Nov. 10, 1959 C. W. KANDLE 2,912,225

METHOD AND APPARATUS FOR DRILLING LARGE DIAMETER HOLES

Filed Oct. 1, 1957 2 Sheets-Sheet 1

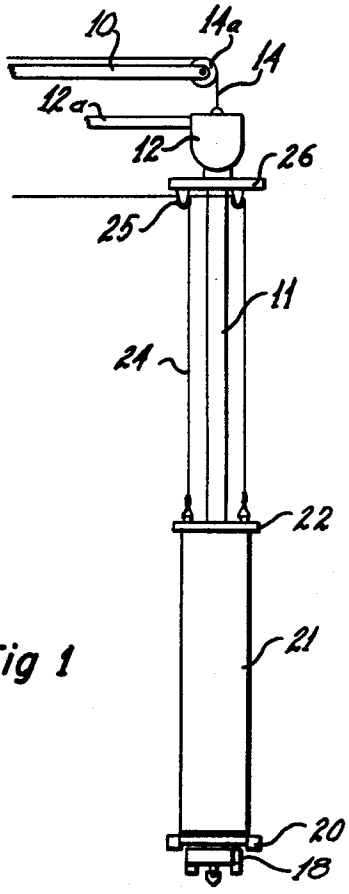

Fig 1

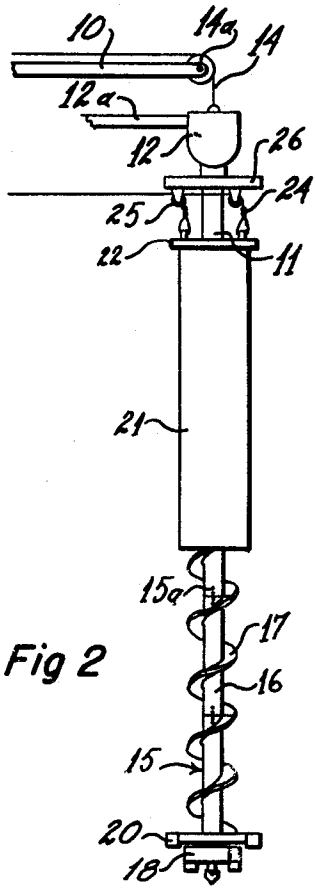

Fig 2

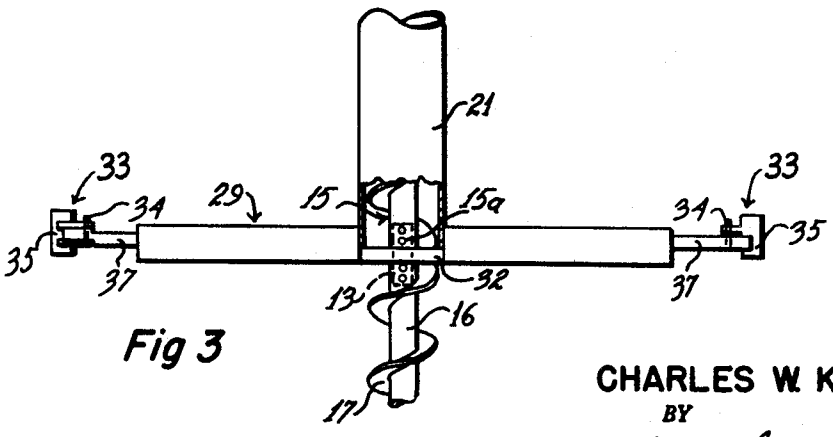

Fig 3

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METHOD AND APPARATUS FOR DRILLING LARGE DIAMETER HOLES

Filed Oct. 1, 1957 2 Sheets-Sheet 2

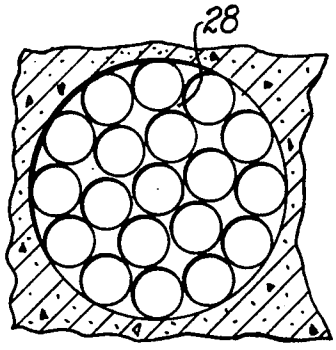

Fig 4

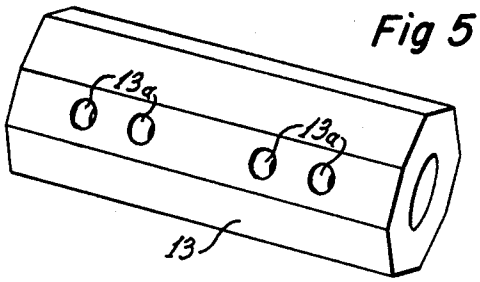

Fig 5

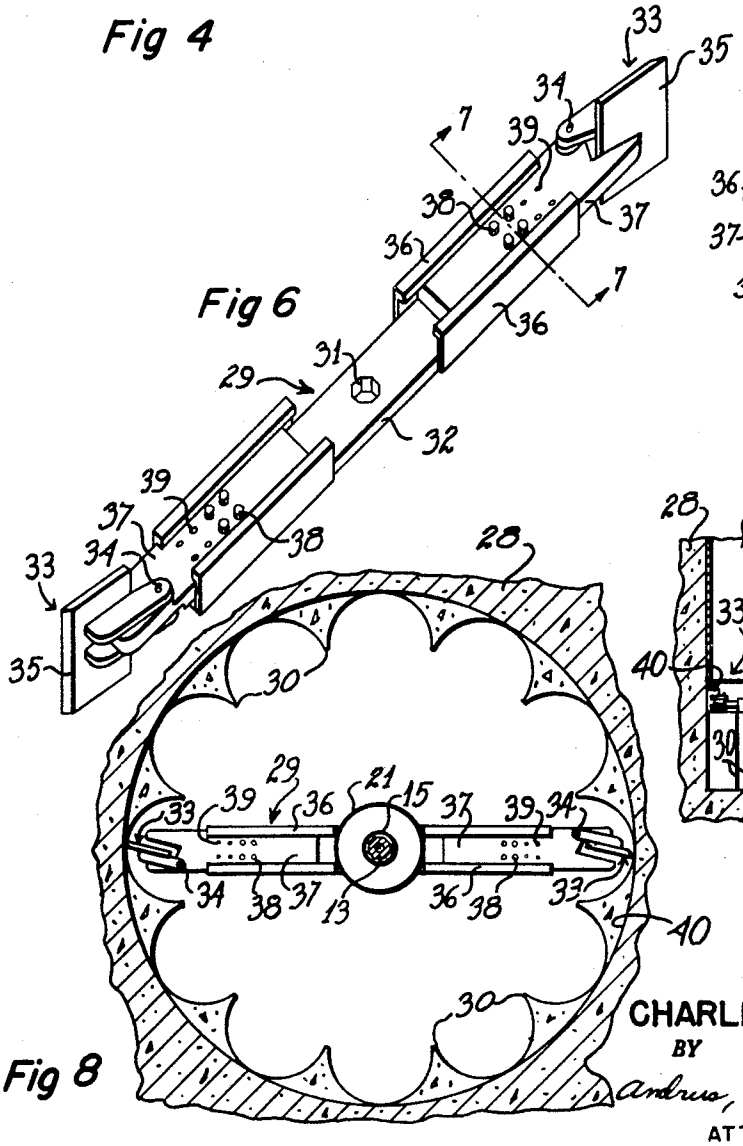

Fig 6

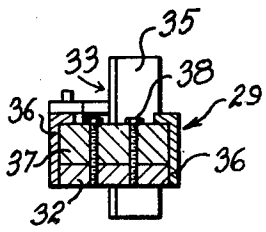

Fig 7

Fig 8

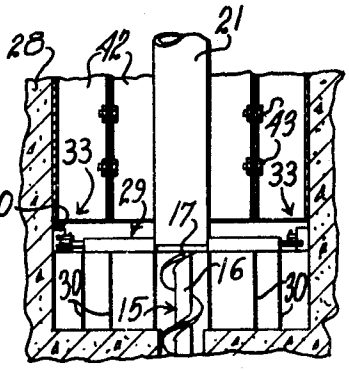

Fig 9

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METHOD AND APPARATUS FOR DRILLING LARGE DIAMETER HOLES

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Application October 1, 1957, Serial No. 687,558

2 Claims. (Cl. 255—1.8)

This invention relates to drilling apparatus and finds particular utility in drilling very large diameter holes which are often of considerable depth. The invention also relates to a method for drilling such a hole.

