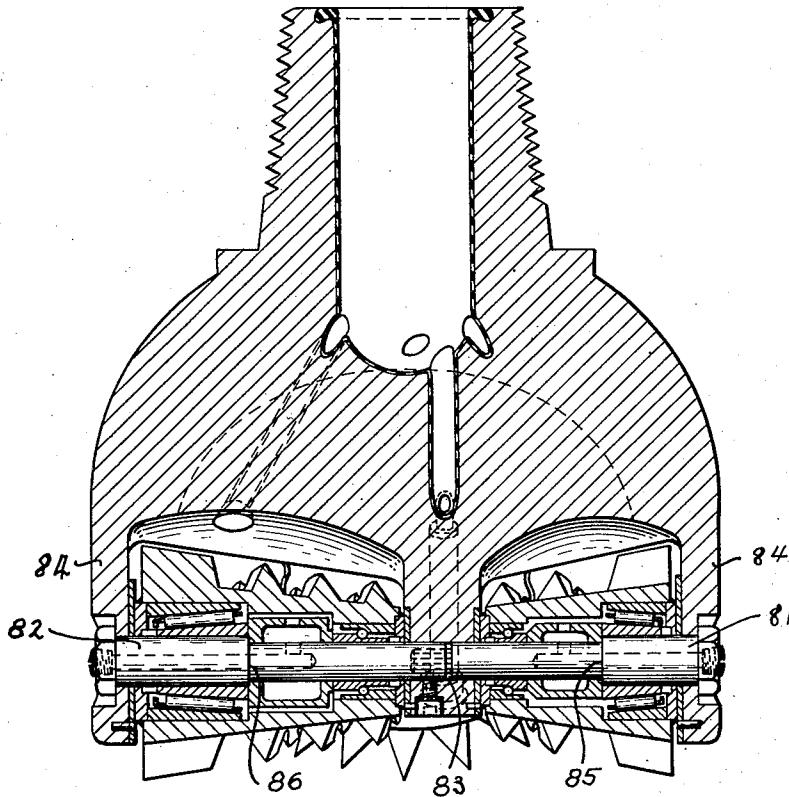
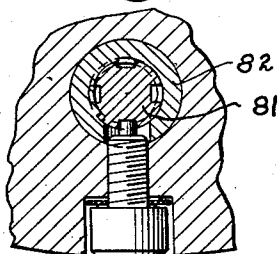


Fig. 20



INVENTOR.
Martell D. Ingram
BY
Wayland D. Keith
HIS AGENT.

UNITED STATES PATENT OFFICE

2,644,671

ROCK DRILLING BIT

Martell D. Ingram, Wichita Falls, Tex.

Application March 4, 1947, Serial No. 732,171

7 Claims. (Cl. 255—71)

1

This invention relates to improvements in rock bits employed in rotary well drilling, and more particularly to rock bits which may be readily assembled or disassembled for the repair and replacement of the bearings, the rotary cutter elements and other parts connected therewith.

Rock bits have been proposed heretofore which embodied rolling cutters but, for the most part, it has been found that these wear rapidly and that they do not readily lend themselves to disassembly for the repair or replacement of worn parts, due to the manner of construction. Furthermore, it has been found that certain parts of rock bits wear exceedingly fast as compared with other parts. Therefore, in the present invention, an attempt has been made to correct the defects existing in bits that have been made heretofore, and to provide other new and salient features which make possible more efficient operation and more rapid cutting than has heretofore been possible.

The primary object of the present invention is to provide a rock bit structure made of relatively few parts, yet providing a structure that is strong and sturdy and which may be readily assembled and disassembled.

Another object of this invention is to provide a rock bit in which the cutter unit is provided with bearings adapted to sustain both radial and thrust loads.

Another object of this invention is to provide a rock bit in which hardened metal inserts may be applied to the cutter teeth thereof, as by welding or by centrifugal casting.

Another object of this invention is to provide a rock bit in which the bowl and wash pipes thereof are provided with a resilient lining, such as rubber or synthetic rubber, to prevent abrasive action thereon.

A still further object of this invention is to provide, in a rock bit, a self-cleaning action for the cutter teeth.

