July 3, 1945. J. S. CRANDALL 2,379,685

FLOATING DRY DOCK

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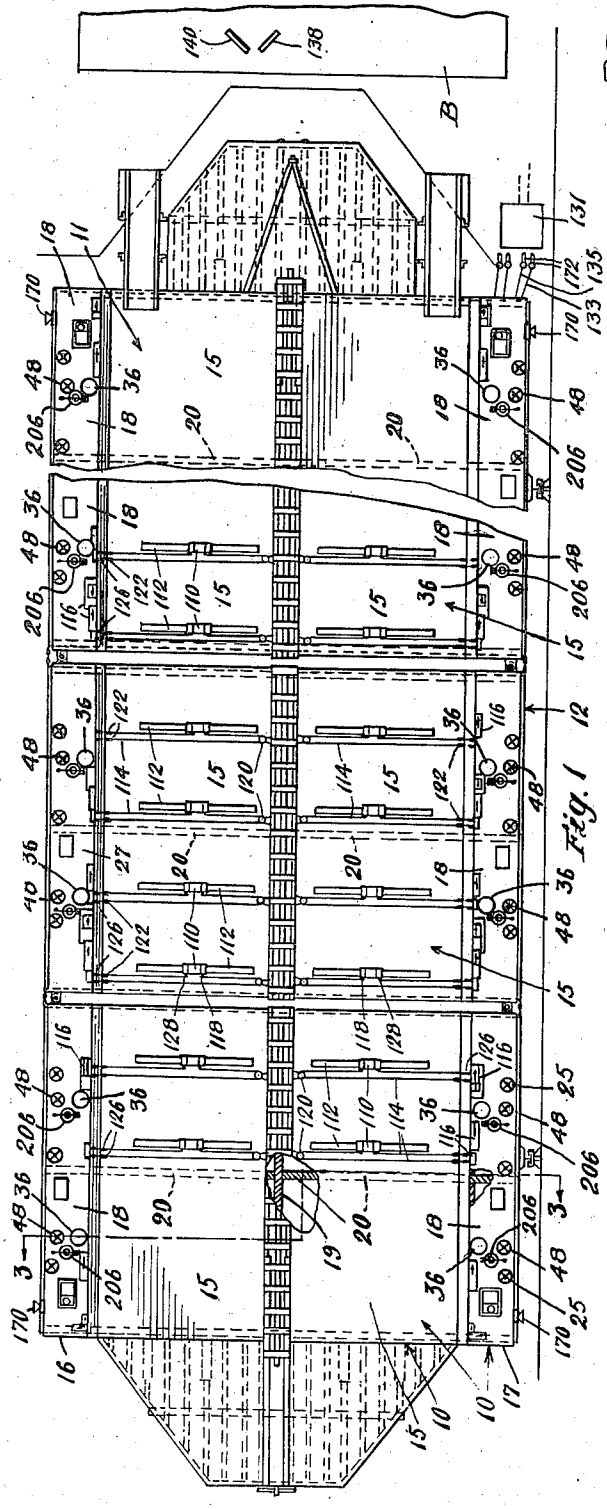


