This invention relates to improvements in under reaming devices for under reaming holes for foundations thereby enabling the footings or any intermediate point of the hole to be enlarged materially so as to provide a greater bearing area when filled with concrete or the like. Various under reamers have been proposed heretofore, but these for the most part have been cumbersome in construction and use, which has precluded their acceptance in the construction field where such a device would have the widest use.

The present device may be used in conjunction with a regulation power hole digger, and may be used to enlarge the hole at the bottom thereof or at any intermediate point, at the will of the operator. The device may be so arranged as to automatically feed the cutters outward in proportion to the revolutions of the rotary table or the cutters may be expanded outward manually to give the desired degree of expansion, up to the maximum capacity. The device may be provided with removable cutter teeth which teeth may be hard surfaced if desired, to make the under reamer adaptable for use on many types of earth formation.

An object of this invention is to provide an under reaming device the cutters of which may be manually adjusted while the device is being operated.

Another object of this invention is to provide an under reaming device that may be positioned within a hole and expanded to the desired degree so as to cut an enlargement at the bottom of the hole or at any intermediate point between the top and bottom thereof.

Yet another object of the invention is to provide an under reaming device having expandable cutting elements with removable toothed sections.

A still further object of the invention is to provide a device the rotary table of which may be readily removed to permit the withdrawal of the expandable cutter elements through the opening formed by the removal of the rotary table.

Still another object of this invention is to provide a self contained under reaming unit that provides driving, lifting and expanding mechanism for the operation of the unit.

An embodiment of this invention is illustrated in the accompanying drawings, in which:

Fig. 1 is a side elevational view of the device with parts broken away and shortened and showing diagrammatic representation in section of the manner of operation;

Fig. 2 is a fragmentary vertical sectional view through the rotary table with parts shown in elevation to show the construction of the rotary table and associated parts;

Fig. 3 is an enlarged fragmentary view with parts broken away and shown in section of the automatic under reaming expander feed control;

Fig. 4 is a perspective view showing the under reamer and the rotary drive table and associated mechanism together with the drill stem;

Fig. 5 is a horizontal sectional view taken above the under reamer cutters and looking downward, with parts broken away and shown in section to show the details of construction and showing the under reamer cutters in expanded position;

Fig. 6 is a fragmentary top plan view of a portion of the rotary table and associated feed mechanism and showing the drill stem in section; and

Fig. 7 is a fragmentary sectional view through the removable cutter portion of the under reamer showing the attachment of the under reamer blades.

With more detailed reference to the drawing, the numeral 1 designates a vehicle for the transportation of the under reaming device from place to place. The entire under reamer unit, generally designated at 2, is mounted on a frame 3 comprising a power unit 4, a clutch mechanism 5, a transmission 6 out of which extends a drive shaft 7. A bevel gear 8 is positioned on the end of drive shaft 7 and meshes with a complementary bevel ring gear 9 which forms a rotary table, as will best be seen in Figs. 1 and 2, and 4. The rotary table is journaled on a bearing 10 and has removable spaced hold-down lugs 11 at spaced intervals around the periphery of the rotary table in overlapping relation so as to keep the rotary table in place, yet allow the rotary table to be readily removed when necessary to remove the expandable reamer, as will be more fully described hereinafter. The rotary table, generally designated by the numeral 12, has a squared axial opening 13 throughout which opening slidable receives a drill stem 14. A boom or derrick 15 is supported on frame 3 so as to position a sheave 16 over the rotary table in such manner that a cable 17 will align substantially with the center of the axial opening 13 therein. A swivel member 18 interconnects drill stem 14 with cable 17 to permit turning action of the drill stem 14 by rotary table 12 without twisting the cable 17. The cable 17
may be spooled on a hoist 10 and payed out a
given amount to lower the under reaming element
20 into a bore hole 21 to perform the under reaming
operation, such as shown at 22 and 22a in Fig. 1.
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A pair of squared shafts 32 extend upward
through bushings 33 in rotary table 12, which
bushings have sprockets 34 on the respective ends
thereof around which sprockets a chain 35 passes
and which chain also passes around sprocket 31 so
that the turning of bushing 33 is imparted to under reamer
elements 25 to permit these to be moved outward or to
enable these under reamer elements to be forcibly
retracted.

