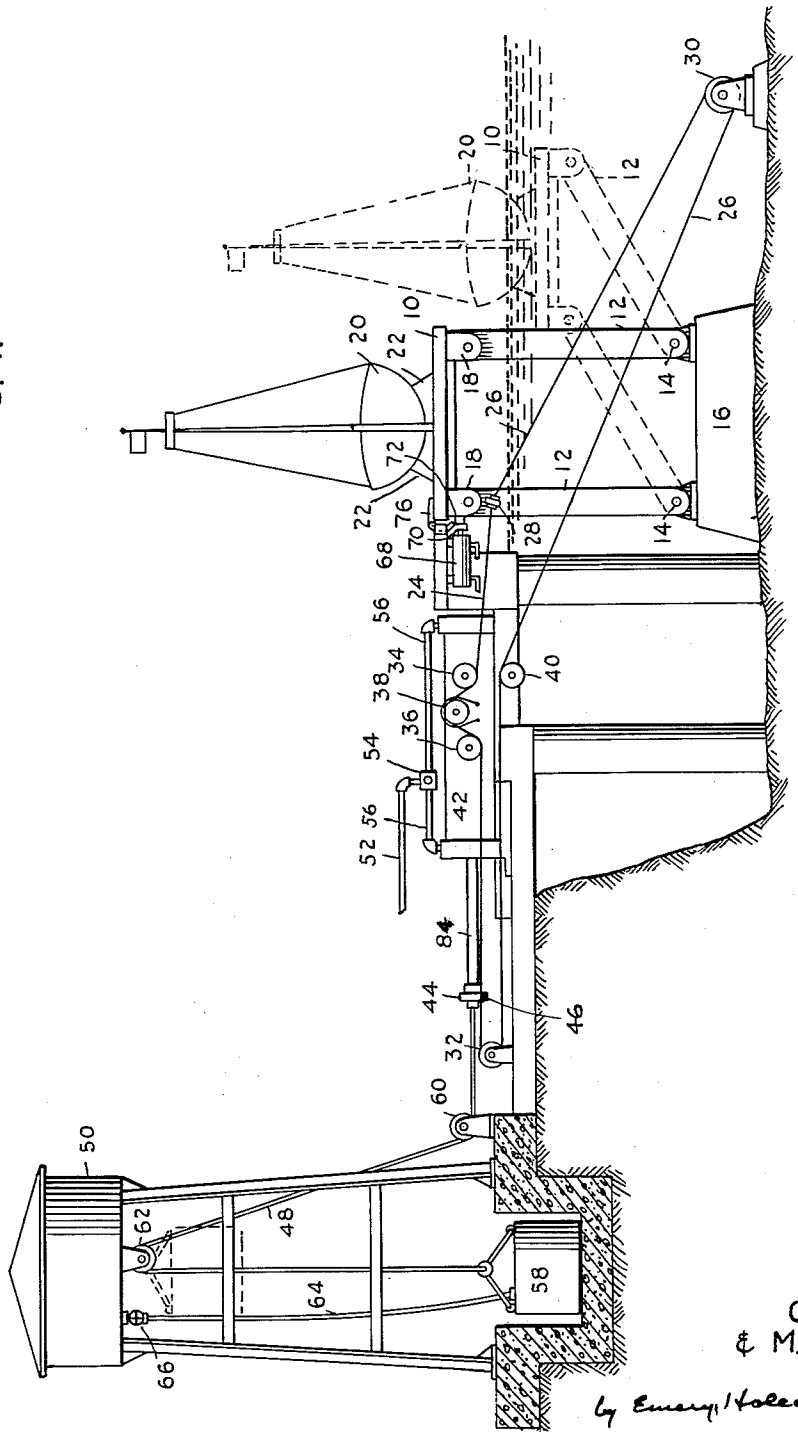
Dec. 13, 1960 M. R. MACHOL ET AL 2,963,870

COUNTERBALANCED UNWATERING APPARATUS

Filed Feb. 20, 1959 4 Sheets-Sheet 1

FIG. 1.



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COUNTERBALANCED UNWATERING APPARATUS

