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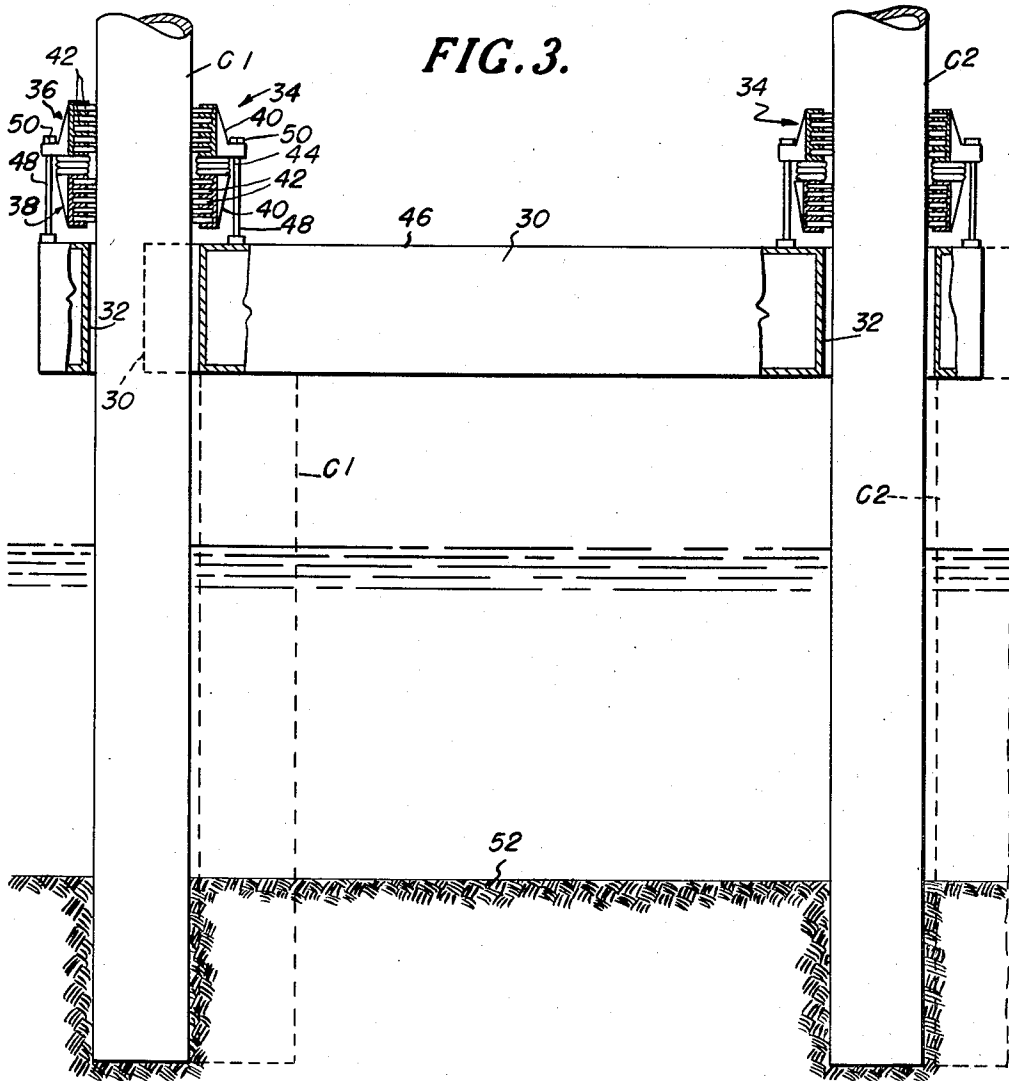
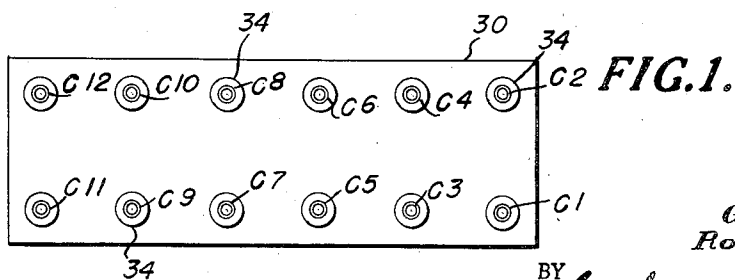
G. BAUER ET AL