A preferred embodiment of this invention together with modifications thereof are illustrated in the accompanying drawings in which:

Fig. 1 is an elevational view of a rock bit showing a quarter section removed therefrom so as to show the details of construction;

Fig. 2 is a fragmentary exploded view of a portion of the bit, partly in section and partly in elevation;

Fig. 3 is a sectional view through the lower portion of the bit taken at right angles to Fig. 1;

Fig. 4 is a fragmentary exploded view of a lower

2

portion of parts of the bit as shown in Fig. 3, partly in section and partly in elevation;

Fig. 5 is an elevational view of the cutter elements removed from the bit;

Fig. 6 is a sectional view taken on the line 6—6 of Fig. 3, looking in the direction indicated by arrows;

Fig. 7 is a view similar to Fig. 1 but of a modification of the invention which shows a different method of mounting the cutters and shaft thereon;

Fig. 8 is a fragmentary view of the modified form of the invention, showing the manner of locking the shaft against rotary movement;

Fig. 9 is a perspective view of a wash pipe for directing drilling fluid to a point near the bottom of the well;

Fig. 10 is a sectional view taken on the line 10—10 of Fig. 7;

Fig. 11 is a fragmentary view of an end portion of the cutter shaft showing how a lubrication fitting may be temporarily installed thereon so that a lubricant may be introduced into the shaft;

Fig. 12 is a bottom view of the form of bit shown in Fig. 7;

Fig. 13 is a longitudinal sectional view through the cutter elements showing how the various bearings are installed and sealed within the cutter unit;

Fig. 14 is a sectional view taken on the line 14—14 of Fig. 12, looking in the direction indicated by the arrows;

Fig. 15 is a view similar to Fig. 14 but showing a modified form of applying the hard surfacing material to the teeth;

Fig. 16 is a perspective view of the bit body with a quarter section removed therefrom to show the details of construction;

Fig. 17 is a fragmentary sectional view taken on the line 17—17 of Fig. 16, showing how the drilling fluid may be directed downward;

Fig. 18 is a view similar to Fig. 17 but showing certain of the openings plugged and certain of the other openings having orifices therein so as to direct the fluid laterally therefrom;

Fig. 19 is a view similar to Fig. 10 but showing a modified manner of installing the cutter shafts therein; and

Fig. 20 is an enlarged fragmentary detail, partly in section and partly in elevation, showing the manner of locking the cutter shafts against rotation or longitudinal displacement.

With more detailed reference to the drawings, the numeral 1 designates the body of a rock bit

3

on which a threaded pin 2 is disposed on the upper end thereof, which threaded pin is adapted to be connected to a conventional drill stem in a manner well understood in the drilling art. The body 1 has a downwardly depending center portion 3 which center portion has a central water course 4 therein and which central water course connects with lateral water courses 5, 5. The upper end of water course 4 connects with a central bowl portion 6. It is preferable to have the water courses 4 and 5, 5 lined with a rubber lining 7 and 8, respectively. The bowl 6 is also provided with a rubber lining 9, having a bead 9a engaging top of pin 2.

The bit body 1 has downwardly depending arms 10, 10 disposed on opposite sides thereof and secured to the body as by welding, as indicated in dot-dash outline in Fig. 1. The welding may be done by any of the various conventional methods of welding, such as flash, electric or acetylene. Cutters 11, 11 are disposed intermediate the depending center portion 3 and the arms 10, 10. Each of the cutters 11, 11 has a shaft 12 made integral therewith and protruding outward from either face thereof. It is preferable to have the outer cylindrical surface of the shaft 12 covered by a hard surfacing material which may be in the form of tungsten carbide applied thereto by welding and said outer surface material ground or machined until a finished surface results, or a hard surfacing alloy material forming a sleeve 13 may be applied to the shaft as by pressing or shrinking said sleeve thereon.

