Dec. 6, 1938. E. H. ZUM-BERGE 2,139,323

SELF EXPANDING AND CLEANING EARTH REAMER

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FIG. 1.

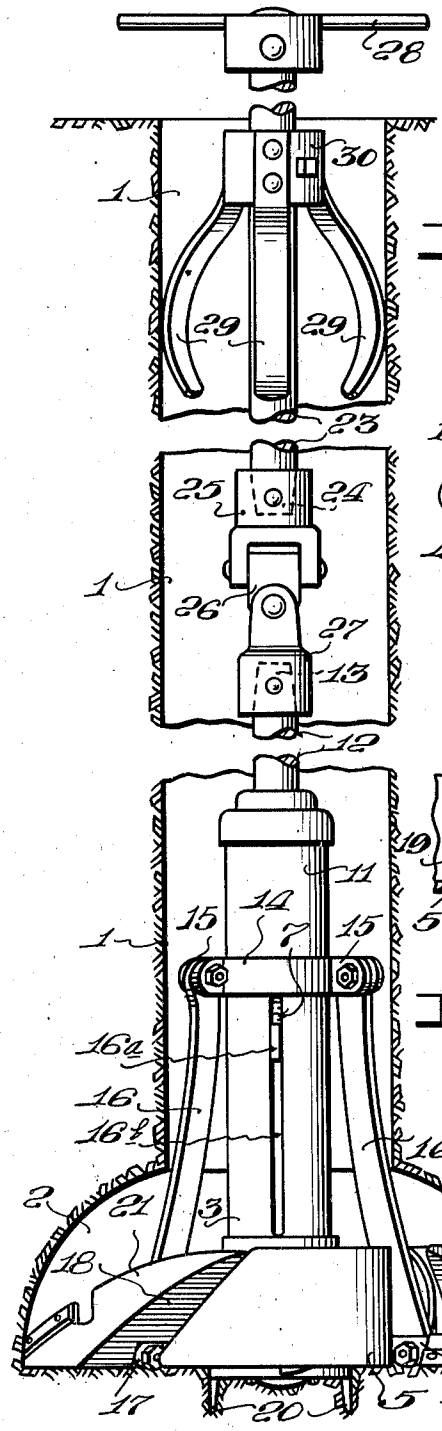



FIG. 2.

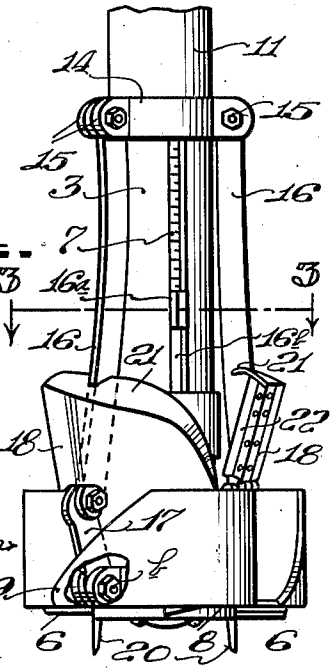



FIG. 4.

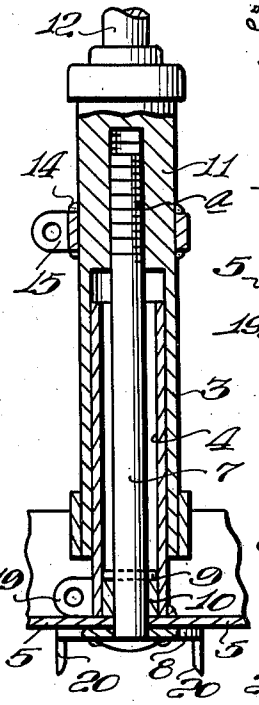



FIG. 3.

