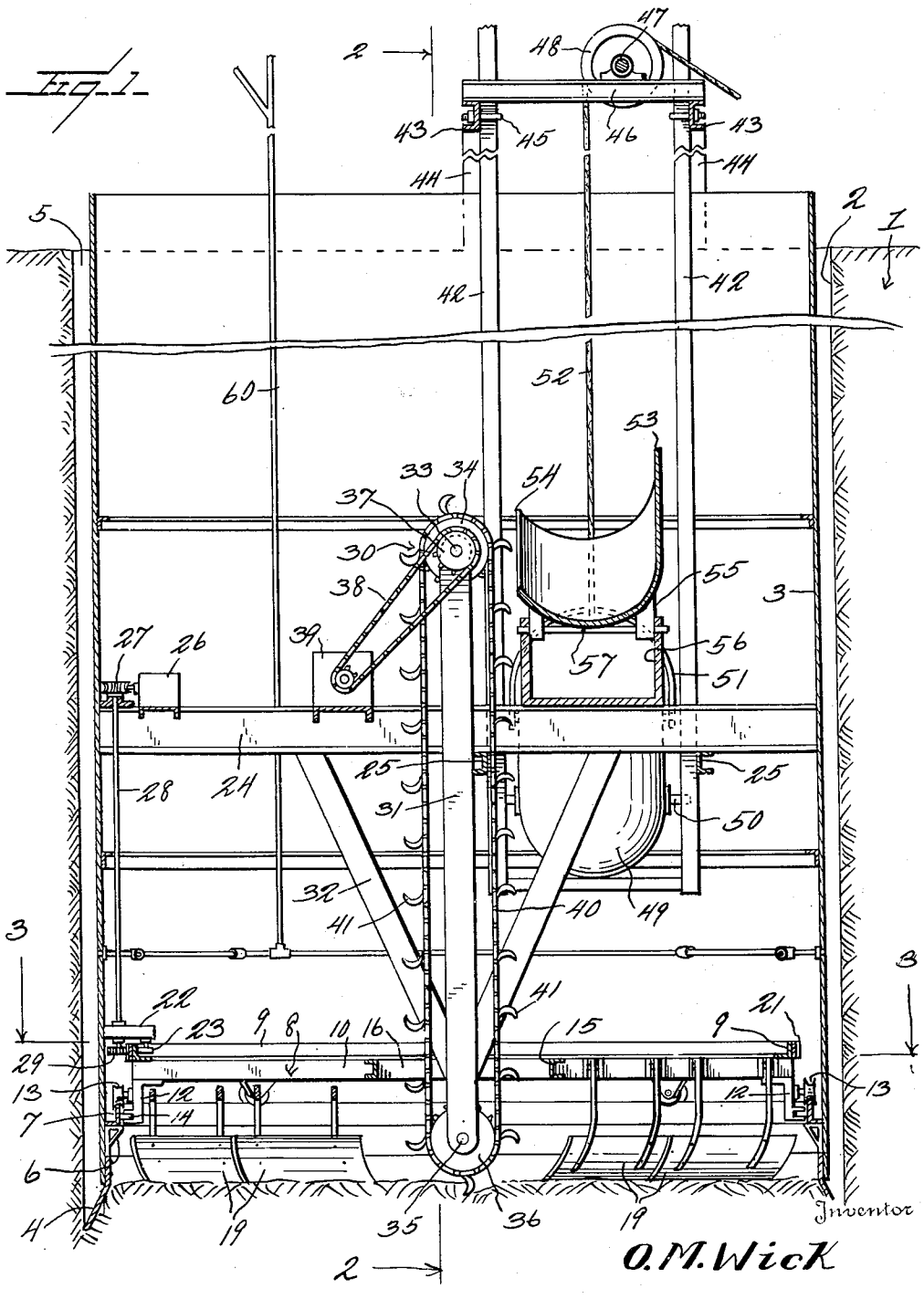
Nov. 12, 1940. O. M. WICK 2,221,226

SHAFT SINKING AND EXCAVATING DEVICE

Filed Feb. 8, 1940 3 Sheets-Sheet 1

Fig. 1.



