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EARTH DRILLING APPARATUS

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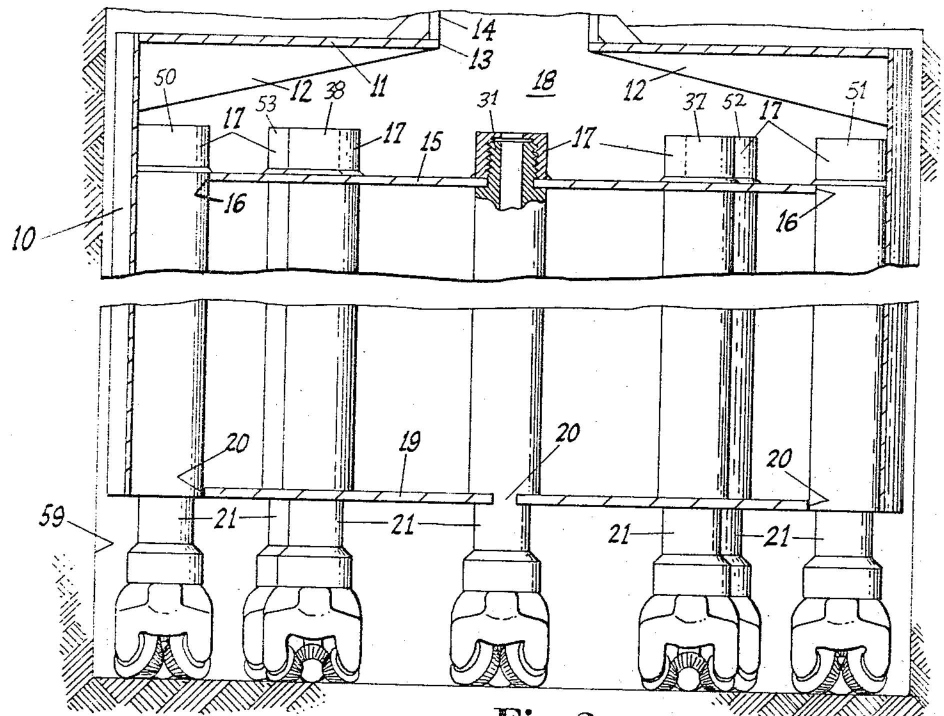

Fig. 2

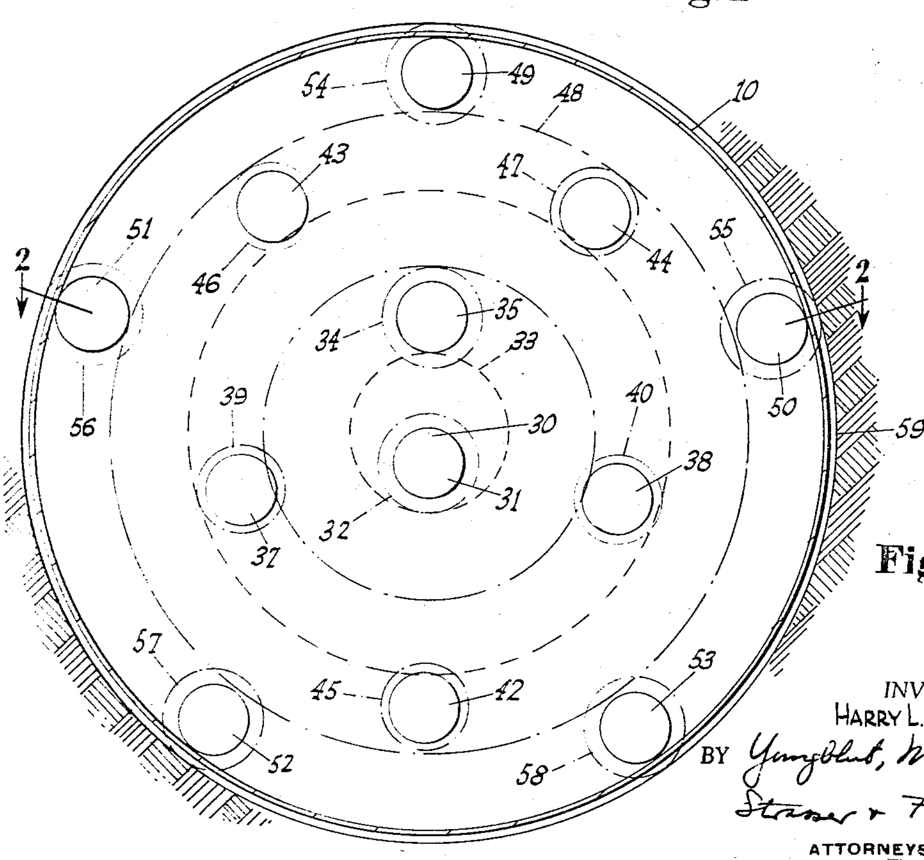

Fig. 1

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EARTH DRILLING APPARATUS

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This invention relates to earth drilling apparatus and more particularly to apparatus for drilling large diameter holes in the earth as distinguished from the drilling of holes for oil, gas or water wells.

