

Feb. 11, 1930.

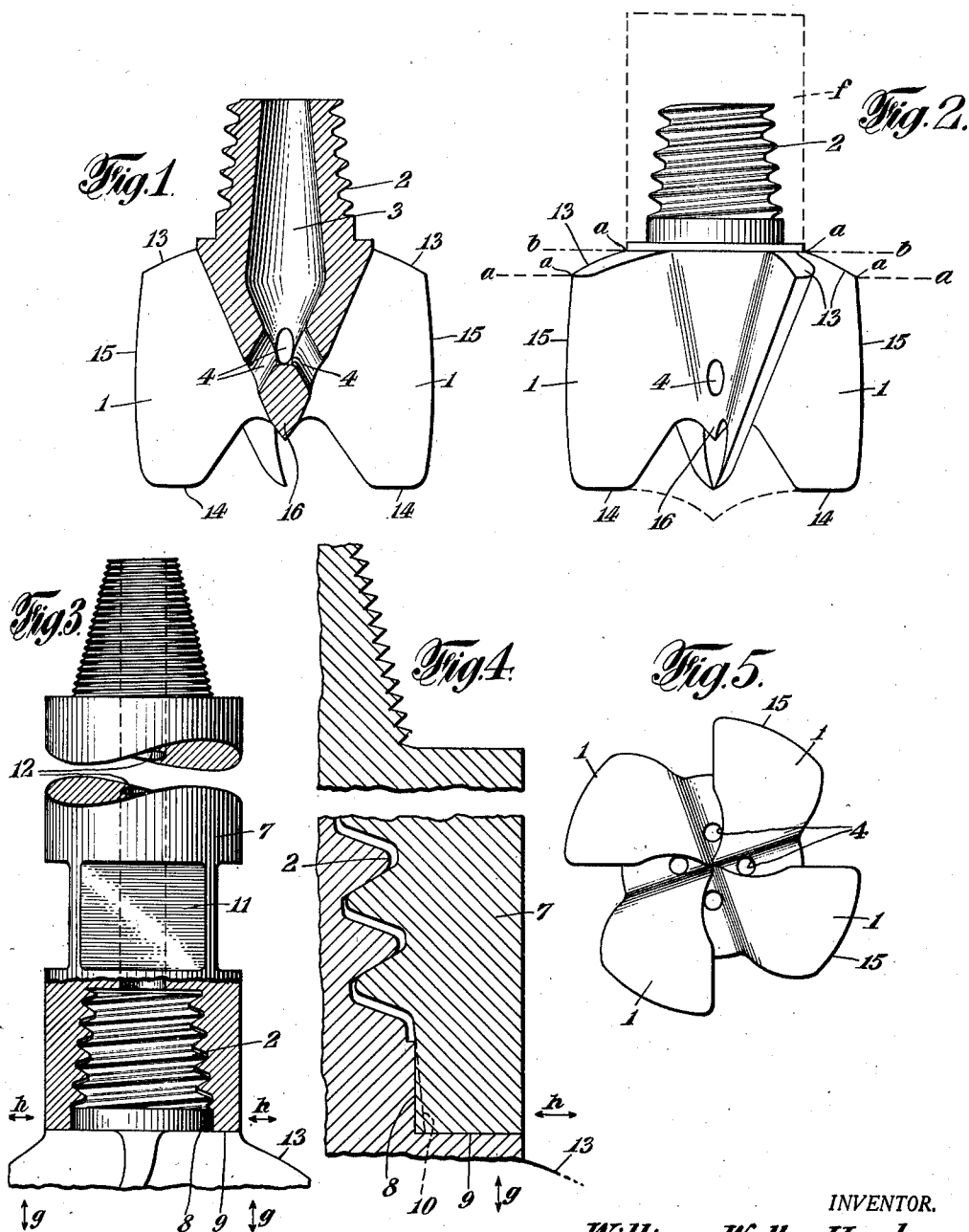
W. W. HARTMAN

1,746,423

WELL DRILLING BIT

Filed Sept. 30, 1925

2 Sheets-Sheet 1



INVENTOR.
William Walter Hartman
BY *Robert A. Steps*
ATTORNEY.

Feb. 11, 1930.

