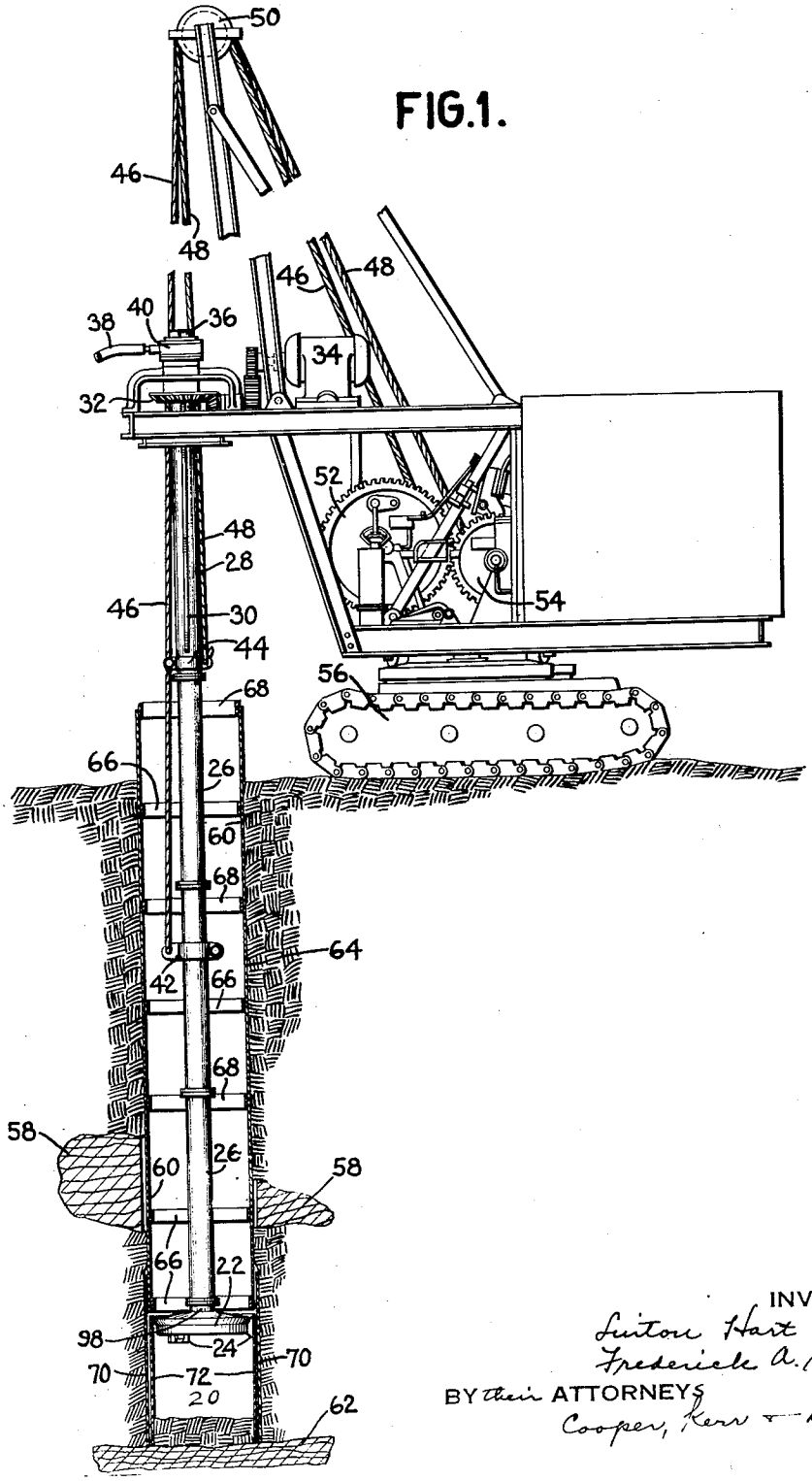
Oct. 24, 1933. L. HART ET AL 1,931,845

METHOD AND APPARATUS FOR FORMING CONCRETE COLUMNS

Filed April 4, 1931 5 Sheets-Sheet 1

FIG.1.