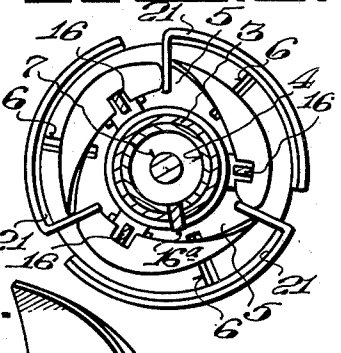
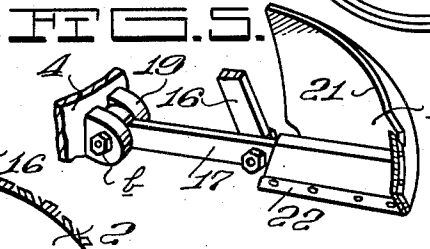



FIG. 5.




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FIG. 6.

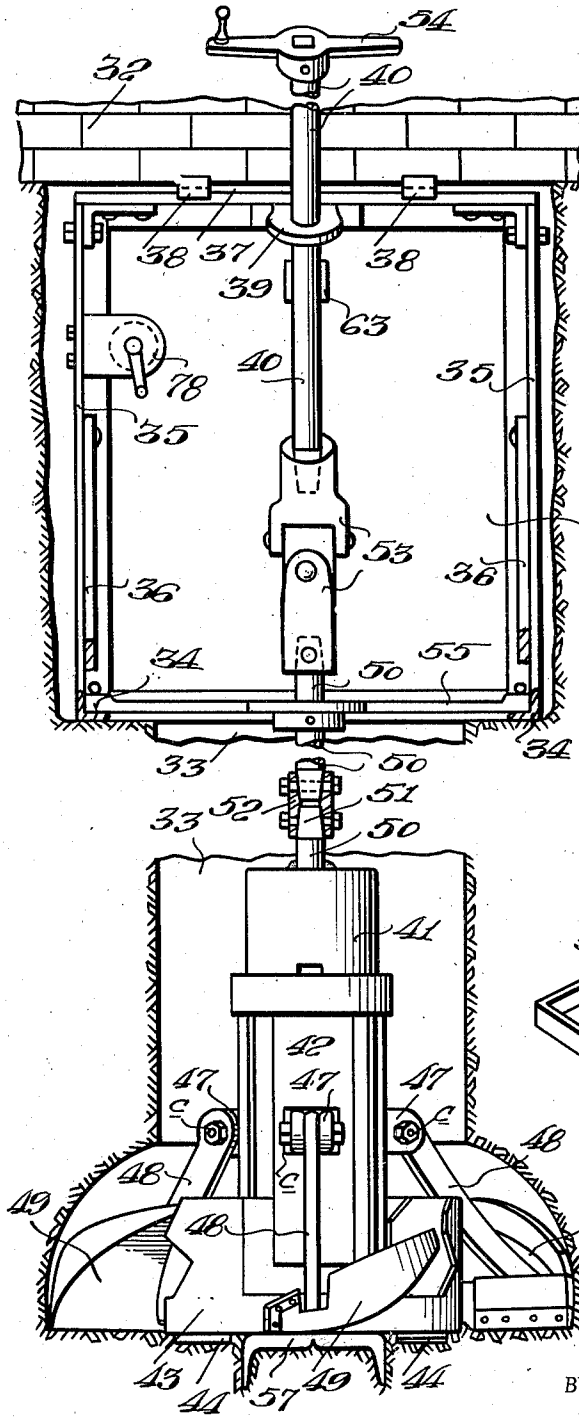



FIG. 8.

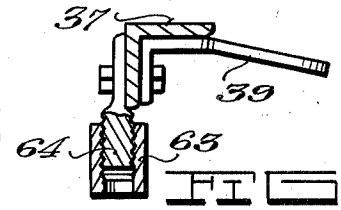



FIG. 10.

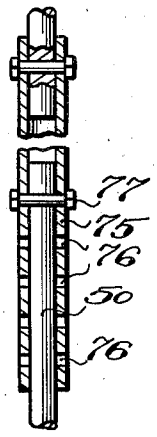



FIG. 9.