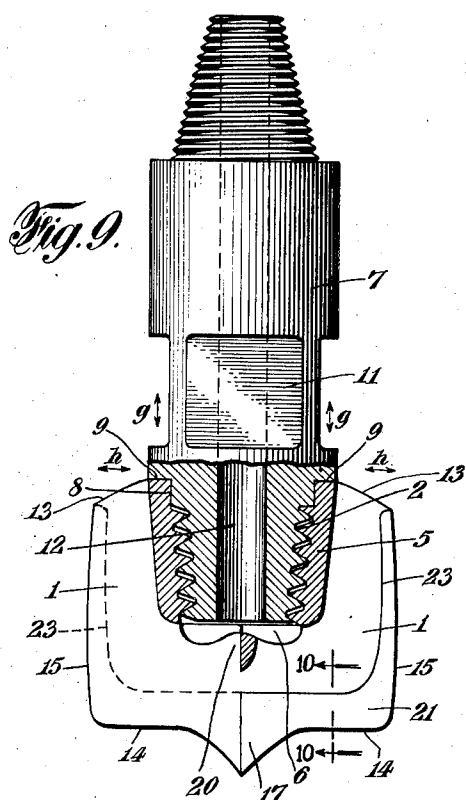
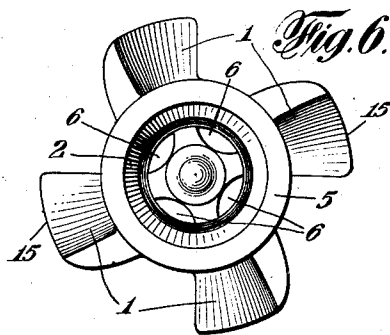
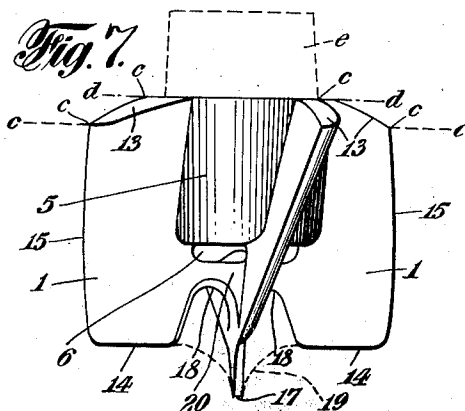
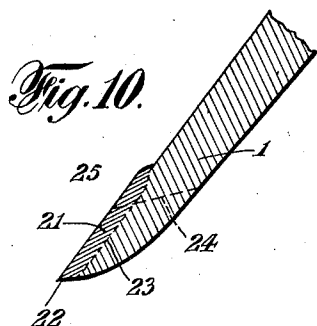
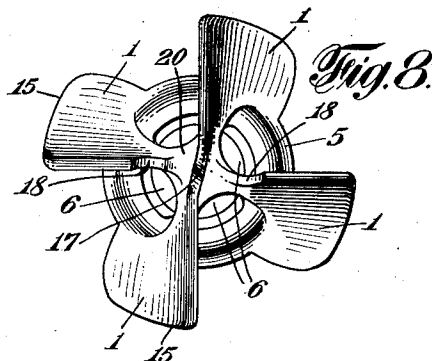
W. W. HARTMAN

1,746,423

WELL DRILLING BIT

Filed Sept. 30, 1925

2 Sheets-Sheet 2



INVENTOR.

William Walter Hartman

BY

Robert A. Steps

ATTORNEY.

UNITED STATES PATENT OFFICE

WILLIAM WALTER HARTMAN, OF LOS ANGELES, CALIFORNIA

WELL-DRILLING BIT

Application filed September 30, 1925. Serial No. 59,529.

The most common type of well drilling bit in use today is known as the fish tail bit, and is carried on the lower end of the drill stem made up of joints of pipe each approximately 24 feet long. As the drilling proceeds, joint after joint of pipe is added to the drill stem at the top, and when the drill becomes dull, it is removed from the well by raising the stem and disconnecting it joint by joint until the bit comes out of the hole.

When the bit is drilling at a great depth, say 2,000 feet or more below the surface, and becomes dull, a great deal of time is wasted in disassembling the entire drill stem in order to remove the bit from the well and put a new sharp one on in its place, and approximately the same amount of time is spent in reassembling the stem as the new bit is lowered into position in the hole. At the great depths at which oil well drilling is done today, it is not unusual to have the crew engaged for 4 hours in pulling the bit out, and 4 more hours in running the new one in again, making a total of 8 hours thus consumed, and often the new bit will become dull, and ride without making a hole, after one or two hours of operation, after which another 8 hours approximately must be spent in coming out and going in before further drilling can be done.

