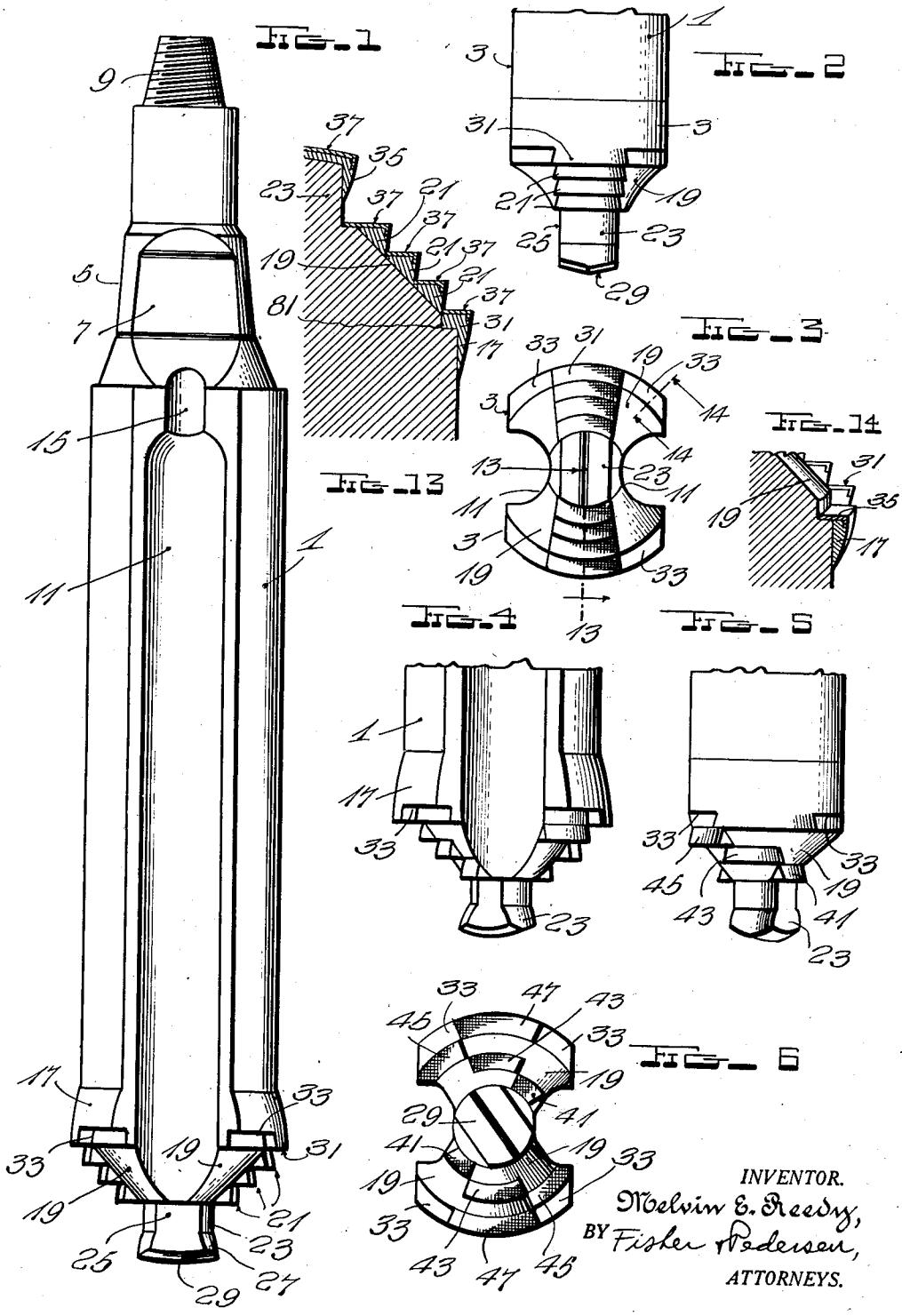
Feb. 25, 1936. M. E. REEDY 2,032,328

DRILL BIT

Filed Dec. 19, 1933 2 Sheets-Sheet 1



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Filed Dec. 19, 1933 2 Sheets-Sheet 2

