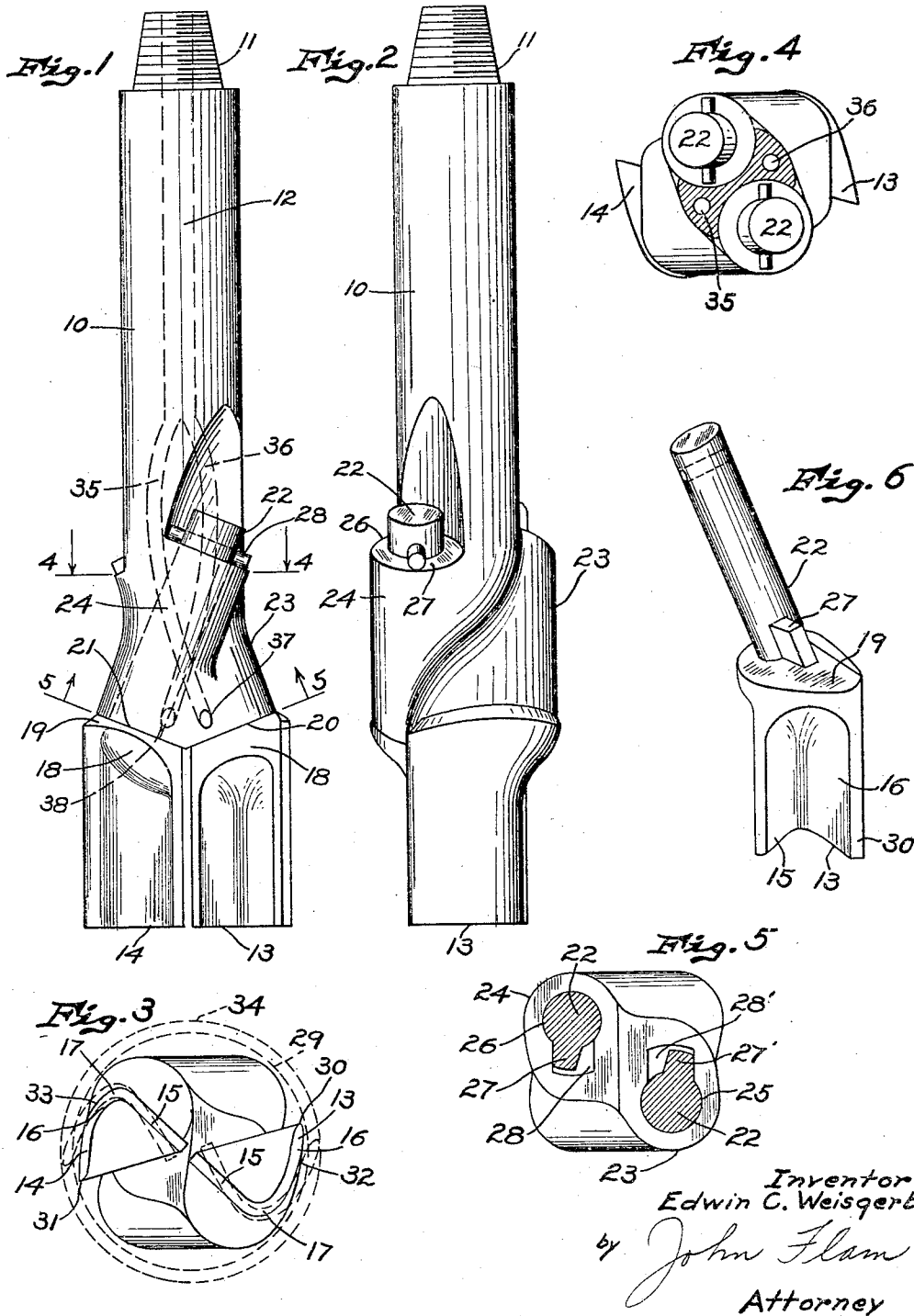


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E. C. WEISGERBER  
EXPANSIBLE FISH TAIL BIT

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## UNITED STATES PATENT OFFICE

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## EXPANSIBLE FISH TAIL BIT

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This invention relates in general to fish tail type bits for drilling bore holes in the earth by the rotary method, and more particularly to expansible fish tail bits for this service. In other words, this new and novel fish tail bit may be passed through a casing or bore hole of a definite size and will generate a bore hole of larger diameter when rotated. That is, it will act as a reamer or under-reamer to enlarge the hole or to drill a hole larger than it may be passed through in its normal or collapsed position.

