E. O'TOOLE.

METHOD OF AND APPARATUS FOR SINKING SHAFTS.

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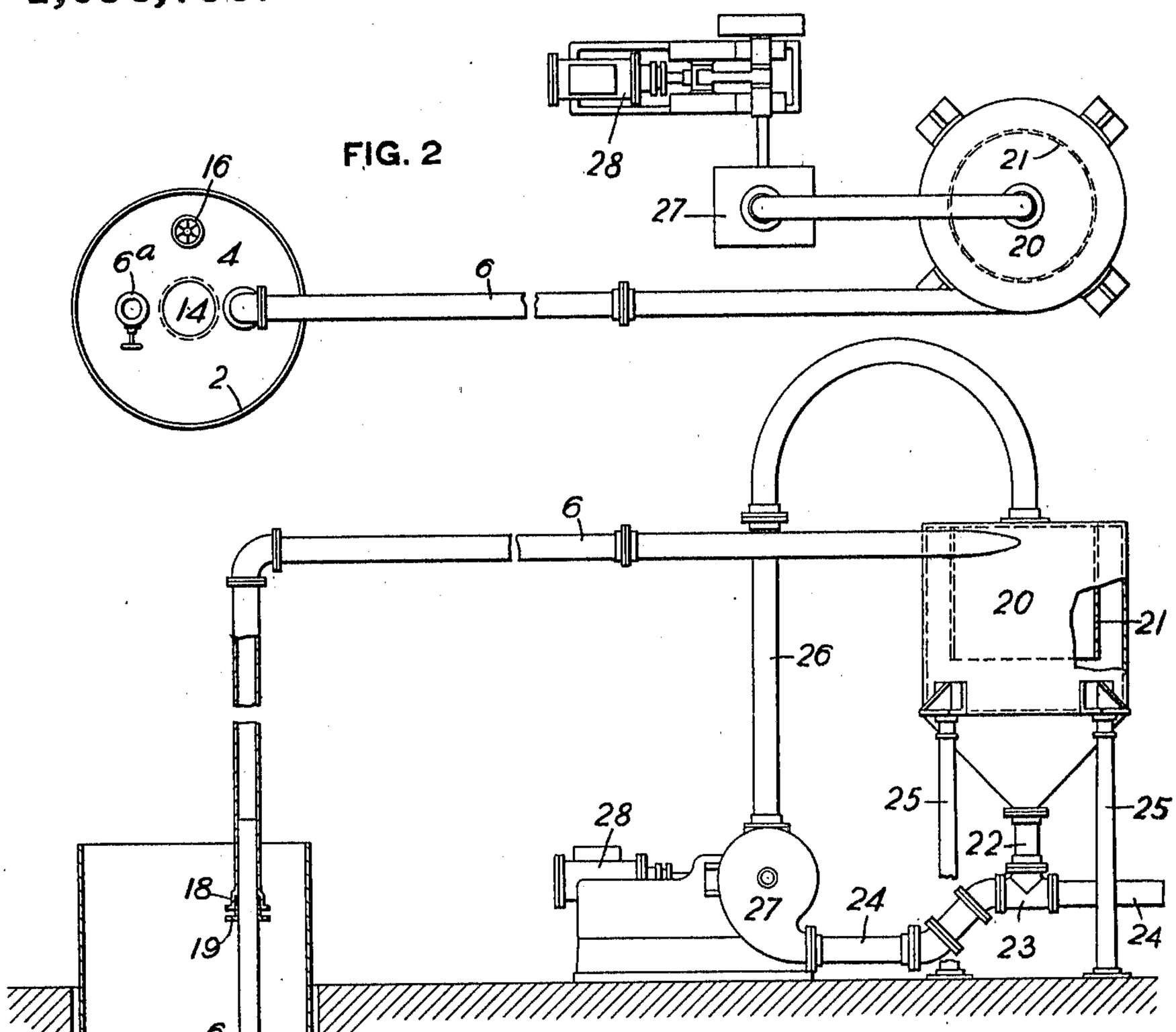