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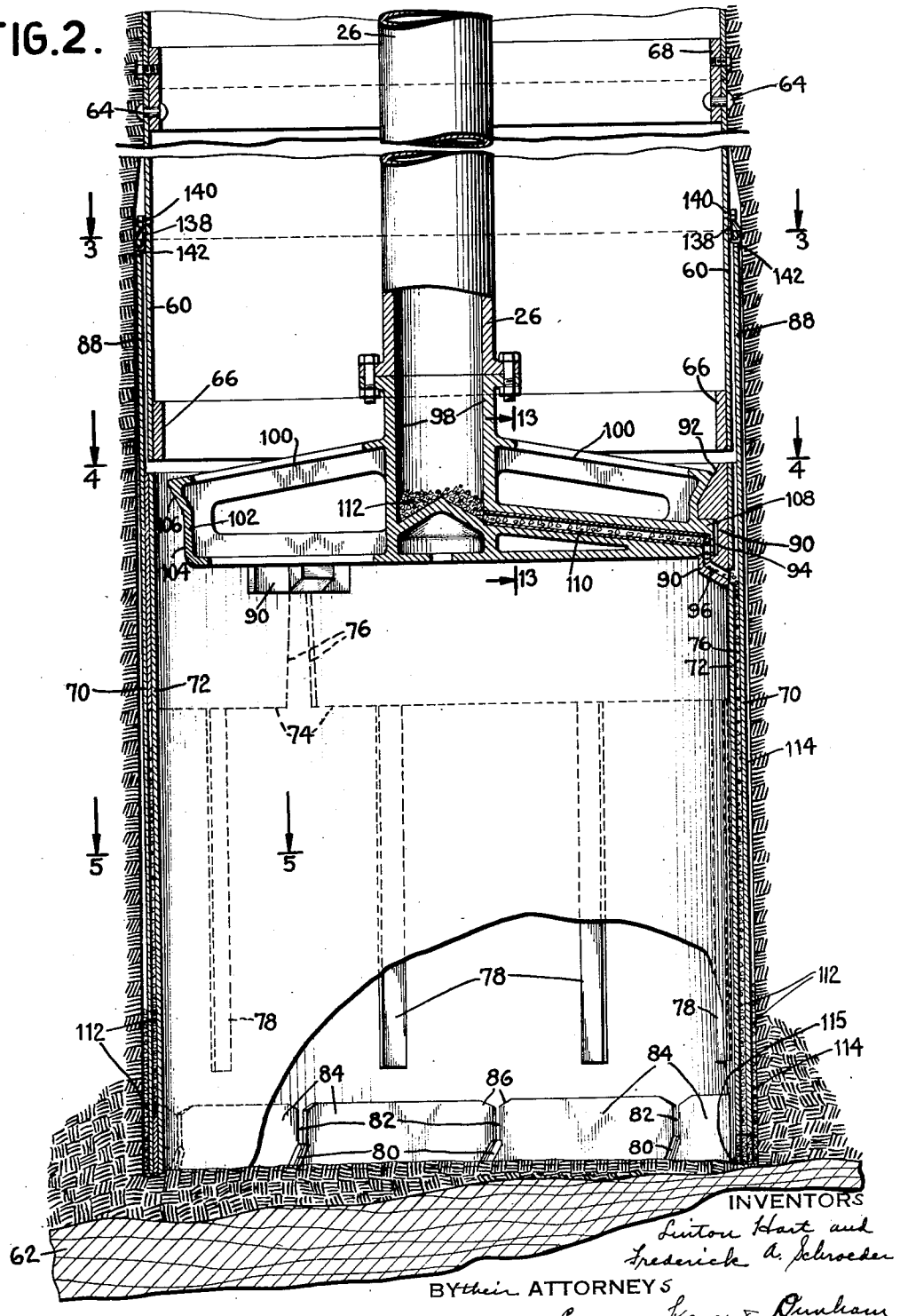
BY their ATTORNEYS
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Oct. 24, 1933. L. HART ET AL 1,931,845

METHOD AND APPARATUS FOR FORMING CONCRETE COLUMNS

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FIG. 2.



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METHOD AND APPARATUS FOR FORMING CONCRETE COLUMNS

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FIG. 3.

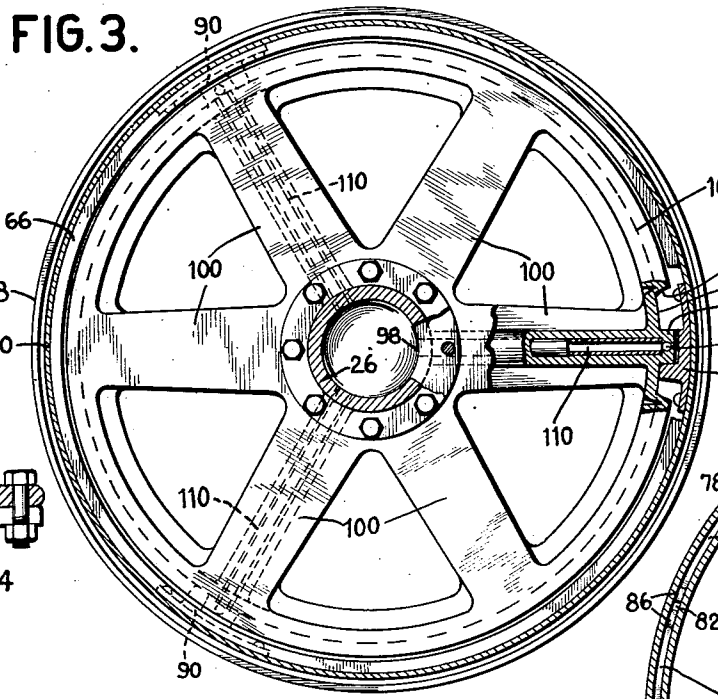


FIG. 6.

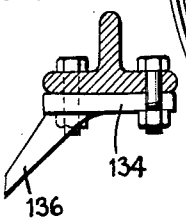


FIG. 5.

