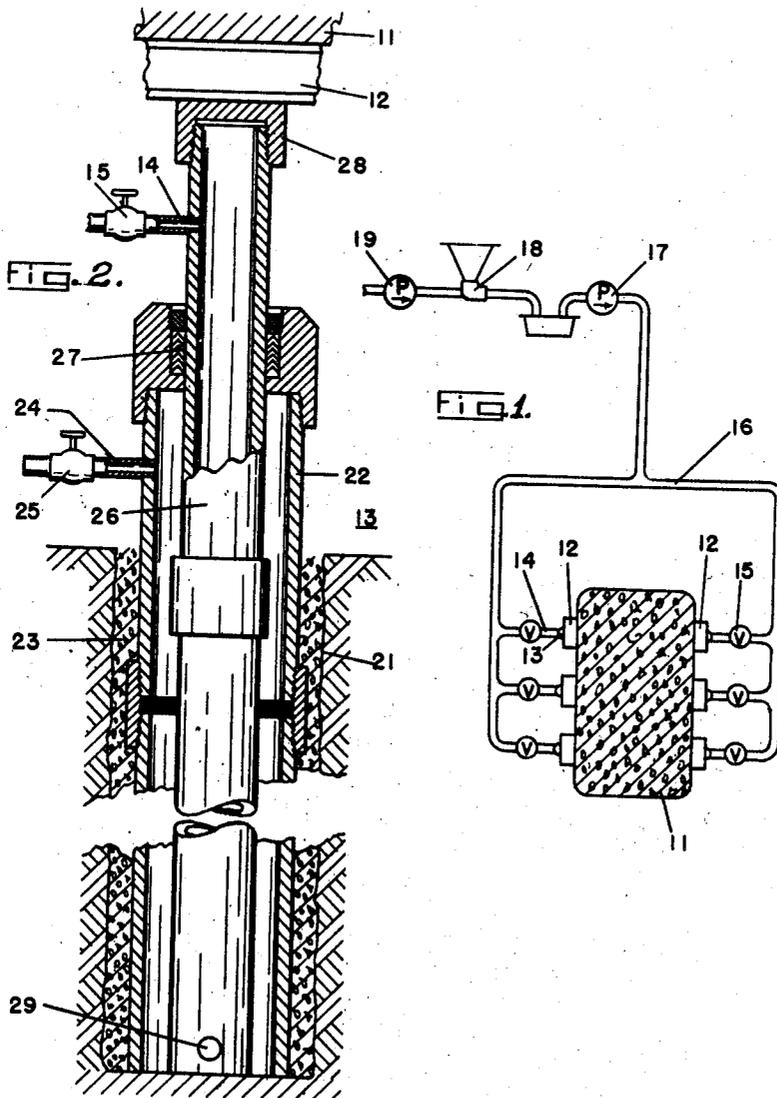


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T. P. LENAHAN
METHOD AND APPARATUS FOR RAISING AND PERMANENTLY
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INVENTOR
THOMAS P. LENAHAN
BY

Carl Babcock

UNITED STATES PATENT OFFICE

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METHOD AND APPARATUS FOR RAISING AND PERMANENTLY SUPPORTING HEAVY STRUCTURES

Thomas P. Lenahan, Duncan, Okla., assignor to Halliburton Oil Well Cementing Company, Duncan, Okla.

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This invention relates to method and apparatus for raising and permanently supporting heavy structures such as dams, bridge piers, docks, foundations and the like, which have settled or shifted.

Load sustaining structures of the type mentioned are sometimes located in places where there is a layer of unstable earth, such as silt or sand, over the load bearing substratum or bed rock. As a result, the structure sometimes sinks below its intended level, either wholly or at one side or corner.

In accordance with the present invention, it is proposed to raise and permanently support such structures by the employment of a hydraulic jack in which cement slurry is either used as the actuating liquid or follows the actuating liquid, the jack being so constructed that when the structure is raised the desired amount, valves may be closed and the cement allowed to harden, leaving the jack permanently in place, it then becoming a reinforced concrete column.

If the structure is relatively small, or if only one corner of it has sunk into the earth, it may be possible to bring it back into the desired position by the use of only one jack. If a large structure has to be raised, however, any number of jacks may be employed and the arrangement for supplying the cement slurry thereto may be such that the jacks exert their lifting force either one after the other or simultaneously.

Accordingly, it is an object of the present invention to provide a novel system for raising a heavy structure such as a pier and for permanently holding it in place.

It is another object of the present invention to devise novel methods of raising heavy structures and for holding them in place.

Other objects and advantages reside in certain novel features of the method and the arrangement of parts, as will be apparent from the following description taken in connection with the accompanying drawing, in which:

Figure 1 is a diagram showing a plan view of a pier with a system of jacks, valves, pumps, etc., for raising it in accordance with the present invention; and

Figure 2 is a partial cross-sectional view of a hydraulic jack constructed in accordance with the principles of the invention.

Referring to the drawing in detail, and first to the arrangement of Figure 1, it will be seen that a pier is there illustrated at 11. In order to illustrate the invention, let it be assumed that the entire pier has sunk into the earth and that

it is desired to raise the same uniformly at all points.

In accordance with the present invention, suitable lifting members 12 are secured to the pier at spaced points. In the diagram of Figure 1, six such lifting members are illustrated. These may be sections of I-beams or other structural steel members and are secured to the pier in any suitable manner.