FIG. 2

FIG. 1

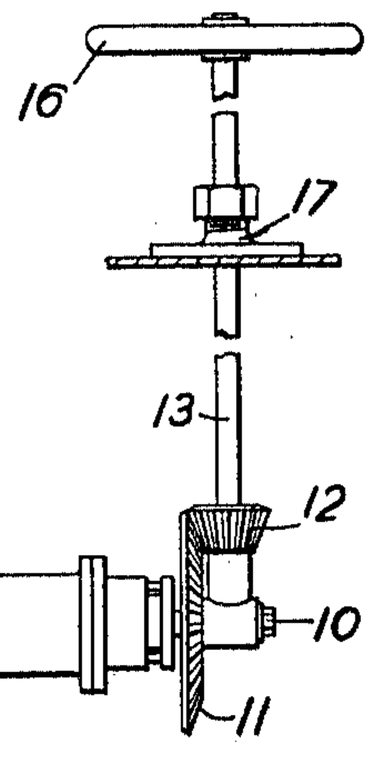


FIG. 3

WITNESSES

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# UNITED STATES PATENT OFFICE.

EDWARD O'TOOLE, OF GARY, WEST VIRGINIA.

## METHOD OF AND APPARATUS FOR SINKING SHAFTS.

1,096,795. Specification of Letters Patent. Patented May 12, 1914.

Application filed December 6, 1911. Serial No. 664,142.

*To all whom it may concern:*

Be it known that I, EDWARD O'TOOLE, a citizen of the United States, residing at Gary, in the county of McDowell and State of West Virginia, have invented a new and useful Method of and Apparatus for Sinking Shafts, of which the following is a specification.

My invention relates to the sinking of shafts through earth, sand, gravel and similar materials, and more particularly to sinking such shafts through earth, sand, gravel, quicksand and similar strata carrying large amounts of water.

One object of my invention is to provide a novel method of sinking shafts through a stratum of earth carrying large amounts of water and of handling and conveying out of the shaft, the excavated materials and the water encountered during the shaft sinking operations.

Another object of the invention is to provide an improved shaft sinking apparatus having novel means for carrying out the steps of my improved method.

A further object of my invention is to provide shaft sinking apparatus having novel means whereby the excavated materials carried out of the shaft are separated from the fluid pressure means employed in propelling the materials from the excavation.

Still further objects of my invention will appear as the invention is more fully described hereinafter.

Referring to the accompanying drawings forming part of this specification, Figure 1 is a side elevation partly in section, showing an improved shaft sinking apparatus constructed and arranged in accordance with my invention and applied for use in excavating the shaft in accordance with the method forming part of this invention. Fig. 2 is a plan of the apparatus shown in Fig. 1 showing the location of the parts forming my improved apparatus, relative to each other and to the shaft being formed. Fig. 3 is a detail elevation, on a larger scale, showing the construction of the valve controlling the inlet opening through which the excavated materials are introduced from the caisson to the conduit and showing the valve operating mechanism.

In the drawings, the numeral 2 designates a caisson having an enlarged outwardly flared open lower end. A diaphragm 3 is secured in and partitions the caisson lengthwise into compartments 4 and 5. A conduit 6 leads into and out of the lower compartment 5 of the caisson, and the inlet end of the conduit is provided with a valve 6ª located in the compartment 4 by which its inlet opening is regulated and closed.

The inlet to the conduit located in the lower compartment of the caisson is provided with a valve 7 and on top of the valve is a hopper or funnel 8 having an open upper end. The body of the valve 7 has a series of holes 9 provided on the upper side of the gate in the valve, through which accumulations of water flow from the lowermost compartment 5 of the caisson into the conduit 6. The stem 10 of the valve 7 is provided with a bevel gear 11 which meshes with a bevel pinion 12 secured on one end of a spindle 13. This spindle extends vertically upward through the diaphragm 3 into the upper compartment 4 of the caisson.

The diaphragm 3 in the caisson is provided with a manhole 14 having a cover 15 by which the manhole is closed when it is desired to form a water and air tight compartment in the lower portion 5 of the caisson 2.

A handwheel 16 on the upper end of the spindle is provided to open and close the valve 7, and a stuffing box 17 having a gland is provided to maintain an air and water tight sliding joint around the spindle 13 where it passes through the diaphragm 3 in the caisson.

The outlet end of the conduit 6 extends upwardly out of the caisson 2 and, at an intermediate point in its length, the conduit is provided with a telescoping joint to permit the lower sections of the conduit 6 to move vertically downward with the downward movement of the caisson 2 as the shaft deepens. The stuffing box 18 and gland 19 provided on the end of one section of the conduit 6 form a watertight and airtight sliding joint with the telescoping section of the conduit.