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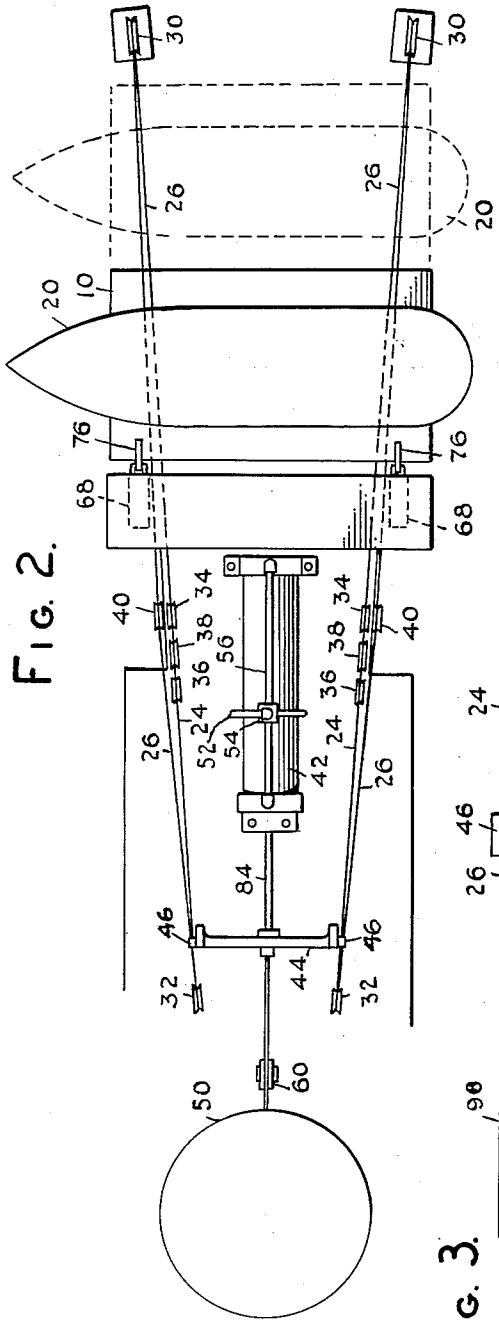


FIG. 2.

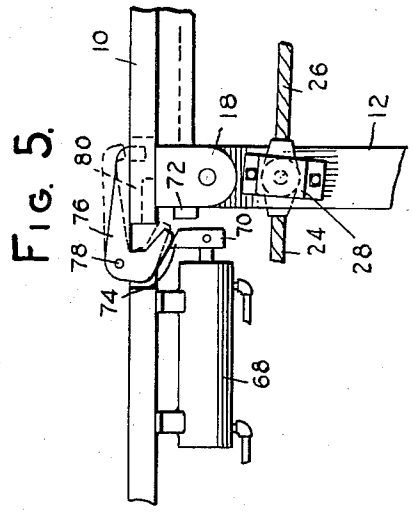


FIG. 5.

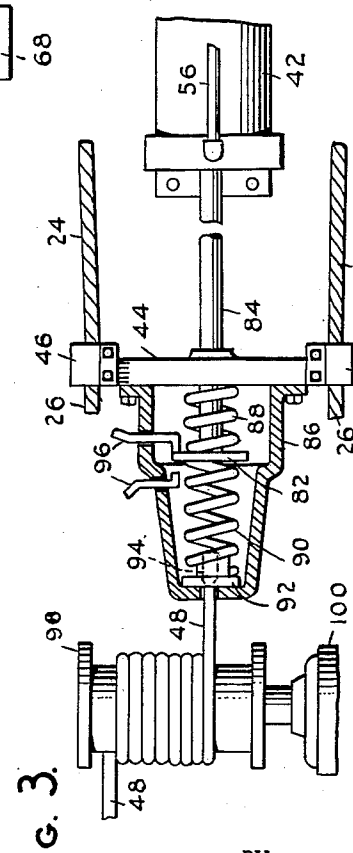


FIG. 3.

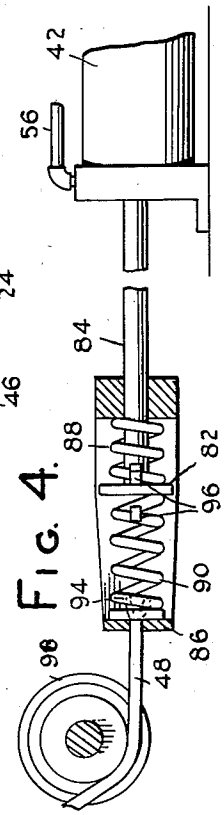


FIG. 4.

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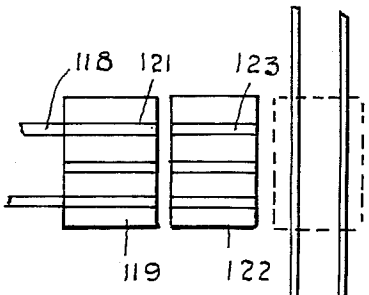
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Dec. 13, 1960 M. R. MACHOL ET AL 2,963,870

COUNTERBALANCED UNWATERING APPARATUS

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FIG. 6.