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METHOD OF OPERATING MARINE STRUCTURES

Filed April 26, 1955

3 Sheets-Sheet 1



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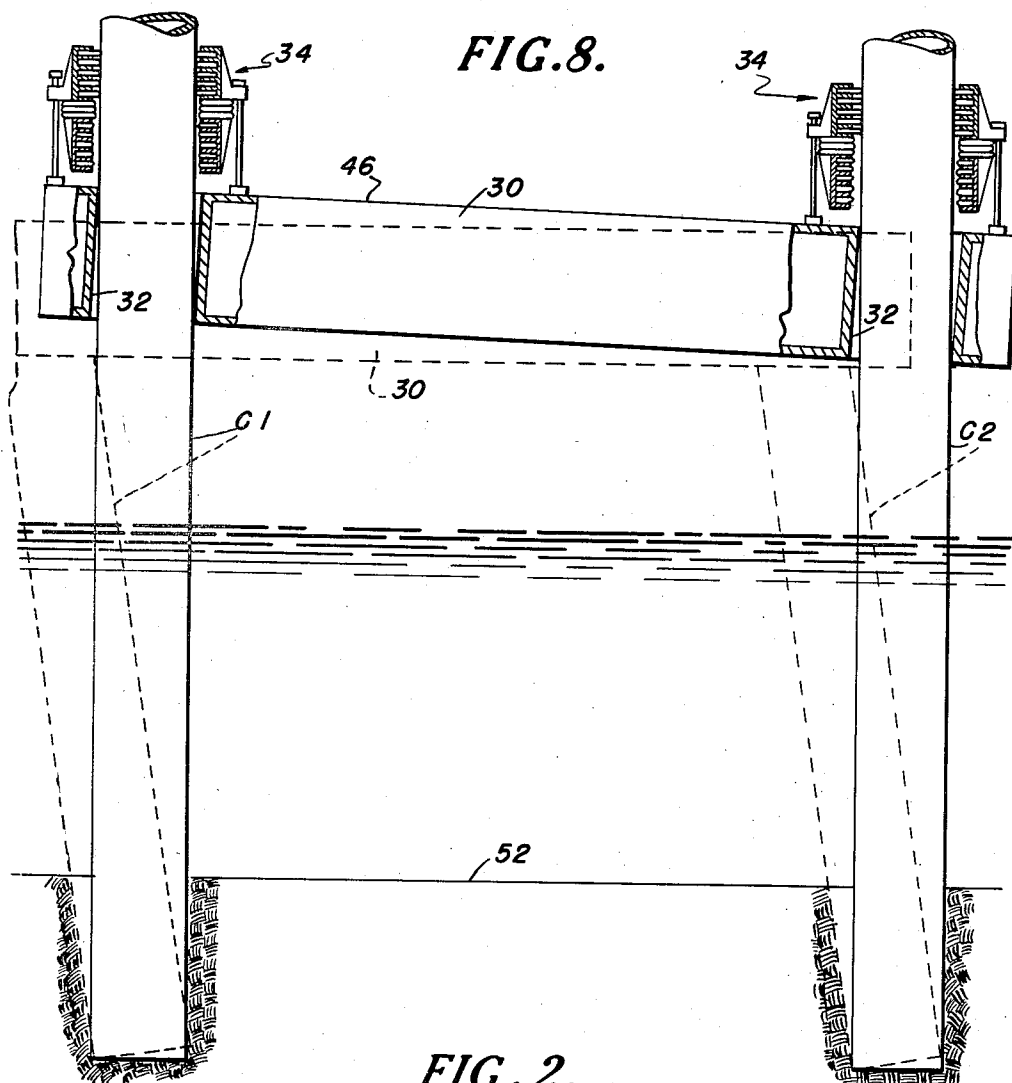
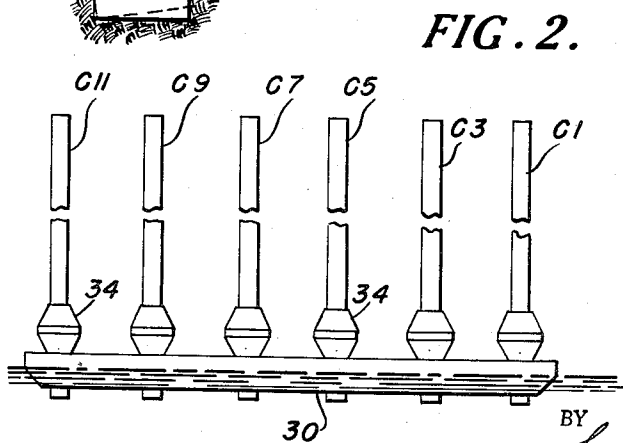
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3 Sheets-Sheet 2