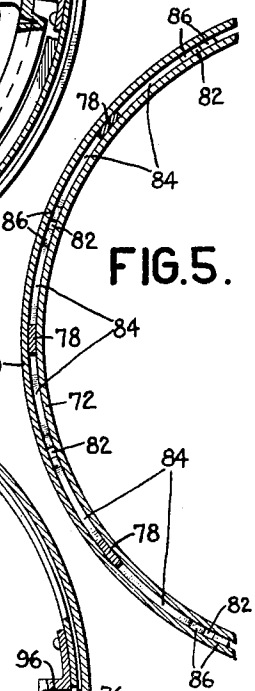
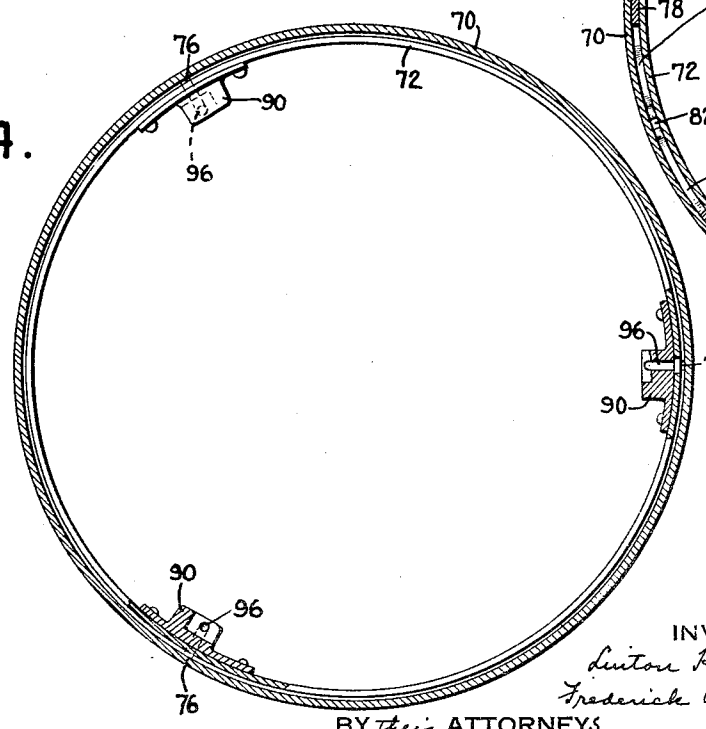


FIG. 4.



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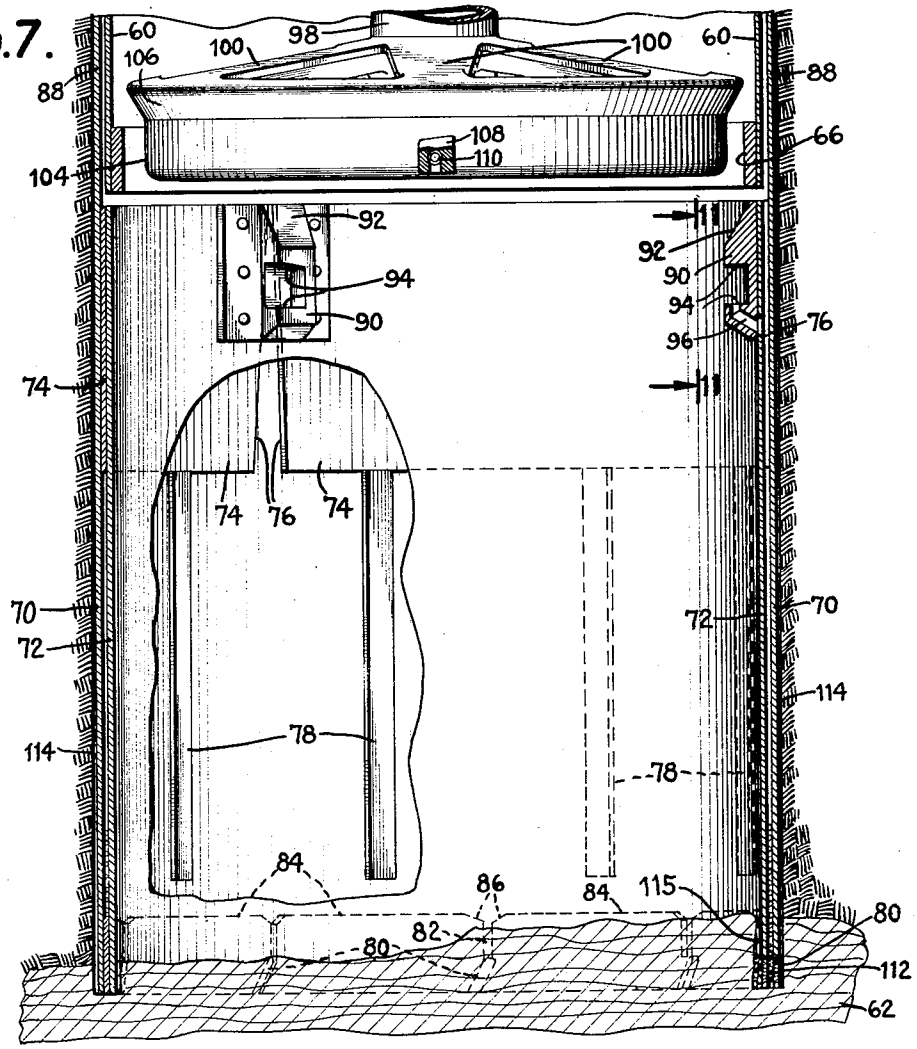
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Oct. 24, 1933. L. HART ET AL 1,931,845

METHOD AND APPARATUS FOR FORMING CONCRETE COLUMNS

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FIG.7.



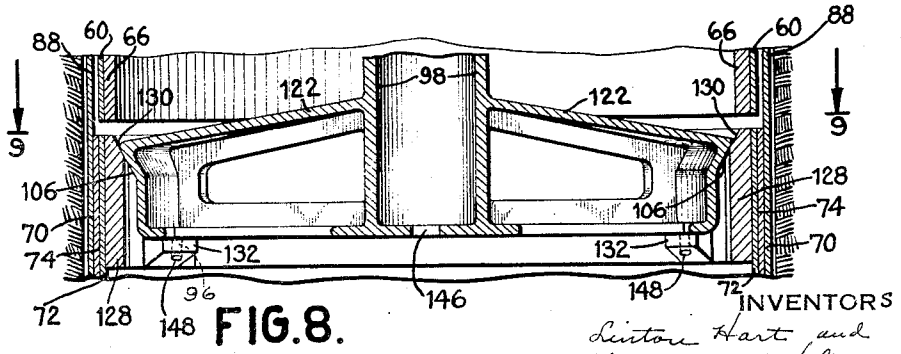


FIG.8.