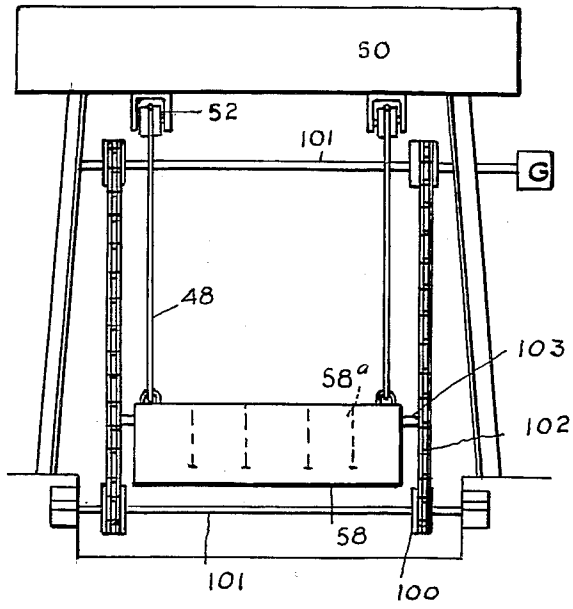


FIG. 9.

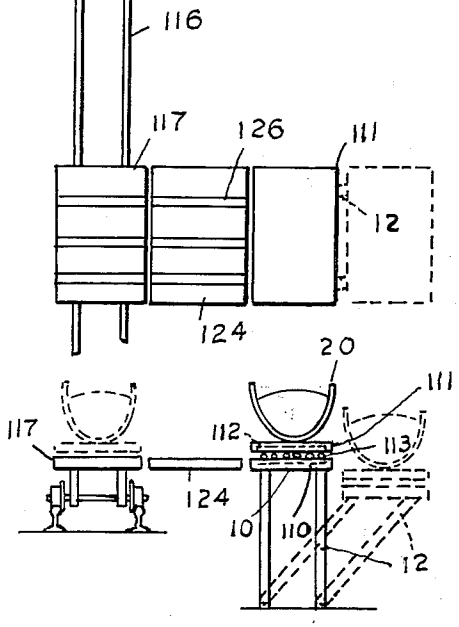


FIG. 7.

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COUNTERBALANCED UNWATERING APPARATUS