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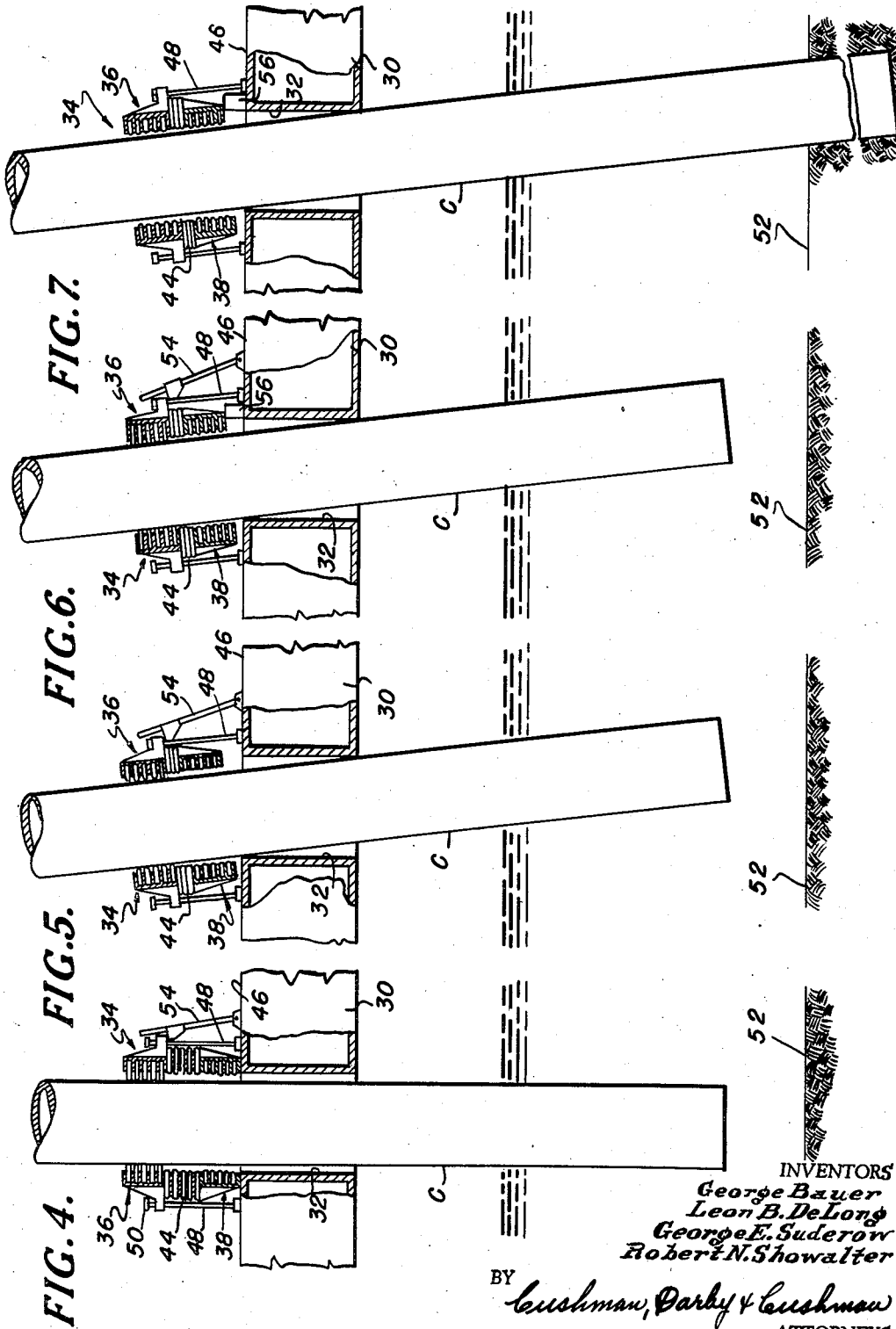
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METHOD OF OPERATING MARINE STRUCTURES