Fig. 1

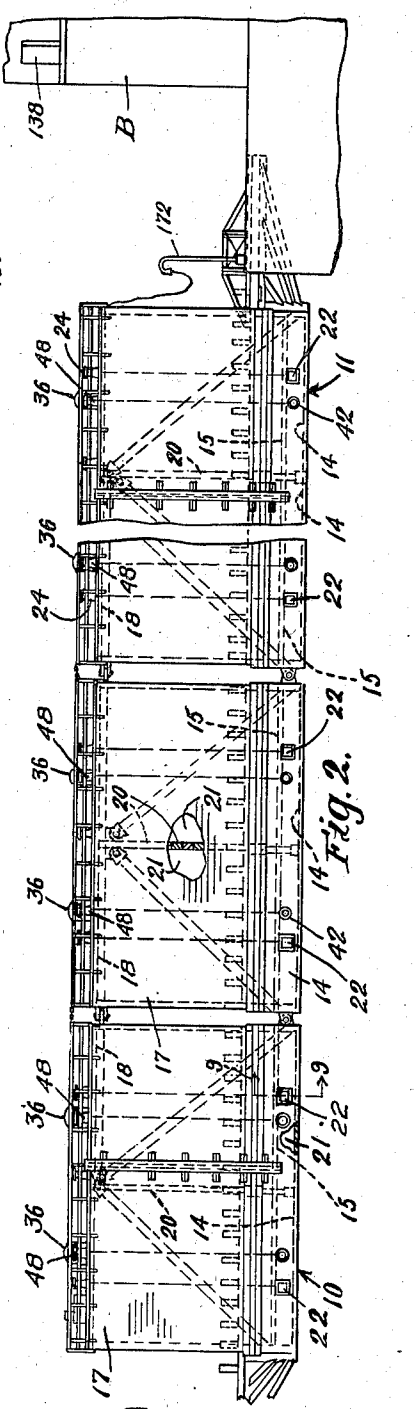


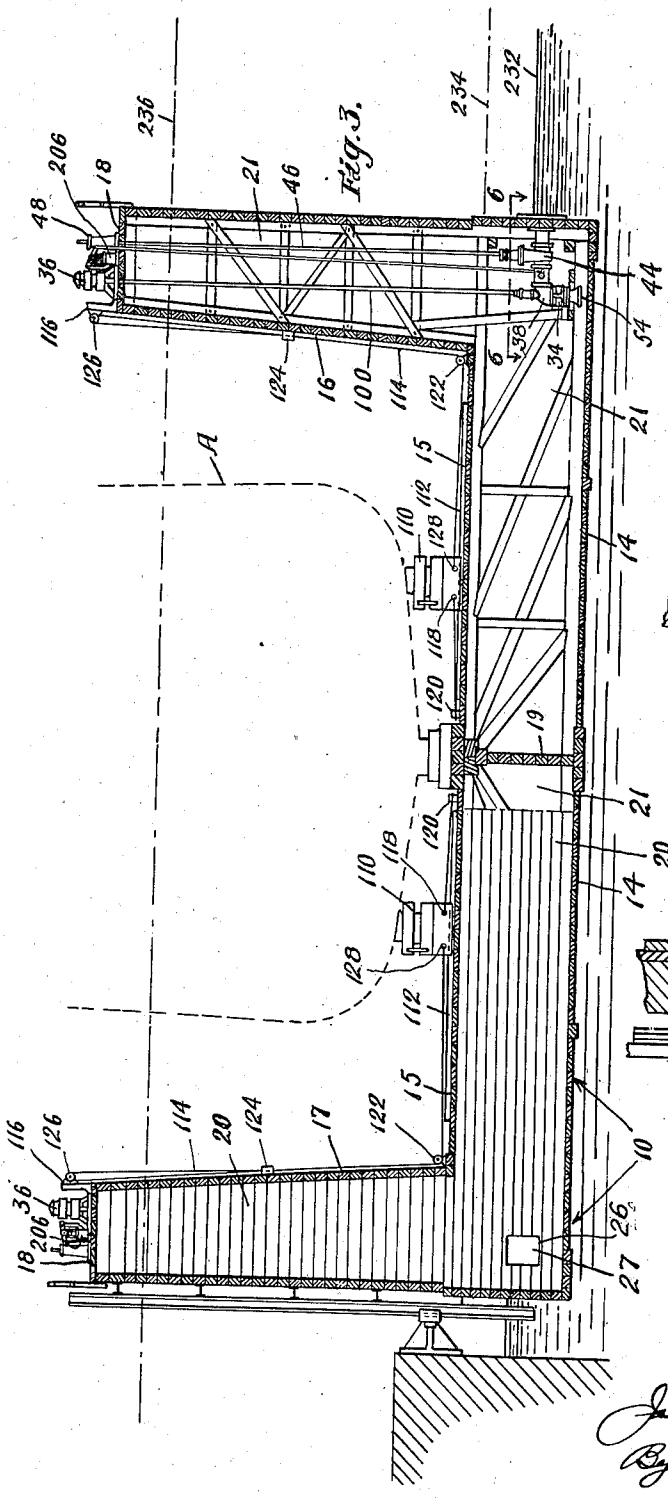
Fig. 2.

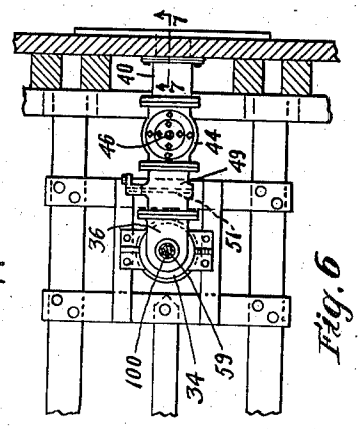
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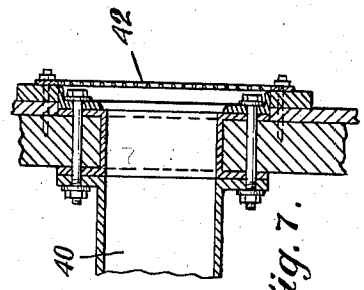
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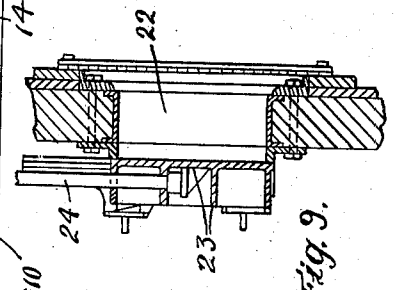
FLOATING DRY DOCK

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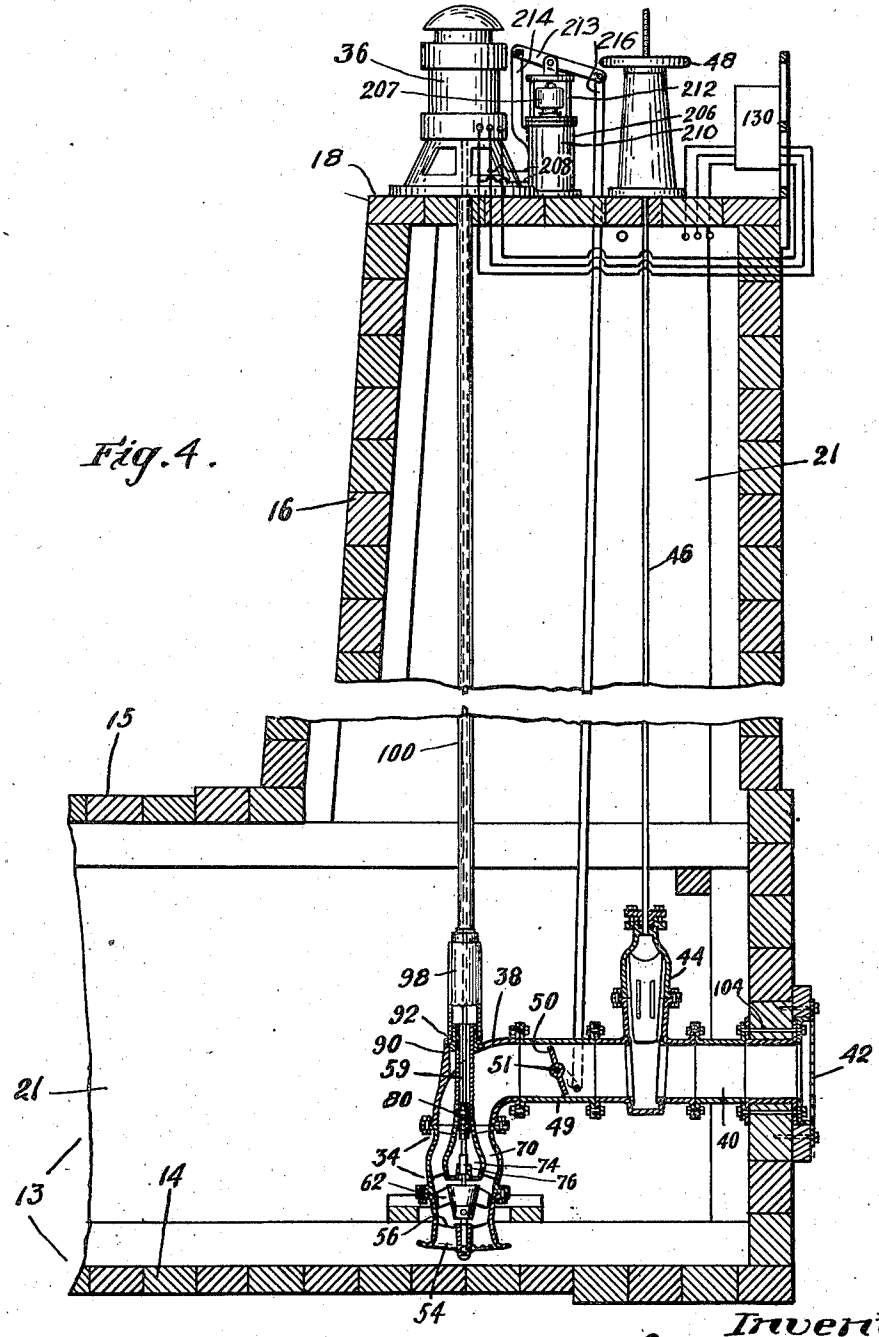
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Fig. 4.