Filed Feb. 20, 1959 4 Sheets-Sheet 4

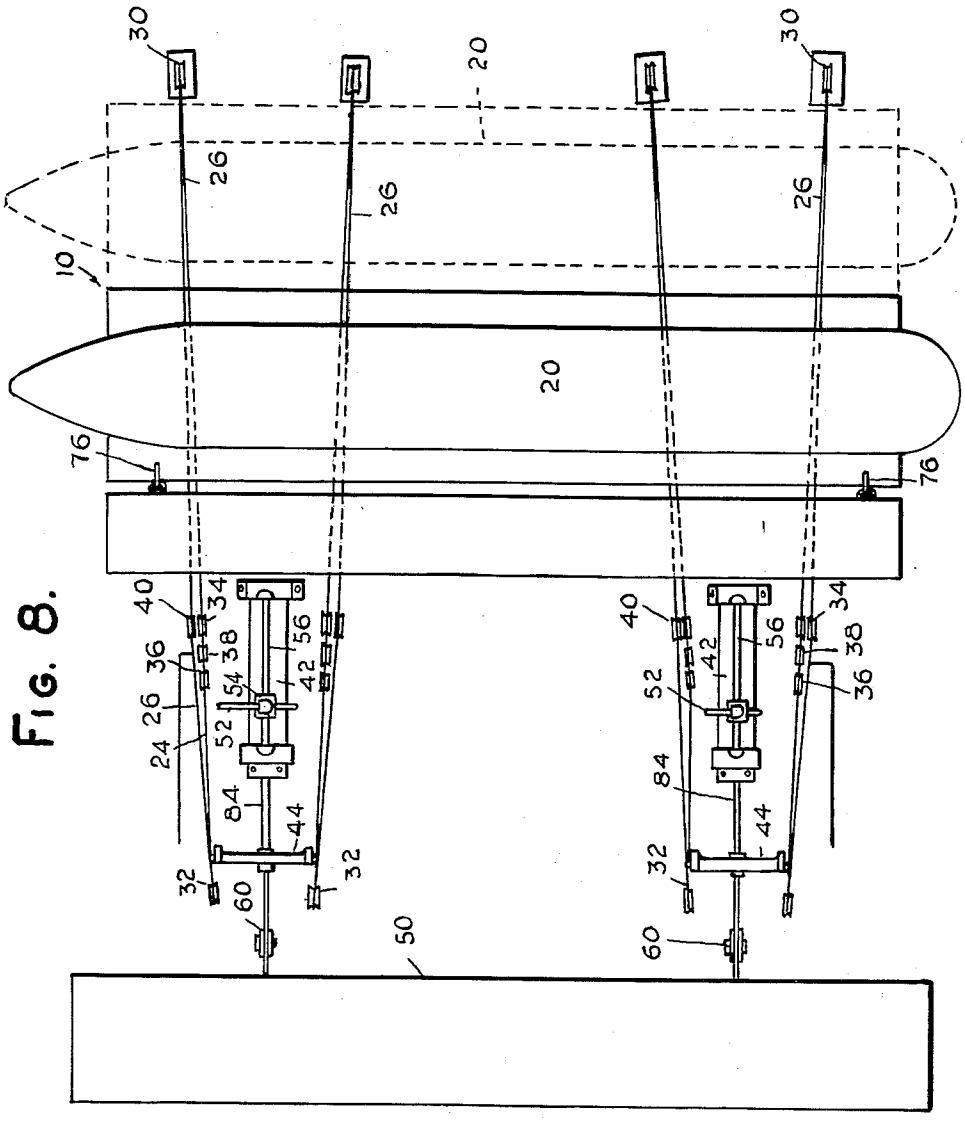


FIG. 8.

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United States Patent Office 2,963,870 Patented Dec. 13, 1960

2,963,870

COUNTERBALANCED UNWATERING APPARATUS

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Filed Feb. 20, 1959, Ser. No. 794,766

12 Claims. (Cl. 61—65)

This application is a continuation-in-part of applicants' copending application Serial No. 324,778, filed December 8, 1952, and now abandoned.

This invention relates to hydraulic means for elevating and lowering heavy bodies, particularly floating objects such as vessels and barges, to remove the object from the water and place it upon a cradle or other support which may be provided with one or more wheeled trucks to enable it to be moved with its load over the land.

There are four well known means for lifting a vessel or other floating object out of the water in order to examine or work on its underwater body, including graving docks (usually called dry docks), floating dry docks, marine railways and vertical hoists. Each of these is suitable for certain conditions but all four are extremely expensive to build and to operate. Each requires large quantities of power which is only used a small part of the time (this being one reason for the costly operation); and each of the first three are slow of operation. The vertical hoist, which has been used only in small capacities, is faster by virtue of using proportionately larger amounts of power.

The purpose of this invention is to provide means for unwatering floating objects which will cost much less to build than the conventional means, which will require a minimum of mechanical effort, will need little or no power from an outside source (stream or electric) and will require only a small fraction of the operating and maintenance costs of the conventional types and which will raise the vessel in a very short time. By "unwatering" is means removing floating objects from the water and supporting them otherwise.

This invention is a combination of well known and thoroughly tested principles of mechanics which produces an unwatering facility that costs much less to build, costs very much less to operate, requires a minimum of mechanical effort, and will operate in a fraction of the time needed for the conventional methods.

The simple principle on which this invention depends is that water from an elevated tank, which can either be filled by a hydraulic ram or small pump or from a public water supply system, is used so that its weight will counterbalance the weight of the vessel.

A preferred embodiment of the invention is shown in the accompanying drawings, wherein

Figure 1 is a side elevation and Figure 2 is a plan view of the device showing the lifting platform raised from the water and the counterweight tank in lowered position. These figures also show in dotted lines the platform lowered beneath the water to receive or discharge a vessel or other floating object, the counterweight tank being likewise shown in elevated position.

Figures 3 and 4 are respectively a plan and side elevation of the control device for the power motor and valves which control the flow of water into and out of the counterweight tank.

Figure 5 is a side elevation of the platform stop and tipping means.

Figure 6 is a schematic plan view showing an arrangement which utilizes our unwatering apparatus to position a plurality of ships in dry storage on the land.

Figure 7 is an end view of the arrangement of Fig. 6.

Figure 8 is a diagrammatic view similar to Fig. 2, showing an elongated tank for use with large ships; and

Figure 9 is a diagrammatic elevational view looking toward the left side of Fig. 8.

In the apparatus shown in the drawing, a lifting platform **10** is movably supported by two or more pairs of columns **12**, pivotally mounted at their lower ends on fixed supports **14** carried by a suitable underwater foundation **16**, and hinged to brackets **18** on the under side of the lifting platform, near the edges thereof, to cause the lifting platform to maintain a horizontal position when being raised from or lowered into the water, as shown in Figure 1. The vessel or other object **20** to be lifted from the water is readily chocked up on the lifting platform when floating above it in alinement therewith by raising the platform and cradle **22** until the latter engages beneath the bottom of the floating object, as by pulling in on the pair of cables or chains **24** which are secured by fastenings **28** to the two inner columns of two of the pairs of supporting columns **12** near their upper ends where they are pivoted to the lifting platform.