Each end of the shaft 12 has a spot of hard surfacing material located in the center thereof to form thrust bearings 14, 14, respectively, for engagement with complementary spots of hard surfacing material 15 and 16 formed on a plane surface within cylindrical races 17 and 18, which races are formed on depending center portion 3 and the arm 10 respectively. The cylindrical races 17 and 18 have their inner surfaces covered with a lining of hard surfacing material such as tungsten carbide, or a sleeve of hard alloy material may be provided, which sleeve may be pressed or shrunk thereinto, and when ground or finished, pin bearings 19 and 20 may be fitted into the respective races so as to support shaft 12 for rotation of the cutter element 11. The cylindrical races 17 and 18 have cylindrical neck portions 21 and 22 respectively, which neck portions protrude outward and have a ground surface around the outer cylindrical periphery thereof. These neck portions are in close fitting relation with the inner cylindrical surfaces 23 and 24 respectively of the counter bore within the bit roller 11, as will be seen in Fig. 1. It is preferable to have the cylindrical races 17 and 18 recessed into depending center portion 3 and arms 10 respectively so that the load transmitted from the cutter 11 will be transmitted directly to the center of the depending center portion 3 and the center of arm portion 10 without the neck portions 21 and 22 sustaining the entire load.

By having the neck portions 21, 22 interfitting with the inner cylindrical surfaces 23 and 24, a substantially fluid tight seal will result and which will normally exclude drilling mud or other abrasive matter. The arms 10 are welded to the body 1 as indicated in Fig. 1 and when the various parts of the rock bit are assembled in the relation as shown in this figure, it is impossible for the cutters 11 to become mislocated. When the cutter or bearings are in need of repair, the arms 10, 10 may be readily removed with a cutting

4

torch along the line where they were welded, and they may be reassembled after making necessary repairs or installing new parts in the same manner as the bit was originally assembled.

Water course tubes 25, 25 are mounted in the bottom of the bowl 6 in position to direct the drilling mud into the teeth of cutters 11, 11 and, due to the construction of the bit body, these water courses may be brought into close proximity to the faces of the cutters for cleaning the debris from between the teeth of the cutters during the drilling operation. It is preferable to have these water course tubes 25, 25 threaded exteriorly and to have them rubber or synthetic rubber lined, because this lining resists the abrasive action of the drilling mud. By having the ends of these water courses threaded, they may be inserted or removed when worn or as desired, and interchanged with course tubes of different lengths, or with tubes having a different type of outlet nozzle openings. It is also preferable for these water course tubes to be inclined slightly tangential to the arc formed by the bottom of the teeth. By having the drilling mud striking the cutters at this angle the teeth are cleaned as the cutter rolls.

Arms 31, 31 are oppositely disposed on either side of the bit body 1 and secured thereto as by welding, and are spaced intermediate the arms 10, 10. Cutters 32 and 33 are elongated and have shafts 34, 34 and 35, 35 respectively made integral therewith. The shafts 34, 34 and 35, 35 are round and have a hard surfacing material applied to the outer surfaces thereof, which material may be ground or machined to present a smooth finish. Each of the arms 31 has a cylindrical recess 37 formed therein, the concave surfaces of which are covered with a hard surfacing material 38, such as tungsten carbide, which surfacing material is applied as by welding, or by sleeves of hard alloy material 36 which may be pressed or shrunk into place, or pressed or shrunk on the shafts 34, 34 and 35, 35.

Cylindrical recesses 39, 39 are formed in depending center portion 3 on opposite sides thereof, and each cylindrical recess 39 is in axial alignment with recess 37 in each respective side. The cutters 32 and 33 are mounted on pin roller bearings 40, 40 and 41, 41, as will best be seen in Fig. 3. Each end of each shaft 34, 34 and 35, 35 has a hard alloy insert 42, 42, 42, 42 attached thereto as by welding or fused by welding into a recess, and which engages a complementary hard alloy insert 43, 43, 43, 43 in each cylindrical bearing recess 37, 37 and 39, 39. These inserts may be fused thereto as by welding. The hard alloy inserts 42, 43 may be formed of tungsten carbide or other suitable hard surfacing material.

The cutters 32, 33 are of the roller type and have wedge-shaped teeth 44, 44, 44 and teeth 45, 45, 45 formed thereon, respectively. It will be noted from Figs. 3 and 4 that cutter 32 is substantially longer than cutter 33 and that the teeth of the cutters are arranged so that when the rock bit is rotated around its axis the teeth on the opposite cutter will cut the "land" which has been left by the opposite cutter teeth as they pass over, that is, the ridge left by the teeth 44, 44, 44 will be removed by the two inner teeth 45, 45 on cutter 33 when the bit is rotated about its axis.