Fig. 7

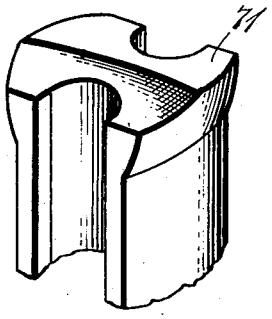


Fig. 9

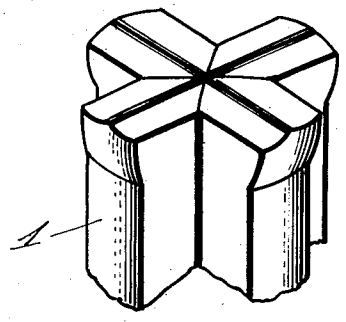


Fig. 8

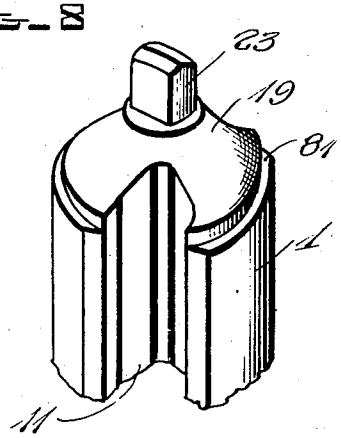


Fig. 10

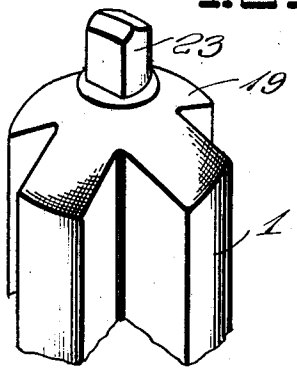


Fig. 11

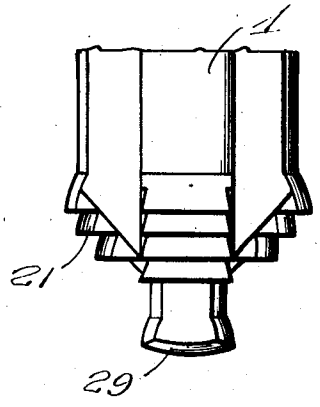
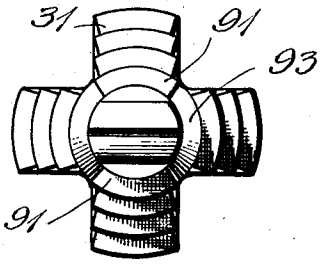


Fig. 12



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Patented Feb. 25, 1936 2,032,328

UNITED STATES PATENT OFFICE

2,032,328

DRILL BIT

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Application December 19, 1933, Serial No. 703,110

13 Claims. (Cl. 255—63)

This invention relates to an article of manufacture useful particularly in earth boring.

In drilling holes to substantial depths into the earth for oil, gas, water and the like, a number of methods have been developed which include, among others, rotary drilling and percussion or cable drilling, and it is particularly with reference to the latter method that the present invention is directed.

In this method of drilling, a relatively heavy drill bit is suspended at the end of a long cable which is raised and lowered by means of a walking beam, jerk line, or other means of imparting the reciprocating drilling motion to the cable and tools. The drill bit, always the lowermost member of the assembly of the various drilling tools, is usually of very substantial weight and includes a cutting surface at the lower end, a body of five to eight feet or more in length, and a wrench square above which is a threaded tapered pin which is attached to the threaded tapered box at the lower end of the drilling stem. The upper or opposite end of the drilling stem has a threaded tapered pin to which is attached the threaded tapered box of the rope socket attached to the lower end of the drilling cable, or a set of jars may be interposed. When such drilling tools, whose suspended assemblies weigh several thousand pounds in the larger sizes of hole, strike the bottom of the hole, they exert a tremendous force and particularly when in contact with the harder formations are subjected to great shocks, and excessive vibration.