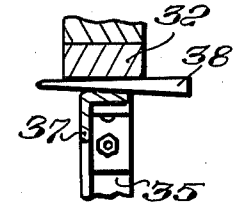
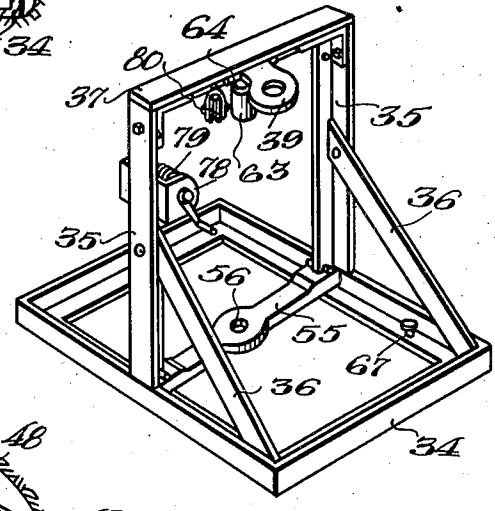



FIG. 2.




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SELF EXPANDING AND CLEANING EARTH REAMER

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FIG. 11.

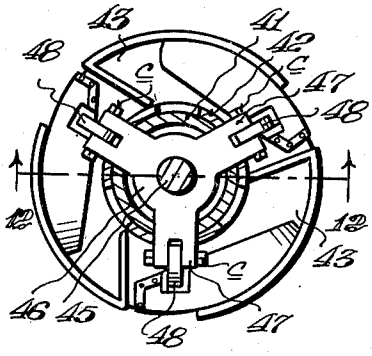



FIG. 13.

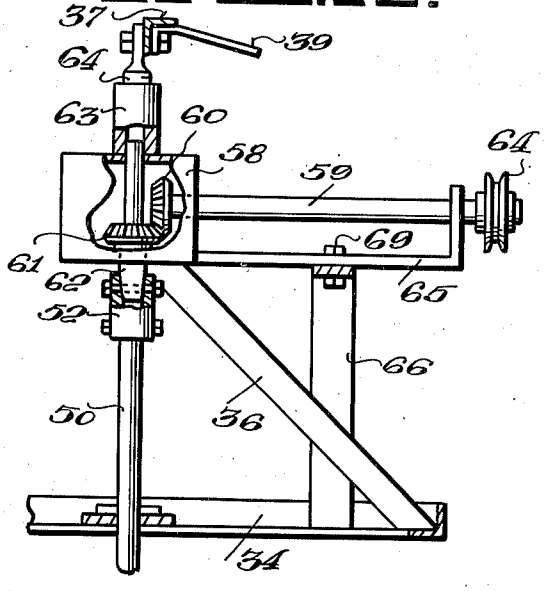



FIG. 12.

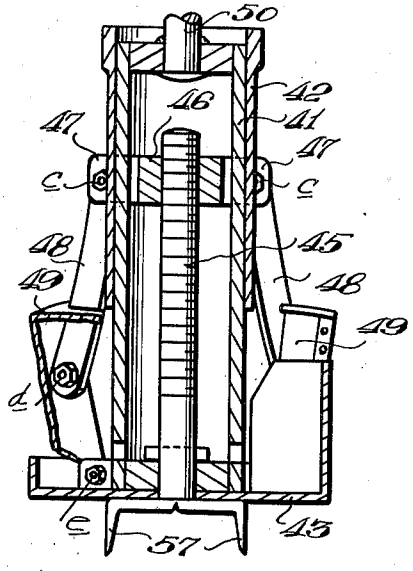



FIG. 14.

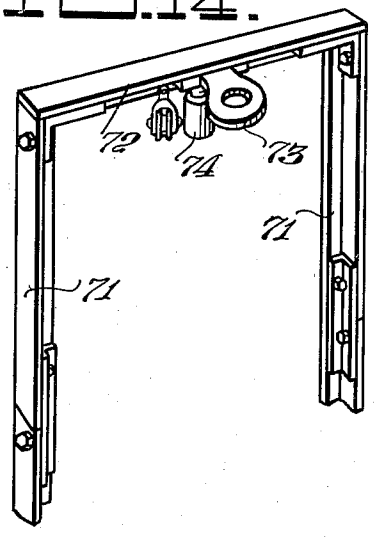
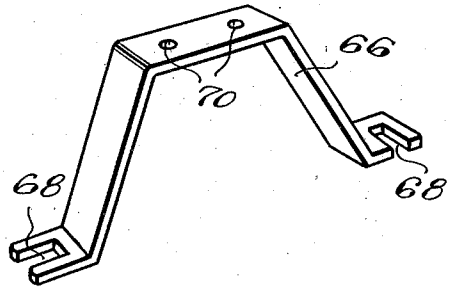



FIG. 15.