The cutters 32, 33 are angularly disposed on axes of approximately fifteen degrees from the horizontal with the axes converging at approximately the center of the drill bit. The upper portion of each cutter is partially enclosed by the

5

bit body 1 and has rubber or synthetic rubber lined conduits 46 leading from the rubber lined bowl 6 of the bit body 1. The nozzles on the lower ends of these conduits are elongated so as to discharge the drilling fluid along the faces of the teeth to wash them and to keep them free of debris. Teeth cleaning fingers 47 are provided between the rows of teeth 44, 44, 44 and between the rows of teeth 45, 45, 45, each of which is a piece of metal attached to the lower portion of bit body 1 and projecting downward in close proximity to the cutter body, as will best be seen in Fig. 6. It is preferable to have the cleaning fingers of greater width than thickness in order that they will be sufficiently strong to dislodge rocks which may become lodged between the cutter teeth.

The form of the invention as shown in Figs. 1 to 6 has arms 10, 10 and 31, 31 secured to the body 1 as by welding and when these arms are welded in place they become substantially an integral part of the bit body 1 and the cutters 11, 11 and 32, 33 cannot be misplaced or lost in the well unless the arms are broken off. The cutters preferably are made each of a single piece of metal, and each cutter may be replaced by cutting off the arm along the weld line where the arm has been previously welded to the bit body 1 and, in so doing, the bit members are separated into component parts, such as shown in Figs. 2 and 4, and if desired new cutters and new bearings may be installed and the bit made serviceable again at very little cost.

A modified form of the invention is shown in Figs. 7 to 18, inclusive, and has a body 51 made of unitary construction having a threaded pin 52 at the upper end thereof for connecting the bit with the drill stem in a manner well understood in the drilling art. Bit body 51 has downwardly depending center portion 53 which forms a support for the bearings of the roller cutters, as will hereinafter be more fully described. Arms 54, 54 are oppositely disposed on the bit body 51 (see Fig. 16) and are made integral therewith. Recesses 55 are formed in the bit body 51 to receive cutters 56, 56, which cutters are mounted on shafts 57, 57. Shafts 57, 57 are screw threaded into the depending center portion 53 and are frictionally locked therewith by the ends of said shafts abutting the bottom of the respective threaded holes therein. The shafts 57, 57 have shoulders thereon which engage bearings 58, 58 that are of the semi-thrust type. Bearings 59, 59 are also mounted on the shafts 57, 57 and may be of the roller type and may seat upon the larger portions thereof. These bearings seat in inner bores of cutters 56, 56, and hardened thrust plate bearings 60, 61 are secured to opposite sides of the cutters 56, 56, as by welding, so as to form cutter units with self-contained bearings. The cutter units may be replaced readily on the job by unscrewing the shafts 57, 57, putting the cutters in place and replacing the shafts.

Seals 62, which may be made of felt or the like, are provided to retain the lubricant within the bearings 58 and 59 and to exclude mud therefrom. Lubricant may be introduced through a conventional fitting 64, such as shown in Fig. 11 which fitting may be attached temporarily in hole 63, and after the lubricant is introduced, the lubricant fitting 64 may be removed and the hole 63 plugged with plug 65 which may be screwed therein to prevent the entrance of foreign matter.

After the shaft 57 is screwed into place a pin 66 may be passed through the perforated head

6

of the shaft 57 and its end bent into slot 67 in the arm 54, so as to prevent the shaft from becoming unscrewed.

A dowel pin 68 is adapted to pass through the thrust plate bearing 69, which thrust plate bearing is made of a hardened alloy metal. Each thrust plate bearing 69 is mounted on the inside face of each of the depending arms 54 and doweled so as to prevent rotation of the thrust plate upon rotation of thrust plate 61 which is welded to the cutter 56. A dowel pin 70 secures in like manner a thrust plate bearing 71 in place and prevents rotation thereof upon rotation of thrust plate 60. These thrust plate bearings 69 and 71 are detachably secured, respectively, to the inner face of the arm 54 and the outer face of the depending center portion 53 so they may be replaced as may be desired.