In the formation of particularly large diameter holes, for example on the order of twelve feet in diameter such as are necessary in mining shafts or in making caisons, it is difficult to form the hole in one continuous pass without special, very large and complicated equipment. It is also very difficult to maintain the correct direction during the formation of such a hole, for example, maintain a perfectly vertical hole. Furthermore, it is difficult by conventional means to insure that the hole is true, that is to say, not out of round. These problems will be appreciated more fully when it is realized that these holes are sometimes as deep as one hundred and twenty feet and the drilling apparatus is suspended from booms that are over one hundred feet in length.

According to the present invention, the large hole is formed by making a series of smaller holes closely adjacent one another and to a certain depth that is only a fraction of the total finished depth to be drilled. The rough large hole thus formed by the series of smaller holes is then finished and "trued up" by a reaming operation. Steel liner sections are then installed in the finished section of the hole for lateral support of the wall. Thus an incremental length of the hole is finished. This process is then repeated until the final desired depth is reached.

By means of this invention an expander tool has been provided which can be quickly and readily attached to the drill without substantial modification or alteration. The arrangement is such that a drill is piloted in the bottom of the rough hole before the reaming operation so as to guide the expander and insure a true and accurately positioned hole.

A casing or tube is provided for the drill which permits the quick removal of spoil from the hole being drilled and the dumping of the spoil remote from the hole. By this means, the spoil from one hole will not spill over into the previously formed adjacent hole.

These and other objects and advantages will appear hereinafter as this disclosure progresses, reference being had to the accompanying drawings in which

Figure 1 is an elevational view of the drilling apparatus embodying the drill casing made in accordance with the invention;

Figure 2 is a view similar to Figure 1, but showing the relative position of the casing and drill when the former has been raised above the drill to dump the spoil therefrom;

Figure 3 is a fragmentary view of the drill, on an enlarged scale, with the casing partially raised and with the expander tool inserted between flights of the drill as when a reaming operation is to be performed;

Figure 4 is a plan view of the ground showing the arrangement of the series of small holes which would be drilled to form a large hole;

Figure 5 is a perspective view, on an enlarged scale,

of the connecting stub shaft on which the expander is mounted;

Figure 6 is a perspective view of the expander or reamer, taken generally from its upper side;

Figure 7 is a cross sectional view through the expander, taken generally on line 7—7 in Figure 6;

Figure 8 is a plan view of a large rough hole being reamed, the view being a section taken just above the expander and through the connecting stub shaft; and

Figure 9 is a fragmentary elevational section through a hole being formed and showing one increment of depth already completed with the liner in place and the second increment of depth being reamed.

Referring in greater detail to the drawings, a swinging boom **10** is mounted on a power vehicle (not shown) and a rotatably driven drive shaft **11**, driven by the motor **12**, hangs downwardly therefrom, the motor being secured to the cable **14** which is trained over pulley **14***a*. A torque arm **12***a* is connected at one end to the motor **12** and its other end may be anchored to the power vehicle so as to prevent the motor from rotating when driven. The length of the boom will vary, of course, depending on the depth of holes to be drilled. The drive shaft length may also be varied by detachably securing any number of lengths together by means, for example, of short stub shafts **13** (Fig. 5) of non-circular cross section which fit complementary recesses in the ends of the shafts **11**. As the depth of the hole increases, the drilling apparatus is lowered by paying out cable **14**.

The drill **15** itself may also be comprised of sections having a central shaft **16** to which an auger flight **17** is attached and these sections are similarly connected together by stub shafts **13**. The shafts **13** have spaced apertures **13***a* which register with apertures adjacent the shaft ends and bolt means **15***a* pass therethrough to rigidly secure the sections together.

A conventional drill head **18** has a shaft section (not shown) which is similarly attached to the lower end of the lowermost auger section.