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METHOD OF OPERATING MARINE STRUCTURES

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1 Claim. (Cl. 61—46.5)

This invention relates to above-water marine platforms, which may be in the nature of a dock or in the nature of an offshore installation. More particularly, this invention relates to methods of operating and manipulating apparatus which can be erected as an above-water marine platform in accordance with the teachings of the co-pending application of Robert W. Pointer, Serial No. 283,567, filed April 22, 1952, now Patent No. 2,775,869.

In the aforementioned patent, there is disclosed a barge having a buoyant hull equipped with a plurality of vertically-extending supporting elements or legs, there disclosed as caissons which are mounted for vertical movement relative to the hull in corresponding guiding openings or wells in the latter. Jacks are mounted on the hull and are releasably engageable with each caisson for forcefully effecting relative vertical movement between the caissons and the hull. By means of this structure, the hull can be floated to any selected marine location and the caissons moved down to engage with the marine bottom while the hull is still afloat. Thereafter, by operation of the jacks, the hull can be raised to any desired elevation on the caissons and supported thereon, to thus provide a stable platform which can be used as a dock, as a base for drilling operations, or for any other appropriate purpose. If the platform is used for drilling operations or the like, after the latter have been completed, the hull can be lowered by the jacks back down into the water until the hull is again afloat. Thereupon, by operating the jacks the caissons can be pulled up and the barge floated to another drilling site.

As disclosed in the aforementioned Pointer patent, a small clearance exists between each caisson and its corresponding guiding well so that each caisson can cant in its well to a limited extent in any direction. Additionally, the jacks are so mounted on the barge that they can cant with their corresponding caissons to thereby avoid any binding action of the caissons in their jacks. The advantages of the slight cantability of the caissons and the novel uses for which this feature may be employed, will become more apparent hereinafter.

Accordingly, it is an object of this invention to provide novel methods for fully utilizing the advantages of the cantability of the aforescribed supporting legs or members of apparatus embodying the general principles of the Pointer invention. To this end, this application discloses methods of manipulating and operating such apparatus, and other inventive objects and advantages of such methods will be evident from the following description and accompanying drawings in which:

Figure 1 is a plan view of apparatus of the type with which this invention is practiced.

Figure 2 is a side view of the apparatus shown in Figure 1.

Figure 3 is an end view of such apparatus illustrating the initial positioning of a dock-type installation therewith.

Figures 4, 5, 6, and 7 are fragmentary views of the

2

apparatus shown in Figure 3 illustrating the successive steps employed in manipulating one of the supporting legs.

Figure 8 is a view corresponding to Figure 3 but illustrating the final step in manipulating the apparatus to shift it horizontally from the position shown in Figure 3.

Referring now to Figures 1 and 2 of the drawings, there is shown apparatus for practicing this invention. Such apparatus includes a generally rectangular buoyant hull in the nature of a barge 30, which in an actual operating embodiment has a length of the order of 200 feet and a beam of the order of 80 feet. It will be obvious, however, that many of the methods disclosed herein are adaptable to barges of other sizes and configurations. Additionally, the actual details of construction and the internal compartmentation of the barge will depend upon the use to which it is to be put, e. g., a dock, a drilling barge, a permanent above-water marine platform, etc.

Spaced along each side of the barge 30 and preferably arranged generally symmetrically with respect to the longitudinal center line thereof are a plurality of vertically extending, hollow circular steel caissons C1 to C12 that are somewhat loosely, slidably guided for relative substantially vertical linear movement in corresponding caisson wells 32 (Figures 3 to 8) that extend vertically through the barge and have aligned, circular, top and bottom guiding openings. These guiding wells 32 are of slightly greater diameter than the caissons C mounted therein so as to somewhat loosely receive and linearly guide the latter, as mentioned above and as disclosed in detail in the aforementioned application. In an actual operating embodiment, such caissons C are of the order of 6 feet in diameter uniformly throughout their entire lengths, while the wells 32 are about 6 feet 1 inch in diameter. Consequently, it will be seen that it is possible for the caissons C to cant slightly in their wells 32. In the drawings, the clearance between the caissons C and their corresponding wells 32 has been greatly exaggerated for illustrative purposes only.

