My invention relates to new and useful improvements in arc cutters for rock drilling, the principal object and essence of my invention being to provide a device whereby a curved hole may be drilled from the main drill hole having a relatively fixed and controllable radius, said curved hole being the same diameter as the parent hole. A further object of my invention is to provide a device of the character hereinafter described in which once the curved hole has been drilled, conventional coring equipment may be used therein.

With the foregoing objects in view and such other objects and advantages as will become apparent to those skilled in the art to which this invention relates as this specification proceeds, my invention consists essentially in the arrangement and construction of parts all as hereinafter more particularly described, reference being had to the accompanying drawings in which:

Figure 1 is a view of my device in a schematically illustrated drill hole.

Figure 2 is an illustration of my device in use, it being understood that the curvature of the branch hole is considerably exaggerated in this view.

Figure 3 is a section substantially along the line 3—3 of Figure 1.

Figure 4 is a section substantially along the line 4—4 of Figure 1.

Figure 5 is a section substantially along the line 5—5 of Figure 1.

In the drawings like characters of reference indicate corresponding parts in the different figures.

In the art of diamond drilling, particularly exploratory diamond drilling, in which sample cores are taken, it is often desirable to ascertain the extent of an anomaly or ore body and heretofore this has necessitated drilling from the surface at various points. It will be appreciated that when the ore body under investigation is a considerable distance from the point of origin of the drill hole, considerable expense and time is consumed in making these tests.

I have overcome these disadvantages inasmuch as my invention permits branch holes to be made from any point along the length of the parent drill hole, said branch holes having a predetermined and relatively fixed radius, so that the area of exploration covered by these branch holes can be ascertained relatively accurately.

Proceeding, therefore, to describe my invention in detail, reference to Figure 2 indicates a parent drill hole 1 and indicating adjacent the lower end 2 thereof an ore body spanning, for example, the dotted lines 3 and 4.

A curved or branch hole 5 is illustrated, it being understood that the approximate length of the curved hole can be predetermined, depending upon where the straight continuation 6 is desired to cut the ore body and at what distance therefrom.

In the foregoing, it is to be appreciated that after the curved hole 5 has been drilled for the required distance, the arc cutting device collectively designated 7 is withdrawn and a conventional coring assembly substituted therefor.

It is also to be appreciated that means are required within the parent drill hole 1 to initiate the curved hole 5 and, in this regard I prefer to use a wedging tool 8 such as that described in my co-pending United States application Serial No. 200,931, now abandoned, in conjunction with a reaming assembly such as that described in my United States Patent Number 2,645,456.

Proceeding now to describe my arc cutting assembly collectively designated 7, reference to Figure 1 will show that it includes a conventional coring or bullnosed bit 9, the cylindrical tube 10 of which is relieved so that the diameter thereof is less than the diameter of the diamond cutting head 11. A reaming shell 12 is provided spaced from the bit 9, the diameter of the reaming shell also being greater than the tube 10.

The bit and shell are secured to an adapter portion 13 having a diameter similar to the tube 10, said adapter portion being screw threadedly secured to another 14 of a length of core barrel 15 in the conventional manner, said screw thread attachment not being illustrated in the accompanying drawing.

The opposite end 16 of the core barrel length is secured to one end of a control rod 34 by means of a universal or flexible joint 18 of special design shown in my United States Patent No. 2,645,456 permitting the passage of water to the bit therethrough, and designed for maximum strength. This control rod hereinafter described is approximately ten feet in length.

A fulcrum bearing collectively designated 19 is situated along the length of the core barrel 15 and consists of a cylindrical shell 20 within which is situated a solid bushing 21 preferably made of bronze or the like secured to the shell 20 by dowels (not illustrated) in the conventional manner. This bronze bushing is adapted to surround the core barrel length 15, which rotates therein during the drilling operation. In this connection, it will be noticed that a small drilling 23 is provided through the wall of the core barrel at this point, so that water normally passing downwardly through the drill rods and core barrel may also pass through the drilling 23 to provide lubrication for this bearing. It will also be noted that striations or grooves 24 are provided upon the outer surface 25 of the shell 20 so that the drilling sludge may pass upwardly therepast.

This fulcrum bearing is selectively spaced along the length of the core barrel 15 by the provision of a spacing tube 26 loosely surrounding the core barrel on one side of the fulcrum bearing and a collar 27 secured to the core barrel upon the other side of the fulcrum bearing, it being understood that the outer diameter of the spacing tube 26 is slightly larger than the inner diameter of the shell 20. By varying the length of the spacing tube 26 and the position of collar 27, the positioning of the fulcrum bearing can be varied along the length of the core barrel 15.

A tension bearing 28 having an outer diameter substantially equal to that of the drill hole, surrounds the lower end 14 of the core barrel, which is adapted to rotate therein midway between the fulcrum bearing and reaming ring, spacing tubes 26 and 26' holding it in this position. This tension bearing has a flexible bushing 28' preferably made of rubber or the like and being bonded to the interior surface 22 of the outer shell 22'. This bushing 28 is adapted to surround the core barrel length 15, which rotates therein during operation. Once again, a drilling 30 is provided in the wall of the core barrel at this point for lubrication purposes and striations 31 are provided upon the outer surface of this bearing to permit the drill sludge to pass thereby.