Recently there has been a great interest in the drilling of holes of say six feet in diameter to great depths and of course, conventional well drilling equipment simply will not perform such an operation without extensive modification and expense for special six foot diameter drill bits.

It is therefore a principal object of the invention to provide an apparatus for drilling large diameter holes in the earth. By large diameter holes is meant holes of a diameter larger than can be drilled with present day drilling equipment.

This object and others which will be described in more detail hereinafter, or which will be apparent to one skilled in the art upon reading these specifications, are accomplished by that certain construction and arrangement of parts of which the following describes an exemplary embodiment.

Reference is made to the drawing forming a part hereof and in which:

FIGURE 1 is a somewhat diagrammatic plan view showing the hole in the earth and the distribution of a plurality of drills in the apparatus.

FIGURE 2 is a cross-sectional view taken on the line 2—2 of FIGURE 1.

Briefly in the practice of the invention there is provided a cylindrical shell having a diameter which is substantially that of the hole which it is desired to drill. This cylindrical shell has a closed top except for a central hole about which an inlet pipe is secured and within the cylindrical shell a top and bottom plate are provided, these plates having aligned holes to accept a plurality of fluid powered drills. Fluid entering the device through the inlet enters the manifold above the upper plate and passes through the respective drills causing them to rotate and perform their cutting action. At the same time the entire shell is slowly rotated by means of a Kelly at the surface in a conventional manner. The apparatus is preferably weighted and the several drills are so disposed that as the cylindrical shell is slowly rotated, the cutting areas of the several drills overlap each other, whereby the earth over the entire area of the bottom of the hole is removed quite evenly.

Referring now more particularly to the drawing, the apparatus comprises a cylindrical shell **10** having a top plate **11**, which may be braced by means of a plurality of gussets as at **12**. An axial hole **13** is provided in the member **11** and an inlet pipe **14** is rigidly secured to the member **11** about the hole **13**.

Near the top of the cylindrical casing there is provided a top plate **15** having a plurality of holes **16**. The plate **15** is suitably secured to the shell **10** around its periphery as for example by welding. Over each of the holes **16** in the plate **15** a sub **17** is secured as by welding.

The structure thus far described, provides a manifold **18** between the top **11** and the upper plate **15** within the cylindrical shell **10**.

Also secured within the shell **10** is the bottom plate **19** which is provided with a number of holes **20** aligned respectively with the holes **16** in the top plate.

The drills used in this apparatus may be drills such as are disclosed and claimed in patent to Clark et al.,

3,112,801, dated Dec. 3, 1963. The drill described in said patent is a fluid driven drill wherein the driving apparatus comprises a pair of gear elements according to the invention of R. J. L. Moineau as disclosed in U.S. Patent No. 1,892,217. The cooperating gear elements disclosed in said Moineau patent are commonly used as pumping elements, but when fluid is forced through these pumping elements they act as a motor. According to said Clark patent, such gear elements constitute a very effective and convenient "down-hole" motor for driving drills in well drilling operations. Other forms of drills which are fluid driven and can operate "down-hole" may also be used. The drill assemblies themselves are indicated in FIGURE 2 at **21**, and since the details thereof do not constitute any part of the present invention, they will not be described in detail herein. For a full disclosure of their construction and operation, reference may be had to the said Clark et al. patent.

When such drills are used in the present invention they are inserted upwards through the holes **20** in the plate **19** and screwed into the subs **17** which are welded to the top plate **15**.

The volume within the cylinder **10** between the upper plate **15** and the lower plate **19** and indicated in the drawing at **22**, may be filled with sand or other suitable material in order to weight the apparatus or provide structural integrity.

From a consideration of the operation of the drills disclosed in the said Clark patent it will be clear that when fluid such as drilling mud is pumped through the pipe **14**, it enters the manifold **18** and thence flows through the subs **17** and through the prime movers of the drills **21**, thereby rotating each of the drills about its own axis.

The entire assembly of drills including the cylindrical shell **10** is rotated solely by means of the conventional Kelly at the surface of the ground. In actual practice the Kelly may rotate the assembly at about two revolutions per minute and the fluid pumped through the drills may rotate the individual drills about their own axes at say 400 r.p.m.

For efficient operation, it is desirable that the area of cutting of each of the drills overlap the cutting area of other drills so that in one revolution of the cylindrical casing **10**, every element of earth at the bottom of the hole will have been subjected to drilling action. It is also desirable for equalization of load and drill thrust, that the several drills be distributed over the area of the hole in a more or less even spacing.

By reference to FIGURE 1, the small solid line circles indicate the individual drills, while the slightly larger broken line circles indicate the cutting area of the respective drills. The center of the cylindrical casing is indicated at **30**. In the particular embodiment disclosed, a first drill **31** is disposed eccentrically with respect to the point **30** but so that its cutting area (indicated by the circle **32**) overlaps the axis of the cylindrical shell **10**. As the shell **10** is rotated, it will be understood that the drill **31** will cover an area indicated by the broken line circle **33**.