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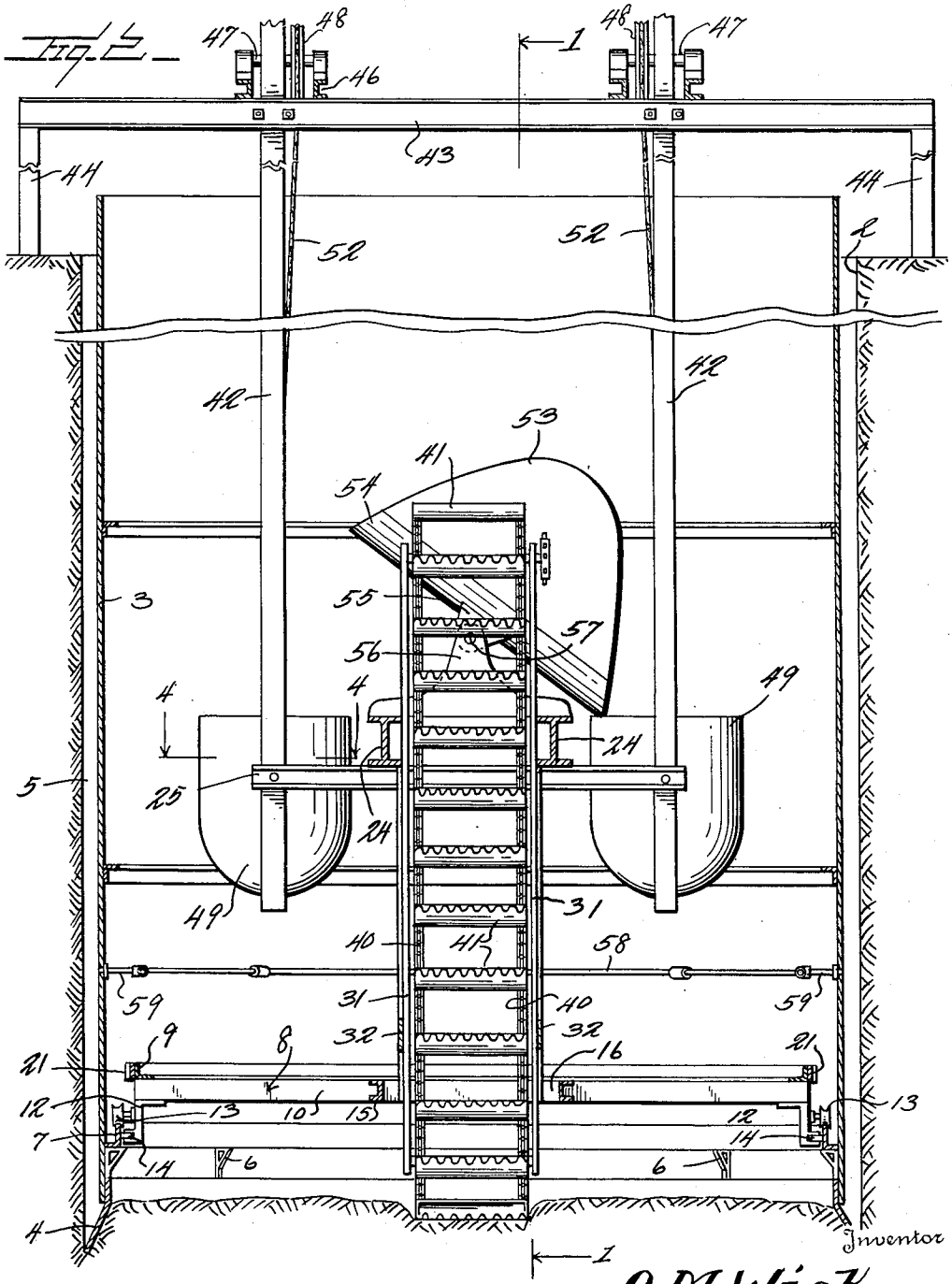
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SHAFT SINKING AND EXCAVATING DEVICE

Filed Feb. 8, 1940 3 Sheets-Sheet 2

Fig. 2



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SHAFT SINKING AND EXCAVATING DEVICE