In the drill bits proposed by the prior art, it has been customary to employ bits which are provided with relatively flat chisel-like cutting surfaces, and therefore likely to have their vertical direction altered in contacting certain difficult formations in the earth. To prevent this deflection, various proposals have been made for changing the character of the bit cutting surface, or for adding reaming members to the bit body, in many cases through the addition of short removable bit heads with cutting surfaces or of light detachable reaming members. But such removable parts, when subjected to the shock and vibration of percussion or cable drilling are frequently broken off or otherwise displaced and when so displaced the condition may not, at once, be apparent to the operator, with the result that the remaining portion of the bit in motion simply drives the displaced portion down to some extent and in some cases wedges it into the hole so that removal is difficult, if not practically impossible.

It is therefore among the objects of the present invention to provide a drill bit preferably made as a single unitary structure which is attached to the drill stem by the usual threaded tapered pin and box joint, and provided with a pilot point that directs the drill bit at the bottom of the hole and makes a straight hole.

It is also an object to provide a drill bit which has a tapered end so that the cutting end of the bit does not contact a flat bottom in the hole, but produces a hole with a concave bottom, with weakened edges which are readily broken away and mixed with the drilling fluid.

It is a further object to provide a novel method of preparing drill bits embodying the present invention and also a method by means of which the conventional drill bits now in service may be adapted to the form proposed in the present invention in a simple and expedient manner.

It is a further object to prepare a drill bit, provided with a pilot point and a tapered end upon which step cutters are formed, which makes a concave bottom with weakened sides, thereby greatly reducing the shock and vibration on the pins and boxes and other sections of the drilling assembly and minimizing breakage of same.

It is a still further object to prepare a drill bit provided with a pilot point and a tapered end upon which step cutters may readily be formed and surfaced with a hard, wear resisting alloy, giving long life to the bit and making for more rapid drilling progress.

Further objects include the provision of auxiliary peripheral reaming cutters which maintain the gauge throughout long service and prevent tapering of the hole being drilled.

These and other objects which will be apparent from the sequent description are all embraced within the present invention, illustrated in the accompanying drawings, in which;

Figure 1 is a front elevation of a drill bit embodying one modification of the present invention;

Figures 2 and 3 are side and bottom views, respectively, of the same embodiment, showing only the cutting end;

Figures 4, 5, and 6 are front, side and bottom views, respectively, of the cutting end of a second modification;

Figures 7 and 8 illustrate the steps in preparing a drill bit embodying the present invention from a conventional form;

Figures 9, 10, 11, and 12 illustrate the steps in preparing a drill bit embodying the present

invention from a modified conventional form; and

Figures 13 and 14 are cross sections taken along the lines 13—13 and 14—14, respectively, of Fig. 3 to illustrate the method of building up the step cutters, flanges and cutting edges as well as surfacing them.

The drill bit of the present invention, which is designed primarily for percussion drilling, may, of course, be embodied in other forms for similar or analogous drilling operations. It involves the usual bit body which is of substantial length, from five to eight feet or more, and generally cylindrical in shape, the diameter of the cylinder being slightly less than the gauge of the hole to be drilled. To provide passages for the drilling fluid, portions of the cylindrical body may be cut away as by the intersection of chords on the circular perimeter or, in addition, by U-shaped grooves on the flattened surfaces. Alternatively, V-shaped grooves may be made into the cylindrical body. All of these as well as other conventional forms of drill bit bodies are embraced by the term "generally cylindrical".

The end of the drill bit which forms the cutting surface is that to which the present invention more particularly relates. This end of the drill bit is provided with a conically tapering surface so that the bottom of the hole is not flat but concave or, more accurately, in the general shape of an inverted cone. This portion of the drill bit may assume other generally conical surfaces such as shapes which provide a surface that decreases in size toward the end. At the apex of the conically tapered surface is a generally cylindrical extension which projects from the apex. This cylindrical extension forms a hole of substantially less size than that of the main portion of the hole and acts as a pilot point in directing the drill bit. At the periphery of the conical surface, that is, its junction with the cylindrical surface of the drill body, a flare is built up which has a diameter or gauge substantially that of the finished hole. On this flare are auxiliary reaming cutters and in addition one of the step cutters, more particularly hereinafter described, may be included. These auxiliary reaming cutters and the edge step cutters maintain the proper gauge for the hole. On the conically tapered surface are built up what may be termed step cutters which may be arranged in any suitable fashion, that is, either in direct line, helically or other more or less uniform arrangement. These step cutters are triangular in cross section, having the hypotenuse on the conically tapered surface and a right angle opposite the hypotenuse and provide a cutting surface in the general shape of an annular sector, although the non-circular edges may be those of chords rather than radii. The side edges of the steps form substantially right angles with the cutting surfaces and provide a sharp edge to assist in the cutting operation. The step cutters need not be, and preferably are not, on all radii of the conical surface to permit the ready passage of drilling fluid and since in operation the drilling tools suspended on a long twisted cable tend to rotate and different sectors of the bottom are struck by any given part of the bit bottom with each reciprocation.