The cables or chains **24** may be continuous and have their inhaul sections passing shorewards and connected to the counter-balancing and control means and their outhaul sections **26** reeved around sheaves or sprockets **30** rotatably supported on underwater pedestals on the water side of the lifting platform and around sheaves or sprockets **32**, rotating on fixed journal supports on the shore side of the lifting platform, as shown in Figures 1 and 2. Each inhaul section of the cables **24** passes over two spaced guide pulleys **34** and **36** between which is a slack take-up pulley or sprocket **38** provided with a brake of any suitable type. Two guide pulleys **40** are provided on the land side of the lifting platform for supporting each outhaul section **26** of the pair of cables **28** near where it enters the water. The cables or chains **24** are actuated by means of a control cylinder **42** having a piston provided with a crosshead **44** to which the inhaul and outhaul sections are connected at their shore ends by means of clamps **46** (see Fig. 3). A counterbalance cable **48** is also attached to the crosshead **44** for supporting the greater part of the weight of the platform and load as it is lifted or lowered.

The cylinder **42** may be operated in any desired way to supply the power needed to actuate the lifting cables, but preferably water from the elevated tank **50** is used to act against the piston within said cylinder although water carried by the piston rod **84** under pressure from the local water supply system may be used for this purpose. Water from either source is admitted through pipe **52** to one end or the other of the cylinder through a four way valve **54** and the pipes **56**, which are so arranged that when one is connected to the water supply **52** the other is open to a drain pipe. The same water supply may also be used to fill the elevated water storage tank **50** or a special pump may serve this purpose.

Manual actuation of the valve **54** permits the speed of operation of the cylinder and lifting chains to be controlled to correspond to the time necessary to fill or empty the counterbalancing tank **58** to which the free or inshore end of the counterbalance cable **48** is attached after passing under the guide pulley **60** at the foot of the storage tank tower and the guide pulley **62** at the top of the tower beneath the storage tank **50**. A flexible pipe **64** leads from the bottom of the storage tank **50** to the counterbalance tank **58** for filling the latter, a suitable

valve or valves 66 being provided for controlling the flow from the storage tank.

The counterweight tank 58 when empty and the platform 10 and columns 12 in lowered position approximately balance each other. The vessel or other object 20 in its lower position is supported by the water in which it floats. Each inch it is raised reduces the bouyant effect of the water and increases the weight or pressure on the platform. Water draining from storage tank 50 into counterweight tank 58 increases the weight of the latter, and the counterweight tank on the one hand and the platform and its load while partially submerged on the other hand approximately balance each other and the vessel comes out of the water just as fast as the water is released into the counterweight tank.

When the platform 10 is at its lowest position, the speed with which the ship rises is roughly half that of the movement of the chain connection 24. As the platform approaches its upper position the vertical speed of the vessel becomes proportionately less until at the top position it has no vertical movement. Therefore the pull on the chain, which may be increased at first, must be thereafter reduced as the vessel rises or the speed will become excessive as the platform hits the dock. This reduction of pull is accomplished in three ways; by closing valves 66 from the storage tank; by releasing water for the counterweight tank 58 through valves in its bottom; by turning valve 54 to apply pressure on the end of hydraulic cylinder 42 and the side of the piston therein away from the platform; and by using the brakes attached to sprockets 38. The speed with which the vessel can be raised is only limited by the size of the valves and the speed with which water can be drained into and out of counterweight tank 58. When the platform is empty and the tank 58 is empty, water pressure on the end of hydraulic cylinder 42 furthest from the platform, acting through the backhaul chains, will pull the platform down. Thus a ship resting on the platform can be launched by the proper control of the amount of water in counterweight tank 58.

When the platform is in its top position, even the weight of a vessel exerts no horizontal thrust to rotate the columns outwards on their lower axes, but as they move outwards the thrust increases as the platform lowers and must be counteracted. Without a vessel, the weight of the platform will not balance the weight of the counterbalance tank until the platform has been moved some distance out and down. For this purpose two hydraulic cylinders 68 are provided, arranged as auxiliary pushers, their pistons being actuated by water from the tank tower controlled by a valve. The pads 70 on the outer end of the pistons engage the pads 72 on the platform for this purpose. The pads have cams 74 which also engage or disengage locking pins 76 pivoted at 78 with lock plates 80 in the manner shown in Figure 5 to release the platform before moving it. As the platform moves out and down its weight becomes effective to balance that of the counterbalance tank and the chains 24 suffice to control its movement.

This invention has many advantages. The only power required to operate the lifting platform is that to run a pump to supply sea water enough to keep storage tank 50 filled in those places where a public water supply is not available, or is too expensive.

Two, three, four or more pairs of columns 12 can be used for whatever length of platform is desired; and the ship may be hauled out sidewise, or the bow of the ship can be pointed inshore lengthwise of the platform and lifted out of the water endwise. In either case where the drawings show only one pair of columns 12 there can be as many pairs of columns extending out into the water or along a slip as are needed to support the length of platform desired.