The drill head also has an expandable wing cutter **20** which reams a clean hole immediately behind the drill head so as to permit the casing **21** to follow directly behind the head as the hole is drilled. For a more complete description of this drill head and wing cutter, if deemed necessary, reference may be had to my co-pending U.S. application Serial No. 665,522, filed June 13, 1957, entitled, "Wing Collar Drill." However, it is believed sufficient to say, for purposes of this disclosure, that the head is readily removed from the lowermost auger section by with-drawing its bolt means from the stub shaft. The construction of the wing cutters is such that its ends are extended when the drill is rotated in the cutting direction. The ends are retracted when the direction of rotation is reversed, which permits ready withdrawal of the entire drill assembly upwardly through the hole.

The casing **or tube 21** closely surrounds the auger flights of the drill. **The top** of the casing is closed by a closure member in the form of a plate **22** welded thereacross. The plate has a central opening large enough to receive the drive shaft **11** which rotatingly extends therethrough.

The casing **21** is adapted to be pulled up above the drill, as shown in Figure 2, by means of flexible members such as cables or chains **24** which are secured at their lower ends to plate **22** and trained over pulleys **25** mounted on the motor bracket **26**. Tension is applied to the chains **24** to raise the casing **11** by power means (not shown) on the power vehicle.

Perhaps the problems involved and the magnitude of a drilling operation in accordance with this invention could be better visualized, if a few dimensions were given for illustrative purposes. For example, assume a finished

hole twelve feet in diameter is desired of considerable depth. A drill 15 would be used which is approximately 30 inches in diameter. As shown in Figure 4, approximately 19 holes of 30 in. diameter would be necessary to form such a large finished hole. These smaller holes must be closely adjacent one another so the material between the drilled holes will be weak and simply crumble into the bottom of the large hole. The spoil removed from one of the small holes must be removed from the vicinity of the operation and prevented from simply falling into the adjoining previously dug holes or adjacent the area where additional holes are to be drilled. As well as material removal and transfer problems, it will be appreciated that simply to drill such a number of holes requires considerable time.

In accordance with this invention a number of closely adjacent holes may be rapidly drilled and the spoil removed therefrom and transferred from the area. To drill an individual hole, the drill is rotated and proceeds to pull itself into the earth while the wing cutter 20 reams the hole clean so the casing follows directly thereafter. As the drilling progresses the spoil is carried upwardly in the casing by the auger. The plate 22 seals the upper end of the casing and prevents spoil from spilling outwardly therefrom. When the casing and auger are packed full of spoil the entire assembly is raised above the ground by winding up cable 14. The boom then swings the assembly to a remote area, or above a truck. To unload the auger and casing, the latter is pulled up above the auger, as shown in Figure 2 and then the auger rotated. The spoil flies off the auger and the complete dumping job takes only a matter of seconds. The casing is then lowered over the drill and it is ready to drill another hole. It has been found that a four foot hole can be drilled and unloaded in approximately 2 minutes. Because the spoil removed is kept within the casing until unloaded, the adjacent holes remain clean and can be located close to one another.

Each hole is made with a single pass of the drill and a pattern of holes is made as shown in Figure 4. The material 28 that is not actually cut by the drill is of an unappreciable amount and readily crumbles to the bottom of the hole.

A reaming operation is then carried on, using the expander or reamer 29 shown in Figures 3, 6, 7, 8 and 9, and which trims off the projections 30 on the wall of the large rough hole that are formed between the small holes around the periphery.

The expander 29 has a central non-circular opening 31 (Figure 6) which complements the short connecting shafts 13 (Figure 5) and snugly fits thereover. The expander may be mounted between the drill head 18 and the lower end of the casing. As shown in the drawings, however, the expander is secured between the lowest and second drill sections and on the hex shaft 13 therebetween. For this purpose a hex shaped shaft is used which has a slightly wider spacing between its centermost apertures 13*a* to provide for the thickness of the central portion 32 of the expander.