Expansible fish tail bits are not new in general, but in so far as I am aware they all depend upon some more or less complicated system of levers, springs, tapered mandrels or eccentric mandrels to produce the change in size. This not only makes them difficult and expensive to manufacture, but renders them liable to clog or jam in use so that they cannot be operated, either to produce a larger hole or to be collapsed so that they can be withdrawn through the bore hole of smaller diameter.

Then again, many of them are so constructed that the cutter blades are not rugged enough to stand up under the severe usage which they receive in producing or enlarging a bore hole. The cutters either break off or become so bent that they will not operate and the bit is useless.

It is an object of my invention to overcome the above defects by providing an expansible rotary bit of the fish tail type which may be readily, simply and easily expanded or collapsed and which will have no complicated parts or mechanisms to give trouble or get out of order.

It is another object of my invention to provide an expansible rotary bit of the fish tail type which will tend to remain open in use, due to the weight of the string of drill pipe resting on the bit. This is a new and novel feature and makes the bit more positive and certain in its action.

Another object of my invention is to provide an expansible rotary bit of the fish tail type which will be expanded by the cutting action of the bit and cannot collapse in service no matter how hard the formation may be.

In the usual type of bit expanded by rotation against the surface to be removed, the construction is such that as the surface is very hard or difficult to cut, the cutters are forced inward and will not generate the full size hole. This will not happen with my improved expansible bit, as it is so constructed that it is impossible for the cutters to be crowded in to a collapsed position by the hard formation.

Another object of my invention is to provide a bit of the type described in which the cutter blades are provided with vertical wings which act as reamer blades and guides to maintain the bore hole true to size, round and straight, regardless of the presence of crevices, hard spots, rocks, etc. in the side walls of the bore hole.

It is another object of my invention to provide a bit very rugged and simple in construction and inexpensive in manufacture.

My invention possesses many other advantages, and has other objects which may be made more easily apparent from a consideration of one embodiment of my invention. For this purpose I have shown a form in the drawings accompanying and forming part of the present specification. I shall now proceed to describe this form in detail, which illustrates the general principles of my invention; but it is to be understood that this detailed description is not to be taken in a limiting sense, since the scope of my invention is best defined by the appended claims.

Referring to the drawings:

Figure 1 is an elevation of the improved bit looking directly at the cutting blades;

Figure 2 is an elevation of the improved bit looking at the side of the cutting blades;

Figure 3 is a bottom view of the bit showing the blades in closed position in the full line view and in expanded or open position by the dotted lines;

Figure 4 is a section along the plane 4—4 of Figure 1, in the direction of the arrows, showing the location of the water courses and the relation of the trunnion pins on the cutter blades;

Figure 5 is a section along the plane 5—5 of Figure 1, in the direction of the arrows,

showing the slots and keys for limiting the movement of the cutter blades; and

Figure 6 is a perspective view of one of the cutter blades with its trunnion pin.

5 The bit comprises a shank 10 with the usual tool joint pin 11 on the upper end thereof to connect the shank to a string of rotary drill pipe. A fluid passage 12 extends longitudinally through the pin and the shank to  
10 carry the rotary mud to the cutting face as will be described more in detail later. The cutters 13 and 14 are mounted on the bottom of the shank 10 in a new and novel manner.

Each cutter has an effective width which is  
15 approximately one-half the diameter of the bore hole to be produced by the bit, and is preferably of a greater height than width. Each cutter is V-shaped in horizontal section. One leg 15 of the V is approximately straight  
20 while the other or outer leg 16 is curved and joined to the leg 15 at their converging point by a curved portion 17. The two wings of the cutter are joined at the top by a head 18 which projects beyond the blade adjacent the  
25 straight portion thereof.