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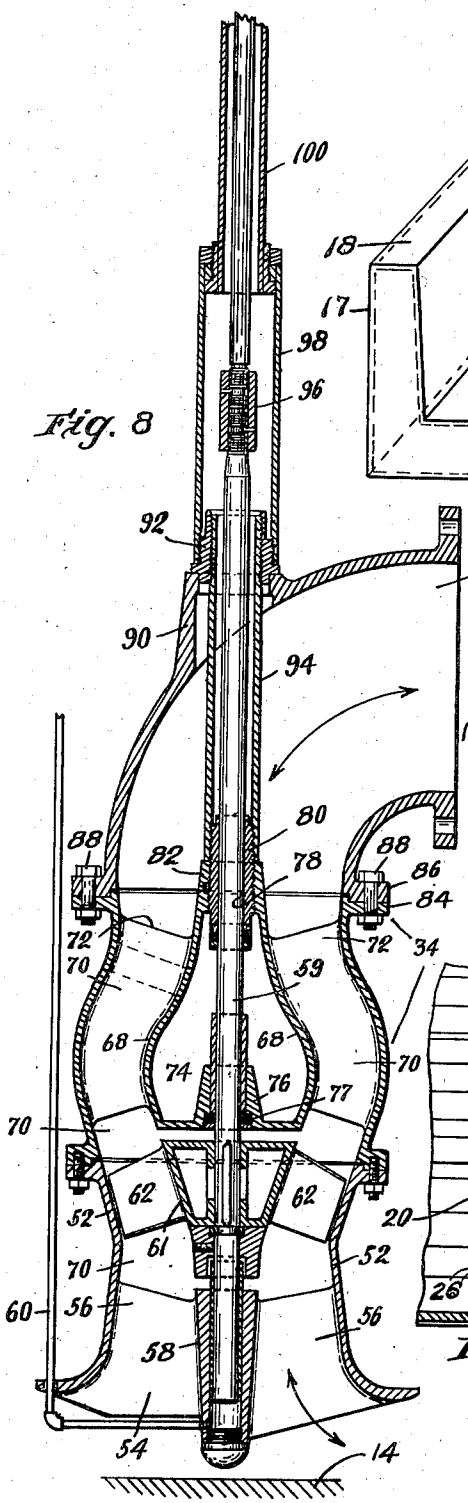


Fig. 8

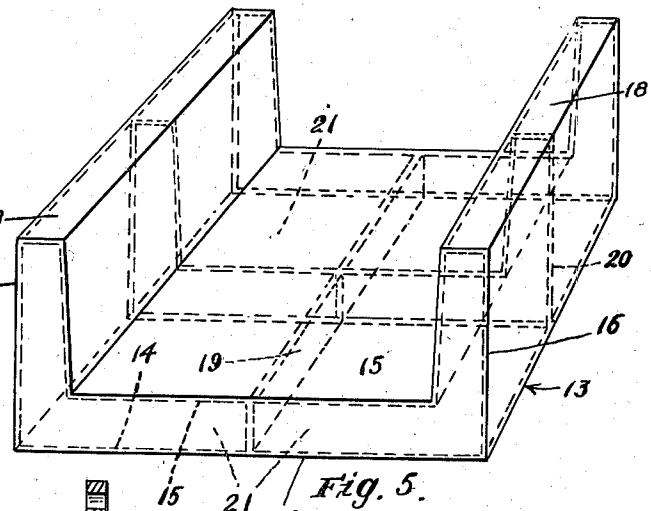


Fig. 5.

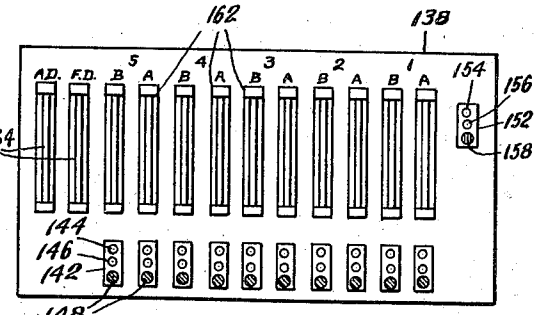


Fig. 12.

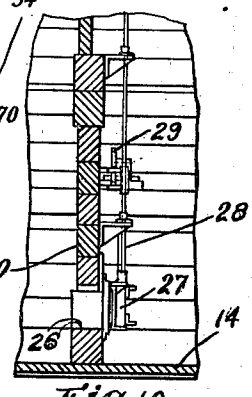


Fig. 10.

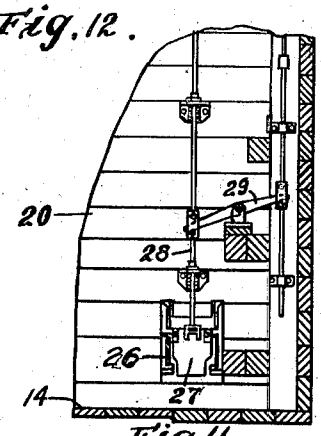


Fig. 11.