It will be appreciated readily that, with a single unitary bit body 51, the cutters may be renewed readily and replaced on the job without having to provide a new bit body each time the cutters become worn. It has been found that the bit bodies wear over a long period of time, but that the life of the cutters, operating in hard formations, is comparatively short. The water courses provided in this bit are substantially like those provided in the form of the bit described above, which courses are provided preferably with a rubber or synthetic rubber lining to resist abrasion.

The roller cutters 72, 73 have semi-thrust ball bearings 72a, 73a, respectively, and roller bearings 72b, 73b, respectively, which bearings are disposed within bores of the respective cutters 72, 73. Said bearings in each cutter 72, 73 are spaced apart by a spacer element 72c, 73c, respectively, which provide an opening therein to distribute lubricant to the respective bearings. The ends of the cutters 72, 73 are partially closed by annular thrust plate bearings 72d, 72e and 73d, 73e in the respective bearings. These thrust plate bearings are formed of a hard alloy metal and are in abutting relation with other thrust plate bearings removably attached to the depending center portion 53 on each outer face thereof and to each inner face of depending arms 75, 75. With the shaft 74 passing through openings in the annular thrust plate bearings the openings are closed in substantially tight relation.

By having the ball thrust bearings arranged as shown in Fig. 10, i. e., bearing 72a at the smaller end of the cutter 72 and bearing 73a at the larger end of the cutter 73, it is possible, by having a pair of shoulders on the shaft 74, to use a single shaft through these cutter elements 72, 73 that will transmit the thrust to arms 75, 75 through the shaft 74, as the thrust plates 72d, 73d are welded on each corresponding end of the respective cutters so as to engage an end of bearings 72a, 73a, respectively.

The roller cutters 72, 73 are mounted on the shaft 74, which shaft is drilled to distribute a lubricant to the bearings. The shaft 74 passes through arms 75 and depending center portion 53. The roller cutters 72, 73 are mounted on the bearings 72a, 72b, 73a, 73b, as above described, which bearings are sealed in the cutters in substantially the same manner as described with respect to the cutters 56. It will be readily appreciated that by removing a nut 76 from the shaft 74, the roller cutter assemblies 72 and 73 may be removed, as well as the thrust bearing plates, and new ones installed in a few

minutes' time, on the job, and with a material saving in both time and money.

Fig. 12 shows one form of tooth pattern for the teeth of the cutters which is designed to cut over the entire surface of the bottom of the well each time the bit is rotated one complete revolution.

Fig. 13 is a cross-sectional view of the cutter element 56 removed from the bit and showing the manner in which the bearings are retained in spaced relation in the cutter element.

The form of the invention as shown in Figs. 19 and 20 is substantially like the form shown in Fig. 10, except two inter-engaging shafts 81 and 82 threadably engage each other at 83 and both shafts are locked against rotation relative to each other and relative to the arms 84. By having the shafts mounted in this manner, and formed with shoulders 85, 86 on shafts 81 and 82, respectively, the thrust of the roller cutters, which roller cutters carry inverse spirals, is transmitted by the ball thrust bearings against the shoulders 85, 86 of the shafts 81, 82 and thence to the arms 84, 84 and to the body of the bit.

The shafts 81, 82 are drilled and cross-drilled to form openings, which openings are adapted to receive a lubricant which passes into a chamber formed between the bearings therein for lubrication of the bearings.

It is preferable to have an insert 87 of tungsten carbide or other hard surfacing alloy applied to the leading side of the cutter teeth, as by welding or by centrifugal casting of the cutters with the hardened tungsten inserts within the casting mold, so as to retard abrasion. The insert is formed substantially as a triangular prism, preferably having one right angle corner which seats within a step joint within tooth 38, as will best be seen in Fig. 15, or granular tube tungsten may be applied to the tooth 89 which is formed having a stepped off-set on the leading side thereof, as indicated at 90. By having the tooth of this construction, the hard alloy material is supported by a tooth of tough steel and with the projection extending up behind the tube tungsten tip 90, which may be applied with a welding torch, or tungsten carbide insert 87, the tooth is not so likely to fracture and break off at its base, as would be a tooth built up entirely of hard alloy material.