The upper surface 19 of this head is a plane surface formed at an angle with the main axis of the cutters such that, when the cutters are in their vertical working position, the  
30 portion of the plane surface adjacent the axis of the bit is lower than the portion farthest removed from the axis. When the cutters are placed in operating position, the two adjoining plane surfaces form a flat V, and the  
35 lower end of the shank has two corresponding plane surfaces 20 and 21, against which the plane surfaces of the cutters bear.

A trunnion pin 22 is formed on each of the surfaces 19 and normal thereto. This trunnion pin is located near one edge of the surface adjacent the straight side of the cutter. Inclined bosses 23 and 24 are formed on opposite sides of the shank, at the lower end thereof, and the trunnion pins 22 on the cutters are mounted in holes 25 and 26 which extend lengthwise through the bosses. These trunnion pins 22 are free to turn in the bosses, and are held against longitudinal movement by any usual means at the upper  
50 end of the boss. I have illustrated the boss as having a flat surface 27 at the upper end, (see Fig. 2) against which a pin 28, through the trunnion pin 22, bears. Obviously any  
55 other common means may be used, such as a nut and washers on the upper end of the pin, a split bushing under a collar on the upper end of the pin, or any similar and commonly used locking device.

60 The rotation of the cutter and trunnion pin, with respect to the shank, is limited by a key 27' on the plane surface 19 adjacent the trunnion pin 22. This key lies in a recess 28' in the lower end of the boss. The recess  
65 is wider than the key, as shown in Figure 5,

so that the trunnion pin 22 is free to turn a predetermined amount in the boss.

When the cutters are in place on the shank in their normal or retracted position, as shown by the full lines in Figure 3, the two  
70 straight surfaces 15 lie in essentially the same plane through the center of the shank, while the curved surfaces 16 lie adjacent the walls of the hole 29. The leading edges 30 and 31 are in contact with the circle 29, but the  
75 curved outer surfaces 32 and 33, back of the leading edges lie inside the circle 29 to provide a suitable clearance for the bit.

When the bit is rotated in a clockwise direction in the hole, which is the direction of rotation when drilling, the cutters assume an expanded position, as shown by the dotted lines in Figure 3, and the bit will generate a circle 34 of a greater diameter than the circle 29, through which the collapsed bit can pass. This expanding action takes place due to the slight rotation of the cutters about the axes of the trunnion pins 22, which are eccentric to the main axis of the cutters, and therefore throws the leading edge 30 outward.  
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The cutters will maintain this expanded position while cutting, due to the fact that all the thrust of the formation on the cutter is applied on one side of the axis of rotation, so that there is nothing to force the cutter  
95 towards contracted position. Another factor which tends to maintain the cutters in expanded position, is the fact that the bearing surface between the cutters and the shank is inclined to the vertical and so located with respect to the axis of rotation of the blades on the shank, that the weight of the shank and string of drill pipe tends to slide the shank down on the inclined surface, which rotates the cutter about the axis of the trunnion pin. The amount of rotation of the cutter blades is limited by the freedom of motion, or clearance, allowed the key 27' in the recess 28'.  
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As soon as the bit is picked up off the bottom of the bore, the mass of the cutter blades tends to slide them downward along the inclined bearing surface and so rotate the blades back to the original full lined collapsed position, shown in Figure 3. If it is  
110 considered advisable to make doubly sure that the cutter blades have resumed the collapsed position, the bit may be rotated a few turns in a counter-clockwise direction, after being lifted off bottom. This will turn the  
115 cutter blades to the collapsed position, and the bit may then be withdrawn through the casing or smaller bore hole.

The main water course 12 is divided near the lower end of the shank into two water  
125 courses 35 and 36, which terminate in openings 37 and 38 just above the cutting face of each blade. Under some conditions it may be deemed advisable to extend the water course to a single opening in the center of  
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the lower end of the shank, between the two cutter blades, or the central opening may be used in connection with the two lateral openings.

5 Instead of using the key 27' to limit the rotation of the cutters with respect to the shank, a projection or lip could be formed on the end of the surface 19 at the point farthest from the trunnion pin 22. This lip  
10 or projection would abut against a shoulder on the lower end of the shank, and limit the rotation of the cutter with respect to the shank. Other usual and commonly used means may be employed to limit the movement  
15 of the cutters.