Filed Feb. 8, 1940 3 Sheets-Sheet 3

Fig. 3

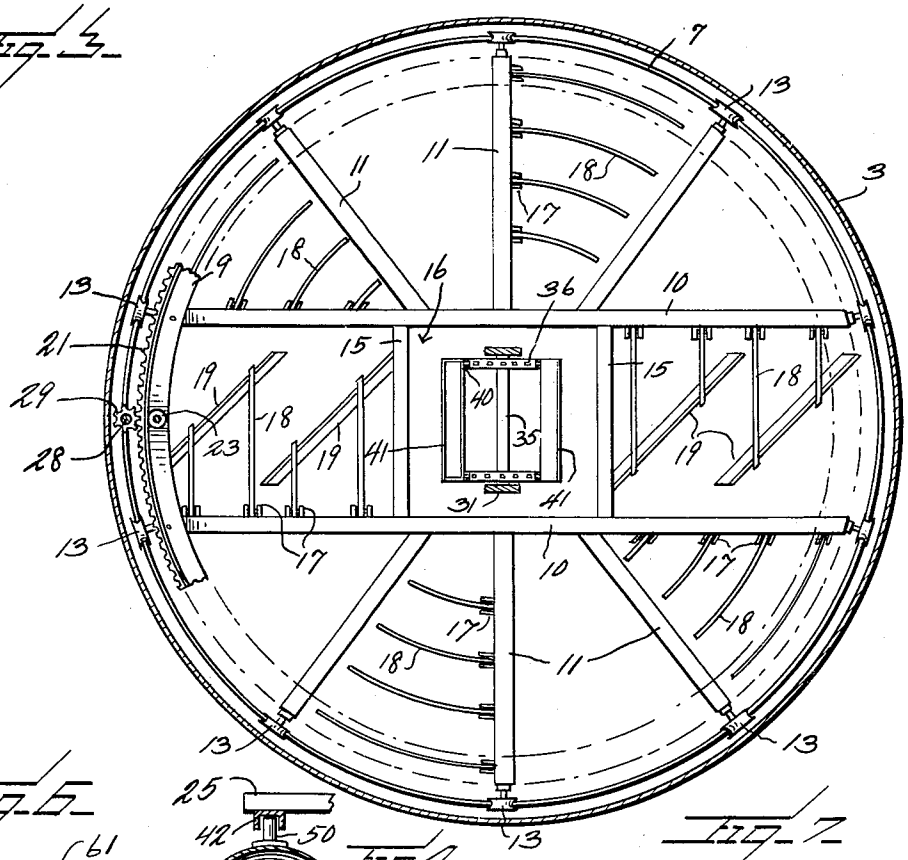


Fig. 6

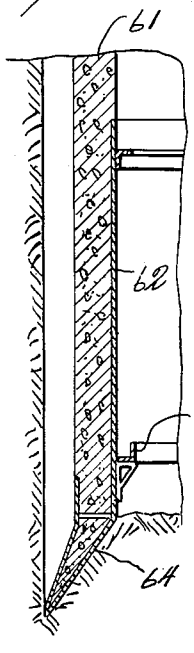


Fig. 4

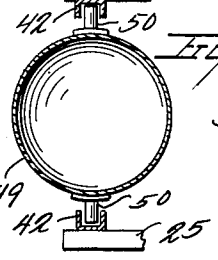


Fig. 5

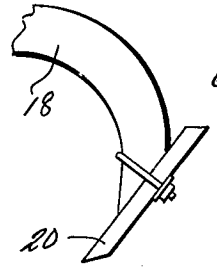
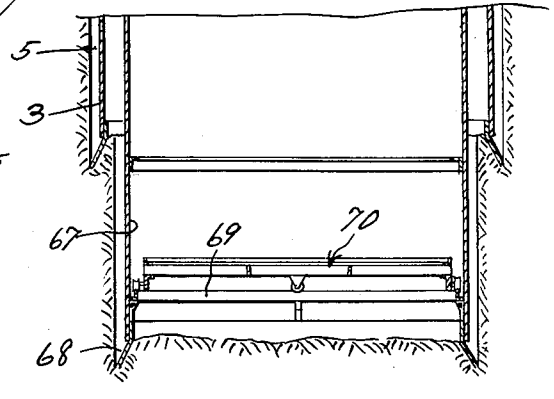


Fig. 7



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UNITED STATES PATENT OFFICE

2,221,226

SHAFT SINKING AND EXCAVATING DEVICE

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Application February 8, 1940, Serial No. 317,992

14 Claims. (Cl. 262—7)

This invention relates to improvements in devices or machines for sinking shafts or for forming excavations in the earth and pertains particularly to such a device which is designed for operation in soft water-soaked earth such as bogs or quicksands or beneath water-covered areas.

A primary object of the present invention is to provide a shaft sinking and excavating device which is designed to facilitate the sinking of shafts in the earth under water or in quicksand-covered areas in such manner that a form retaining caisson is lowered into the excavation as the earth is removed and the collapsing of the walls of the excavation against the wall of the caisson is prevented whereby the caisson is lowered under its own weight.

Another object of the invention is to provide a shaft sinking device wherein means is provided for forming the shaft of a diameter slightly greater than the diameter of the caisson which is lowered thereinto, whereby the space between the caisson and the wall of the shaft may be filled with fluid or mud to hold up the wall of the shaft and to permit the caisson to sink of its own weight into the excavated area.