Obviously, this condition holds back the progress of the well greatly after substantial depths and hard drilling are encountered, and contributes to the great cost of drilling deep wells.

The object of this invention is to improve the character of bit used in this drilling, so that the bit will not become dull so rapidly, and also to give it such shape that it will drill ahead more rapidly, reaming the hole to full accurate bore, and making the hole straight.

Other features and objects of this invention will also become clear from consideration of the following description taken in connection with the drawings and the claims.

In the accompanying figures which illustrate the invention, Fig. 1 is a longitudinal section through one form of my bit, the figure being slightly distorted for purposes of clearness.

Fig. 2 is a side view of the same form of bit as shown in Fig. 1.

Fig. 3 shows the same bit connected to a special drill stem, which may be used, and which forms a part of my invention.

Fig. 4 is an enlarged fragmentary view showing the nature of the screw threads in my special drill stem or drill collar.

Fig. 5 is a bottom view of the bit as shown in Fig. 2.

Fig. 6 is a top view looking down upon another form of my bit.

Fig. 7 is a side view of the form of bit shown in Fig. 6.

Fig. 8 is a bottom view of the form of bit shown in Figs. 6 and 7.

Fig. 9 is a side view taken partly in section and showing my special drill collar attached to the form of drill shown in Fig. 7, some of the parts of the drill being slightly distorted in this figure for purposes of clearness.

Fig. 10 illustrates a special feature of my invention.

As will be noted from the figures, my drill consists in curved or spirally formed vanes or blades, which do the drilling on their bottom and side edges, and also consists of a screw threaded engagement at the top for connecting the bit with the drill collar, special provision being made so that the mud water which is constantly pumped down through the drill stem can come out of the bit near its lower cutting edges in order to keep the bit free from clogging and to rapidly float the drillings and cuttings up through the hole and discharge them from the hole at the surface of the earth.

In the form of bit shown in Figs. 1 to 5 inclusive, the screw thread arrangement for fastening the bit to the drill collar is male type, whereas in the form of bit shown in Figs. 6 to 9 inclusive, this screw thread arrangement is female type in the bit, the former type having the advantage of being more easily adaptable to the present standard forms of equipment used, and also of having more clearance space around the blades for the free and easy removal of the drillings, whereas the latter type has the advantage of more economical use of the metal of which the bit

is made, and also in making a somewhat more sturdy form of construction, as the blades are a little better reinforced. In the latter type the manner in which the mud water circulates out of its ports, and out and around the cutting edges and blades, is also very helpful in keeping the bit clean and in assisting its drilling operation.

The curved or spiral cutting blades 1, and the screw connection 2, in both male and female forms of my bit, are manufactured of one integral piece of metal, and since it would be costly to forge such a bit with curved or spiral blades, I have worked out a new method which contemplates casting these bits, and in this way the cost of making them is reduced. These cast bits can be made of various kinds of alloy steel, and when a steel like manganese steel is used, which is very difficult to machine, or which cannot be machined at all, then the thread in the screw thread connection 2 can be cast also, which makes it possible to use a screw thread connection even with manganese and like type steels, in preference to resorting to some other less desirable type of connection merely because of the difficulty of machining a thread on manganese or other difficultly machinable steels. When the steel that is used is easily machinable, however, the threads 2 can be machined in the usual manner, instead of being cast, but even with such steels, it will sometimes be found preferable to cast the threads rather than machine them, as the cost of manufacture is lower, it being merely necessary to clean out the cast threads with a light grinding or cutting operation,—and metal is saved by casting the threads. When making the bits of manganese steel I prefer to cast the threads, but when making the bits of other kinds of steel I sometimes propose to machine the threads 2, and sometimes to cast them, the machined threads being made relatively fine to comply with usual standard well drilling joints, but the cast threads being preferably coarse with long lead so they can be cast well.