The under reamer elements 25 carry removable
cutter blades 36 which preferably have serrated
dgedges. The cutter blades 36 are bolted to the outer ends of the under reamer elements 25 by bolts 37. These bolts are preferably recessed as shown in Fig. 7, to prevent wear on the bolts
and impingement of material against the bolts.

When the under reamer elements 25 are fully retracted, as indicated in Fig. 1, they may easily
pass into the shaft or hole indicated at 21 and
be either manually expanded outward by crank
30 or permitted to expand outward upon rotation
of the rotary table as will be more fully described
hereinafter.

As pointed out above, the squared shafts extend
upward through rotary table 12 and are slidably
in bushings 33, which bushings are rotatable and
journalled within rotary table 12 and fixed against
longitudinal movement by set collar 33a held in
place by a set screw as shown in Fig. 3.

The sprocket 34 is made integral with bushing
33 and is removable with rotary table 12 as a
composite unit including chain 35 and sprocket
31, by loosening of bolts 11a which enables the
swinging of lugs 11 to one side to permit the lift-
ing of the rotary table 12 from bearings 18 either
upon the removal of bevel gear 8 or the bearing
member 7a.

In certain types of earth formation or strata,
the cutter elements 25 may be fed outward at a
predetermined rate in accordance with the revolu-
tions of the rotary table 12. To do this, a cam
actuating bar 38 is moved inward as indicated in
full outline in Fig. 6, until the bar extends over a
circular path defined by cam 39, which cam is
mounted on a pawl 40, which pawl is pivotally
mounted on a bolt 40a by a pair of upstanding
lugs 40b, which lugs are attached to the upper
face of the rotary table 12.

The cam 39 is adjustable on the angular face
of the heel of pawl 40 as indicated in Fig. 3, so
as to vary the amount of the depression of the
pawl and the length of time of engagement
thereof with the cam bar 38, and the pawl 40 is
forced into engagement with ratchet wheel 41 by
a spring 42 mounted under the heel of the pawl
40. Upon rotation of under reamer element 25, the blades 36 are so positioned as to dig into the
wall of the hole and urge the cutter elements 25
outward, but the outward movement is restrained
by means of a rope or cable 27 which is wound
around pawl 40, and which pawl 40 and ratchet
wheel 41 are restrained against movement by engage-
ment of pawl 40 with ratchet wheel 41 formed
on the upper face of sprocket 31 as will best be
seen in Figs. 3 and 4. However, upon lifting of
pawl 40, either manually or by the action of cam
39 engaging cam bar 38 upon circular movement of
the rotary table thereunder, the cam will de-
press the heel of pawl 40 allowing the under reamer
elements 25 to swing outward, but if the
pawl 40 will pass under the pawl 40 before the pawl engages with the ratchet wheel 41. The ratchet wheel 41
and integral sprocket 31 are journaled on up-
standing shaft 42 that extends upward from below
the rotary table 12. Rotation of the table 12
causing the upwardly turning shaft 42 is
restrained by using pawl 40 and sprocket 31
as described above.

Operation

In preparing footings for certain foundations,
it is often desirable to under ream the footings so
as to present a much larger bottom surface
within the foundation hole, or it may be desirable
to present a larger surface at some intermediate
place within the foundation hole, or in other
types of construction it may be desirable to under
ream a shaft or hole at some particular point
without the necessity of weight having to be
applied to the drill stem, as has been the case
with underreamers in use here-tofore.

To under ream a footing either at the bottom
or at any point thereabove, if generally designated at 20, is lowered by hoist 10 and

Tcable 17 until properly positioned. At this
point the crank 30 may be manipulated so as to
enable squared shafts which are in geared rela-
tion with sprocket 31 to be rotated until the
pointer 44 indicates the desired number of inches,
as shown in Fig. 6, at which the under reaming
or cutting is to start. Then, by the manipulation
of crank 30 and pawl 40, cable 27 is paid out of