A further object of the invention is to provide in a shaft sinking device of the character above described, a novel means for digging up or loosening the earth within the area defined by a caisson and conveying the loosened earth to the top of and discharging it from the caisson by means of alternately operated elevators whereby a continuous operation of the mechanism is obtained.

A still further object of the invention is to provide a shaft sinking and earth excavating device employing a novel means for digging up and removing the earth from the interior of a caisson or lining structure, wherein means is provided for simultaneously cutting the excavated area with a diameter greater than the caisson to provide a mud receiving space between the caisson wall and the wall of the excavation and for shifting the dug up earth in the lower part of the caisson from the periphery toward the center of the same so that the earth may be conveniently taken up by an endless conveyor and carried to elevator buckets.

The invention will be best understood from a consideration of the following detailed description taken in connection with the accompanying drawings forming part of this specification, with the understanding, however, that the invention is not to be confined to any strict conformity with the showing of the drawings but may be changed or modified so long as such changes or modifications mark no material departure from the salient features of the invention as expressed in the appended claims.

In the drawings:

Fig. 1 is a view in vertical section through a device constructed in accordance with the present invention, showing the same in operation, the section being taken substantially on the line 1—1 of Fig. 2.

Fig. 2 is a vertical section through the device taken substantially upon the line 2—2 of Fig. 1.

Fig. 3 is a horizontal section taken on the line 3—3 of Fig. 1.

Fig. 4 is a section on the line 4—4 of Fig. 2.

Fig. 5 is a detail view of one of the earth scarifiers carried by the rotary frame.

Fig. 6 is a fragmentary section through a modified form of caisson structure.

Fig. 7 is a sectional view illustrating a method of continuing the sinking of a shaft in the earth beyond a certain depth.

Referring now more particularly to the drawings, the numeral 1 designates the earth in which the excavated shaft is formed, the shaft being indicated by the numeral 2.

In accordance with the present invention in its preferred construction, there is provided a cylindrical caisson 3, to and around the lower or bottom edge of which is secured the downwardly and laterally projecting shoe blade 4, the circumference of the lower edge of which is materially greater than the outside circumference of the caisson so that as the caisson sinks axially into the earth, there will be formed between the wall of the shaft or excavation 2 and the outside of the caisson, the space 5 around the caisson which is filled with mud and air for the purpose hereinafter stated.

Adjacent the lower part of the caisson there is secured upon suitable supporting brackets 6 which are fastened to the inner wall surface, an annular track 7, the top edge of which is of circular cross section, the track preferably being shaped from angle iron material and constituting the vertically extending flange thereof, the horizontal flange of such material resting upon the brackets 6 and spacing the track from the caisson wall.

The annular track 7 supports a rotary frame which is indicated as a whole by the numeral 8. This rotary frame is preferably made up of a ring member 9 across which extend two spaced parallel beams 10, the ends of which are secured to the

under side of the ring, and the radial beams or spokes 11 which extend from the outer sides of the beams 10 and have their outer ends secured to the ring 9, as illustrated in Fig. 1. The outer ends of the beams 10 and 11 have secured to their under sides the downwardly extending brackets 12, each of which supports upon its outer side, a grooved wheel 13, for rotation upon a horizontal axis extending radially with respect to the frame and adapted to rest upon the rounded top edge of the track 7.

The lower end of each bracket 12 supports a roller 14 for rotation on a vertical axis, these rollers 14 constituting centering rollers for the frame and being disposed within the area defined by the track 7 and engaging the inner surface of the track.

The beams 10 of the frame are spaced by the short transversely extending spaced cross bars 15 which together with the parts of the beams 10 lying between them form a central well space 16 in the frame through which the hereinafter described vertically disposed endless conveyor structure extends to the earth beneath the frame.

Certain of the frame beams have formed upon one side a series of clevises 17 to which are pivotally attached downwardly extending arms 18. Certain of the arms 18 coact to hold in ground engaging position shovel members 19 which are arranged within the circular area defined by the ring 9 so that when the ring is rotated in one direction as, for example, in a counterclockwise direction when viewed as in Fig. 3, the earth scraped up by the blades or shovels will be shifted toward the center of the excavation beneath the well 16. The others of the arms 18 have secured to their lower ends, plows or earth scarifiers, as indicated by the numeral 20 in Fig. 5. These members dig up the earth so that the shovel blades 19 may operate to shift the same toward the center of the excavation.

Secured or formed about the outside of the ring 20 is a ring gear 21. Above this ring gear and the ring 9 there is secured to the caisson wall an arm 22 which supports adjacent its free or inner end a roller 23 which turns on a vertical axis and engages the inner side of the ring 9.