In casting the form of bit shown in Figs. 1 and 2, the blades 1 are cast in the drag, and the male screw connection 2 is cast in the cope, the line of sand parting being along the broken line *a-a-a-a-a-a*, and the line of pattern parting is along the line *b-b*, Fig. 2. In casting the form of bit shown in Figs. 6 and 7, however, the entire bit, both blades 1 and the screw threads 2, is cast in the drag, the broken line *c-c-c-c-c-c* being the line of sand parting and the line *d-d* the line of pattern parting, Fig. 7, the projection *e* indicated by dotted lines in this figure representing the core print for holding the core by which the screw threads 2 in this form are preferably cast. In the form of bit shown in Fig. 2, the screw threads 2 can be cast in the green sand, but it will sometimes be found preferable to cast them in the core, because

the core is baked hard and therefore casts cleaner threads, and when this is done the projection *f* represented by dotted lines extending upward from the top of the blades in Fig. 2, is used on the pattern to form the core print. After the threads are cast they can be cleaned out by a very simple and light grinding operation which can be performed much more quickly and economically on the coarse cast thread, than the machining of a fine thread can ordinarily be done.

In the form of bit shown in Fig. 1 the mud port 3 is cored down through the male threaded part 2, and near its lower end has appropriate holes or ports 4 from which the mud water passes out of the bit to clean off the blades and float the drillings upward.

In the form of bit shown in Figs. 6, 7 and 9, the mud comes down through the hole in the drill stem and passes out from the cylindrical body part 5 of the bit through cored ports 6.

To make the casting of these bits practical, I give them a shape which at the same time improves their drilling functions. I have formed the blades spirally in such manner that the spiral extends substantially continuously along the entire height or length of the blade, and I have also made them with a gradually tapering thickness starting with a thinner section near the bottom and becoming gradually thicker toward the top, as can be clearly seen in Figs. 2 and 7. Both these features make the production job practical as a cheap casting operation, and at the same time these features improve the performance of the bit because the continuous spiral shape of the blades aids in lifting borings and in making the hole straighter and of more accurate diameter than can be procured with bits in which the blades are vertically straight or partly straight. In addition the cored fluid ports are formed as a part of the casting operation and this further cheapens production because coring is always cheaper than drilling.

If the male threaded portion 2 is cast in the green sand, the threaded pattern can be screwed out of the sand in the manner similar to that used in rotating the blade part of the pattern out of the sand.

When the threads 2 are cast, I prefer to cast them coarse, for reasons stated, and on this account they may not fit the regular threads ordinarily used on the tool joints or other special tools which the drilling crews have, and I therefore provide a special drill collar 7, Figs. 3, 4, 6 and 9, which is threaded coarse at its lower end to receive the bit and is threaded finer at the upper end to join with the standard well drilling equipment commonly used. Both the fine threads at the top and the coarse threads at the bottom are preferably tapered, but it should be noted that the taper of the fine threads is much greater

than the taper of the coarse threads, which latter can be made zero if desired, my object in making the taper of the latter less than in the former being to make more backward turns on the coarse thread necessary before the bit would fall off, than would be necessary before the fine threads at the top of the drill collar would separate in their joint and permit the drill collar to drop out of the drill stem to which it is fastened.

With coarse cast threads on the bit it is permissible to make the screw connection between these coarse threads and the drill collar 7 with considerable clearance so they can go together quickly and easily, and so that both threads can be made cheap and easy. This clearance is plainly shown in Figs. 3, 4 and 5. Threads that fit somewhat loose in this manner however, would soon tend to twist around and wear against one another, while the drilling is proceeding, unless some provision were made for accurately centering the connection and preventing shifting and twisting around on the slightly loose threads. This centering action I obtain with the following expedient which can be best seen in Figs. 3, 4, 5 and 9.

At the end of the thread there is provided a cylindrical shoulder 8 and also an annular face or shoulder 9, both of which should be very accurately ground or machined on the bit as well as on the drill collar, so that when the joint is made up the relatively loose coarse threads will run together freely, but at the end the cylindrical shoulders 8 and the annular faces 9 make up very accurately and draw the bit and drill collar into tight locked engagement which permits no twisting or shifting whatever, despite the relatively loose threads. The tight joint on the annular face 9 prevents any looseness in a direction of arrows *g*, Figs. 3, 4 and 9, and the tight joint on the cylindrical face 8 prevents any looseness in the direction of arrows *h* of the same figures. Though I prefer that the cylindrical shoulder or face 8 should be truly cylindrical, i. e. with its surface parallel to the axis of the bit, nevertheless good results can also be obtained if the surface is tapered as indicated by the dotted line 10, Fig. 4.