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METHOD AND APPARATUS FOR FORMING CONCRETE COLUMNS

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FIG.9.

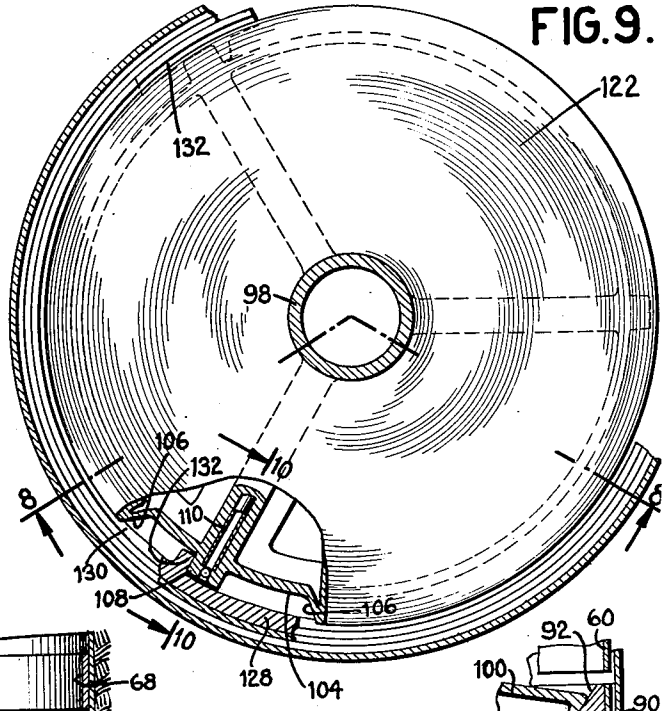


FIG.11.

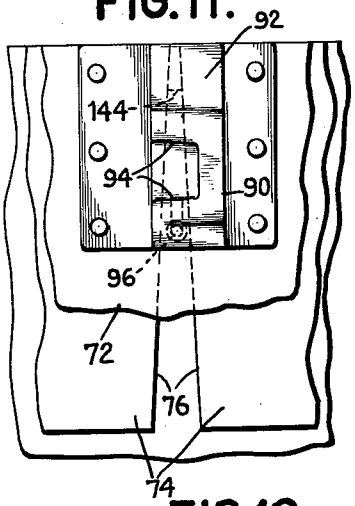


FIG.12.

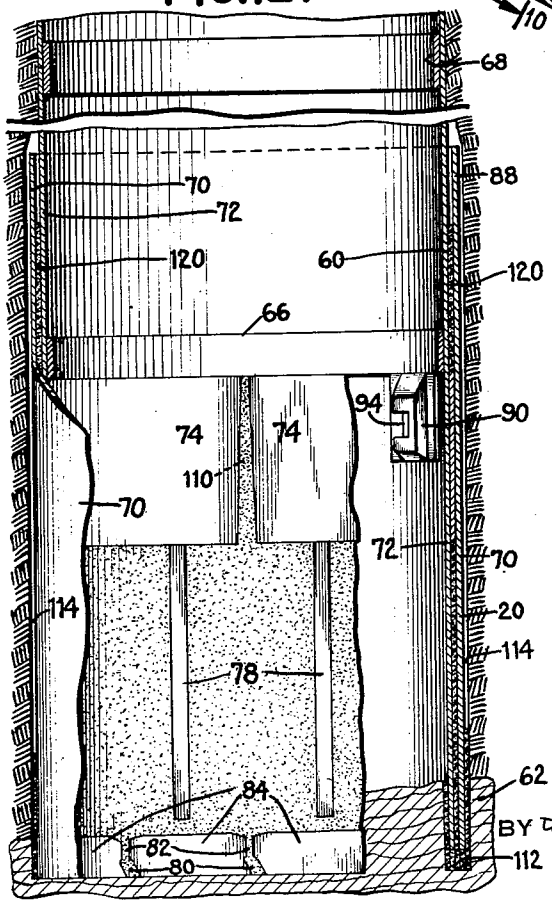


FIG.10.

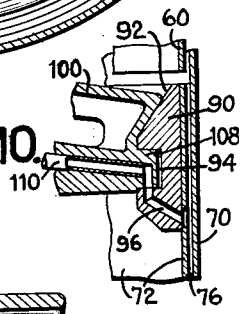
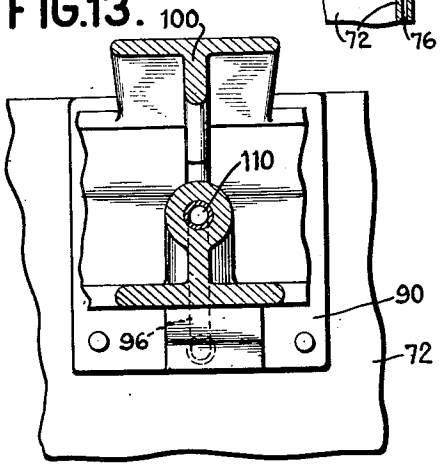


FIG.13.



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Patented Oct. 24, 1933 1,931,845

UNITED STATES PATENT OFFICE

1,931,845

METHOD AND APPARATUS FOR FORMING CONCRETE COLUMNS

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Application April 4, 1931. Serial No. 527,630

37 Claims. (Cl. 61—57)

In the formation of large diameter concrete columns for supporting buildings, bridges and other structures, it has been customary to drill or excavate a hole in the ground to form a mold and then to fill the mold with plastic concrete which, when set, forms the column.