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FLOATING DRY DOCK

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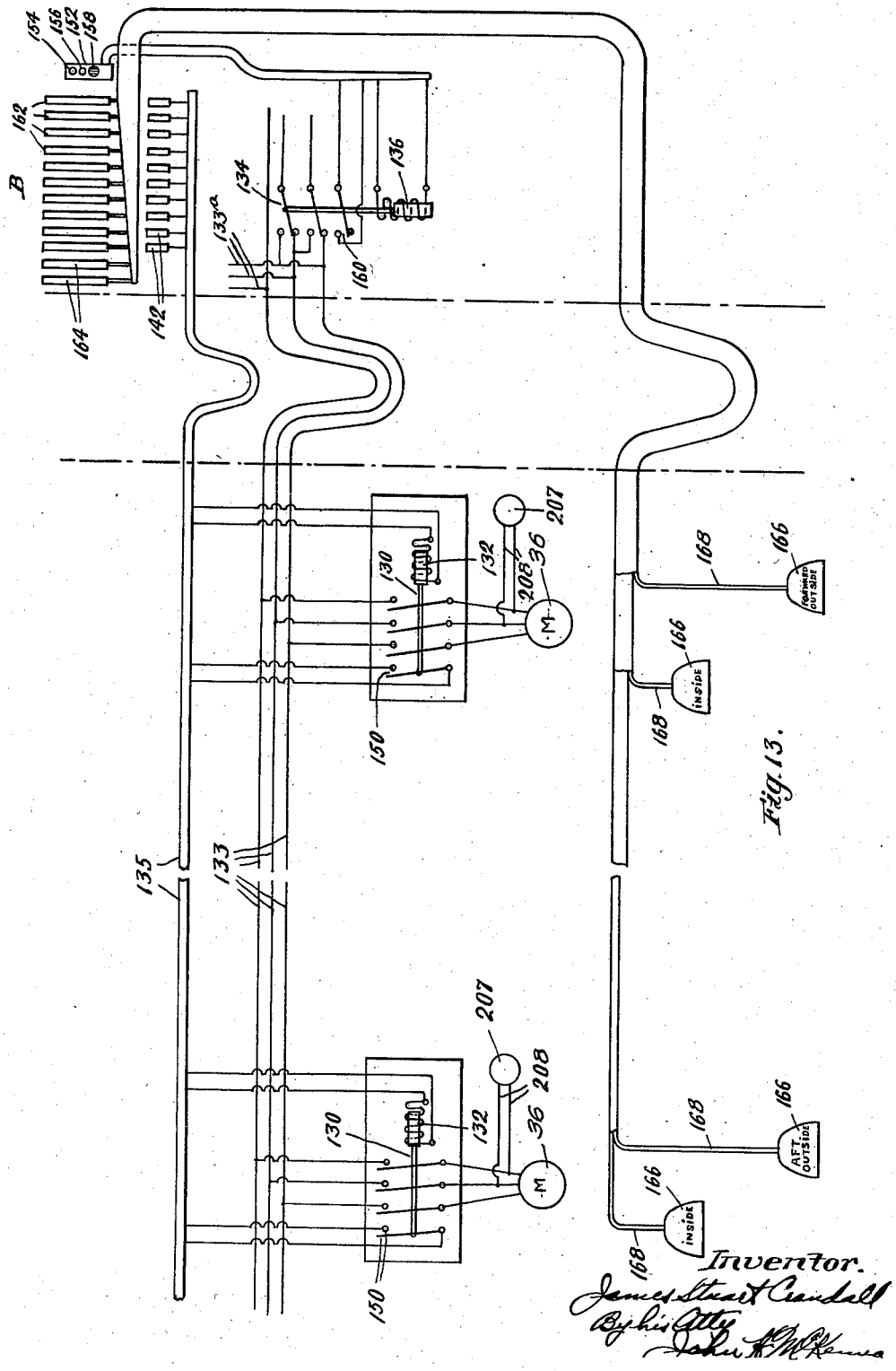


Fig. 13.

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UNITED STATES PATENT OFFICE

2,379,685

FLOATING DRY DOCK

James Stuart Crandall, Lexington, Mass., assignor to Crandall Dry Dock Engineers Inc., Cambridge, Mass., a corporation of Massachusetts

Application November 25, 1943, Serial No. 511,713

15 Claims. (Cl. 114—45)

This invention relates to improvements in floating dry docks. More particularly it relates to a floating dry dock having a bottom hollow section and hollow wing sections rising vertically from the bottom section at each side thereof between which and over the bottom section a boat to be dry docked may be floated when the dry dock is submerged. Ordinarily, the bottom section is divided centrally and longitudinally by an interior central bulkhead extended from end to end and longitudinally of the bottom section, and transverse bulkheads extending from the longitudinal bulkhead to the sides of and into the wings of the dry dock provide a longitudinally aligned series of water tight compartments along each side of the central bulkhead. Each compartment usually is provided with a flood gate opening and valve therefor and each is equipped with means for pumping water from the compartments when the dry dock is to be elevated. The amounts of water in the various compartments may be different to adjust the buoyancy of the dock at such compartments to the weight of the parts of the boat over them.

Some floating dry docks have a bottom section constituted of steel while others are of wood construction. A wood construction is more buoyant than a steel construction and is sometimes ballasted to reduce its buoyancy. With a steel construction the height of water in the wings may not be higher than, or as high as, the level of the outside water to obtain sufficient submergence of the dock to permit entrance thereto of the boat of deepest draft the dock is designed to receive. With a wood dock, unless permanent ballast is used, the water in the wings may be higher than the outside water level for maximum dock submergence. With a steel construction, in absence of a sealed air chamber which sometimes is provided in the lower body of a steel dock, the tendency for gravitational water flow always is into the dock while with a wood construction the flow can be in either direction depending upon the degree of submergence of the dock. My invention is useful with docks of either wood or steel construction but is particularly useful in connection with docks of wood construction.

Heretofore, centrifugal or other uni-directional-flow pumps have been employed for filling and exhausting the water compartments and a system of piping has provided for control of the water entering and leaving the dry dock with control valves for changing the direction of flow of the water. Inasmuch as these pipes are necessarily of large size, such as 10 inches or more in diameter, the amount of piping, heretofore necessary, has been considerable and as many as four direction-controlling valves have been required at each compartment, in addition to the flood gate valve, for satisfactory control of the entering and departing water. This has involved heavy expense for the piping and the valves and the valves have had to be operated by hand by men on the top of the wings, or decks of the dock.

It is an object of the present invention to reduce greatly the amount of piping required for each compartment and also to eliminate the direction-controlling valves and hence to reduce the number of valves necessary at each compartment by the use of a reversible-flow pump and a reversible driving motor therefor so that water can be pumped into or out of the dock compartment by rotating the pump and motor in either one or the opposite direction.