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Patented Dec. 6, 1938

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# UNITED STATES PATENT OFFICE

2,139,323

## SELF-EXPANDING AND CLEANING EARTH REAMER

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Application April 26, 1937, Serial No. 138,930

4 Claims. (Cl. 255—67)

This invention relates to underreamers and it has especial reference to self expanding and cleaning earth reamers.

The principal object of the invention is to provide an underreamer for enlarging the area at the bottom of a bore hole or other excavation in the earth for receiving pillars, piers and the like whereby a foundation is provided for a pier or the like of a more substantial nature than when set in a straight walled hole.

Another and equally important object of the invention, is to provide an apparatus capable of underreaming an excavation beneath the wall line of a building where it is necessary to reinforce the foundation of the building with additional piers, and this may be done through the medium of the invention so that these piers are substantially in vertical plane. By thus setting the piers, with an anchorage such as provided by underreaming, there will be no further tendency on the part of the building foundation, to settle as would be the case if the reinforcement was set up at an angle under the walls.

Another object of the invention is to provide for both manual and automatic operation of the underreamer through the provision of interchangeable elements conforming to the frame of the underreamer and adapted, each for its particular means of operation.

Another object of the invention is to provide for elevation of cuttings from the excavation by suitable power means thereby eliminating that this labor be done manually.

Another object of the invention is to provide means by which the cavity at the bottom of a hole or excavation may be made larger by the simple expedient of changing the blades of the tool, which operation requires but a minimum of time and labor.

Broadly, the invention seeks to provide simple apparatus for underreaming holes and excavations, both in close areas such as described and in open areas and in either case, the provision of self expanding underreamers, requiring only rotation of a common shaft at the surface to effect constant and uniform movement of the tool, with an underreaming action.

With the foregoing objects as paramount, the invention has particular reference to its salient features of construction and arrangement of parts which will become manifest as the description proceeds, taken in connection with the accompanying drawings, wherein:—

Figure 1 is an elevation of one form of the invention showing an underreamer for work in open areas.

Figure 2 is a fragmentary detail view showing the cutters contracted.

Figure 3 is a transverse section on lines 3—3 on Figure 2.

Figure 4 is a fragmentary detail view in vertical section.

Figure 5 is a fragmentary perspective view of one cutter and arm.

Figure 6 is an elevation of another form of underreamer for close and restricted areas, showing the cutters extended.

Figure 7 is a perspective view in detail of the frame supporting the operating gear for the underreamer.

Figure 8 is a fragmentary detail view, partly in section, showing the brace supporting the rotating shaft and centralizing socket for the operating gear.

Figure 9 is a fragmentary detail view of the wedging means, holding the frame rigid with respect to the mass under which the underreamer is operated.

Figure 10 is a detail view partly in section, showing the length adjustment of the shaft by which the underreamer is operated at a point spaced from its vertical axis.

Figure 11 is a transverse section of the tool shown in Figure 6.

Figure 12 is a section on lines 12—12 on Figure 11.

Figure 13 is a side elevation of the frame, power unit, centering and holding means.

Figure 14 is a perspective view of the means for increasing the effective height of the frame, and

Figure 15 is a detail perspective view of the support for the power unit shown in Figure 13.

Continuing with a more detailed description of the drawings, it is first pointed out that while the principle remains unchanged, the invention is embodied in two forms of underreamer, that is, one form whose length is affected as the cutters are moved and another form whose length remains the same as the cutters are displaced. The first form is employed in open and unrestricted areas while the companion form is particularly adapted for underreaming excavations or holes under a building foundation or other mass preparatory to the installation of auxiliary or additional supporting piers where the foundation has settled or is considered to be improperly reinforced. In either case, however, manipulation of the cutters is the same and the movement of these cutters is analogous.