It is to be understood that this invention is applicable to and may be practiced with buoyant hulls or platforms having upstanding, supporting legs of any type, whether of an openwork tower-like construction or of an imperforate caisson-like construction, as is shown herein. Furthermore, it will be realized that the invention can be practiced with supporting elements or legs of any appropriate configuration in transverse section, provided such supporting legs are mounted in wells or equivalent guides so that some limited canting movement of the supporting legs relative thereto is possible.

In the apparatus illustrated in the drawings, the caissons C may be of the order of 180 feet in length when used with a barge that is intended to be employed as a portable, offshore, above-water marine platform. Twelve such caissons C1 to C12, as shown in Figures 1 and 2 of the drawings, have been found adequate for a barge of the above-mentioned size. The caissons C are arranged in opposite pairs, spaced along the length of the barge 30 at locations determined principally by the load distribution on or in the hull, in order to distribute the weight of the barge, and the load thereon or therein, generally equally among all the caissons when the hull is raised out of the water on the caissons, as later described. It will be realized, however, that the number and spacing of the caissons C can be varied to accommodate buoyant platforms of different sizes and operating conditions. In barges of other configurations it also will be realized that other caisson locational patterns may be employed and determined primarily by load distribution.

Secured to the barge 30 at each caisson well 32 and in surrounding relation to the corresponding caisson C is a jack 34, which preferably is of the general type

described in detail in the aforementioned Pointer patent. Since a detailed description of such jacks 34 is given in such patent, a detailed description here would be unnecessarily repetitious. It is sufficient to state that, as shown in Figure 3, each jack 34 includes upper and lower gripper sections 36 and 38 each comprising a caisson-surrounding rigid collar or sleeve 40 having a plurality of inner circumferential channels within which are disposed fluid-pressure-constrictable rings 42 for positively, yet releasably, gripping their caisson C. Between the upper and lower sections 36 and 38 is a caisson-surrounding fluid-pressure-expandible bellows-like section 44 capable of exerting a powerful force to move the upper and lower jack sections apart, while several pressure cylinder retractors (not shown) are spaced about and connected to both the upper and lower jack sections to draw them toward each other when the bellows is exhausted. The lower gripper section 38 is engageable against the deck 46 of the barge 30 about the caisson well 32 to exert a downward force against the barge and the upper gripper section 36 is secured to the barge for exerting an upward force thereagainst by a plurality of tie rods 48, usually about four such rods being arranged circumferentially about the jack 34. Each tie rod 48 has a head 50 on its upper end to limit upward movement of the upper jack section 36 relative thereto, but such section is free to move downwardly on the rods. The rods 48 are so connected to the barge 30 and to the upper gripper section 36 of the jack 34 that the entire jack can move slightly in any transverse direction relative to the caisson well 32 and also can cant with the caisson C as the latter cants in its well.

As described more in detail in the aforementioned Pointer patent, each jack can be operated to impart step-by-step vertical linear relative movement in either direction between its caisson C and the hull. Thus, for example, in order to raise a caisson C relative to the barge 30 and starting with the lower jack section 38 resting on the deck 46 and engaged with a caisson, the upper section 36 is then disengaged from the caisson and the bellows 44 exhausted to permit the upper section to move downwardly by its own weight or it may be forced downwardly by the retractors. The upper section 36 is then engaged, the lower section 38 disengaged, and the bellows 44 expanded to thereby raise the caisson C relative to the barge 30 a distance corresponding to the stroke of the jack 34. At the end of such caisson-lifting stroke of the jack 34 the lower section 38 is re-engaged and the cycle repeated to again raise the caisson. To raise the barge 30 on the caissons C when the latter are engaged with the marine bottom, the bellows 44 is expanded to move the upper jack section 36 up into engagement with the tie rod heads 50 and the upper section is then engaged with its caisson C. Thereupon, the lower jack section 38 is disengaged, the bellows 44 exhausted, and the lower section lifted by the previously-mentioned retractors. The lower section 38 then is re-engaged, the upper section 36 disengaged, and the bellows 44 expanded to thereby exert a strong barge-raising force on the caisson C. As is also described in detail in the aforementioned Pointer patent, controls (not shown) are provided for the jacks 34 to enable their selective, individual operation or their operation in unison.