Another object of the invention is that the reversible-flow pump is a propeller type pump and one designed not to become unduly overloaded even though the gate or shut-off valve in the piping between the dock-compartment and the outside should close on the operating pump.

In pumping-up or elevating a steel dock and, usually, in both pumping down and pumping up a wooden dock there is, at the end of the pumping operation, a hydrostatic head of water tending to cause water to flow through the pump in the opposite direction to the direction of flow during the pumping operation if the shut-off valve in the pump line is not closed promptly at the end of the pumping operation. It is not always practicable to close the manually-operated valve promptly so that the water level can change and the level must be restored by another pumping operation until the valve can be closed. The reverse flow of the water rotates the pump impeller and motor reversely by turbine action and the motor must reverse the direction of rotation of the spinning parts. This imposes a considerable overload on the motor and its circuit and strain on the impeller and its long shaft connection with the motor.

It is an object of the present invention to prevent the rotation of the pump impeller when the motor is de-energized and particularly to provide for the purpose means automatically responsive to the energization and de-energization of the driving motor.

It is particularly an object of this invention to provide a valve in the pump line that will close automatically when the pump ceases to be driven positively by the motor, thereby to shut off water

flow therethrough and prevent the turbine-rotation of the pump and to open automatically upon the motor drive of the pump in either of its two directions of rotation.

It is also an object of this invention to have the opening and closing of such valve automatically responsive to the energization and de-energization of the motor on its circuit.

A yet further object of the invention is the provision of a control valve in the pump line capable of being operated electrically from a remote location.

Since the propeller type reversible-flow pump of my invention has large free water passages therethrough it is possible, under favorable conditions, and where there is a favorable hydrostatic head of water, to allow water to flow through the energized pump, without opening the flood gate. For this purpose the automatically-operative valve can be blocked open or dispensed with; and such arrangement of the pumping system and method of using it constitutes a further object of the invention. Such use of the system has some advantages under certain conditions but for general purposes the use of the automatically-operative valve is preferred, however.

A further object of this invention is to provide for remote control of the series of pumps with provision for operating any one pump or any group of pumps alternately or in unison and for reciprocating operation of all or particular pumps to maintain a desired level of water in compartments without closing the gate valves associated therewith.

It is, moreover, a general object and purpose of my invention generally to improve the construction and operation of floating dry docks.

In the accompanying drawings,

Fig. 1 is a top plan view, somewhat diagrammatic, of a multi-sectional floating dry dock embodying features of my invention;

Fig. 2 is a side elevation thereof;

Fig. 3 is an enlarged cross-sectional view in section on line 3—3 of Fig. 1, illustrating the pumping system associated with a dock compartment, the section being illustrative of the cross-sectional views of all dock sections;

Fig. 4 is an enlarged sectional detail of the right hand part of Fig. 3, illustrating the pumping system in greater detail;

Fig. 5 is a diagrammatic perspective view of one of the hollow sections of my improved dry dock;

Fig. 6 is a fragmentary plan view in section on line 6—6 of Fig. 3, and illustrating, in plan, one of the reversible flow compartment pumps;

Fig. 7 is a cross-sectional view of a pump inlet and discharge pipe where it passes through the side of the dock-section, taken on line 7—7 of Fig. 6, on an enlarged scale;

Fig. 8 is a cross-sectional view in medial vertical section through one of my reversible-flow pumps;

Fig. 9 is a cross-sectional view on line 9—9 of Fig. 2, showing one of the flood gates and its valve;

Fig. 10 is a sectional view showing one of the emergency flood gates and valve associated with the transverse bulkheads between compartments;

Fig. 11 is a sectional view showing the valve of Fig. 10 but looking at right angles with respect to Fig. 10;

Fig. 12 is a face view of one of my control panels located at the control center; and

Fig. 13 is a diagrammatic view showing a wiring diagram of the connections between the pump motors and the compartment water-level indicator on one side of the dock with the control panel, the arrangement for the other side of the dock being generally similar.

Referring to the drawings, and more particularly to Figs. 1 to 3, my improved floating dry dock is shown as consisting of end units or sections 10, 11, and a series of similar intermediate sections or units 12, all units being rigidly connected in line in a well known manner. Each section or unit is complete in itself and comprises a hollow buoyant bottom section 13 with a bottom wall 14 and a top wall or floor 15 upon which the docked boat A rests. Each section also has, at the longitudinal sides, hollow upstanding wings 16 and 17, the horizontal tops 18 of which provide working platforms or decks at opposite sides of the docked boat.

The dock herein illustrated is of wooden construction and is particularly buoyant in that it is necessary to pump water into the water compartments to stand, in the wings, above the level of the outside water, for maximum submergence of the dock. Prior wooden docks usually require fixed ballast of stone, iron, or other heavy material for overcoming excess buoyancy, and the ballast is a fixed weight added to the natural weight of the wooden dock itself. Because the ballast occupies space within the dock, the lifting capacity the dock otherwise would have is reduced substantially. The present invention utilizes the full lifting capacity of the hollow wooden dock by avoiding the need for fixed ballast and by providing so that water can be pumped into the interior of the dock to a level substantially above the water level exteriorly of the dock. However, I do not limit myself to an all-wood dock or to a dock which has no fixed ballast, because a dock made partly of steel and partly of wood and one having some fixed ballast, can have some of the advantages of my present invention if constructed generally according to my present disclosure.

Each unit 10, 11 and 12 is complete in itself having a centrally disposed longitudinal bulkhead 19 dividing its interior into two side chambers which in turn have transverse bulkheads 20 dividing each side chamber into two water tight compartments 21, see especially Fig. 5. Thus each of the units as illustrated has four water tight compartments 21 therein. The wings open into the bottom section and each transverse bulkhead 20 extends upwardly in its respective wing so that the compartments 21 occupy the wings.

In the operation of the dock water is flowed into these compartments to submerge the floor 15 below the surface of the body of water in which the dock floats sufficiently to permit the boat A to pass into the dock between the wings. If desired, the submerging may be hastened by pumping water into the compartments, as by starting the pumps when the interior water level approaches the exterior water level and the inflow slows down.