Beneath each of the lifting members 12, hydraulic jacks 13 are mounted, the jacks preferably extending down to bed rock. The hydraulic jacks 13 are each supplied with individual supply conduits 14. Each of these conduits is provided with a valve 15 and is connected to the supply conduits 16, to which liquid under pressure may be supplied from a pump 17.

The pump 17 may supply water or other liquid to the conduits 16 to initially fill the jacks 13. At the desired time, the water may be replaced by cement slurry. In Figure 1, the cement mixer is diagrammatically illustrated at 18, the mixing being accomplished through the agency of an auxiliary water pump 19, in accordance with the United States patent to Halliburton, No. 1,486,883, for example.

With the arrangement illustrated in Figure 1, it will be seen that any jack 13 may be supplied with any given quantity of liquid after which the valve 15 may be closed. Likewise, the jacks 13 may all be supplied with liquid simultaneously or successively. Likewise, any group of jacks may selectively be supplied with liquid. Thus, if desired, the valves 15 at the right of the figure may remain closed, while those at the left are opened and liquid supplied to the left-hand jacks, after which those valves may be closed and the ones on the right-hand side of the figure opened to raise the right-hand side, so that first one side of the pier and then the other is lifted, the pier thus being rocked back and forth as it is lifted.

An important feature of the invention resides in the construction and mounting of each individual hydraulic jack. To place the jack in position, a hole is first drilled along side the pier where it is desired to locate the jack, the hole going down to bed rock. The equipment for drilling this hole may be such as is commonly used in drilling oil wells.

Such a hole is illustrated at 21 in Figure 2. After the hole is completed, casing 22 is lowered therein and secured in place by placing cement 23 in the annular space between it and the wall of the hole 21. The manner of carrying on this

operation may be the same as that employed in cementing surface casing in oil wells.

The casing 22 may extend above the surface of the ground as illustrated, and is provided with a discharge conduit 24 equipped with a valve 25.

Lowered into the casing 22 is a jack pipe 26. Preferably this pipe should extend to the bottom or nearly to the bottom of the hole 21. It is some longer than the casing 22 and extends up through structure providing a suitable stuffing box, as illustrated at 27. An ordinary Braden-head such as is used in the oil fields may serve as the stuffing box.

The upper end of the jack pipe 26 is provided with a cap 28 positioned just beneath the lifting members 12 secured to the pier 11. In the arrangement illustrated, the conduit 14 equipped with the valve 15 referred to above, is connected into the jack pipe 26.

It will be seen that with the structure illustrated, liquid may be supplied from the pump 17 to the interior of the jack pipe 26, the liquid flowing in the direction of the arrows of Figure 2, assuming the valves 15 and 25 are open. If desired, the lower end of the jack pipe 26 may be provided with suitable discharge ports 29 to facilitate this circulation. (If desired, the circulation might be in the opposite direction, the pump 17 then being connected to pipe 24.)

As illustrated, if at any time the valve 25 is partially or wholly closed, pressure will build up within the jack and cause the jack pipe 26 to exert a lifting force upon the member 12.

Where conditions are ideal, no liquid will be placed in the jack prior to the time that cement slurry is placed therein. In such a case, the valves 15 and 25 will both be opened, slurry pumped into the jack and circulated in the direction of the arrows, until a return is had through the conduit 24. The valve 25 will then be closed, and the supply of cement slurry to the jack continued until the member 12 has been raised the desired amount, at which time the pumping will be discontinued, the valve 15 closed and the cement allowed to harden.

At other times it may be necessary or desirable to use water or other liquid for exerting the necessary pressure to lift the structure, this liquid to be followed by cement slurry with the valves 15 and 25 carefully controlled, so that the desired position of the jack pipe 26 is maintained.

In any event, cement will ultimately be left not only in the jack pipe 26, but also in the annular space between it and the casing 22.

After the cement has hardened it will be seen that a very rigid column is provided, consisting of the outer body of cement 23 interlocking the casing 22 with the earth, an intermediate body of cement between the casing 22 and the jack pipe 26 and an inner body of cement left within the jack pipe 26.

Of course, after the cement has hardened, the valves 15 and 25 and the connecting pipes 14 and 24 may be removed from the column.

If the pier or other structure is raised by rocking motion, as mentioned above, the cement in one set of jacks may be allowed to harden before slurry is supplied to the other set, the apparatus being capable of use in several different ways.

Also, it is, of course, possible to force cement or other supporting material under the pier or other structure during or after the application of the method and apparatus of this invention.

While only one embodiment of the invention has been shown and described herein, it is obvious that various changes may be made in the method of application or in the structure, without departing from the spirit of the invention or the scope of the annexed claims.

I claim:

1. The method of raising and permanently supporting a structure which consists in drilling a plurality of holes in the earth, placing a casing in each hole, cementing the casings in place, placing jack pipes in the casings through stuffing boxes, filling the jack pipes and the casings with liquid, exerting hydraulic pressure on the liquid to raise the jack pipes replacing the liquid in the jack pipes and casing with cement slurry while maintaining the hydraulic pressure therein, and holding the pressure until the cement hardens, the hydraulic pressure being exerted on the liquid alternately, to rock the structure slightly in raising the same.

2. The method of raising and permanently supporting a structure which consists in drilling a hole in the earth, placing a casing therein, cementing the casing in place, placing a jack pipe in the casing through a stuffing box, filling the jack pipe and the casing with a liquid, exerting hydraulic pressure on the liquid to raise the jack pipe, replacing the liquid in the jack pipe and casing by cement slurry while maintaining the hydraulic pressure therein and while maintaining the jack pipe in its raised position and holding the pressure until the cement hardens.

THOMAS P. LENAHAN.