Above the rotary frame 8 there is secured diametrically of the caisson a fixed supporting structure made up of two spaced parallel beams 24 and a pair of cross beams, each of which is indicated by the numeral 25, this pair of cross beams being disposed at one side of the axial center of the caisson as shown in Fig. 1. The supporting structure carries the stationary mechanism for the excavating device, which mechanism includes a source of power such as an electric motor 26 supported upon one of the beams 24 and having an operative connection between its armature and a gear 27 which is supported upon the upper end of a vertical shaft 28, the lower end of which shaft passes through the arm 22 and carries on its lower end a pinion 29 which meshes with the ring gear 21. The motor 26 operates through the shaft 28 and the ring gear 21 to rotate the frame 8 upon the annular track 7.

Disposed vertically within the caisson is an endless conveyor unit indicated generally by the numeral 30 and consisting of vertically disposed side boards 31 secured to the inner sides of the beams 24 and extending downwardly through the well 16. The lower ends of these side boards are braced by the upwardly converging brace beams 32 which are joined to the beams 24, as shown.

Connecting the upper ends of the side boards 31 is a shaft 33 which carries sprocket wheels 34 between the boards while the lower ends of the boards are connected by a shaft 35 which carries between the boards the sprocket wheels 36. The upper shaft 33 also carries outside one of the boards 31 a small sprocket wheel 37. This latter sprocket wheel is connected by a driving connection such as the sprocket chain 38 with a source of power such as is generally indicated by the numeral 39 and which may consist of an electric motor or any other means may be provided for transmitting power to the shaft 33, as will be readily understood. The motor unit 39 here conventionally shown is supported preferably by the beams 24.

The upper and lower pairs of sprocket wheels 34 and 36 are connected by endless sprocket chains 40, which chains are joined together by transverse scoops or buckets 41. Thus the chains 40 move in unison around the upper and lower sprocket wheels of the conveyor to carry the buckets up and down in the usual well known manner, the lower sprocket wheels being located at a proper elevation below the rotating frame to facilitate the engagement of the downwardly moving buckets with the earth as they swing around under the lower sprocket wheels.

At each side of the conveyor structure 30 there is disposed a pair of vertical channeled tracks 42, the channels of which are in opposed relation. The lower end of each track of each pair is secured to an end of a bar 25.

Extending across the top of the caisson is a pair of spaced parallel beams each of which is indicated by the numeral 43, these beams being supported upon the earth by suitable posts 44 and the upper ends of the channeled tracks extend across the inner sides of the beams 43 and pass through guides 45 which are secured to the beams 43 and which permit the tracks to be vertically shifted with respect to the adjacent beams. These beams 43 support upon suitably located pairs of cross members 46, a shaft 47 which carries a pulley 48. Each pair of tracks 42 extends between the pairs of cross members 46 and upon opposite sides of the shaft 47, as shown in Figs. 1 and 2. The beams 43, supporting posts 44 and cross members 46 constitute a hoisting frame on which the pulley sheaves are supported and with which the tracks 42 are shiftably connected.

Disposed between each pair of tracks 42 is an elevator bucket 49 which carries near its bottom the pair of oppositely directed trunnions 50, each of which slidably engages in a channeled track. The top of each bucket has connected therewith a bail 51 with which is connected a hoist rope 52 which passes upwardly over the overlying pulley 48 to a suitable power source (not shown) by means of which the bucket may be raised. By reason of the connection of each bucket between its channeled guide tracks by the trunnions 50, it will be readily seen that when the bucket reaches the top of the caisson, it may be readily tipped over to have the contents discharged into a suitable receiver.

Disposed between each pair of channeled tracks is an oscillatable or swinging spout which is indicated by the numeral 53. This spout has the two discharge ends 54 and has bearing ears 55 located upon its bottom and midway between the ends 54. The beams 24 support a pair of spaced vertical bearings 56 between which is supported a rock bar 57 which extends through the ears 55. Thus the spout is supported for rocking move-

ment on an axis extending midway between the buckets 49 and the length of the spout from its oscillating center to each end is such that when one end is down, it will extend over the edge of a lowered bucket 49 while the other end, being raised, will be outside the vertical path of the wall of the other bucket, thus permitting the said other bucket to be raised to the top of the caisson. With this arrangement it will be readily seen upon reference to Fig. 2, that when one bucket has been filled with earth and it is raised, it will engage the adjacent end of the spout and tip the same over to a position where the bucket may move past the spout and also where the other end of the spout will be brought into position with respect to the other bucket so that it may discharge into that other bucket the earth thrown thereinto by the endless conveyor.