Each compartment is provided with a flood gate opening 22, Figs. 2 and 9, that opens thereinto through the outer shell or skin of the dock at least partially submerged when the dock is least submerged, the gate opening being closed by a gate valve 23 raised and lowered by a shaft 24 and hand wheel 25 on the top or deck of the dock wing. When the dock is up and unloaded, opening the gate permits water to run into the compartment and submerge the dock. A steel dock usually can be fully submerged entirely by the

gravitational flow of water thereinto. A wood dock usually sinks only a certain amount less than full submergence, at which time the water is at about a common level under and outside the dock and the gate is then closed and water is pumped into the dock to elevate the water level therein above the outside level to sink the dock to its full extent. The pumps also exhaust the water from the compartments with the flood gate closed to pump up or elevate the dock.

It is common also to provide emergency flood gate openings at **26**, Figs. 3, 10 and 11, opening through the transverse bulkheads **20** between the compartments to flood and empty one compartment from an adjacent one, upon need, the gate opening being controlled by a gate **27**, vertically movable by a shaft **28** operated through a lever **29** by a vertically movable shaft operated from the top of the dock wing.

Instead of pumping water by uni-directional flow pumps and using valves to control the direction of flow of the water into and out of the compartments, the pump of the present invention, for each compartment, is a reversible-flow pump **34** operated by a reversible electric motor **36**, Figs. 3, 4 and 8. The pump is vertically disposed and the upper open end of the casing thereof is connected to the lower end of an elbow **38**, the other end of which is connected to a short horizontal conduit **40**, that opens to the outside water through the side or skin of the dock section, the opening preferably being covered by a grating **42**. The gate valve **44** is interposed in the conduit between the pump and the outside conduit-opening and is operated by a vertical shaft **46** and a hand wheel **48** above the deck of the wing. An automatically-operated valve casing **49** is also interposed in the conduit between the pump and the gate valve and contains a butterfly valve **50** fixed to a shaft **51** and journalled in the casing **49** and operated by mechanism hereinafter to be described so that the valve is open when the pump motor is energized and is closed when the motor is de-energized.

The particular type of reversible pump illustrated in enlarged detail in Fig. 8 has a casing body **52** having a bell shaped entrance and discharge opening **54** at its lower end terminated above the bottom wall **14** and within which bell is axially mounted on radial ribs **56** a bearing **58** for the lower end of the pump shaft **59**. Provision is made as at **60** for suitably supplying the bearing with lubricant.

The pump propeller or impeller **61** is fixed on shaft **59** close above the bearing **58**. Its generally radial blades **62** are of shape and pitch to propel water in opposite directions through the pump in response to opposite directions of rotation of the impeller. Also, the pump is so designed, in a well known manner, as by proper selection of blade shape and clearances, to obviate overloading of the pump and its motor in case its gate valve **44** should be closed against outflow while the pump continues in operation, thereby permitting closing of the gate valves at will prior to shutting down the pumps.

The upper portion of the pump casing body has interior annular walls **68** which curve outward from the pump axis and which, with the outwardly curved outer walls of the casing, define an annular passage **70** which is divided by the radial swirl-preventing partitions or ribs **72**. This construction provides an axial space **74** which is excluded from the flow passage of the pump, and the drive shaft **59** extends through this space and has bearings **76**, **78** on opposite ends thereof. The upper end of the casing also has an annular exterior flange **84** to which a coacting flange **86** on elbow **38** may be secured as by the bolts **88**. A boss **90** on the outer curved wall of the elbow **38** is apertured for reception of the lower reduced end of an interiorly threaded sleeve **92** within which is screwed one end of a longer sleeve **94** whose lower end is threadedly engaged with the sleeve **80**. This long sleeve **94** constitutes a fixed tubular protective casing extending vertically across the flow passage of elbow **38**, and the pump shaft extends within this sleeve.

As illustrated in Fig. 8, the pump shaft is made in two sections, the lower section of which terminates a little above the elbow **38**. The upper end of the lower section of shaft and the lower end of the upper section of shaft are joined together by coupling member **96**, the joint being protectively encased as at **98**, and the upper section of shaft being encased as at **100**.

The driving motor **36** for the pump is located on the wing deck, above the pump, and is connected to the upper end of the pump shaft **59**. The motor is reversible as to its direction of rotation and preferably is a three phase alternating current motor.

While I have herein described a particular construction of reversible flow pump which I find satisfactory, reversible flow pumps of other design may be employed within the scope of this invention.

As shown in Fig. 3, each of the pumps **34** is located low down in its compartment, being vertically disposed therein, with its open mouth close to the bottom wall of the dry dock so that water in the compartment may be sucked into the pump and driven through the conduit out to the exterior when the pump is operated in one direction.

Unless provision is made for preventing it, there may be times during the operation of the dock with the pump conduit open when water can flow through the idle pump and rotate it as a turbine at the time the pump is started up in a direction to reverse the water flow. Applying driving power in a reverse direction on the motor of the spinning water-driven pump results in an overloading of the motor and the imposition of undesired stresses on the drive shaft and the pump impeller. To prevent such overloading and over-stressing of the parts of the pumping system means preferably is provided to prevent the pump from rotating except when the motor is energized. To this end use is made of the heretofore described butterfly valve **50**, said valve being self-closing and being opened automatically with energization of the pump motor. The valve is so arranged that it automatically assumes closed position, as shown, as for instance, by being balanced against water pressure acting thereon and being overbalanced in a closing direction by the weight of the operating linkages connected therewith; and also is caused to open in response to operation of the pump. For this latter purpose an electro-magnetic valve-operating device **206** is provided including a motor **207**, the two terminals of the magnetizing motor winding of which are connected through two leads **208** with two separate terminals of the pump motor **36** or to the conductors leading therefrom to a starting switch **130** for the pump motor. This latter motor **36** can be a three phase motor as it drives a pump impeller which can turn in either direction equally well and effec-

tively. Such motor 207, when energized, operates its armature or rotor to operate a pump that creates fluid pressure on a piston in the casing 210 to raise the piston rods 212 against a lever 213 pivoted at one end on the fixed bracket 214 and connected at its other end with a vertical pull rod 216 pivoted at its lower end to the end of an arm 218 fixed to the valve 50. The arrangement is such that the valve is moved from closed to open position concurrently with the energization of the pump motor and retains this open position during the operation of the motor and pump and closes because of the weight of the rod 216 and associated parts upon the de-energization of the motor. The motor 207 preferably rotates in the same direction irrespectively of reversal of energization of the preferably three phase pump motor so that the valve 50 is opened each time the pump is operated, regardless of the direction of rotation. Thus water flows through the pump only when the pump is operating and danger of injury to the motor and pump and connections therebetween is obviated. The butterfly valve, where used, eliminates the necessity for running the pumps after the dock has been fully elevated and until the gate valves 44 can be closed and hence is convenient although it does not eliminate the gate valve since the butterfly valve, by reason of its nature, cannot be completely water tight and hence the gate valve has to be closed ultimately.