shaf 28 in a gauged amount to permit the under
reamer elements 25 to swing outward, as illus-
trated in Figs. 4 and 5. Although, if desired, the
cam actuating bar 38 may be moved inward so
that upon rotation of the rotary table 12, by
means of power unit 4, the cam 39 will cause
under cam actuating bar 38 to lift pawl 40 for a prede-
termined time so that ratchet wheel 41 will rotate
one or more notches to pay out cable 27 at a
uniform rate for each revolution of the rotary
table 12. As indicated above, the rotary table 12
is driven by pinion 8 in mesh with teeth on the
table 12 is rotated, the drill stem 14
is suspended by swivel 18 and cable 17 so as to
maintain the under reamer at the desired posi-
tion until the complete under reaming operation
is performed.
As the earth is removed from the side walls of the bore hole 21, the cutter elements 25 receive the loose dirt thereinto until the cutter elements are approximately filled, at which time the under reamer elements 25 are retracted by manipulation of crank 38, after which the drill stem 14 is lifted upward by cable 11 and hoist 19 to a position seen in Fig. 1, if the earth formation therein removed either manually or by the rotary table being reversed and the earth slung out by centrifugal force, as soon as the earth is removed the cutter elements 25 are retracted and the under reamer lowered into the hole and the operation repeated until the desired results are obtained.

It is to be pointed out that a circular plate 23 is positioned below the cutter elements 25 to give additional support to the cutter elements and also to form a table on which part of the loose earth formation may rest until the tool is withdrawn and elements 25 retracted.

To operate the device without the automatic feed feature, of the cam actuating bar 38 and cam 38, the bar 38 may be retracted as indicated in dashed outline in Fig. 6, and held in this retracted position by a set screw 45, screw threaded into bracket 48, which bracket is attached to the frame member 3 exterior of the rotary table 12.

It is to be further pointed out that the cutting element or serrated blade 36 is easily removable for replacement or resurfacing with hard material as desired.

Having thus described the invention, what is claimed is:

1. In an earth under reamer the combination of an under reamer stem, a pair of longitudinal, spaced supports secured to said stem near the lower end thereof, a pair of hollow under reamer buckets each of which has an arcuate side wall, a top plate and a bottom plate secured to the respective upper and lower extremities of said side walls, each of said buckets being pivotally mounted at one end between said support members, a blade member on the respective ends of said bucket members being arranged in opposed relation, means for limiting the outward movement of said bucket members, a blade on the respective ends of said hollow buckets opposite the pivoted ends, said bucket members being arranged in opposed relation, means for limiting the outward movement of said bucket members a gauged amount, and means remote from said buckets for moving said buckets inward.

2. In an earth under reamer the combination of an under reamer stem, a pair of longitudinal, spaced supports secured to said stem near the lower end thereof, a pair of hollow under reamer buckets each of which has an arcuate side wall, a top plate and a bottom plate secured to the respective upper and lower extremities of said side walls, each of said buckets being pivotally mounted at one end between said support members, a blade member on the respective ends of said hollow buckets opposite the pivoted ends, said bucket members being arranged in opposed relation, means for limiting the outward movement of said bucket members a gauged amount, and means remote from said buckets for moving said buckets inward.

3. In an earth under reamer the combination of an under reamer stem, a pair of longitudinal, spaced supports secured to said stem near the lower end thereof, a pair of hollow under reamer buckets each of which has an arcuate side wall, a top plate and a bottom plate secured to the respective upper and lower extremities of said side walls, each of said buckets being pivotally mounted at one end between said support members, a blade member on the respective ends of said hollow buckets opposite the pivoted ends, said bucket members being arranged in opposed relation, means for limiting the outward movement of said bucket members, a blade on the respective ends of said hollow buckets opposite the pivoted ends, said bucket members being arranged in opposed relation, means for limiting the outward movement of said bucket members a gauged amount, and means remote from said buckets for moving said buckets inward.

4. In an earth under reamer the combination of an under reamer stem, a pair of longitudinal, spaced supports secured to said stem near the lower end thereof, a pair of hollow under reamer buckets each of which has an arcuate side wall, a top plate and a bottom plate secured to the respective upper and lower extremities of said side walls, each of said buckets being pivotally mounted at one end between said support members, a blade on the respective ends of said hollow buckets opposite the pivoted ends, said bucket members being arranged in opposed relation, means for limiting the outward movement of said bucket members, a blade on the respective ends of said hollow buckets opposite the pivoted ends, said bucket members being arranged in opposed relation, means for limiting the outward movement of said bucket members a gauged amount, and means remote from said buckets for moving said buckets inward.