The cylindrical extension from the apex of the conically tapered surface is also flattened on one or two sides as by chords of the circle and the bottom surface is provided with a hard, abrasion-resisting metal. The cylindrical portion of the extension is flared out by building up the metal so that the cutting surface is slightly larger on the arcuate edges than the cylindrical extension itself.

Considering now the invention as illustrated in the drawings which, however, are not to be taken as limiting, but simply as illustrating some of the many possible modifications of the present invention, attention is directed to Figures 1, 2, and 3, in which 1 is the body of a conventional drill bit that is flattened on two sides as by chords 3 so that the body does not completely fill the hole. The upper end of the bit body is tapered off at 5, on which section is a wrench square 7. Above this is the threaded tapered pin 9 which is attached to the threaded tapered box of the stem by wrenches used on either a circular or straight jacking track. Extending along the cylindrical portion of the body of the bit on the flattened sides are U-shaped grooves 11 to provide channels through which the drilling fluid may readily flow. At the upper extremity of the channel it may diminish somewhat to a smaller channel 15.

At the base of the cylindrical portion of the body 1 is a flare 17 of slightly greater diameter than that of the cylindrical body by about .05 to .10 which is substantially the gauge of the hole. The method and materials used in forming this flare will be considered more specifically in connection with Figs. 13 and 14. Below this flare the drill body tapers rapidly in the form of a conically tapered surface 19. On this conically tapered surface are the step cutters 21 which, as illustrated in Figs. 1, 2, and 3, are diametrically opposed. Extending from the apex of the conically tapered surface is the generally cylindrical extension 23 which serves as a pilot point. This extension has flattened sides 25. On the arcuate portions of the generally cylindrical extension a flare 27 is provided and the bottom surface is given a flat, chisel-like face 29 built up of wear-resisting alloy. The last step cutter from the apex of the conical surface, designated as 31, is partly built up directly on the flare 17. Adjacent the step cutter 31 are auxiliary reaming cutters 33 which assist in maintaining the proper gauge of the hole.

As stated above, the drill bit of the present invention may either be originally constructed according to the teachings of the present invention or the conventional types of drill bits may be modified to embody the novel features herein described.

If the operator is possessed of a drill bit generally similar to that shown in Fig. 1, except that the end has the conventional flat chisel-like cutting surface 71, as shown in Fig. 7, which type of drill bit is normally dressed by forging, he may secure the advantages of the invention by removing the tempering and machining or otherwise working the end of the drill bit to secure the structure of Fig. 8 which includes the bit body 1 with an annular cut-out portion 81, conically tapering surface 19 and a generally cylindrical extension 23 from the apex of the conical surface.

Whether the structure illustrated in Fig. 8 is secured from machining a conventional drill bit or prepared in original manufacture, the step cutters, auxiliary reaming cutters and pilot point may be built up and arranged thereon in the manner shown in Figs. 13 and 14 by electric arc or oxy-acetylene welding. Before building up these members on the parent metal by oxy-acetylene welding the end of the bit should be

heated in a furnace to a temperature below the scaling point, when the bit is taken from the furnace and while still heated the welding on of the alloy metals is started. The purpose of this heating is twofold, first, the coefficient of expansion of the parent metal and the welded alloys are practically the same, therefore, when the parent metal is preheated there are few or no contraction checks in the finished and cooled welds and second, more rapid and economical welding is secured since the heat of the welding flame is not so rapidly dissipated as it is in cold metal. A tough, abrasion-resisting alloy (such as "Stoody Self-Hardening," "Hascrome", or other similar alloy) is welded onto the end and cylindrical side near the end of the cylindrical extension **23** as at **35** and on the conically tapered surface **19** to build up the step cutters **21**. This alloy is also employed to flare the cylindrical portion of the bit body **1** and form the last step cutter **31** which is lower than the annular groove **81**. On the surface of the alloy used to build up these members is welded a still harder, wear and abrasion-resisting alloy ("Stoodite", "Stellite", or other alloys having similar properties), at **37**. This relatively thin coating is applied on the cutting surface and the edges as well as extended a short distance along the side.