The boat is chocked to hold it vertical when it rests on the floor of the dock. Any suitable chocking means may be provided on the bottom section of the dry dock. I have illustrated in Fig. 3 chocking devices 110 movable transversely on tracks 112 by means of cables 114 extending up the wing to suitable mechanisms 116 on each wing for manual operation of the chocking devices. As illustrated, one end of a cable 114 is anchored at 118 on the chocking device, extending thence toward the center of the bottom section and around the pulley 120 and then back over the bottom section and around the pulley 122, whence the cable extends upwardly along the wing through the guides 124 and over pulley 126 at the operating device 116 on the wing platform 18. From the pulley 126 the cable extends downward through the guides 124 and around pulley 122 and has its end anchored at 128 on the chocking device 110. Thus by suitable manipulation of the operating devices 116 from the wing platform the chocking device 110 may be moved along its track toward or away from a boat in the dry dock.

The control means for the reversible motors for driving the pumps 34 is best illustrated in the diagrammatic showing of Fig. 13. Each motor 36 has a switch 130 operable between open and closed positions by means of an electro-magnet 132, and the circuit 133 to all of the motors has a switch 134 operable between normal closed or forward-running position and a reverse position by means of electro-magnet 136. The motor switches 130 preferably are located on the wings of the dry dock near their respective motors while the switch 134 controlling the circuit to all of the motors may either be on a wing of the dry dock, if the dock-control house is there located, as may be the case at times, or on the pier at which the dry dock is anchored, such as in the terminal pit 131 indicated in Fig. 1.

The motors 36 herein shown are for three-phase operation, and the circuit 133 thus is a three-phase circuit of suitable voltage and capacity and common to all the motors on the same wing, being duplicated in the other wings, as indicated at 133a, and both connected together prior to passing through the reversing switch 134 so that all motors, on both wings, are conditioned all for forward drive or all for reverse drive, depending upon the setting of the reverse switch. The motor control switches 130 and the reversing switch are herein diagrammatically illustrated and can be of different constructions and hence are not intended to illustrate any particular construction being illustrative only. As herein illustrated, the conductors controlling the opening and closing of the control switches 130 and herein specifically the conductors connected with the electro-magnet 132 enter a multi-conductor cable 135 extended along the line of the wing and from the dock to the control house B.

The electrical controls are best illustrated in Figs. 12 and 13, two panels 138, 140 in the control house B being provided each for the control of a separate wing of the dry dock, one of which panels is illustrated in Fig. 12. The separate motor switches 130 have their control circuits running through the cable 135 to the push button control switches indicated generally at 142, each control switch 142 having a push button 144 for effecting the closing of the motor control switch 130 to cause the motor to rotate and a separate push button 146 to effect the opening of the switch 130 and the stopping of the motor. The manner in which these push buttons effect control of the operating solenoid or magnet 132 of the motor switch is well known and need not be explained in detail. Each push button control switch 142 also is provided with a light 148, the energization of which is controlled by auxiliary contacts 150 of the associated motor-control switch 130 and is illuminated when the latter switch is closed and the motor is conditioned for operation.

Each panel has on it the push button switches for the motors of its associated wing. In addition, one of the panels, as the panel 138, has a push button switch 152 similar to the switches 142, for controlling the operating coil 136 of the reversing switch and having one push button 154 that operates the reversing switch 134 to reverse the current to the motors and a second push button 156 that restores the reversing switch to its normal condition for forward rotation of the motors. Cable 157 contains the electrical wiring which connects switch 152 with the reversing switch 134. Said push button switch also has a light 158, controlled by auxiliary contacts 160 of the reversing switch, to be illuminated when the reversing switch is closed for reverse operation of the pump motors. Usually the light 158 will be red while the light 148 will be green. Hence a green light indicates motor operation and when not accompanied by the red light indicates forward rotation and when the red light also shows, indicates reverse rotation. Thus all motors can be individually started and stopped by push button control and all motors collectively are conditioned for forward or reverse rotation. Since the motor control is by push buttons and hence by the finger tip the individual motors can be controlled easily for long or short periods of operation each independently of all others and each can be started and stopped easily as often as desired.

Also, on each of the control panels are a series of water-level indicating gauges 162 for indicating the level of water in the respective compart-

ments of the dry dock, each panel carrying gauges associated with its respective wing and there being a gauge for each compartment. Each gauge is closely associated, as immediately over, the push button switch for the motor of its compartment. In addition, the panel **138** carries additional draft indicator gauges **164** for indicating the outside level of the water at each side of the dry dock and forward and aft. The water level gauges **162** and **164** can be of any suitable construction and those herein illustrated are of the type containing a liquid column that rises and falls in accordance with the pressure of air acting thereon entrapped in an open-bottomed bell **166** located in the bottom part of the associated compartment for a gauge **162**, and connected to the gauge by a small pipe or duct **168**. All ducts of the gauge of a wing are grouped in a bundle and conducted from the dock to the control house and to the gauges. As the control panels for the two wings are closely associated together the operator can know at all times the condition in the various compartments of the dry dock and can quickly start or stop any particular pump whenever the occasion seems to require and reverse the operation of all pumps. Also the operator at the control center by reason of its chosen location is in position to observe the operations being performed upon the dry dock and can direct and guide these operations by means of the usual speech-amplifying system which is indicated generally at **170**, Fig. 1, there being one loud speaker instrument at each corner of the dry dock, both forward and aft.

As illustrated in Fig. 2, and also in Fig. 13, the electrical connections leading from the dry dock to the control center on the pier extend through the goose neck devices **172**, in Fig. 2, which can provide the necessary slackness in the wiring, represented by the looped portions in Fig. 13, to permit raising and lowering of the dry dock without putting harmful stresses on the wiring connections. From the goose necks, stationarily mounted on the pier, the wiring may go to the terminal pit **131** whence the various circuits lead to the control panels at the control center.