In the following description, reference to the first mentioned form of the invention is made as illustrated in Figures 1 to 5 inclusive and in which the reference character 1 designates a hole in the earth, made by any type of drill or auger suitable for the purpose. The invention, with its cutters in the position shown in Figure 2 is then set in the hole 1, whereupon it is rotated to effect expansion of its cutter blades, in the arcuate manner shown in the bottom of the hole to create the cavity 2 therein. Afterwards, the operation is reversed to contract the cutter blades to enable the tool to be withdrawn and to remove, in convenient buckets or receptacles, surplus earth cuttings.

The tool is comprised primarily of a tubular body 3, into the lower end of which extends another tubular member 4. Affixed to the bottom of member 4 is a cylindrical element 5, which will be hereinafter referred to as a bucket and which is divided into as many compartments as there are cutter blades and in the present case, there are three of the latter. Hence these compartments, as the blades are elevated, receive cuttings from the blades for conveyance to the surface. In addition to being divided into compartments, the bucket 5 has radial slots 6 struck out of the bottom of each compartment, with blades on one edge, all projected in the direction of effective rotation of the bucket 5.

These blades are not intended entirely as cutting blades but merely a means to maintain vertical position of the tool as the cavity 2 is created by arcuate movement of the cutter blades.

Within the tubular member 4 is disposed axially, a threaded stem on shaft 7 which is held against longitudinal displacement relative to member 4 by a disc 8, affixed to its lower end below the bottom of the bucket 5 and a pin 9, extending transversely therethrough, above a bushing 10 within member 4 above the bottom of bucket 5. This construction is shown in Figure 4.

The shaft 7 therefore is free to rotate in the tubular member 4 and since its upper end is threaded into the solid portion 11 of the tubular body 3 at *a* (Fig. 4) the shaft 7 is constrained to move longitudinally as the body 3 is rotated, provisions for which rotation are made at the upper end of the body in the form of a stem 12 with a squared portion 13 (Fig. 1) on its extreme upper end, and to which further reference will be later made.

Surrounding the body 3 intermediate its ends is a collar 14, welded or otherwise affixed thereto. Projecting from this collar at three equidistant points are ears 15. Pivoted in these ears are the upper ends of downwardly directed arms 16. The lower ends of arms 16 are pivoted to arms 17 (Fig. 5) and which latter arms are rigidly attached to the cutters 18 adjacent one end and pivoted at their opposite ends at *b* to ears 19, affixed to the lower end of the inner tubular member 4, (Fig. 4) which fixation point is, of course in alinement with the pivotal point 15 of the upper ends of arms 16 on the tubular housing or casing 3. In order to prevent undue strain on arms 16 in the operation of the tool, a key 16ª is affixed to the tubular member 4 and extends through a slot 16ᵇ in the body 3.

Accordingly, when the anchor pins 20 of the disc 8 (Figs. 1, 2 and 4) are set into the bottom of the hole 1 and the tubular casing 3 rotated, the shaft 7 will remain stationary while the casing 3 will move downward telescopically thereover and in so doing, will urge the arms 16 downward, exerting a force on the arms 17 to cause the cutters 18 to move outward arcuately, due to their pivotal connection at *b* to the bottom of sleeve 4 which likewise remains stationary with the shaft 7.

The particular construction of the cutter blades 18 is such that they will retain the cuttings, being provided with walls 21 which curve inward toward the common rotating axis of the blades from the relative radius of the cutting edges 22 thereof and which edges are interchangeable or replaceable. Thus, the earth cuttings which are displaced in the downward operation of the blades are received by the cylindrical element or bucket 5 of the tool when the cutter blades are contracted by reverse rotation of the body 3, for conveyance to the surface for disposal.

The means by which the tool is operated in the hole 1 may be a form of device such as shown in Figure 1, consisting of a shaft 23, having a squared end 24 received by a socket 25 of a universal joint 26. Another and similar socket 27 of this joint receives the squared pin 13 of the casing 3 of the underreamer.