A second drill **34** is disposed diametrically opposite the drill **31**, such that its cutting area which is indicated by the circle **35**, overlaps the circle **33**. As the cylinder **10** is rotated one revolution the drills **31** and **34** will cover the area within the circle **36**.

A third drill **37** and a fourth drill **38** are disposed at equal distances from the center of the shell **30** and are symmetrically disposed with respect to the drill **31**, and closer to the drill **31** than to the drill **34**. The cutting areas of the drills **37** and **38** are indicated by the circles **39** and **40**, so that as the cylinder **10** rotates the four drills thus far described completely cover the area within the circle **41**.

A fifth drill is indicated at **42**, a sixth drill at **43**, and a seventh drill at **44**. The drill **42** is disposed diametrically opposite the drill **34** and the drills **43** and **44** are disposed symmetrically with respect to the drill **34** and more or less opposite the drills **37** and **38**. The cutting areas of the drills **42**, **43** and **44** are indicated respectively at **45**, **46** and **47**, and it will be clear that as the shell **10** rotates the seven drills thus far described completely cover the area within the circle **48**.

Finally in the outer ring there are provided an eighth drill **49**, a ninth drill **50**, a tenth drill **51**, an eleventh drill **52** and a twelfth drill **53**. The drill **49** is diametrically opposite the drill **42**. The drills **50** and **51** are respectively diametrically opposite the drills **37** and **38**, and the drills **52** and **53** are respectively diametrically opposite the drills **44** and **43**. The cutting areas of the drills **49** to **53** inclusive are indicated respectively at **54**, **55**, **56**, **57** and **58**, and it will be seen that these cutting areas overlap the circle **48** just as the circles **45**, **46** and **47** overlap the circle **41**. It will also be seen that the circles **54** to **58** inclusive overlap the outer periphery of the shell **10** so that the sum total of the twelve drills described completely covers the circle indicated at **59**, which is the diameter of the hole being drilled, which is slightly larger than the outside diameter of the cylindrical shell **10**.

It will be clear that the specific arrangement of the drills may be varied, and will have to be varied if the number of drills differ, but it is important to note that the entire area must be covered in the revloution of the cylinder and that the drill pressures must be substantially evenly distributed over the area of the hole being drilled.

The mud being used to actuate the drills passes out through the drill bit in conventional manner and the chips are flushed aside and pass upwardly through the annular space between the casing **10** and the wall **59** of the hole being drilled.

In other respects, conventional practice of oil well drilling may be used in that the well may be provided with casing, or it may be cemented or left as drilled according to the type of formation involved. It will also be understood that reamers or other types of bits could be added to the outside ring of drills to expand the hole for the casing.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. An apparatus for drilling large diameter holes in the earth, said apparatus comprising a cylindrical shell having a diameter subsatntially that of the hole to be drilled, a top member for said shell having a central aperture, an inlet pipe for fluid rigidly secured to said top member in comunication with said aperture, an upper plate disposed within said shell and rigidly secured to said shell and having a plurality of apertures, said upper plate providing, between it and said top member, a fluid manifold, an internally threaded sub rigidly secured to said upper plate in communication with each of the apertures therein, a lower plate rigidly secured to said cylinder shell adja-

cent the bottom thereof, and having a plurality of apertures in vertical alignment with the respective apertures in said upper plate, and a plurality of fluid actuated drills passing through the apertures in said lower plate and secured to said subs respectively, the axes of said drills being distributed radially and circumferentially such that, as said cylindrical shell is rotated, the cutting area of said drills overlap from the axis to the periphery of said cylindrical shell, and such that the drilling thrust of said plurality of drills is substantially uniformly distributed over the cross-sectional area of said cylindrical shell, said cylindrical shell being weighted by means of a weighting substance filling the space between said upper and lower plates in the interstices between said drills.

2. Apparatus according to claim **1** wherein a first drill is disposed eccentrically of said cylindrical shell so that its cutting area overlaps the axis of said cylindrical shell, a second drill is disposed diametrically opposite said first drill and farther from the axis of said shell, but so that its cutting area overlaps that of said first drill when said shell is rotated, a third and fourth drill are disposed equidistant from the axis of said shell so that their cutting area overlap that of said second drill when said shell is rotated, said third and fourth drills being symmetrically disposed with respect to a line connecting said first and second drills and being closer to said first drill, a fifth, sixth, and seventh drill disposed equidistant from the axis of said shell so that their cutting areas overlap those of said third and fourth drills when said shell is rotated, said fifth drill being diametrically opposite said second drill and said sixth and seventh drills being disposed symmetrically with respect to said second drill, and an eighth, ninth, tenth, eleventh and twelfth drill equidistantly disposed with respect to the axis of said shell so that their cutting areas overlap those of said fifth, sixth and seventh drills, and so that their cutting area extend beyond the outer circumference of said shell when said shell is rotated, said eighth drill being disposed diametrically opposite said fifth drill, said ninth and tenth drills being diametrically opposite said third and fourth drills respectively, and said eleventh and twelfth drills being disposed diamterically said seventh and sixth drills respectively.

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