5. In an earth under reamer the combination of an under reamer stem, a pair of longitudinal, spaced supports secured to said stem near the lower end thereof, a pair of hollow under reamer buckets each of which has an arcuate side wall, a top plate and a bottom plate secured to the respective upper and lower extremities of said side walls, each of said buckets being pivotally mounted at one end between said support members, a blade on the respective ends of said hollow buckets opposite the pivoted ends, said bucket members being arranged in opposed relation, means for limiting the outward movement of said bucket members, a blade on the respective ends of said hollow buckets opposite the pivoted ends, said bucket members being arranged in opposed relation, means for limiting the outward movement of said bucket members a gauged amount, and means remote from said buckets for moving said buckets inward.

6. In an earth under reamer the combination of an under reamer stem, a pair of longitudinal, spaced supports secured to said stem near the lower end thereof, a pair of hollow under reamer buckets each of which has an arcuate side wall, a top plate and a bottom plate secured to the respective upper and lower extremities of said side walls, each of said buckets being pivotally mounted at one end between said support members, a blade member on the respective ends of said hollow buckets opposite the pivoted ends, said bucket members being arranged in opposed relation, means for limiting the outward movement of said bucket members, a blade on the respective ends of said hollow buckets opposite the pivoted ends, said bucket members being arranged in opposed relation, means for limiting the outward movement of said bucket members a gauged amount, and means remote from said buckets for moving said buckets inward.
extending upwardly substantially parallel with said stem, means for operatively rotating each of said parallel shafts, means connected with each of said shafts for operatively moving the respective buckets, and means for holding said shafts in adjusted position.

7. In an earth under reamer the combination of an under reamer stem, a pair of longitudinal, spaced supports secured to said stem near the lower end thereof, a pair of hollow under reamer buckets each of which has an arcuate side wall, a top plate and a bottom plate secured to the respective upper and lower extremities of said side walls, each of said buckets being pivotally mounted at one end between said supports, a blade member on the respective ends of said hollow buckets opposite the pivoted ends, said bucket members being arranged in opposed relation, a pair of shafts journaled in said spaced supports near the outer ends thereof and extending upwardly substantially parallel with said stem, a sprocket mounted on each of said shafts in driving relation thereto and relatively slidable therein, a chain encircling said sprockets on said shafts and also encircling a drive sprocket, means for rotating said drive sprocket to simultaneously rotate said parallel shafts, means for holding said drive sprocket in an adjusted position and cable means connected with each of said shafts and to the outer end of each of said buckets to adjust said buckets in direct relation to the rotation of said shafts.

8. In an earth under reaming device a base, a rotary table mounted on said base for rotation relative thereto, power means for driving said rotary table, gearing for connecting said rotary table and said power means for rotating said rotary table, an aperture formed axially of said rotary table to slidably receive a stem, said stem being mounted in said aperture for unitary rotary movement with said rotary table, means connected to said stem for lowering said stem, a pair of spaced, longitudinal supports secured to said stem near the lower end thereof, a pair of hollow under reamer buckets each of which is pivotally mounted at one end between said support members, a blade member on the respective ends of said hollow buckets opposite the pivoted ends, said buckets being arranged in opposed relation, a pair of shafts each of which is journaled in said spaced supports and extending upwardly substantially parallel with said stem, a sprocket on each of said shafts which sprockets are journaled on said rotary table and slidable relative to said shafts and rotateable therewith, a further sprocket journaled on said rotary table and having a ratchet formed thereon, a chain passing around said sprockets so as to operatively connect said sprockets on said shafts with said sprocket on said rotary table, a pawl cooperating with said ratchet for releasing said sprocket having a ratchet formed thereon for rotation of said sprocket a predetermined amount, cam means for actuating said pawl in timed relation with the rotation of said rotary table, and means connected with each of said shafts and each of said buckets to adjust each of said buckets in direct relation to the rotation of said shafts.

9. In an earth under reamer the combination of an under reamer stem, a pair of spaced, longitudinal supports secured to said stem near the lower end thereof, a pair of hollow, semi-oval under reamer buckets each of which has an arcuate side wall, a top plate and a bottom plate secured to the respective upper and lower extremities of said side walls, each of said buckets being pivotally mounted at one end between said support members, a blade on the respective ends of said hollow, semi-oval under reamer buckets opposite the pivoted ends, said bucket members being arranged in opposed relation, means for limiting the outward movement of said bucket members, and means remote from said buckets for moving said buckets inward.

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