The shaft 23 extends out of the hole 1 and carries a cross arm 28 or other means to effect rotation of the shaft 23, thereby to operate the underreamer.

A guide or centering device, shown in Figure 1 is comprised of a series of flexible arms 29, depending from a collar 30, secured to the shaft 23. By this means, the shaft is held in a central position in the hole without interference with uniform rotation of the body of the tool in the hole.

Referring now to the form of the invention shown in Figures 6 to 15 inclusive, it is pointed out in Figure 1 that the heretofore difficult problem of underreaming an excavation or hole beneath the foundation of a building is rendered less difficult by the invention. An excavation 31 is made directly under the wall 32 of the building, at the point selected for additional reinforement. A hole 33 is bored to a desired depth, and the underreamer inserted into the hole.

However, to make the work easier, a frame such as shown in Figures 6 and 7 is disposed in the cavity 31 and is comprised of an angle iron base 34 which is disposed on the bottom of the cavity 31. A pair of uprights 35 extend upward from the frame and are braced by a pair of angular members 36 (Fig. 7). A cross member 37 extends from the top of one upright 35 to the other.

To secure the frame against displacement from its position shown in Figure 6, wedges 38 are driven into the space between the cross-member 37 and the lower edge of the wall or building foundation 32 (Figures 6 and 9).

The frame is further provided with a projecting bearing 39, secured to the cross-member 37 midway between its ends and serves as an upper bearing for the operating or driving shaft 40 for the underreamer, and to which further reference will be made presently.

The tool comprising the present form of the invention, like the form set forth in the foregoing, has a cylindrical or tubular body 41, about which is a skeleton sleeve 42. Carried upon the lower end of the body 41 is a segmental or partitioned bucket or receptacle 43 having slots 44 in its bottom, serving as blades to collect surplus cuttings from the bottom of the hole as the tool is rotated.

Within and in axial alignment with the body 41 is a threaded rod 45 and threadedly engaged with this rod is a spider 46 having arms 47. These arms are bifurcated at their outer ends to pivotally receive at c, the arms 48, which latter, at their lower ends, are pivoted at d (Fig. 12) to the blades 49 at a point adjacent their cutting edges and midway between the outer and inner ends of these blades.

The blades 49 are pivoted at e (Fig. 12) at points equally spaced about the lower end of the body 41 and these blades have side walls to define a sort of shovel to retain the earth cuttings as they are loosened. When the blades are contracted or moved to the position shown in Figure 12 after operating in the hole, the retained cuttings are dumped into the bucket or receptacle 43 for conveyance to the surface as the tool is withdrawn from the hole.

To operate the tool, a shaft 50 is affixed to the upper end of the body 41 and has a squared end 51 (Fig. 6). Over this end is disposed one end of a tubular extension 52 which is employed in cases where the hole 33 is of such depth that the squared portion 51 of shaft 50 will not rise above the base 34 of the frame shown.

The shaft 40 (Fig. 6) has a universal joint 53, the lower end of which is provided with a socket to engage over the squared upper end of the shaft 50. The universal joint 53 enables shaft 40 to be operated at an angle with respect to the rotating axis of the tool so that the latter may be operated vertically while shaft 40, held rotatably by bearing 39 may extend from under the obstructing foundation or wall 32 for rotation.

A crank 54 or other means for operating shaft 40 is provided thereon.

When the underreamer is properly stationed in the hole 33, a cross brace 55 is moved into a position from one side of the base 34 of the frame to the other so that the shaft 50 of the tool will be received in the aperture 56 in the said cross brace 55, thereby holding the tool in a central position in the hole. The universal joint 53 is then mounted on the shaft 50, after which the operating shaft 40 is inserted through the aperture in the projecting bearing 39 and engaged with the other section of the universal joint 53. The anchoring means 57, affixed to the lower end of the screw rod 45 prevents rotation of the latter and allows the body 41 to revolve about the same and since the body carries the cutter blades 49, these are rendered operative to uniformally cut the earth and to move outward as the spider 46 travels on the threads of the rod 45.