In order that a wrench can be applied to stem 7, I prefer to form same with a square portion 11, having flat faces as indicated to receive the wrench. It is also understood that a hole 12 passes through the entire length of the drill collar from end to end in order to transmit the mud water from the drill stem above down through the bit as above described.

The upper face or surface 13 of the blades 1 is preferably beveled off as shown, so that when the bit is being raised through the well it will tend to glance off of any projections or surfaces which it might encounter, rather than to bump against and hang up on same.

It will also be noticed that I have provided four blades instead of only two, my object in this being to provide more cutting edge in order that the drill can remain sharp longer and do more drilling before having to remove it from the hole. Another object in providing four blades instead of only two is to keep the hole straighter, as a four-blade bit will keep itself centered a little better than a two-blade bit will do. However, it is obvious that any desired number of blades can be adopted to suit the requirements of the user, and in this respect I have it in mind to make these bits with as few as 2 blades and with as many as 8 or 10 on the larger sizes, but it is not necessary to illustrate these separately, as the arrangement is readily understood from this description.

The cutting edges of the blades of course extend along the bottom 14 and also along the sides 15, the latter extending up a substantial distance at uniform diameter in order to ream the hole to accurate bore. The cutting edge 14 at the bottom may be arranged as indicated in Figs. 1 and 2, the edges of the four blades blending into a common downwardly pointing tip 16, which is sharp and pointed and therefore assists in penetrating ahead into the earth; or else the cutting edges 14 at the bottom may be arranged as shown in Figs. 7 and 9, where 2 of the opposite blades sweep downward from the edges 14 so as to form a pilot point 17, and two or more of the remaining blades sweep upward as indicated at 18, Fig. 7, and pass somewhat above the range of actual cutting. The pilot point 17 in the latter arrangement has a tendency to assist the drill in holding to a true course and therefore to make a straight hole, which is obviously desirable. Although I prefer that only a portion of the blades should sweep down to form the pilot point 17, the remainder of the blades receding upward toward the center as indicated at 18, Figs. 7 and 9, nevertheless all of the blades can be made to sweep downward and merge into the pilot point 17 as indicated by the dotted line 19, Fig. 7. The specific arrangement shown by full lines in Fig. 7 leaves considerable blade clearance around point 17, which is an advantage in that it reduces or eliminates balling or sticking of gummy formations around the point.

These alternative modes of arranging the bottom cutting edge 14 of the blades can be used both in the male or female forms of my bit as respectively illustrated by the full and dotted lines in Figs. 2 and 9. However, I wish to point out that there is an important advantage in relieving the lower edge of some of the drilling blades. This relief, in comparison with blades in the same bit which are either not relieved at all, or are relieved less, or are advanced to form a guiding tip, is illustrated in one of its applications by

the full lines in Fig. 7. The idea is to allow the unrelieved blades to do all the drilling near the center of the bit, which they are able to do because of the relatively small amount or area of material to be drilled away there, but at more distant points from the center the relieved blades come into full action with the unrelieved ones, and together they drill away the larger area or amount of material to be removed at these more distant places. This is an important relationship, because it eliminates the tendency of the drill to "ride", due to excessive cutting edge near the center where it is not required, and at the same time it keeps the average condition of the bit sharper because relatively more cutting edge is provided for the outer part of the bit where more material is to be removed. The term relief as used in this paragraph is, of course, only relative as between the different blades, and such relief is considered as procured by any arrangement in which only some of the blades cut near the center of the hole, and additional ones come into service with the others toward the outside of the hole where the area and amount of material to be drilled increases.

It will be noted that all my drilling blades extend to the maximum drilling diameter or perimeter of the bit, and that they are all symmetrically disposed with regard to the axis of the bit. This gives maximum cutting utility, and also balances the blades on either side of the axis, all of which promote, especially in rotary bits, the drilling of straight holes instead of crooked ones, and my type of spiraled blades assists further in this regard.

In the male type of drill as shown in Figs. 1 to 5 the mud ports 4 are directed downward to wash the cuttings and sticky soils off the blade, but if this drill drops into soft and sticky formation there is sometimes a tendency for this formation to press up into the mud ports 4, tending to plug or seal them against the action of the pumps above.