The expander 29 includes outer wing cutters 33 which are pivoted at 34 for swinging movement between a fully extended or cutting position and a retracted position which permits easy withdrawal of the expander from the hole. The cutting blades 35 are of considerable width so as to insure the entire wall is reamed without any spots thereof being missed due to too rapid descent of the expander.

The central portion of the expander includes guideways 36 which are generally of channel shape in cross-section for slideably receiving the extensible arms 37 therein. Cap bolts 38 extend through apertures 39 in arm 37 and are threadably engaged in the bottom of central member 32, and serve to rigidly secure the arms

37 in any one of a plurality of positions, depending on the finished size hole desired.

To perform the reaming operation the drill head is accurately located in the bottom of the hole and drilling commenced. As the drill moves downwardly, the wing cutters have been extended by contact with the wall 40 of the hole and cut away the projections 30 leaving a smooth and concentrically formed hole. The lower drill portion acts as a pilot and guides the reamer so as to form a "true" hole. A much more accurately formed hole is thus formed than is possible with clay spades or grubs.

As shown in Figure 9, the first incremental length of hole formed has been lined with steel arcuate sections 42 which are bolted together by bolt means 43. Thus as each section of the hole is finished, it is reinforced by such a liner.

By forming the large hole in steps, the path or direction of the hole can be checked often and corrected if necessary before starting a new length or step. The bottom drill section acts as a pilot for the reamer and can accurately position and maintain the expander within the hole. In practice a hole four feet deep and twelve feet in diameter can be trimmed in approximately 10 minutes, whereas hand trimming would take considerably more time with less satisfactory results.

Various modes of carrying out the invention are contemplated as being within the scope of the following claims particularly pointing out and distinctly claiming the subject matter which is regarded as the invention.

I claim:

1. In apparatus for drilling large holes in the earth, a drill head, a drill shaft secured to said head and extending upwardly therefrom, said shaft being constructed of successive sections with couplings therebetween, a spiral flight on the lowermost section of said shaft and adapted to receive spoil from said drill head and to lift the same upwardly, means to rotate said shaft, a tubular casing adapted to surround said flight and adapted to confine the spoil thereon during a drilling operation, means to raise said casing from said flight to discharge the spoil therefrom when said drill is raised from the earth, a reamer removably secured in the coupling between said lowermost shaft section and the next succeeding section, and means on said reamer to support said casing above the reamer and in an inoperative position during reaming.

2. A method for forming a relatively large diameter hole in the earth, comprising drilling a relatively small hole by means of a drill and spiral flight assembly and confining the loose spoil in a tubular casing surrounding the assembly, removing the assembly and casing from the hole to an area remote from the hole, raising the casing relative to the assembly, rotating the assembly to discharge the spoil, repeating the above steps to provide a plurality of smaller holes in closely adjacent relation and thereby form a relatively large hole having a rough wall of substantially the diameter desired, coupling a reamer to the drill and spiral flight assembly to support the tubular casing in an inoperative position above the reamer, and reaming the rough hole to the proper diameter while drilling a central smaller hole to a greater depth with the drill to guide the reaming operation.

UNITED STATES PATENTS

References Cited in the file of this patent

Re. 19,281	Schroeder	Aug. 21, 1934
174,083	Morgan	Feb. 29, 1876
175,987	Howard	Apr. 11, 1876
419,909	Beagle	Jan. 21, 1890
641,960	Herfert	Jan. 23, 1900
1,363,049	Moore	Dec. 21, 1920

(Other references on following page)

5

UNITED STATES PATENTS

1,559,761	Nebergall	Nov. 3, 1925
1,600,681	Lidell	Sept. 21, 1926
1,764,377	Wickersham	June 17, 1930
2,116,359	McCann	May 3, 1938
2,234,451	Ransome	Mar. 11, 1941
2,425,193	Lehr	Aug. 5, 1947
2,480,372	Kandle	Aug. 30, 1949
2,576,799	McKinstry	Nov. 27, 1951
2,637,542	Yarmak	May 5, 1953
2,643,096	Bates	June 23, 1953
2,702,180	Horner	Feb. 15, 1955
2,783,974	Veasman	Mar. 5, 1957

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