Fig. 14 illustrates the structure of the auxiliary reaming cutters which are arranged on the annular groove **81** and the built up flare **17**. These auxiliary reaming cutters are built up in the same manner as the step cutters or the pilot point and, in addition, since being on the periphery, they are subject to particularly hard wear, they are given an overlay of very hard alloy (such as "Borium", "Haystellite Composition", or similar alloys). While specific alloys have been mentioned in connection with building up the cutting elements of the bit on the parent metal, it is to be understood that these are given as illustrative of those which have been found successful, but that other alloys possessing generally similar properties might be employed in their place.

When the cutting members, cutting edges and surfaces have been built up as described, the bit, preferably is again placed in the furnace and brought to a normalizing heat, after which it is allowed to cool in the atmosphere. The step and reaming cutters on the outer circumference, i. e., **31** and **35** of the cutter head, should be kept as large or full to the gauge of the casing in the well as possible, otherwise no great care need be taken in finishing the step cutters to any particular gauge, as in actual use a percussion method bit drills a hole having a diameter of 1.05 to 1.10 or more of the greatest diameter of the bit.

It is probable that the drill bit of the present invention may be prepared by those skilled in the art by methods other than the novel ways described, but it should be understood that this invention includes the novel drill bits by whatever method they may be prepared.

After the drill bit has been in use for some time it will, of course, wear down and the edges of the step cutters may be rounded off to some extent and also the auxiliary reaming cutters as well as the last step cutters may be worn down so as to decrease the diameter of the hole drilled, and it is then necessary to restore the cutting surfaces to their proper shape and dimension. This is accomplished simply and expediently in generally the same manner that was employed in building up the step cutters, flanges, and the auxiliary reaming cutters, by applying a building up layer of alloy and an additional layer of a harder, abrasion and wear-resisting alloy.

Figs. 4, 5, and 6 illustrate an additional modification in which the step cutters instead of being on a single diameter as in Figs. 1, 2, and 3, are staggered or arranged helically with opposite helix on opposite sides so that each step cutter in a given position has a corresponding step cutter diametrically opposed as, for example, **41—41**, **43—43**, **45—45**, **47—47**. In this modification auxiliary reaming cutters **33** are also provided on the circumference. The pilot point **23** is illustrated as having the axis of its flat, chisel-like face somewhat oblique to the chords cutting the cylindrical surface of the bit body **1**.

In Figs. 9 to 12 are illustrated the development of a bit embodying the features of the present invention from the conventional cross or star shaped bit, which development is similar to that shown in Figs. 7 and 8. When, however, the step cutters of the present invention are employed in connection with a star or cross shaped bit, they are put on two axes at right angles to each other. Otherwise the arrangement is generally similar to that of the embodiments formerly considered, with the exception that on one axis there would normally be two more cutters, as **91**, since these cutters are omitted from the conically tapered surface **93** in order that there will be no continuous member above the cylindrical extension **23** which would tend to obstruct the drilling fluid and prevent its free passage along the sides of the bit or through the channels otherwise provided.

While the invention has been described in great detail with respect to the several modifications thereof, these are not to be construed as limiting, but simply as illustrative, and what I claim as my invention is:

1. A unitary percussion drill for earth boring having a body member terminating at its lower end in a downwardly tapering conical surface from which projects a centrally arranged cutting and pilot point of a diameter substantially smaller than the diameter of the drill body, and a plurality of arcuate cutters on a portion of said conical surface just above the pilot point extending in stepped relationship toward the periphery of the drill.