The control rod 34, of reduced diameter with regard to the drill string 17, is connected to the drill string by
means of a further universal joint 35 of similar design to joint 18 but having a diameter similar to the diameter of the hole. A solid control rod ferrule 36 is welded or otherwise secured adjacent to the centre of the length of this control rod, the diameter of the ferrule being just less than the diameter of the hole.

In operation, the wedge 8 is positioned along the parent hole at the desired location of the curved hole, whereupon the arc cutting assembly, attached to the end 17 of the drill rod string, is lowered into the hole. When the coring bit 9 strikes the inclined surface 8° of the wedge, it is deflected to the limit of the wedge (approximately one and one half degrees deviation) and the curved hole 5 commences to be formed. As the shoulder 1′ (shown in dotted line) of the drill hole has been removed by the aforementioned reaming assembly, it will be appreciated that this wall is straight and permits the apparatus to pass the wedge.

In passing the wedge the leading universal joint 18 on the control rod is deflected, causing considerable side pressure at point 37, thus forcing the universal joint against the outer wall 32 so that the arc cutting assembly pivots upon the fulcrum bearing 19 and applies pressure upon the points 33 of the bit, it being understood that the assembly can rock slightly due to hole clearance of the fulcrum bearing. This increases the arc being cut to a predetermined radius controlled by the position of the fulcrum bearing along the length of the core barrel 15 and therefore, assuming a constant density of rock being drilled, the arc will be maintained at the desired radius for as long as required.

When the curved hole 5 has been drilled for a sufficient length, the arc cutting assembly is withdrawn and a conventional coring assembly is substituted therefor, which will then pass by the wedge 8 and continue around the curved hole 5 and, once it reaches the end of the curved hole 5, will continue substantially in a straight line tangential to the curved hole as long as desired. From the foregoing, it will be appreciated that the horizontal distance between the parent hole where it cuts the ore body at 3 and 4 and where the branch hole 5 cuts the ore body can be calculated fairly accurately.

The tube 10 and adapter 13, being relieved with regard to the diameters of the reaming shell 12 and the bit 9, allow the diamonds to work freely with a cutting action in a direction governed by the fulcrum bearing, which is substantially hole size. In this regards, it will be appreciated that reference to the drawings will show that the universal joint 18 is below hole size also, thus permitting the sideways movement shown exaggerated in Figure 2.

The core barrel, which is also smaller than the hole 5 is at all times held centered in the hole at the point where it turns in the fulcrum bearing, so that the core barrel acts through this fulcrum in the plane of the arc, being directed by the position of the universal joint.

While passing the wedge 8 or in an arc, the control rod 34 driving the universal joint 18 connecting it to the arc cutter is forced to bend and so keeps the universal joint under constant pressure against the outer wall of the arc, thereby maintaining the direction started by the wedge, the position of the fulcrum on the core barrel fixing the radius of arc being cut.

The tension bearing 28 is provided to eliminate any float which might occur in the fulcrum bearing caused by clearance between the core barrel and the fulcrum bearing, and the fulcrum bearing and the hole, thereby permitting the minimum arc to be cut allowed by the position of the fulcrum instead of causing the radius to vary between minimum and maximum due to said clearances.

The trailing universal joint 35 absorbs any whip that may be present in the drill string 17 and delivers only downward pressure and torque through the control rod to the cutting bit. The control rod 34 is bent to conform with the arc being cut as hereinbefore described and fluctuating or whip is eliminated by the near hole sized ferrule 36 on the surface of which the control rod 34 is bent to, the control rod 34 being free from the arc being cut.
end of a conventional string of drill rods, and a tension bearing situated substantially mid-way between said fulcrum bearing and said bit, said core barrel also revolving in said tension bearing.

5. The device according to claim 1 in which said means consist of a spacing tube surrounding said core barrel in advance of said fulcrum bearing and between said fulcrum bearing and said drill bit, and a collar secured to said length of core barrel behind said fulcrum bearing thereby clamping said fulcrum bearing in position between said collar and said spacing tube, said fulcrum bearing including a relatively short cylindrical outer shell, a bushing within said shell, and secured thereto, said bushing surrounding said core barrel length, and at least one striation on the outer surface of said shell.

6. The device according to claim 1 which includes a reaming shell immediately behind said bit.

7. The device according to claim 4 in which said tension bearing includes a relatively short cylindrical outer shell, a resilient bushing within said shell, and secured thereto, said bushing surrounding said core barrel length, and at least one striation on the outer surface of said shell.

8. The device according to claim 6 which includes a tension bearing between said fulcrum bearing and said bit, said core barrel adapted to rotate within said tension bearing.

9. The device according to claim 1 which includes a near hole sized control rod ferrule secured approximately medially along the length of said control rod.

10. The device according to claim 6 which includes a near hole sized control rod ferrule secured approximately medially along the length of said control rod.

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