The earthen walls of the hole may form the walls of the mold, but preferably the hole is lined with a metal casing to prevent collapse or caving of the walls and to facilitate sealing of the mold against inflow of water, earth, sand, etc., thereby permitting inspection of the mold before filling it with plastic concrete to form the column. The casing then may or may not become a permanent part of the structure.

One method of preparing the hole is to drill into the ground with a tool of the required diameter in order to loosen the earth, at the same time supplying sufficient water around the tool to mix with the loosened earth to form soft mud. The mud prevents caving of the hole during the drilling process. After the drill reaches proper footing it is removed, the casing is lowered into the hole, the mud is removed and the casing is then filled with plastic concrete to form the column, the casing being either withdrawn as the concrete is deposited, or left permanently in place.

It is often necessary to sink the hole to bed rock. If the rock be a sloping formation, or if boulders are encountered above the bed rock, as is often the case, then the above type of drill is practically useless for finishing the hole.

An object of the present invention is to disclose means for cutting through earth, boulders, rock, etc. to either drill the entire hole or to finish the hole after the above described earth drill has penetrated as far as is practical and has been removed.

Another object is to disclose ways and means for penetrating any kind of material to the required depth, thereby avoiding the use of the elaborate and expensive air-lock devices which have heretofore been often found necessary in the placing of caissons which extend materially below water level, especially when boulders, uneven rock or the like are encountered.

Another object is to disclose a rock cutter which may be lowered into the hole, below the casing, for actuation in that position to provide a cavity below the casing so that the casing may follow down into the cavity.

Another object is to disclose a drill having a cutter barrel which is, in effect, simply a lower section of the casing, adapted for rotation by detachable means, and which may be left in the hole to become part of the column structure.

Further and other objects and advantages will be apparent from the specification and claims, and from the accompanying drawings which illustrate what is now considered the preferred embodiment of the invention.

In the drawings:

Fig. 1 is an illustration, largely diagrammatic, of the apparatus in process of drilling a hole.

Fig. 2 is an enlarged detail view, largely in cross-section of the cutter in action.

Fig. 3 is a view on line 3—3 of Fig. 2.

Fig. 4 is a view on line 4—4 of Fig. 2, with drive head removed.

Fig. 5 is a view on line 5—5 of Fig. 2.

Fig. 6 is a detail cross-section on the line 6—6 of Fig. 3 showing the scarifying teeth attached to the spokes of the drive head.

Fig. 7 is a view of the driving head being lowered into operative position, with details of the cutter barrel.

Fig. 8 is a cross-section on line 8—8 of Fig. 9 showing details of a solid-web driving head.

Fig. 9 is a view on line 9—9 of Fig. 8.

Fig. 10 is a detail view on line 10—10 of Fig. 9.

Fig. 11 is a detail view on line 11—11 of Fig. 7.

Fig. 12 is a cross-section of the lower end of the finished mold with cutter barrel cemented into rock and with the mold lining cemented into the cutter barrel.

Fig. 13 is a detail cross-section on line 13—13 of Fig. 2.

Referring to Fig. 1, numeral 20 designates the annular cutter barrel; 22 is the drive head therefor adapted to operatively engage the barrel through the instrumentality of lugs 24 attached to the barrel; 26 is the vertical hollow stem, coupled together in comparatively short lengths and attached at its lower end to the drive head; 28 is the upper section of the drive stem, having a spline 30, and slidable vertically through bevel gear 32, which rotates the stem when driven by reversible motor 34.

The top of stem section 28 is provided with plug 36, which when removed, permits cutting material such as chilled shot to be dropped down the drive stem to find its way to the cutting edge of the drill barrel. Water may be provided to the drive stem through hose 38 and swivel 40. If water under pressure is desired in the stem, plug 36 is replaced and water or grout may be pumped in through hose 38.

For raising or lowering the drive stem and head 22, and for supporting the stem while sections

thereof are inserted or removed, clamps 42, 44, and cables 46, 48 may be provided. The cables pass over head sheaves 50 to hoisting drums 52, 54 carried on tractor 56. This arrangement permits the drive stem and head, or any desired portion of their weight to be used as a feed-load on the drill.

The hole shown in Fig. 1 may have been drilled from the surface with the apparatus of the present invention or it may have been drilled down to boulder 58 by the earth-drilling apparatus above described. If by the latter method, the earth drill was removed when boulder 58 was encountered, the present drill 20 was lowered into place with casing 60 above it, and the drilling then proceeded by the method to be described.

Boulder 58 has been penetrated and, as shown, the drill is penetrating earth, to reach bed rock 62. The drill barrel 20 cuts an annular groove through the earth or boulders or rock and if the interior of the barrel becomes filled with a core of material so as to form an obstruction to the downward progress of head 22, the head and stem 26 are temporarily removed from the hole and the interior of the barrel is cleared out by hand, by diver, by orange peel bucket or rotary drilling bucket, or the like, assisted if necessary by ordinary rock drills to break up any rock into convenient fragments. It will be understood that the present apparatus drills holes of sufficient size to readily accommodate buckets and other devices of the kind mentioned.

After bed rock is reached it is necessary, at least when water is found in the soil, to seal the bottom of the casing so that it may be pumped out for inspection and other purposes before beginning to fill the casing with concrete. This means that the drill barrel will have to penetrate the bed rock until the entire circumference of the lower end of the barrel is below the level of the rock, whereupon the lower end of the barrel may be sealed into the rock and the upper end may be sealed to the casing above it, as will be explained, thus making the entire casing watertight and permitting it to be pumped out after removal of the drive head and stem. The cutter barrel thus becomes a permanent part of the mold for the column.