In some cases it is desirable to employ power means to operate the underreamer. Such a means is shown in Figure 13 in which a gear box 58 is provided having a horizontal shaft 59 carrying a gear 60, disposed within the gear box 58. This gear is enmeshed by a gear 61, which is connected with the extension coupling 52 of shaft 50, the latter driving the underreamer just described. The stub shaft 62 extends through the top of the gear box 58 and is received by a socket or sleeve 63 (Fig. 8) which socket is threaded onto a depending threaded member 64, secured to the cross member 37. By maniplating the socket or sleeve 63 the power unit described may be secured or removed from its position in the frame, as shown in Figure 13.

The shaft 59 of the power unit carries a pulley 64, disposed on the outside of a reinforcing brace 65, extending from the gear box 58 to a point adjacent said gear and is turned upward and apertured to receive the said shaft 59. This pulley 64 is grooved to receive a belt, particularly of the V-type but it is understood that a sprocket, gear or other type of driving means may be employed.

In order to support the power unit described, in the frame, a mounting 66 (Fig. 15) is provided and secured in the frame by bolts 67 (Fig. 7) on the base 34 of the frame which are received by slots 68 in the legs of the mounting 66. Bolts 69, (Fig. 13) received by apertures 70 in the mounting 66 hold the power unit in secure position in the frame as the same is operated to transmit rotary motion in the underreamer.

Should it be desired to increase the height of the frame shown in Figure 7, the structure illustrated in Figure 14 is provided. This arrangement consists of uprights 71 of angle iron, whose lower ends are bolted to the sides of the uprights 35 of the frame (Fig. 7). These uprights 71 have a cross member 72, similar to the member 37, in Figure 7, even to the projecting bearing 73 for the reception of an operating shaft, comparable to the shaft 40 in Figure 6, and the threaded socket or sleeve 74, comparable to the element 63 in Figure 7, for rigidifying the power unit shown in Figure 13 and just described.

In some cases, the shafts, such as the shafts 40 and 50 in Figure 6, must be elongated. An arrangement for this adjustment is shown in Figure 10 wherein is illustrated a sleeve 75, slidable on the shaft to be elongated, and is provided with aligned apertures 76 for the reception of a bolt 77, which extends through an aperture in the shaft 50 or 40 as the case may be.

In order that the labor of removing the underreamer laden with cuttings from the hole may be lessened, a winch 78 is provided, carrying a line 79, to be received over a pulley 80, thence into the hole to be connected to the underreamer, thereby to elevate the same to the surface after the desired cavity has been made.

Manifestly, the construction as shown and described is capable of some modification and such modification as may be construed within the scope and meaning of the appended claims is also considered to be within the spirit and intent of the invention.

What is claimed is:

1. An underreamer including a threaded shaft having prongs at its lower end to engage the earth at the bottom of a bore hole, a base portion defining a plurality of buckets, an underreaming cutter hingedly attached to each of said buckets, a spider threadably mounted on said shaft, toggle means interconnecting said spider and each of said cutters whereby said cutters are arcuately actuated as said base and cutters are rotated about said shaft.

2. An underreamer including a cylindrical body arranged to be disposed in a bore hole, a segmental bucket mounted adjacent the lower end of said body, a cutter blade pivoted to each of the segments of said bucket, screw means within said body and anchored in said bore hole, a spider threadably connected to said screw means, toggle means interconnecting said spider and each of said cutter blades, and surface means to rotate said body whereby to actuate said cutter blades to underream said bore hole.

3. An underreamer including a cylindrical body arranged to be disposed in a bore hole, earth cutting means pivoted to said body, screw means within said body and anchored in said bore hole, a spider threadably connected to said screw

means, toggle means interconnecting said spider to said earth cutting means, surface means to rotate said body to move said earth cutting means arcuately and in a spiral path as said body is rotated.

4. Apparatus for underreaming a bore hole beneath an obstructing mass comprising a rotatable body having radially disposed and arcuately displaceable cutter blades operatively connected thereto, screw means within said body and anchored in said bore hole, a spider threadably connected to said screw means, toggle means interconnecting said spider to said cutting means to impart movement thereto, a shaft connected to said body having surface means to rotate said shaft and said body.

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