The discharged water from the counterweight tank 58, if led to the area of the platform foundations, will provide an outward current of water that will help to keep that area free from silt.

When a vessel or other floating object is resting in chocks on the platform in the water and is ready for the lift to begin, it exerts no weight on the platform, since it is afloat and entirely supported by the water. The counterbalance tank's weight when empty equals and balances the weight of the platform and columns. If, at the start of the lift, the columns are at an angle of 60° with the horizontal, the chain 24 will move two inches while the platform rises one inch. Therefore, for each 100 pounds additional weight on the platform as the ship rises from the water, only 50 pounds of water will be needed in the counterbalance tank.

If the cable 48 from this tank, instead of being fastened to the crosshead as shown, is fastened at the lower sheave 60 and then reeved around another sheave on the crosshead and from there over the lower sheave 60, the tank would move twice the distance that the crosshead moves and only 25 pounds of water would balance 100 pounds of ship.

The smaller the angle of the supporting legs the greater the discrepancy between the vertical distance travelled by the platform and the distance (not quite horizontal) travelled by the chain. If the chain moves twice as fast as the platform rises vertically the strain on the chain is half the weight of the ship. So it becomes desirable to keep the angle as small as possible—the deeper the foundations for support of the pillars the less the angle of the pillars in the bottom position.

Two factors control this depth—one the amount by which the depth of the water exceeds the draft of the ship. If the hoist's design intends that it only be used during the upper half of the tide run—one half of the total tide will be added to the depth.

If it be assumed that the ship to be raised has a displacement of 5000 tons, without cargo or fuel it might weigh 3600 tons. Be it assumed further that the ratio of chain travel to vertical travel of the platform is 2 to 1, a ratio which may easily be provided. Near the top of its swing the vertical rise of the platform is very small in proportion to the movement of the chain, so that the ratio of the weight of the platform to the tension on the platform is very high. But when the platform is near its lower position, the ship is largely waterborne, and there is very little weight on the platform. If the ship draws 24 feet of water, when it is half out of water the weight on the platform should be in the neighborhood of 2000 and the travel ratio of chain to platform about 10 to 1. At that point the strain on the chain should be near its maximum and would be about 200 tons. In other words, as the ship rises, the increase in the proportion of its weight which must be supported from the chains is largely offset by the mechanical advantage resulting in the increase of the ratio between the distance travelled by the chain and the vertical rise of the platform.

As the platform rises, each one degree rotation of the columns gives almost the same movement of the chain but each degree rotation of the columns gives less and less lift of the vessel until when the columns are vertical the lift is zero. As the ship is raised toward the top of the lift its weight rests entirely on the platform, but less and less weight of water is needed in the tank 58 to balance it because of this change in angle. Thus in order to maintain a balance between the weight of the ship and the weight of the counterbalance tank 58, it is necessary that during the first part of the lift water must flow into the counterbalance tank to increase its weight while during the latter part of the lift water must drain from the counterbalance tank to decrease its weight.

To accomplish this automatically the invention includes a tension meter, as illustrated in Figures 3 and 4. This comprises a flanged metal plate or disc 82 fixed on the end of the piston rod 84 which slides through the crosshead 44. A housing or yoke 86 to which the wire cable

48 is attached projects from the crosshead 44 and contains a spring 88 surrounding the piston rod between the disc 82 and the crosshead which is under compression when the weight of the vessel on the platform is less than that of the counterbalance tank as shown in Figures 3 and 4. A heavier compression spring 90 is arranged in the housing 86 between the disc 82 and the fitting 92 into which the end of the wire rope 48 is secured by means of a swivel 94. These two springs 90 and 88 limit the travel of the disc 82 in relation to the housing and crosshead 44 and transmit the pressure on the piston to them and to the chains 24. Electric contacts 96 attached to the housing 86 are contacted by the disc 82 at the two limits of its movement and act to open and close the valves that permit flow of water into and out of the counterbalance tank. With the disc in its middle position neither contact is closed and all valves are closed. Thus the balance between the pull on the cable due to the weight of the counterbalance tank and the pull on the chains due to the weight of the ship on the platform is maintained and effected automatically within small limits determined by the tension of the springs. If the tension of the heavier spring 90 is 50 pounds more than that of the lighter spring 88, then the imbalance (or unbalance) will not exceed 100 pounds.

A drum 98 actuated by an electric motor 100 may be substituted for or may augment the cylinder 42. With a 50 pound spring tension mentioned above, the drum need only exert a pull of 101 pounds to raise or lower a ship regardless of how many tons it weighs, and only a very small electric motor is needed. The speed with which the ship can be raised and lowered is limited only by the size and number of valves controlling the flow of water into and out of counterbalance tank.