2. A unitary percussion drill for earth boring having a body member terminating at its lower end in a downwardly tapering conical surface from which projects a centrally arranged cutting and pilot point of a diameter substantially smaller than the diameter of the drill body, and a plurality of arcuate cutters on a portion of said conical surface just above the pilot point extending in stepped relationship toward the periphery of the drill, the several stepped cutters being formed in relatively small segments, with intervening spaces, such spaces providing for the ready flow of the drilling fluid.

3. A unitary drill bit for percussion earth boring comprising a drill body, a conically tapered end surface, arcuate cutting edges on a portion of the conically tapered surface, a pilot point projecting from the apex of the conical surface and a channel extending along the drill body cutting away a portion of the conical surface.

4. A unitary drill bit for percussion earth boring comprising a drill body, a conically tapered end surface, permanent arcuate projections from a portion of said conical surface provided with cutting edges and surfaces and a pilot point pro-

jecting from the apex of the conical surface to center and direct the drill.

5. A drill bit for percussion earth boring comprising a drill body, a conically tapered end surface, arcuate projections triangular in radial cross section permanently attached to and projecting from a portion of the conical surface in stepped relation to act as cutters.

6. A drill bit for percussion earth boring comprising a drill body, a conically tapered end surface, arcuate projections triangular in radial cross section permanently attached to and projecting from a portion of the conical surface in helical stepped relation to act as cutters.

7. A drill bit for percussion earth boring comprising a drill body, a conically tapered end surface, stepped arcuate projections triangular in radial cross section permanently attached to and projecting from a portion of the conical surface to act as cutters and a pilot point extending from the apex of the conical surface to center and direct the drill.

8. A drill bit for percussion earth boring comprising a drill body, a conically tapered end surface, stepped arcuate projections triangular in radial cross section permanently attached to and projecting from a portion of the conical surface to act as cutters, a pilot point extending from the apex of the conical surface to center and direct the drill and a channel extending along the drill body cutting away a portion of the conical surface.

9. A unitary drill bit for percussion earth boring comprising a drill body, a conically tapered end surface, projections from a portion of said conical surface providing arcuate cutting surfaces and auxiliary reaming cutters on the periphery of the conical surface which extend slightly beyond the generally cylindrical surface of the drill body.

10. A drill bit for percussion earth boring comprising a generally cylindrical drill body, a conically tapered end surface, stepped arcuate projections triangular in cross section permanently attached to and projecting from a portion of the conical surface to act as cutters, auxiliary reaming cutters on the periphery of the conical surface which extend slightly beyond the said cylindrical surface of the drill body, a pilot point extending from the apex of the conical surface to center and direct the drill and a channel to permit the passage of drilling fluid extending along the drill body cutting away a portion of the conical surface.

11. A drill bit for percussion earth boring comprising a drill bit body having a peripheral flare to form auxiliary reaming and crushing surfaces, a conically tapered end surface, annular sectors forming cutting members including projections substantially right triangles in radial cross section disposed in regular stepped relation on portions of the conically tapered surface, each projection having its hypotenuse on the conically tapered end surface to provide cutting and crushing surfaces disposed at right angles to the axis of the bit, and a pilot bit with cutting edges and crushing surfaces extending from the apex of the conically tapered surface.

12. A drill bit for percussion earth boring comprising a drill bit body having a peripheral flare to form auxiliary reaming and crushing surfaces, a conically tapered end surface, annular sectors forming cutting members including projections substantially right triangles in radial cross section disposed in helical stepped relation on portions of the conically tapered surface, each projection having its hypotenuse on the conically tapered end surface to provide cutting and crushing surfaces disposed at right angles to the axis of the bit, and a pilot bit with cutting edges and crushing surfaces extending from the apex of the conically tapered surface.

13. A unitary percussion drill for earth boring having a body member terminating at its lower end in a downwardly tapering conical surface from which projects a centrally arranged cutting and pilot point of a diameter substantially smaller than the diameter of the drill body, and a plurality of arcuate cutters on a portion of said conical surface just above the pilot point extending in stepped relationship toward the periphery of the drill with adjacent conical surface, whereby said arcuate cutters act to chip off earth formations at the conical bottom of the hole and the conical surface adjacent the cutters assists in mixing the loosened formations with the drilling fluid.

MELVIN E. REEDY.