To recapitulate, the cutters are moved to the collapsed position and the bit lowered through a casing or open bore-hole. When the bit is rotated in a right-hand, or clockwise  
20 direction with the cutters in contact with the side or bottom of the bore-hole, the cutter blades will rotate a predetermined amount with respect to the shank of the bit and expand to produce a bore-hole of greater  
25 diameter than that through which the bit was lowered. When it is desired to raise the bit through the smaller bore-hole, the bit is lifted off of the bottom and rotated slightly to the left. This rotates the cutter blades  
30 in the opposite direction, with respect to the shank, and collapses the bit to its minimum diameter.

When the cutter blades become dull they may be removed from the shank by simply  
35 removing the holding means 28 at the top of the boss on the shank and sliding the trunnion pin 22 out of the boss 23, 24. A new sharp cutter is quickly slipped in place and locked and the bit ready for service again  
40 without the necessity of removing the bit from the drill pipe. If it should be desirable to change the size of the hole that the bit will generate, it is done quickly and easily by changing the cutter blades for ones of the  
45 required width.

The majority of cutting is done by the lower edge of the face 15 while the leading edge of the curved face 16 acts as a reamer to keep the hole true to size and also as a  
50 guide to maintain the bore hole straight and true, which is a very desirable feature.

I claim:

1. In an expansible rotary bit having a shank and means at the upper end thereof  
55 adapted to attach the shank to a string of drill pipe; a plurality of inclined bearing surfaces formed on the lower end of the shank, a plurality of cutters having inclined bearing surfaces adapted to cooperate with the first named bearing surfaces, whereby a  
60 weight on the shank will tend to separate said second named surfaces and cause a rotation of the cutters to expand them.

2. In an expansible rotary bit having a  
65 shank; a plurality of inclined bearing sur-

faces formed on the lower end of the shank, a plurality of cutters having upper inclined bearing surfaces rotatable against said first named surfaces whereby a weight on the shank will tend to separate said second  
70 named surfaces and cause a rotation of the cutters to expand them, said cutters being further characterized whereby a release of the weight on the shank will cause the cutters to collapse.

3. In a rotary bit including a shank having means at the upper end thereof adapted to attach the shank to a string of drill pipe; a plurality of plane surfaces formed on the lower end of said shank, each of said  
80 plane surfaces forming an obtuse angle with a plane through the axis of said shank; a blade type cutter rotatably mounted on each of said plane surfaces whereby the axis of the cutter is maintained substantially parallel to the axis of the shank.

4. In a rotary bit having a shank and means at the upper end thereof adapted to attach the shank to a string of drill pipe; a plurality of plane surfaces formed on the lower end of said shank, each forming an obtuse angle with a plane through the axis of said shank; said plane surfaces intersecting on the axis of said shank; a cutter  
90 rotatably mounted on each of said plane surfaces whereby the axis of the cutter is maintained substantially parallel to the axis of the shank; and means adapted to restrict the rotation of each cutter within certain predetermined limits with respect to the shank.

5. In a rotary bit having a shank and means at the upper end thereof adapted to attach the shank to a string of drill pipe; a plurality of cutters trunnioned on the lower  
105 end of said shank, said cutters being eccentrically mounted on said trunnions; and means adapted to restrict the rotation of each cutter within certain predetermined limits with respect to said shank.

6. In a rotary bit having a shank and means at the upper end thereof adapted to attach the shank to a string of drill pipe; a plurality of plane surfaces formed on the lower end of said shank, and intersecting on the axis of said shank, each plane surface forming an obtuse angle with the axis of said shank; a cutter trunnioned on each of said plane surfaces, said cutter being eccentric on said trunnion; and means adapted to restrict the rotation of each cutter within certain predetermined limits with respect to said shank.