The upper end of the conduit 6 is arranged to discharge materials carried there-

through into a chamber 20 forming a separator. This separator, as shown, comprises a cylindrical shell having a cylindrical partition 21 depending therein from the top of the chamber, the lower end of the partition being open. The discharge end of the conduit 6 opens into the annular space formed in the separator 20 by the depending partition 21. The lower end of the separator has a conical bottom and its smaller lower end is connected by the pipe or tube 22 to the branch of a T 23 forming part of the discharge pipe or conduit 24.

The separator 20 is elevated some distance above the ground level, being supported by means of the posts or columns 25. The top of the separator is also connected by means of a pipe 26 to the suction side of a rotary pump 27, the discharge side of this pump being connected to the T 23 forming part of the bottom discharge 24 on the separator 20. The pump 27 is directly connected to and is driven by a suitable motor 28, a reciprocating engine being the type of motor shown.

In the operation of my improved apparatus in accordance with the method forming part of this invention the caisson 2 is erected in the location at which the shaft is to be sunk and the separator 20, pump 27 and pump motor 28 are erected and connected to the conduit 6 leading into and out of the caisson, as shown. The telescoping connections in the vertical leg of the conduit 6 being arranged to permit a relative sliding movement thereof, enables the caisson to descend into the shaft as the shaft is deepened in being excavated while maintaining a working connection with the pump 27 and the lower compartment 5 of the caisson.

The workmen enter the lower compartment 5 of the caisson through the manhole 14 in the diaphragm 3, and the excavating operations are commenced. Meanwhile the pump 27 has been started in operation so as to create and maintain a partial vacuum within the conduit 6 leading into and out of the caisson. The valve 6ª on the inlet end of the conduit is then partly or entirely closed, to the extent found necessary or desirable, and the valve 7 on the inlet to the conduit from the lower compartment of the caisson is opened. The materials removed by the workmen are then deposited as excavated in the hopper or chute 8, and, entering the conduit 6, are caused to travel therethrough and are delivered into the separator 20 through the medium of the partial vacuum constantly maintained within the conduit 6 by the pump 27.

More or less water will be constantly entering and accumulating within the lower compartment of the caisson which must be removed and it will be necessary to remove the water prior to the time the workmen enter the lower compartment 5 of the caisson after interruption or delay of any length in the shaft sinking operations. In such case the valve 7 on the conduit 6 within the lowermost compartment of the caisson will be opened by means of the handwheel 16, which is located in the upper compartment 4 thereof, and the pump 27 having been started, the accumulated water will flow into the conduit 6 through the series of holes or openings 9 in the valve and when enough water is present, through the hopper 8, and passing through the conduit 6, will be discharged into the separator 20.

The materials delivered through the conduit into the separator 20 are separated therein, the water and the solid materials passing downwardly through the bottom of the separator into the discharge pipe 24. The air is drawn upwardly through the inner chamber formed by the depending partition 21 in the separator 20 into the pipe 26 connected to the suction or inlet opening on the pump 27 and is caused to pass through the pump and enter under pressure into the discharge pipe 24. The pressure developed in this way in the pump 27 forces the solid materials and water delivered into the discharge pipe 24 from the separator 20 and causes such materials to be discharged or expelled in a stream from the discharge pipe 24.

As the excavating operations proceed in forming the shaft, the caisson 2 will of its own weight descend into the shaft opening, and, by reason of the outwardly flared lower end of this caisson, the shaft will be made slightly larger in cross section than the body of the caisson so that contact of the earth wall of the shaft with the caisson will be lessened and resistance to the descent of the caisson caused by friction with the sides of the shaft will be reduced to a minimum.

When the excavating operations are stopped, the manhole cover 15 will be adjusted to close the manhole 14 in the diaphragm 3 in the caisson and the valves 6ª and 7 on the conduit 6 are closed. Should a quantity of water seep into and collect within this lower compartment 5 while the shaft forming operations are interrupted, the collected water is first removed. In removing the water the pump is started in operation and the handwheel 16 in the upper compartment 4 of the caisson is turned to open the valve 7. The water then flows into the conduit over the top of the hopper 8 and, when the level of the water is below the top edge of the hopper 8, through the holes 9 in the body of the valve 7 above the top side of its gate and is drawn through the conduit 6 and out of the caisson.