In the operation of the rock bits herein described, the bit is adapted to be screwed onto the lower end of a drill stem (not shown) for rotation by a conventional rotary drilling rig in a manner well understood in the drilling art.

The reamer cutters designated as 11, 11 in one form of the invention and designated as 56, 56 in another form of the bit, preferably have their axes disposed at an angle of from 24 degrees to 33 degrees above the horizontal with the cutting edge projecting beyond the outer confines of the bit bodies 1 and 51, respectively, so as to give a sizing or reaming action to the wall of the well being drilled.

The form of the invention as shown in Figs. 1 to 6, inclusive, has transversely disposed rolling cutter elements 32, 33 that have their axes disposed approximately from 7 degrees to 15 degrees above the horizontal. It is preferable to have the cutter points of the transverse cutters 32, 33 lead the points of the reamer cutters by from one-half inch to one inch so as to keep the greater area of the hole advanced ahead of the portion to be reamed by the reaming cutters. By having the cutters arranged in this manner and within the

limit of angles herein given, it has been found that a speedy cutting action results with a minimum of strain on the cutters.

Upon rotation of the drill stem and the rock bit connected with the lower end thereof, the various cutter elements 11, 11 and 32, 33 of the form of the invention shown in Figs. 1 to 6, inclusive, are rotated due to their frictional contact with the bottom of the hole being drilled. The cutters 11, 11 preferably have a different number of teeth thereon, as 21 and 22 teeth respectively, so that the teeth will not "track" when describing a pattern on the bottom of the well, and with the cutter elements 32, 33 having the teeth arranged as hereinbefore described, they will describe a pattern which cuts over the entire bottom of the well, which will give a true circular hole.

The mud or fluid is pumped down through the drill pipe into the bowl 6 of the drill bit and the earth cuttings that are cut by cutter elements 11, 11, 32, 33 will be floated to the top of the well in a manner well understood in the rotary drilling art.

By having the water or fluid courses disposed in the manner shown herein, the drilling fluid is directed downward into the cutters and to a point immediately adjacent the bottom of the well, which will keep the cutter teeth cool and lubricated with drilling mud or fluid and will cause the immediate flotation of the earth formation to the top of the hole.

Angularly disposed recesses are formed in the body 1 between depending arms 10 and 31, so as to enable the mud that is being discharged upward to be given a spiral action.

The forms of the bit as shown in Figs. 7 to 18, inclusive, and in Figs. 19 and 20, operate in substantially the same manner as described with respect to the form illustrated in Figs. 1 to 6, inclusive.

Having thus described my invention, I claim:

1. In a rock bit structure for rotary drilling, a bit body having an opening formed therein, a threaded connection on the upper end of said bit body for connection with a drill stem, roller cutters, arms depending downwardly from said bit body, a roller bearing element mounted on each of said arms, said roller cutters being journaled in said roller bearing elements for rotary movement about the axis of each respective cutter, conduits formed through said bit body for directing drilling fluid to said cutters, each of said cutters having a shaft formed integral therewith and having an annular recess formed in each end of said cutter and exterior of said shaft to receive said roller bearing elements, and a bearing race adjacent each end of each cutter and interfitted therewith in telescoping relation with the annular recesses of said cutters so as to seal said bearing races against the entrance of drilling mud thereinto.

2. In a rock bit structure for rotary drilling, a bit body having a hollow body formed therein, a threaded connection on the upper end of said bit body for connection with a drill stem, roller cutters, arms depending downwardly from said bit body, a roller bearing element mounted on each of said arms, said roller cutters being journaled in said roller bearing elements for rotary movement about the axis of each respective cutter, conduits formed through said bit body for directing drilling fluid to said cutters, each of said cutters having a shaft formed integral therewith and having an annular recess formed therein in each end thereof and exterior of said shaft to receive

said roller bearing elements, an annular rim formed on each of said depending arms in axial alignment with said annular recess formed in the respective cutters so each of said rims will extend inwardly into the respective recess formed in the respective cutters for maintaining the axis of the respective cutter in aligned relation with the axis of its respective annular rim in the respective recess, and a bearing race formed adjacent each end of each cutter and interfitting therewith in telescoping relation with the annular recesses of the cutters so as to seal said bearing races against the entrance of drilling mud thereinto.