The drill usually provides a hole larger than the casing, but the walls of the hole may cave in or collapse against the casing, as at 64. If the casing will not follow down by gravity, it is forced down so that its lower end will always be close to or resting upon the top of the drill barrel. In order to prevent collapse of the casing, due to external pressure after the casing is pumped out, reinforcing bands such as 66 may be provided at spaced intervals. Joints between sections of the casing may be provided with bands 68 of extra width which serve to couple the sections together as well as to stiffen them.

As a cutting agency the drill barrel may be provided with saw teeth, diamonds, diamond substitutes, or the like. These devices may be used alone or in combination with chilled shot fed to the cutting edge, or the chilled shot may be used alone, independently of the other agencies. For the purpose of illustration and description the drill is shown as operating with shot alone.

The drill barrel in the embodiment shown, (Figs. 2, 7) is inexpensively formed of outer and inner concentric steel plate shells 70 and 72 respectively, spaced from each other to stiffen the structure and to provide passages for the water and chilled shot used in the drilling operation, and for the cement grout which may be used to seal the casing. Towards the upper part of the barrel the spacing comprises three steel plates 74, so shaped as to provide between their adjacent ends vertical channels 76 which are preferably tapered, as indicated, to be smaller, or even closed, at their upper ends. Below plates 74 are a number of spaced vertical spacer strips 78.

Around the bottom edge of the cutter barrel, shells 70 and 72 are provided with spaced inclined slots 80 which register with passages 82 formed between the adjacent ends of spacer plates 84 placed between shells 70 and 72 around the lower rim of the barrel. The upper corners of plates 84 are clipped as at 86 to form funnel-like upper ends for channels 82. Barrel shell 70 extends well above shell 72 and spacer plates 74, to form an upwardly extending skirt 88, adapted to surround the lower end of casing 60 but spaced slightly therefrom. The skirt, may, if desired, be within the casing instead of outside, as shown.

Attached to the inner upper part of the cutter barrel below the tops of plates 74, are three driving lugs 90, each located at a slot 76. Each lug 90 has a surface 92 sloping upwardly and outwardly, and has a tapered side-opening socket 94. From the bottom of socket 94 a passage 96 leads through the bottom of the lug to open into a channel 76.

The above described drill barrel is rotated by a driving head comprising a hollow hub 98, spokes 100, and rim 102. To the top of hub 98 is bolted the drive stems 26. Rim 102 has a cylindrical portion 104, a conical portion 106, and three radially projecting ears 108 designed to enter and engage sockets 94.

To assemble the drive head in operative engagement with the cutter barrel, the head and stem 26 are lowered until lugs 90 are encountered whereupon sloping surfaces 92 serve to center the head in the lugs. When conical surface 106 rests on surfaces 92 the head is rotated until ears 108 enter sockets 94. Further rotation in the same direction will rotate the cutter barrel, while rotation in reverse direction will release the ears from the sockets to permit withdrawal of the head. While in operative position a passage 110 connects the interior of hub 98 through passage 96 with each channel 76.

In operation, after the parts are assembled as above described, chilled shot 112 may be thrown into hub 98 through stem 26 or by other means. Water supplied through the stem carries the shot through pipes 110 and 96 into channels 76 between shells 70 and 72. Through channels 76 the shot falls between spacer strips 78 onto the tops of bands 84, thence finding its way through passages 82 and slots 80 to the underside of the cutter barrel, there to act as a cutting agent in the well known manner.

The drilled hole in rock or boulders, is slightly larger than the cutter on account of shot working radially outwardly and inwardly, thereby forming annular spaces 114 and 115 between cutter barrel and outer and inner walls. Part of the water discharged through slots 80 finds its way upwardly through spaces 114 and 115, thereby reducing friction between cutter barrel and the walls of the cavity. Under certain circumstances it is desirable to have a greater flow of water upwardly around the outside of the barrel and this is accomplished by using a drive head

with a closed web instead of spokes, as will be later described.

Part of the water emerging from passage 96 into channels 76 may be forced upwardly to pass between skirt 88 and casing 60, keeping that space clear of detritus and reducing the friction between the surfaces. The tapered formation of channels 76 may be designed to increase the velocity of the water passing through them to produce a nozzle-like discharge thereby rendering the water more effective for its intended purpose.

After the lower end of the cutter barrel has entered bed rock 62 (Fig. 12), grout may be forced into drive stem 26 to find its way through passages 110, 96, 76, 82, and slots 80 to fill the clearances between the barrel and rock, to effectively seal the lower end of the barrel into the rock. As more grout is added, the entire space between shells 70 and 72 becomes filled with cement, and as still more grout is forced into stem 26, the grout is forced upwardly through nozzles 76 to fill the space between skirt 88 and casing 60, as at 120, thereby effectively sealing the lower end of the casing into the upper end of the drill barrel. The drive head is then removed and cleaned of grout by forcing water through it, leaving the drill barrel in place as a permanent lower section of the casing which forms the mold for the column.