As shown in Fig. 1, the top edge of the side of the spout nearest the endless conveyor is straight and disposed below the highest elevation attained by the conveyor buckets so that, the spout being located upon the down-travel side for the buckets, will receive earth thrown from the buckets as they swing upwardly and over the upper sprocket wheels 34.

As previously stated, the present excavating device is designed primarily for operation in soft earth which has a tendency to cave in as the shaft is sunk, therefore, provision is made for holding the walls of the shaft against collapse. This consists in providing the lower part of the caisson with the annular pipe line 58 which has connected therewith a plurality of radially extending distributing nozzles 59 which open through the wall of the caisson into the area 5. This annular pipe, acting as a manifold, has connected therewith a supply pipe line 60 through which mud and air is delivered to the manifold for discharge through the nozzles 59 into the area 5, this area being kept filled with mud and air mixture so that such mixture operates in the capacity of a lubricant for the caisson, allowing the same to move downwardly or settle as the earth is removed from its lower end and preventing earth and rock from wedging against the caisson wall and thus retarding such movement.

In the operation of the mechanism, it will be obvious that the rotary frame carries the plows and blades or shovels around in a circular track to dig up the earth, the blades shifting the earth toward the center of the excavation. Here the earth is picked up by the buckets of the endless conveyor and elevated to the spout 53 where it is discharged by way of the spout into the elevator buckets to be then lifted to the top of the excavation. As the earth is dug out from the central part of the caisson and loosened up adjacent the wall of the caisson by the plows, the outwardly flaring steel shoe or blade 4, carrying the weight of the caisson and all of the mechanism supported thereby, will be forced down into the earth and will operate to wedge or shift the earth adjacent its upwardly and inwardly inclined inner face toward the center of the excavation. Thus the double function is performed by the blade of shifting the earth and providing the annular space around the caisson into which the lubricating mud and air mixture is discharged.

In the illustration of the invention in Figs. 1 and 2, the caisson device has been shown as being in the form of a steel cylinder but it is within the scope of the present invention to form the caisson of annular sections of concrete such as indicated at 61 in Fig. 6, in which case the lower part of the lower concrete section might have a steel liner 62 for the support of the annular track 63 upon which the rotary frame, not shown, may be supported, and this steel liner would also support or have secured thereto the beams (not shown) upon which the fixed mechanism is supported.

The liner 62 may have a steel shoe 64 formed integrally therewith and of double wall construction as shown, to be filled with concrete and to function in the same manner as the shoe 4.

In sinking shafts of considerable depth, the friction between the mud and air mixture filling the area 5 and the wall of the caisson may become so great as to retard or even stop the descent of the caisson in which case the arrangement illustrated in Fig. 7 is provided for continuing the shaft with a smaller diameter. This is done by removing the rotary frame and the fixed supporting beams with the structure carried thereby, cutting the fixed beams 24 and decreasing the size of the rotary frame structure so that it may be disposed within a second caisson or smaller diameter such as is indicated at 65 in Fig. 7. This smaller caisson would have an outwardly flared steel shoe 68 at its lower edge corresponding with the shoe 4 and would have secured therein the circular track 69 for the support of the rotary frame here indicated generally by the numeral 70, for the support of the various necessary additional units, not shown. Naturally this smaller caisson structure would be provided with the other mechanism shown in Fig. 1 for raising and removing the dug up earth, but it is not considered necessary to repeat the illustration of this structure in connection with the caisson 67 as it will be readily understood how such a structure would be installed.

It will be readily apparent that as the excavating of the earth proceeds and the lower caisson sinks in the earth, additional sections either of steel or concrete are connected at the top until the desired depth has been reached.

From the foregoing, it will be readily apparent that a novel and efficient mechanism has been disclosed whereby digging of shafts in soft earth may be accomplished without the necessity of using compressed air for maintaining the earth walls in position to prevent cave-ins and that such mechanism can be operated with a minimum of attention and labor.

What is claimed is:

1. An earth excavating structure, comprising a vertically arranged cylinder, an earth digging unit supported in the lower end of the cylinder for rotation about a vertical axis, means supported centrally within the cylinder and extending downwardly to the earth through said rotating unit for raising the earth to a predetermined elevation in the cylinder, and a vertically moving elevator arranged to receive earth from said raising mechanism to carry the earth upwardly to the top of the cylinder for discharge.