3. In a rock bit structure for rotary drilling, a bit body having an opening formed therein, a threaded connection at the upper end of said bit body for connection with a drill stem, said bit body having a depending center portion and depending arms spaced apart and from said depending center portion, bearing races mounted on said arms and on said depending center portion, rolling elements in said races, a roller cutter mounted between each of said arms and said depending center portion and journaled at its respective ends in said bearing races for rotary movement of each respective cutter about its axis, said bearing races having hard surfacing material, such as tungsten carbide thereon, which hard surfacing material is machined to a smooth finish for engagement with said rolling elements.

4. In a rock bit structure for rotary drilling, a bit body having an opening formed therein, a threaded connection at the upper end of said bit body for connection with a drill stem, said bit body having a depending center portion and depending arms spaced apart and from said depending center portion, roller cutters, bearing races in said arms and said depending center portion, rolling bearing elements in said races, said rolling bearing elements journaling said roller cutters between said arms and said depending center portion for rotary movement of said roller cutters about their respective axes, and said bearing races having sleeves of hard alloy material fitted thereinto and so finished as to present a smooth interior finish for said bearing elements to roll upon.

5. In a rock bit structure for rotary drilling, a bit body having an opening formed therein, a threaded connection at the upper end of said bit body for connection with a drill stem, said bit body having a depending center portion and depending arms spaced apart and from said center portion, roller cutters, bearing races in said arms and said depending center portion, rolling bearing elements in said bearing races, said rolling bearing elements journaling said roller cutters between said arms and said depending center portion for rotary movement about their respective axes, and said bearing

races having sleeves of tungsten carbide fitted thereinto, which is so finished as to present a smooth interior surface in said races for said bearing elements to roll upon.

6. In a rock bit structure for rotary drilling, a bit body having an opening formed therein, a threaded connection at the upper end of said bit body for connection with a drill stem, depending arms on said bit body which arms are spaced apart, a bearing race in each of said arms, rolling bearing elements in each of said races, said races having hard surfacing material, such as tungsten carbide, thereon, which hard surfacing material is machined to a smooth finish for engagement with said rolling bearing elements, and roller cutters having an axial projection extending from each end thereof and journaled in said rolling bearing elements.

7. In a rock bit structure for rotary drilling, a bit body having an opening formed therein, a threaded connection at the upper end of said bit body for connection to a drill stem, arms mounted on said body and depending downwardly therefrom and spaced apart, a depending center portion mounted between said arms, roller cutters, an axial projection on each end of each of said roller cutters and forming an axis therefor, bearings in said arms and said depending center portion for journaling said axial projections of each of said cutters, a hard material insert on the outer end of each of said axial projections adapted to be in complementary abutting relation with a hard material insert in each of said arms.

MARTELL D. INGRAM.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
250,385	Parsons	Dec. 6, 1881
1,729,063	Bull	Sept. 24, 1929
1,908,049	Reed	May 9, 1933
1,990,007	Sperry	Feb. 5, 1935
2,017,834	Hummel	Oct. 15, 1935
2,043,142	Zublin	June 2, 1936
2,049,047	Brownlee	July 28, 1936
2,063,012	Catland	Dec. 8, 1936
2,087,500	Catland	July 20, 1937
2,116,561	Crum	May 10, 1938
2,143,909	Crum	Jan. 17, 1939
2,155,040	Fisher	Apr. 18, 1939
2,160,852	Gouthey	June 6, 1939
2,168,060	Catland	Aug. 1, 1939
2,168,192	Carleton	Aug. 1, 1939
2,170,320	Catland	Aug. 22, 1939
2,171,057	Crum	Aug. 29, 1939
2,174,102	Catland	Sept. 26, 1939
2,279,129	Pennington	Apr. 7, 1942
2,336,029	Ogarrio	Dec. 7, 1943