It also is pointed out that other types of jacks which operate on somewhat the same general principles as the Pointer jack can be employed for practicing this invention, provided the platform-supporting legs are mounted for limited canting movement in their wells or other guiding structure, and the jacks can cant with the legs.

The method of this invention will now be described with reference to the use of the aforesaid apparatus for a precision installation, i. e., a dock which must be exactly positioned with a close tolerance, such as under 1 inch, with reference to shore installations. Such a dock might be used, for example, for ore or coal handling

facilities wherein conveyor system tracks and machinery are built into the dock prior to its erection, and such tracks must be exactly matched with previously installed shore tracks.

In order to erect such a dock in accordance with this invention, the caissons C are first inserted into their wells 32, as by a crane (not shown) so that they project only a short distance therebelow, and are held in upright position therein by the jacks 34, as shown in Figure 2. The barge 30 or buoyant dock structure may then be towed to a predetermined dock-erection site by a tug (not shown), and at such site the barge is maneuvered, e. g., by shore lines, anchors, and winches, etc. (not shown), as nearly as possible into its predetermined desired position. The jacks 34 of several of the caissons C are then released to allow such caissons to drop into engagement with the marine bottom 52 (Figure 3), and thus hold the barge 30 in place. The position of the barge 30 may then be surveyed to determine its exact position. If the barge 30 is within several inches of its desired position, the jacks 34 of all of the remaining caissons C are then released to allow the remaining caissons to drop into engagement with the marine bottom 52, whereupon by operation of all the jacks 34 in unison the entire barge 30 is raised on the caissons C to its approximate predetermined desired elevation, as shown in Figure 3, and then leveled, if necessary, by selective operation of the jacks. The position of the barge 30 is again surveyed, and quite frequently it will be found that the barge will have moved somewhat due to wind, currents, and/or a sloping condition of the marine bottom 52, so that it usually will be several inches out of the predetermined desired position.

By the practice of this invention, however, the barge 30 can be moved several inches in any direction without being refloated, so that it can be precisely positioned in an exact, desired location.

Referring again to Figure 3, it is assumed that the desired position of the raised barge 30 is as shown in dotted lines. Hence, in order to be positioned correctly, the raised barge 30 needs to be moved several inches sideways and to the right. In order to accomplish this small movement, each caisson C is, in turn, manipulated as follows: First of all, the caisson C is pulled up, by operation of its corresponding jack 34, until its lower end is out of engagement with the marine bottom 52, as shown in Figure 4, leaving the weight of the barge 30 supported on the remaining caissons. In this position of the caisson C it will be seen that the lower gripper section 38 of the jack 34 is in engagement with the deck 46 of the barge 30, the bellows 44 is at least partially extended, and the upper section 36 is gripping the caisson. The next step is to interpose an adjustable prop or jack 54 of any conventional design between the deck 46 and the right hand side of the upper gripper section 36, e. g., beneath that portion of the jack 34 to which the right hand tie rod 48 is connected. The bellows 44 is then slowly exhausted, and it will be seen that because of the presence of the prop 54, the entire jack 34 will tilt in a direction to cause the lower end of the caisson C to swing in an arc toward the right until the caisson contacts the lower edge of the well 32 on the right hand side and the upper edge of the well on the left hand side, as shown in Figure 5. As stated heretofore, the clearance between each caisson C and its well 32 has been greatly exaggerated for illustrative purposes only. Hence, it will be realized that in actual practice of the method being described, the lower end of the caisson will swing only a few inches because of the small actual operating clearance and also because docks usually are erected in relatively shallow water and the barge 30 is not far above the surface thereof, so that the section of the caisson which projects beneath the barge is not very long.

As the bellows 44 becomes fully exhausted, the lower gripper section 38 is raised relative to the upper 36 by

the previously-mentioned retractors and at that time a block 56 may be interposed between the lower gripper section, at the right hand side thereof, and the deck 46 in order to maintain the jack 34 and its caisson C in the canted position shown. The bellows 44 then is extended slightly so that the prop 54 may be removed as shown in Figure 7. The upper gripper section 36 is then disengaged from the caisson C, allowing the same to drop back into engagement with the marine bottom 52 while in the canted position shown in Figure 7. The jack 34 is then operated to forcefully drive the caisson C into the marine bottom 52 until the caisson again supports its proportionate share of the total weight of the barge 30.