As mentioned above, it is sometimes desirable to use a solid web drive head in order to be sure that water fed through the drill barrel will flow outwardly therefrom into space 114. A head of that kind is shown in Figs. 8 and 9. The spokes 100 are replaced by a solid web 122. In order to completely close the upper end of the drill barrel, it is necessary to close the space between the head and the drill barrel. This may be done by replacing lugs 90 with a ring 128 having a conical upper surface 130, upon which, conical surface 106 of the head may seat. Ring 128 is provided with appropriate lugs 132 for engaging the drive ears 108 on the head. Passages 76 may also be closed as indicated by dotted line 144, (Fig. 11). Valves may be placed in the closed head, if desired, in order to permit water to pass through the head in either direction, thereby facilitating the raising and lowering of the head when the hole is filled with water.

When the closed head is used, as above described, the flow of water is always outwardly past the cutting surface of the drill barrel. Therefore, instead of feeding the shot to the cutting surface through passages in the drill barrel the shot may simply be fed to the interior of the barrel through an opening 146 in the bottom of hub 98, (Fig. 8) or openings 148 may be provided from channels 96 through the bottom of lugs 132 so that the shot will drop around the inner circumference of the barrel.

When the drill barrel becomes filled with a core of earth it is sometimes advantageous to place on the bottom of the drive head plates 134 (Fig. 6) having downwardly projecting teeth 136 which serve to scarify the upper surface of the earthen core to form mud, through which the drive head may continue to rotate downwardly.

It is usually desirable to simultaneously lower the cutter barrel and casing 60 into the hole. To facilitate that operation, wire loops 138 are attached to the casing as at 140 (Fig. 2) and pass through holes 142 in the upper rim of skirt 88. The wires are of sufficient strength to hold the barrel for lowering purposes, yet are readily broken when power is applied to rotate the barrel relatively to the casing.

It is to be understood that the invention is not limited to the specific embodiment herein illustrated and described but may be used in other ways without departure from its spirit as defined by the following claims.

We claim:

1. An annular casing adapted for lining a hole in the ground to form a mold for a concrete column, comprising in combination, an upper section, a lower section, means for rotating said lower section, and means for feeding liquid under pressure to said lower section whereby said lower section acts with the liquid as the sole means for sinking the entire casing to bed rock through any type of stratum.

2. An annular casing adapted for lining a hole in the ground to form a mold for a concrete column, comprising in combination, an upper section, a lower section, means for rotating said lower section whereby said lower section acts as the sole means for sinking the entire casing into the ground, and means on one of said sections serving to guide said lower section while said lower section is being rotated.

3. The invention set forth in claim 1 in which means is provided for supplying cutting material to the bottom of the lower section.

4. The invention set forth in claim 1 in which means is provided for supplying cutting material through said rotating means to said lower section, substantially as described.

5. The invention set forth in claim 1 in which a skirt concentric with the lower end of said upper section is provided whereby said upper section serves to guide said lower section while said lower section is rotating.

6. The invention set forth in claim 1 in which said lower section is adapted to drill a hole of diameter greater than the diameter of said upper section.

7. The invention set forth in claim 1 in which said lower section is provided with a skirt concentric with the lower end of said upper section whereby said upper section serves to guide said lower section while said lower section is rotating and in which water is delivered between said upper section and said casing for the purpose set forth.

8. The invention set forth in claim 1 in which means is provided for applying a feed-load to said lower section, said load being adjustable at the will of the operator.

9. The invention set forth in claim 1 in which said rotating means is adapted to serve as a feed-load on said lower section while it is being rotated.

10. The invention set forth in claim 1 in which said rotating means is adapted to serve as a feed-load on said lower section while it is being rotated, and in which means is provided for applying as the feed-load any desired portion of the weight of said rotating means.

11. The invention set forth in claim 1 in which means is provided for introducing water between said lower section and the surrounding earth in order to reduce friction between said section and the earth.

12. The invention set forth in claim 1 in which means is provided for feeding water under pressure from the lower edge of said lower section to pass upwardly on the outer surface of said lower section for the purpose set forth.

13. The invention set forth in claim 1 in which

said rotating means includes means comprising a drive head for sealing the upper end of said lower section for the purpose set forth.

14. The invention set forth in claim 1 in which said rotating means includes means comprising a drive head for sealing the upper end of said lower section and in which said head has valves permitting passage of water through said head in either direction when the pressure of said water is greater than a predetermined amount, substantially as described.

15. The invention set forth in claim 1 in which means is provided for supporting said lower section from said upper section while lowering said casing into the hole, said supporting means being adapted to be readily broken when power is applied to rotate said lower section relatively to said upper section.

16. Apparatus for drilling a hole for receiving a casing to form a mold, comprising a casing, a core cutter operating below the casing and cooperating with the casing to prevent collapse of the walls of the hole, and means for actuating said core cutter to provide a cavity in any character of stratum below the casing whereby the casing may follow the cutter into the cavity while the cutting operation is proceeding.

17. Apparatus for drilling a hole for receiving a casing to form a mold, comprising a casing, a core cutter extending below the casing and cooperating with the casing to prevent collapse of the walls of the hole, and means for rotating the cutter to provide a cavity whereby the casing may follow the cutter while the cutting operation is proceeding, together with means for feeding liquid to the cutting edge of the cutter.

18. Apparatus for drilling a hole for receiving a casing to form a mold, comprising a casing, a core cutter extending below the casing and cooperating with the casing to prevent collapse of the walls of the hole, a driving head for said cutter attachable and detachable at any stage in the hole forming operation, means for rotating the cutter through the instrumentality of said head whereby a cavity is provided so that the casing may follow the cutter into the cavity while the cutting operation is proceeding and means for feeding liquid to said cavity.

19. The method of producing a concrete column for supporting a superstructure, which comprises sinking a two part annular casing in the ground through rotation of one part thereof until bed rock is reached, cutting into said bed rock, and filling the casing with concrete.