A site may be selected which it not too far away from high ground on which there is a natural source of water—a pond, lake, reservoir or even a stream. One obvious example would be the Hudson River running past the Palisades on the Jersey shore. In such a situation the upper tank or tanks 50 would be eliminated and replaced by the outlet end of a pipe laid from the water supply described—to discharge into the rectangular trough. This would eliminate pumps and the power to drive them and also eliminate the time taken to pump water into the tanks.

When such a distant water source is available, the structure supporting the rectangular trough may be built tall enough to allow a greater vertical travel of the trough. This could be made 100 feet and the total travel of the crosshead 44 could be made 20 feet. If the wire cable 48 between the pulley 60 and the crosshead 44, is then reeved over a series of pulleys like a rope is reeved in a block and fall, the additional 5 to 1 reduction in speed will make the strain on cable 48 (and the weight of water needed in the tank) 40 tons, to balance a 5000 ton ship.

The embodiment of our invention thus far described comprises a platform that will raise a small ship—one not over 75 or perhaps 100 feet in length. A longer ship—perhaps 500 feet—would require a longer platform and a number of towers and tanks would be needed. But this would require absolute control of the rate of flow of water to insure that each tank would fill or empty at exactly the same rate. This would be difficult if not impossible to accomplish. If the tank at one end filled faster or slower than the other end—one end of the platform would be further out and further down. This twisting strain might well wreck even a sturdy platform and the ship on it.

We meet this situation by substituting one long rectangular trough for the tank 58. This trough may be provided with transverse baffles 58*a* to prevent a sudden surge of water to any point which may temporarily be slightly lower than another. It can be filled either from a higher trough, from tanks or from an outside source of water. As many piston and cylinder engines as desired may be provided, each connected by cables to both the platform supporting columns and to the counterweight suspension means. To keep the rectangular tank moving evenly at both ends two shafts 101 will be run parallel to the length of the tank, one above and one below. On the end of each shaft is a sprocket 100 with a chain 102 engaging the upper and lower sprockets. The chains would be fastened to the end of the tank at 103. There would be little or no strain on the chains since water in the trough would constantly seek its own level.

One of the shafts 101 may provide a convenient method of preventing excessive speed, since a gear on one end thereof may be connected through a suitable speed increasing gear train to a governor which regulates the flow of water into and/or out of the tank 58, or other means for regulating the speed of movement of said tank.

A marine railway or dry dock can only handle one ship at a time and the facility is tied up until repairs are completed which may be from a day to many weeks.

The hoist herein described can be coupled to a transfer system and service an entire fleet of ships, lifting each ship out of the water and moving it to a prepared place on shore in a matter of minutes.

The platform 10 is then equipped with a set of transverse rails or bearing races 110—preferably bearing races, since bearings would require much less weight than wheels. Resting on top of platform 10 is the platform 111 on which the ship and its cradle rests. There are bearing races 112 on the bottom of this platform and bearings 113 between the two sets of races in retainers or cages. Alongside the platform 10, in its top position, and running parallel to the center line of the ship is a set of rails 116. Another platform 117 is equipped with supporting axles and wheels to run on the rails 116. On the top of the platform 117 is another set of bearing races to match the bearing races on platform 10. At various stations along the rails 116 are sets of rails 118 running at right angles to rails 116. A wheeled platform 119 runs on the transverse rails 118, and bearing races 121 on top of platform 119 match those on platform 10.

Between platform 119 and the rails 116 and between platform 117 and platform 10 in its upper position there are stationary platforms 122 and 124 respectively, equipped with bearing races 123 and 125.

Docking a ship proceeds as follows: After platform 10 is in its top position and locked, the platform 111 and ship is rolled on bearings 113 over platform 124 onto platform 117 utilizing an additional set of caged bearings 126 and platform 117 is then moved on its wheels until it is alongside platform 119 in its prepared position. The ship supporting platform 10 is then rolled on the bearings 126 onto platform 122 and thence by means of caged bearings 127 onto platform 119. Platform 117 can then be rolled back to pick up another ship and move it to any one of several other prepared platforms similar to 119.

In this way the hoist can lift one ship after another and each can be easily and quickly moved to a position on shore, where it may be stored out of the water with no fouling of bottoms and no cluttering up of the water or stream. Any work needed can be done on the underwater body of the ship in the dry.

We claim and desire to secure by Letters Patent the following and equivalent arrangements of dock, platform, columns and lifting means, with our control apparatus:

1. In an unwatering apparatus the combination with a stationary dock of a vessel supporting platform movably mounted alongside said dock on spaced right columns pivoted at their bases to underwater supports and hinged at their upper ends to the underside of said platform, means for lowering and raising said platform into and out of the water while maintaining it horizontal by tilting said columns, an elevated water source alongside said dock, a counterweight water tank and means for movably suspending it at a lower level than said water source, means for discharging water from said storage tank into said counterweight tank and means for dis-

charging water out of said counterweight tank, control means for said water discharging means, a connection between the counterweight tank suspending means and the platform lowering and raising means through which the weight of said counterweight water tank and the water therein counterbalance that of said platform and its load, and means responsive to changes in the tension on said connection for operating the water discharging control means to maintain a proper balance between said counterweight tank and said platform during lowering and raising of the latter.