7. In a rotary bit having a shank and means at the upper end thereof adapted to attach the shank to a string of drill pipe; a plurality of plane surfaces formed on the lower end of said shank and intersecting on the axis of said shank, each plane surface forming an obtuse angle with the axis  
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of said shank; a cutter rotatably mounted on each of said plane surfaces and having its axis parallel with the axis of said shank; and means adapted to restrict the movement of said cutter within certain predetermined limits with respect to said shank.

8. In a rotary bit having a shank and means at the upper end thereof adapted to attach the shank to a string of drill pipe; a plurality of plane surfaces formed on the lower end of said shank and intersecting on the axis of said shank, each plane surface forming an obtuse angle with the axis of said shank; a cutter trunnioned on each of said plane surfaces and having its axis parallel with the axis of said shank; said trunnion being eccentric with regard to the axis of said cutter; and means adapted to restrict the movement of said cutter within certain predetermined limits with respect to said shank.

9. In a rotary bit having a shank and means at the upper end thereof adapted to attach the shank to a string of drill pipe; a plurality of plane surfaces formed on the lower end of said shank and intersecting on the axis of said shank, each plane surface forming an obtuse angle with the axis of said shank; a cutter trunnioned on each of said plane surfaces and having its axis parallel with the axis of said shank; said trunnion being eccentric with regard to the axis of said cutter and normal to said plane surface; and means adapted to restrict the movement of said cutter within certain predetermined limits with respect to said shank.

10. In an expansible rotary bit having a shank and means at the upper end thereof adapted to attach the shank to a string of drill pipe; a plurality of plane surfaces formed on the lower end of said shank and intersecting on the axis of said shank, each plane surface forming an obtuse angle with the axis of said shank; a cutter trunnioned on each of said plane surfaces for rotation within predetermined limits with respect thereto, said cutter being eccentrically mounted on said trunnion whereby said cutters describe a circle of greater diameter in one position than they do in the other positions.

11. In a rotary bit having a shank and means at the upper end thereof adapted to attach the shank to a string of drill pipe; a plurality of plane surfaces formed on the lower end of said shank and intersecting on the axis of said shank, each plane surface forming an obtuse angle with the axis of said shank; a V type cutter trunnioned on each of said plane surfaces and having its axis parallel with the axis of said shank; and means adapted to restrict the movement of said cutter within certain predetermined limits with respect to said shank.

12. In an expansible rotary bit having a shank and means at the upper end thereof

adapted to attach the shank to a string of drill pipe; a plurality of cutters eccentrically trunnioned on the lower end of said shank for rotation within predetermined limits with respect thereto, the axis of each of said cutters being parallel with the axis of said shank, whereby the diameter of the circle generated by said bit is varied as and for the purpose specified.

13. In an expansible rotary bit having a shank and means at the upper end thereof adapted to attach the shank to a string of drill pipe; a plurality of plane surfaces formed on the lower end of said shank and intersecting on the axis of said shank, each plane surface forming an obtuse angle with the axis of said shank; a cutter eccentrically trunnioned on each of said plane surfaces for rotation within predetermined limits with respect thereto, and having its axis parallel with the axis of said shank, whereby the diameter of the circle generated by said bit is varied.

14. In an expansible rotary bit having a shank and means at the upper end thereof adapted to attach the shank to a string of drill pipe; a plurality of plane surfaces formed on the lower end of said shank and intersecting on the axis of said shank, each plane surface forming an obtuse angle with the axis of said shank; a trunnion pin in each of said plane surfaces and normal thereto; a cutter eccentrically mounted on each of said trunnion pins and having its axis parallel with the axis of said shank, and co-operating means on said shank and said cutter adapted to limit the rotation of said cutter with respect to said shank.

15. In an expansible rotary bit having a shank and means at the upper end thereof adapted to attach the shank to a string of drill pipe; a plurality of plane surfaces formed on the lower end of said shank and intersecting on the axis of said shank, each plane surface forming an obtuse angle with the axis of said shank; a trunnion pin in each of said plane surfaces and normal thereto; a V-shaped cutter eccentrically mounted on each of said trunnion pins and having its axis parallel with the axis of said shank, and co-operating means on said shank and said cutter adapted to limit the rotation of said cutter with respect to said shank.

In testimony whereof, I have subscribed my name.

EDWIN C. WEISGERBER.