20. The method of producing a concrete column for supporting a superstructure which comprises sinking a two part annular casing in the ground through rotation of one part thereof until bed rock is reached, cutting into said bed rock, sealing the cutting section in the rock, and filling the casing with concrete and thereby locking the sections together.

21. The method of producing a concrete column for supporting superstructures, which comprises sinking a core cutter into the ground through rotation thereof, following the cutter with an annular casing, and filling the casing and cutter with concrete.

22. The method of producing a concrete column for supporting a superstructure which comprises sinking a two part annular casing in the ground through rotation of one part thereof and then filling the entire casing with concrete.

23. The method of lining a hole in the ground to receive a concrete column which consists in cutting an annular ring-like cavity in the ground through rotation of one part of a two-part annular lining element and forming a core in the interior of said element, then removing the core and filling the lining element with concrete.

24. Apparatus for drilling a hole in the ground to receive a casing to form a mold for a concrete column, comprising, in combination a two-part casing, an annular cutter forming one part of the casing, means for rotating said cutter, including a skeleton head arranged to pass through the upper part of the casing and detachably engage with the cutter, said cutter when driven adapted to form a cavity in the ground and produce a core, and means for disintegrating the core downwardly as the cutting proceeds to form loose detritus which may pass through the skeleton head.

25. Apparatus for drilling a hole in the ground to receive a casing to form a mold for a concrete column, comprising, in combination a two-part casing, an annular cutter forming one part of the casing, means for rotating said cutter, including a skeleton head arranged to pass through the upper part of the casing and detachably engage with the cutter, said cutter when driven being adapted to form a cavity in the ground and produce a core, means for disintegrating the core downwardly at a speed equal to the formation of the core by the cutter, and means for feeding water to the disintegrated portion of the core to form mud through which the drive head may continue to rotate downwardly.

26. Apparatus for drilling a hole in the ground to receive a casing to form a mold for a concrete column, comprising, in combination, an annular cutter forming one part of the casing, means for rotating said cutter, including a skeleton head detachably engaged with the cutter, said cutter when driven adapted to form a cavity in the ground and produce a core, and scarifying teeth carried by the head adapted to disintegrate the top of the core as the cutting proceeds.

27. Apparatus for drilling a hole in the ground to receive a casing to form a mold for a concrete column, comprising, in combination, an annular cutter forming one part of the casing, means for rotating said cutter, including a skeleton head detachably engaged with the cutter, said cutter when driven adapted to form a cavity in the ground and produce a core, scarifying teeth carried by the head adapted to disintegrate the top of the core as the cutting proceeds, and means for feeding water to the disintegrated portion of the core to form mud through which the drive head may continue to rotate downwardly.

28. Apparatus for drilling a hole for receiving a casing to form a mold for a concrete column comprising, in combination, a unitary annular cutter having passages therein, a driving head adapted to pass through the casing and detachably engage with said cutter, said driving head having passages therein arranged to register with the passages in the cutter when in driving relation therewith whereby cutting material may be fed through said passages to the operative surface of the cutter, and means for effecting a one-way operative driving engagement of said head with said cutter at any time during the hole forming operation.

29. The method of producing a concrete column for supporting a superstructure which comprises sinking a two-part annular casing in the ground solely through rotation of the lower part thereof, feeding the upper part into the

cavity thus formed in step with the lowering of the lower part and then filling the entire casing with concrete.

30. A concrete column for superstructures comprising a rotatable annular cutting section and a non-rotatable upper section adapted to cooperate with the cutting section to support the walls of the hole, and a filling of concrete in both of said sections.

31. The method of producing a concrete column for supporting a superstructure which comprises sinking a two-part annular casing in the ground through rotation of one part thereof while applying a positive downward force to said part independently of the other part and then filling the casing with concrete.

32. The method of producing a concrete column for supporting a superstructure which comprises sinking a two-part annular casing in the ground through rotation of the lower part thereof while applying a positive downward force thereto independently of the upper part and feeding the upper part into the cavity thus formed in step with the lowering of the lower part and then filling the casing with concrete.

33. The method of forming a concrete column which consists in rotating one part of a two-part annular lining element whereby a core is formed in the interior of said element, disengaging the rotating means, then removing the core and filling the lining element with concrete.

34. The method of forming a concrete column which consists in engaging, with a rotating means, one part of a two-part annular lining element, feeding liquid to the cutting edge of said element and rotating said element whereby a core is formed in the interior of said element, disengaging the rotating means, then removing the core and filling the lining element with concrete.

35. Apparatus for drilling a hole for receiving a casing to form a mold for a concrete column, comprising in combination, a rotary cutter, a drive head, means for engaging said head in operative relationship with said cutter and for releasing said head from said cutter at any stage in the hole-forming operation, and means for feeding liquid through said head to the cutting edge of said cutter when said head is in operative engagement with said cutter.

36. Apparatus for drilling a hole for receiving a casing to form a mold for a concrete column comprising, in combination, an annular cutter, a driving head adapted to pass through the casing and detachably engage with the cutter, said driving head having passages therein arranged to deliver fluid to the cutter when said head is in driving relation with the cutter, and means for effecting a one-way driving engagement of said head with said cutter at any time during the hole forming operation.

37. Caisson forming apparatus comprising, in combination, a unitary annular cutter adapted to cut a core, a casing serving with the cutter to support the walls of the hole formed by the cutter, means attachable and detachable from the cutter for rotating the same independent of the casing, said casing and cutter serving as a mold for a concrete column when the rotating means is removed, and means for feeding liquid to the cutting edge of the cutter.

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