2. An earth excavating structure, comprising a vertically arranged cylinder, an earth digging unit supported in the lower end of the cylinder for rotation about a vertical axis, means supported centrally within the cylinder and extending downwardly to the earth through said rotating unit for raising the earth to a predetermined elevation in the cylinder, a vertically moving elevator arranged to receive earth from said raising mechanism to carry the earth upwardly to the top of the cylinder for discharge, and means at the lower end of the cylinder forming an out-

wardly flaring earth penetrating blade having a maximum diameter greater than the overall diameter of the cylinder.

3. An earth excavating structure, comprising in combination with a vertically arranged casing, a downwardly and outwardly flaring blade extending around the lower edge of the casing and having a maximum diameter greater than the overall diameter of the casing, the inner side of said blade sloping upwardly and inwardly in the casing, an earth scarifying means within the lower part of the casing, and mechanism arranged in the central part of the casing for picking up earth broken up by the scarifying means and conveying the same to the top of the casing.

4. An earth excavating structure, comprising in combination with a vertically arranged casing, a downwardly and outwardly flaring blade extending around the lower edge of the casing and having a maximum diameter greater than the overall diameter of the casing, the inner side of said blade sloping upwardly and inwardly in the casing, an earth scarifying means within the lower part of the casing, mechanism arranged in the central part of the casing for picking up earth broken up by the scarifying means and conveying the same to the top of the casing, said mechanism comprising a vertically disposed endless conveyor, means at the upper end of the conveyor for receiving earth raised thereby, and a vertically reciprocable receptacle arranged to receive the earth from said means to convey the earth to the top of the casing.

5. An earth excavating mechanism, comprising a vertically arranged cylindrical casing, means at the lower edge of the casing forming a continuous annular cutting blade extending downwardly and laterally from the casing to form an earth shaft having a materially greater diameter than the overall diameter of the casing whereby to form a space between the casing and the wall of the earth shaft, mechanism operating within the casing to remove earth from within the area defined by said blade and convey the same to the top of the casing, and means for discharging a fluid into said area between the casing and the earth shaft wall to facilitate the downward movement of the casing.

6. An earth shaft sinking mechanism, comprising a vertically disposed cylindrical casing, means within the lower part of the casing forming an annular track, a flat horizontally disposed frame structure supported upon said track for rotation about a vertical axis, means for turning the frame, means carried by the frame for digging the earth beneath the frame, and an earth elevating mechanism for lifting the earth from beneath the frame to the top of the casing, said mechanism including a vertically arranged endless conveyor extending downwardly through the center of said rotating frame.

7. An earth shaft sinking mechanism, comprising a vertically disposed cylindrical casing, means within the lower part of the casing forming an annular track, a flat horizontally disposed frame structure supported upon said track for rotation about a vertical axis, means for turning the frame, means carried by the frame for digging the earth beneath the frame, an earth elevating mechanism for lifting the earth from beneath the frame to the top of the casing, said mechanism comprising a vertically arranged endless conveyor extending downwardly to the earth through the central part of the rotating frame, a vertically shiftable bucket having a lowered position adjacent the upper part of the endless conveyor and a raised position above the top of the casing, and means for receiving earth from the upper part of the endless conveyor and transferring it to said bucket when the latter is in its lowered position.

8. An earth excavating mechanism, comprising a vertically disposed cylindrical casing, an annular track supported within the lower part of and concentrically with the casing, a horizontally disposed frame unit, supporting rollers carried by the frame unit and resting upon said track facilitating turning of the frame in the casing about a vertical axis, power means for rotating said frame, said frame having a central open portion, earth working units carried by said frame upon the under side thereof, a vertically disposed endless conveyor structure supported in the casing and having its lower end extending through the open central part of the frame, a pair of vertically reciprocable elevator buckets arranged on opposite sides of the conveyor and having lowered positions located near the top of the conveyor and raised positions located above the top of the casing, and means mounted adjacent the upper end of the endless conveyor for receiving earth raised by the conveyor for selectively discharging the received earth into said buckets.

9. An earth excavating mechanism, comprising a vertically disposed cylindrical casing, an annular track supported within the lower part of and concentrically with the casing, a horizontally disposed frame unit, supporting rollers carried by the frame unit and resting upon said track facilitating turning of the frame in the casing about a vertical axis, power means for rotating said frame, said frame having a central open portion, earth working units carried by said frame upon the under side thereof, a vertically disposed endless conveyor structure supported in the casing and having its lower end extending through the open central part of the frame, a pair of vertically reciprocable elevator buckets arranged on opposite sides of the conveyor and having lowered positions located near the top of the conveyor and raised positions located above the top of the casing, and a tiltable spout mounted adjacent the upper end of the endless conveyor to receive earth discharged therefrom, said spout having two discharge ends and two working positions, the spout when in either of said working positions having one discharge end overlying the edge of an elevator bucket and the other discharge end out of the path of movement of the other elevator bucket.