In the female type of my bit, as indicated in Figs. 6 to 9, however, the bottom of the hole 12 in drill collar 7 never is exposed to direct pressure of the formation, as the bridge 20 formed by the merging of the blades, always interposes itself between the formation and the bottom of hole 12 in the drill collar, and since this bridge 20 rotates with the blades, the formation is very effectively cut up so that the mud water issuing from the ports 6 can drive it out of the way effectively.

In some of my bits I face the cutting edges of the blades with an exceedingly hard abrasive and cutting alloy such as high speed steel. This is indicated in Fig. 10 which shows an enlarged view of the blade 1 with such especially hard abrasive alloy or cutting alloy 21, welded onto the forward face of same, so as to give an exceedingly durable cutting edge 22. Usually these exceed-

ingly hard alloys, though splendid in their cutting durability are fragile, and for that reason I make the body of the bit and blade of a very strong, tough steel, which however need not be hard, as the hardness is given by the surface of special alloy 21 welded on. This alloy is preferably welded on all along the edges of the bit as indicated by the dotted line 23 in Fig. 9. To have such an especially hard edge and face 21 on a relatively softer body portion of the blade has the additional benefit of actually tending to wear the blade in such manner that it maintains a rather sharp cutting edge. That is, if the original edge of the bit were along the line 23, Fig. 10, as wear progresses by abrasion of the rocks and sand, this edge would not wear itself absolutely flat and blunt, but would tend to wear itself rather along the dotted line indicated at 24, Fig. 10. The reason for this is that the hard, forward surface would stand up very well against the abrasive action, but the rear, softer portion of the blade would yield more freely to the wear, and in consequence of this would tend to wear itself upward and backward as indicated at 24, this action obviously resulting in maintaining a relatively good cutting edge 25, which can continue the drill in satisfactory operation much longer than if the edge became dubbed off and dull in the ordinary manner.

From the foregoing description of my bit, and its various features, its mode of operation will be apparent.

I claim:

1. A rotary well drilling bit having a plurality of drilling blades, and a fluid port passing through said bit, the lower edge of some of said drilling blades being relieved toward the center of the bit by passing upward to a place higher than the place at which the lower edge of other of said drilling blades pass, all of said drilling blades extending to the maximum drilling perimeter of said bit and being symmetrically disposed with reference to the axis of said bit to insure straight rotary drilling.

2. A rotary well drilling bit having a plurality of drilling blades, and a fluid port passing through said bit, the lower edge of some of said drilling blades being relieved by passing upward as they approach the center of the bit, while the lower edge of other of said blades passes downward to form an advanced tip, all of said drilling blades extending to the maximum drilling perimeter of said bit and being symmetrically disposed with reference to the axis of said bit to insure straight rotary drilling.

3. A rotary well drilling bit having a plurality of drilling blades, and a fluid port passing through said bit, the lower drilling edges of said blades being so arranged that only some of the blades drill near the center

of the bit, whereas additional blades come into drilling engagement at places further from the center of the bit, all of said drilling blades extending to the maximum drilling perimeter of said bit and being symmetrically disposed with reference to the axis of said bit to insure straight rotary drilling.

4. A rotary well drilling bit having a fluid port and a plurality of drilling blades all of which blades are spiraled in such manner that the spiral extends substantially continuously from the bottom to the top of said blades, the lower edge of some of said blades being formed into an advanced central tip, while the lower edge of other of said blades is not so advanced toward the center of the bit, all of said drilling blades extending to the maximum drilling perimeter of said bit and being symmetrically disposed with reference to the axis of the bit.

5. A rotary well drilling bit having spiral drilling blades in which the spiral extends substantially continuously from the bottom to the top of said blades, the blades becoming progressively thicker from the bottom toward the top, said bit having a threaded portion for connecting it to other members, and said bit also having a fluid port, the lower drilling edges of said drilling blades being so arranged that only some of the blades drill near the center of the bit, while others join them in drilling further from the center of the bit, all of said drilling blades extending to the maximum drilling perimeter of said bit and being symmetrically disposed with reference to the axis of said bit to insure straight rotary drilling.

In testimony whereof, I have hereunto set my hand at Los Angeles, California, this 16th day of June, 1925.

WILLIAM WALTER HARTMAN.