2. An unwatering apparatus as set forth in claim 1 wherein the means for lowering and raising the vessel supporting platform includes a cylinder and piston engine, a connection between said engine and platform, and means for supplying fluid pressure to said cylinder on either side of the piston to control the direction of movement of said platform.

3. An unwatering apparatus as set forth in claim 1 wherein the connection between the counterweight tank suspending means and the platform lowering and raising means includes a rotatable member, braking means associated with said rotatable member, and control means for actuating said braking means.

4. An unwatering apparatus as set forth in claim 1 wherein the platform raising and lowering means, the counterweight water tank suspending means and the connection between said raising and lowering and suspending means include a flexible cable and power means associated with said cable for pulling it in either direction.

5. In a control device for a lifting platform as set forth in claim 1 having a moving cable in the connection between said counterweight tanks and columns and a member reciprocating therewith, a reciprocating power means, a collar firmly affixed to the power means, spaced limit stop members moving with the reciprocating member, these limit stop members being positioned to limit the travel of said collar with respect to the moving cable, and an electric circuit including means actuated by said travel of the collar to control the valves allowing water to flow into and out of the counterbalancing tank.

6. A control device for a lifting platform as set forth in claim 1 having a cable in the connecting means between the counterweight tank and platform, a drum around which said cable passes, and an electric motor connected to the drum for controlling lifting and lowering movement of said platform.

7. The combination of a stationary dock and platform pivotally mounted on pairs of upright columns pivoted at their bases for tilting away from said dock, an elevated storage water tank, a counterweight tank and means movably suspending it below said storage tank, flexible means for connecting the tank suspending means with said columns for retaining said platform against said dock and counterbalancing said platform when tilted away from said dock, automatic control means for releasing water from said storage tank into said counterweight tank and for releasing water from said counterweight tank for balancing the weight of a movable body on said platform when said platform is tilted, power actuating means associated with said flexible connecting means for operating it in either direction of pull, independent control means for said power actuating means, a tension meter connected between two contiguous ends of said flexible connecting means comprising a link connected at one end to an end of said flexible connecting means, a slide guided for movement with respect to the free end of said link, said slide having a stop at one end and its other end connected to the other contiguous end of said flexible connecting means, spring means mounted in said link and engaging said slide to position said stop normally between the ends of said link, and contact members mounted on said link adjacent its ends in position to be engaged by said slide upon said stop approaching either end of said link under a change in the pull on said flexible connecting means sufficient to flex said springs and cause relative movement of said slide with respect to said link.

8. The combination of a stationary dock and a platform pivotally mounted on pairs of upright columns pivoted at their bases for tilting away from said dock, an elevated storage water tank, a counterweight tank and means movably suspending it below said storage tank, flexible means for connecting the tank suspending means with said columns for retaining said platform against said dock and counterbalancing said platform when tilted away from said dock, automatic control means for releasing water from said storage tank into said counterweight tank and for releasing water from said counterweight tank for balancing the weight of a movable body on said platform when said platform is tilted, power actuating means associated with said flexible connecting means for operating it in either direction of pull, independent control means for said power actuating means, a piston and fluid pressure cylinder fixed to said dock, a thrust connection between said piston and flexible connecting means adapted to move the latter in either direction of pull, a member in said thrust connection having limited sliding movement with respect to said flexible connecting means, and means associated therewith operating at the ends of said sliding movement for actuating said automatically controlled water releasing means.

9. Apparatus of the kind set forth in claim 1 wherein the connection between the counterweight tank and platform comprises a flexible cable, a drum around which the cable passes, and an electric motor to operate the apparatus through the drum.

10. Apparatus as claimed in claim 1 in which the suspension means for the counterweight water tank comprise two parallel rotatable shafts, mounted longitudinally of said tank, one above the uppermost and one below the lowermost limits of its path of travel, sprocket wheels fixed to the ends of each shaft, and a chain at each end of the tank connecting the sprocket wheels on the upper shaft to those on the lower shaft and the adjacent end of the counterweight tank.

11. Apparatus as claimed in claim 10 in which one of said sprocket wheels drives a governor through speed increasing gearing and said governor controls said water discharging means.

12. Apparatus as claimed in claim 1 in which said counterweight tank is provided with transverse baffles to inhibit longitudinal surges of water therein.

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