The advantages of my invention will be

apparent to those skilled in the art. By my improved method of sinking shafts such shafts are readily formed in sand, and quicksand, which carry large amounts of water, and the difficulties experienced heretofore in removing the water and preventing its interfering with the shaft forming operations are prevented and overcome.

The apparatus forming part of my invention is simple and is easily kept in repair and by its use the materials are quickly and automatically carried through the conduit and out of the shaft as the excavating proceeds.

The excavated materials and the water passing through the conduit are drawn or carried to the surface and out of the caisson, where they are positively forced from the discharge outlet on the conduit.

Modifications in the construction and arrangement of the parts may be made without departing from my invention.

The type of pump employed may be other than that shown and described, other forms of motors may be employed for driving the pump, and other changes may be made in the construction and arrangement of the parts without departing from my invention as defined in the appended claims.

I claim:—

1. The method of sinking shafts consisting in excavating within a caisson in forming the shaft, depositing the excavated materials within a conduit leading from the caisson to the exterior thereof, creating an outwardly flowing current of fluid pressure in said conduit to thereby carry water collecting in the caisson and the deposition of excavated materials therethrough and out of the caisson, separating and discharging the air independently of the removed solids carried through and discharged from said conduit, and causing the caisson to descend within the shaft as the excavation is deepened.

2. The method of sinking shafts consisting in excavating within a caisson in forming the shaft, depositing the excavated materials within a conduit leading from the caisson to the exterior thereof, creating an outwardly flowing current of fluid pressure in said conduit to thereby carry water collecting in the caisson and the deposition of excavated materials therethrough and out of the caisson, separating and discharging the air independently of the removed water and solids carried through and discharged from said conduit, and causing the caisson to descend within the shafts as the excavation is deepened.

3. The method of sinking shafts consisting in excavating within a caisson in forming the shaft, depositing the excavated materials within a conduit leading from the caisson to the exterior thereof, inducing a partial vacuum within the conduit to create an outwardly flowing current of fluid pressure in said conduit to thereby draw the deposition of excavated materials therethrough and out of the caisson, separating and discharging the solid materials passing through the conduit independently of the air, and causing the caisson to descend within the shaft as the excavation is deepened.

4. The method of sinking shafts consisting in excavating within a caisson in forming the shaft, depositing the excavated materials within a conduit leading from the caisson to the exterior thereof, inducing a partial vacuum within the conduit to create an outwardly flowing current of fluid pressure in said conduit to thereby draw the deposition of excavated materials therethrough and out of the caisson, separating and discharging the solid materials passing through the conduit independently of the air, and employing the air discharged from the suction pump to force the solid materials from the discharge pipe on the separator, and causing the caisson to descend within the shaft as the excavation is deepened.

5. Apparatus for sinking shafts comprising a caisson having an outwardly flaring open lower end, a conduit opening into the caisson having a discharge outlet on the exterior thereof, a suction pump connected to said conduit and arranged to maintain a partial vacuum and induce an outward flow of fluid pressure therein to thereby carry depositions of excavated materials through the conduit and out of the caisson, and means for separating and discharging the solid materials from the conduit between the caisson and the pump.

6. Apparatus for sinking shafts comprising a caisson having an outwardly flaring open lower end, a conduit opening into the caisson having a discharge outlet on the exterior thereof, a suction pump connected to said conduit and arranged to maintain a partial vacuum and induce an outward flow of fluid pressure therein to thereby carry depositions of excavated materials through the conduit and out of the caisson, and means for separating and discharging the solid materials from the conduit between the caisson and the pump, said pump having a discharge outlet connected to and arranged to force materials from the discharge outlet of said conduit.

7. Apparatus for sinking shafts comprising a caisson having a diaphragm separating the caisson into upper and lower compartments, a conduit having an inlet and an outlet on the exterior of the lower compartment, means for creating a suction in said conduit, a valve for closing the inlet, and means for operating said valve.

8. Apparatus for sinking shafts comprising a caisson having a diaphragm separating the caisson into upper and lower compartments, a conduit having an inlet and an outlet on the exterior of the lower compartment and also having an inlet in the lower compartment, means for creating suction in said conduit, valves for closing said inlets, and means on the exterior of the lower compartment for operating said valves.

In testimony whereof, I have hereunto set my hand.

EDWARD O'TOOLE.

Witnesses:
D. Y. HUGHES,
A. E. SHELBURNE.