10. An earth excavating mechanism, comprising a vertically disposed cylindrical casing, an annular track supported within the lower part of and concentrically with the casing, a horizontally disposed frame unit, supporting rollers carried by the frame unit and resting upon said track facilitating turning of the frame in the casing about a vertical axis, power means for rotating said frame, said frame having a central open portion, earth working units carried by said frame upon the under side thereof, a vertically disposed endless conveyor structure supported in the casing and having its lower end extending through the open central part of the frame, a pair of vertically reciprocable elevator buckets arranged on opposite sides of the conveyor and having lowered positions located near the top of the conveyor and raised positions located above the top of the casing, and a tiltable spout

supported adjacent the upper end of the endless conveyor for oscillation on an axis extending between the adjacent sides of said buckets, the spout being arranged to receive earth discharged from the upper end of the elevator and having two discharge ends and two working positions, said buckets operating when moved from their lowered positions to their upper positions to shift the spout from one working position where it discharges earth into the bucket being raised to the other working position where it may discharge earth into the bucket occupying its lowered position.

11. An earth shaft sinking mechanism, comprising a vertically arranged cylindrical casing, a continuous outwardly and downwardly flaring blade secured around the lower edge of the casing and having a maximum diameter greater than the overall diameter of the casing whereby to cut a shaft having a larger diameter than the outside diameter of the casing, a frame unit supported in the lower part of the casing for rotation about a vertical axis, said frame unit having a central well therethrough, earth working implements carried by and extending down from said frame unit, power means for rotating said frame unit, a vertically arranged endless conveyor supported above the frame unit and extending downwardly through said well to the earth beneath the frame, means at the upper end of said conveyor for receiving earth raised thereby and lifting the earth to the top of the casing, and a pipe line disposed around the interior of the casing and having radial discharge nozzles opening through the casing into the area between the same and the wall of the shaft, and means for conducting liquid into said pipe line for discharge through the nozzles into said area.

12. An earth excavating structure of the character stated, comprising a vertically disposed cylindrical casing, an annular track secured within the lower part of the casing concentric therewith, a flat horizontally disposed frame above said track, wheels carried by said frame adjacent the periphery for engagement on said track, a ring gear supported by the frame concentric therewith, a vertically disposed drive shaft supported within the casing having a gear pinion at one end operatively coupled with said ring gear, power means supported within the casing and operatively coupled with said shaft for turning the same, said frame having a central open area, earth digging implements carried by said frame, an endless conveyor supported vertically within the casing and having its lower end extending through said open area, means forming a pair of vertical tracks at each side of the conveyor and extending to the top of the casing, a bucket slidably supported between each pair of tracks, means disposed over the top of the casing and coupled with said buckets for effecting the vertical movement of the same, a spout pivotally supported adjacent the top of the conveyor to receive earth raised thereby, said spout having two discharge positions relative to said buckets, and means for moving said spout on its pivot from one discharging position to the other for transferring earth from the upper end of the conveyor to the buckets.

13. The method of sinking a vertically arranged cylindrical casing into the earth, which comprises removing through the casing the earth at the lower end thereof throughout an area slightly greater than that circumscribed by the lower end of the casing to form a shaft having a diameter greater than the overall diameter of the casing and provide a space around the casing between the same and the wall of the shaft, then introducing into said space through the wall of the casing a lubricating mixture serving the functions of holding the shaft wall against collapse and facilitating the axial downward movement of the casing, and continuing the removal of the earth throughout said area from the lower part of and through the casing and introducing such lubricant mixture between the casing and the shaft wall until the casing has been sunk to the desired level.

14. The method of sinking a vertically arranged cylindrical casing into the earth which comprises removing through the casing the earth at the lower end thereof throughout an area slightly greater than that circumscribed by the lower end of the casing to form a shaft having a diameter greater than the overall diameter of the casing and provide a space around the casing between the same and the wall of the shaft, then introducing into said space through the wall of the casing a lubricating mixture serving the functions of holding the shaft wall against collapse and facilitating the axial downward movement of the casing, then introducing into the first casing a casing of smaller diameter after the first casing has been sunk to a predetermined depth, removing from and through the lower end of the second casing the earth through an area greater than that circumscribed by the lower end of the second casing to form an area around the second casing between the same and the wall of the shaft, introducing such lubricant mixture into the said area between the shaft wall and the second casing, and continuing the removal of the earth through said last area and introducing said mixture into said last space until the desired penetration of the second casing into the earth is reached.

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