Other methods also may be employed to tilt the jack 34 and, hence, the caisson C. For example, starting with the jack 34 in the condition shown in Figure 4, the lower jack section 38 may be engaged with the caisson C in order to support it, the upper section 36 then disengaged, and the bellows 44 exhausted to allow the upper section to move down, either by its own weight or be drawn down by the retractors. The upper section 36 is moved down sufficiently for shims (not shown) to be interposed between the head 50 of the left hand tie rod 48 and the upper jack section 36. Whereupon, the upper section 36 is engaged with the caisson C, the lower section 38 disengaged, and the bellows extended, thus lifting the caisson C. On engagement of the upper section 36 with the shims, the entire jack will cant or tilt in the desired direction, thus swinging the caisson C as shown in Figure 5.

After the foregoing caisson-pulling and resetting at an angle procedure has been accomplished for each of the caissons C, the lower ends of all of the caissons will have been shifted slightly to the right and they all will be leaning slightly in substantially the same direction, as shown in dotted lines in Figure 8; whereupon all of the jacks 34 are operated in unison to lift the barge 30 slightly on the caissons C so that the lower gripper section 38 of each jack 34 can be raised slightly relative to the barge in order to permit removal of all of the blocks 56, if the procedure requiring their use has been followed. After all of the blocks 56 have been removed, the jacks 34 along the left hand side of the barge 30 are operated to raise that side of the barge on the caissons C, as shown in Figure 8. This action, because of the engagement of the caissons C at the top and the bottom of their wells 32 on opposite sides thereof, will actually pivot the caissons in the marine bottom 52 and straighten them to the vertical. In so doing the barge 30 will move slightly to the right, as shown in solid lines in Figure 8. The jacks 34 along the left hand side of the barge 30 are then operated to lower that side and thereby level the barge on the caissons C, whereupon the barge will be positioned quite precisely in its desired exact position. The caissons C then are driven to refusal into the marine bottom 52 by successive operation of their jacks 34. If the barge 30 is to be used as a permanent dock, the caissons C can then be welded or otherwise rigidly fixed and secured to the barge 30. Thereupon the jacks 34 can be

detached and removed, and the caissons C can be cut off flush with the deck 46 of the barge if desired.

It will be evident that the foregoing method steps can be used to shift the barge 30 slightly in any horizontal direction. It also will be evident that the method is inapplicable where marine bottom conditions are such that the caissons C, when the barge is initially raised thereon, are engaged so tightly in the marine bottom 52, as by a deep penetration therein, that they cannot be pivoted or straightened to the vertical as illustrated in Figure 8. Most dock installations, however, are in locations wherein the nature of the marine bottom readily permits the "shifting" method to be practiced.

It thus will be seen that the objects of this invention have been fully met. It will be realized, however, that the specific method illustrated and described herein for the purpose of illustrating the principles of this invention is subject to variation without departure from such principles. Therefore, this invention includes all methods encompassed within the spirit and scope of the following claim.

We claim:

The method of precisely positioning a marine-bottom-supported above-water platform with apparatus which includes a platform-like buoyant body having a plurality of substantially-upright elongated supporting members mounted for limited universal canting and substantially-unlimited generally-longitudinal movement in guide means on the body, and further having operating means for each member for selectively and forcefully effecting such longitudinal movement in either direction or restraining such longitudinal movement, and starting with the supporting members substantially vertical, engaged with the marine bottom, and supporting at least a major portion of the weight of the body, the steps comprising: successively raising each of the members until its lower end is out of engagement with the marine bottom while supporting the body on the remaining members, canting the raised member to a predetermined extent in one direction, and moving the member, while maintaining it so canted, back down into engagement with the marine bottom and supporting a part of the weight of the body thereon, whereby all the members will be leaning substantially the same extent in substantially the same direction; tilting the body on the members sufficiently and in a direction to straighten the members substantially to the vertical; and leveling the body on the members, whereby the body will have been shifted a predetermined distance horizontally, from its original raised position, in a direction opposite that in which the members were canted.

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