If the dock is floating high and it is desired to submerge it to receive a boat the flood valves are opened to let in the outside water by gravity. The pumps can also be operated to pump in water. With a steel dock or a wooden one heavily ballasted by solid ballast, when the dock has sunk sufficiently to receive the boat, the outside water level may still be below the water level in the dock compartments when the flood valves are closed. With the wooden dock of the present invention, however, when the water levels inside and outside the dock are about the same, and it is desired to further submerge the dock, the flood gate valves are closed and the pumps started to raise the water level in the wings to sink the dock to the required level at which time the pumps are stopped, and the butterfly valves close and the gate valves in the pump lines can be closed. The docking of the boat is not a long operation, however, and the rate of leakage of water from the dock through the butterfly valves is negligible and hence it is not essential to close the gate valves in the pump conduits. If there is successive change of water level for any reason, as is made known to the dock operator by his water level indicators, he can start up the pumps of those compartments that indicate a low water level, to raise the level, thus "jockeying" the pumps to maintain the required submergence and balance of the dock without the necessity for closing the manual valves.

When the boat is in the dock, the pumps are started in a direction to discharge water from the dock compartments to float the dock and the boat and when the proper elevation is attained, with the dock floor usually above water, the gate valves in the pump conduits are closed and the pump motors stopped.

In Fig. 3, the various water levels are indicated by dotted lines, the line **232** indicating the water level exteriorly of the dry dock when it is floating light and with no water therein, and the line **234** indicating the outside water level when the dock is elevated with a boat supported on the dock. The upper line **236** indicates the exterior level of water when the dry dock is submerged.

According to the present invention after the dock is pumped free of water and is thus elevated with the boat thereon it is not necessary to close the gate valves in the pump conduits immediately but the compartments can be kept desirably free of water by the mere operation of the pumps at suitable intervals for suitable periods of time until it is convenient to close the manual valves. The operator at the control center can constantly observe the condition within each of the compartments by means of the gauge indicators on the control panel, and can start and stop or reverse motors selectively to attain desired results as regards level of the dry dock as a whole or to permit water to enter certain compartments to help stabilize the dock structure as determined by distribution of weight in the boat. Also, the operator can continually be aware of the level of water exteriorly of the dry dock and by this means determine whether the dock is horizontal or tilted either fore or aft and can make needed adjustment of water levels in the compartments to bring the dock back to a level condition. Also, from his position in the control station, the operator is able to observe the workmen on the dock and can direct their labors over the amplifying system and thus utilize man power to the best possible advantage.

The use of the reversible-flow pumps thus not only simplifies and cheapens the pumping system by eliminating the flow-direction valves heretofore required with uni-directional flow pumps, but it also permits a single operative, alone, to control the raising and lowering of the dock.

The reversible-flow pump also permits the gravitational flooding of the dock compartments and, with a wooden dock, their partial evacuation, without the use or presence of the flood gate, by the flow of water through the pump since water can flow freely by gravity therethrough, particularly when the stresses due to reversely driving the water-rotated impeller are not harmful or when the reverse drive energy is not suddenly applied full force. For this purpose the butterfly valve can be omitted or blocked open. For the usual conditions of dock operation, however, I prefer the use of the butterfly valve as above described.

I claim:

1. A boat dry-docking system comprising a floating dry dock having a plurality of independent buoyancy-regulating compartments, means including reversible-flow pumps for discharging water into and from said compartments, reversible electric motors driving said pumps, a control station common to all of said pumps and motors, means at said station controlling the starting and stopping of each pump individually and selec-

tively and means at said station also controlling the direction of rotation of said motors and pumps.

2. A boat dry docking system comprising a floating dry dock having a plurality of independent buoyancy-regulating compartments, means including reversible-flow pumps for discharging water into and from said compartments, reversible electric motors driving said pumps, a control station common to all of said pumps and motors, means at said station controlling the starting and stopping of each pump and means at said station also controlling the direction of rotation of said motors and pumps collectively.

3. In a floating dry dock having a plurality of buoyancy-regulating compartments, a conduit connecting each compartment with the body of water in which the dock floats, a reversible flow pump in each compartment, a reversible driving motor for each pump, means for starting and stopping each pump independently of all the other pumps, and means for reversing the direction of rotation of all pumps conjointly.

4. In a floating dry dock having a plurality of buoyancy-regulating compartments, a conduit connecting each compartment with the body of water in which the dock floats, a reversible flow pump in each compartment, a reversible driving motor for each pump, means for starting and stopping each pump independently of all other pumps, means for reversing the direction of rotation of all pumps conjointly, and a control center situated to overlook said dry dock housing said starting and stopping means and said reversing means.

5. A boat dry-docking system comprising a floating dry dock having a plurality of independent buoyancy-regulating compartments, means including reversible-flow pumps for discharging water into and from said compartments, reversible electric motors driving said pumps, control means for each motor and pump by which any pump and its motor can be operated independently of all other pumps and motors, and means for conditioning all motors conjointly for rotation in any selected one of opposite directions of rotation.

6. In a floating dry dock having a plurality of buoyancy-regulating compartments, a conduit connecting each compartment with the water in which the dock floats, a reversible flow pump in said conduit for each compartment, a valve controlling water flow through each conduit, an electric motor for operating said pump selectively in opposite directions, electro-responsive means controlling said valve, a control station remote from said pumps and valves, and means at said station operative to effect the operation of both said electric motor and said electro-responsive means.

7. A floating dry dock having a plurality of buoyancy-regulating compartments, a conduit connecting each compartment with the body of water in which the dock floats, pumps in said conduits, a motor for driving each pump, valves in said conduits, said valves being normally biased for closing movement, and means, including an operating rod extending from a region adjacent a said valve to a region adjacent a said motor, responsive to the operation of a pump motor and independent of flow in said conduits for effecting the opening of the associated valve.

8. In a floating dry dock having a buoyancy-regulating compartment, a conduit for admitting water into and discharging water from said compartment, a reversible-flow pump in said conduit, a reversible motor for operating said pump to pass water selectively in opposite directions in said conduit, a normally closed valve in said conduit, and automatic means for opening said valve when said pump is operated in any one of its two directions under power of said motor.

9. In a floating dry dock having a buoyancy-regulating compartment, a conduit for admitting water into and discharging water from said compartment, a reversible-flow propeller pump in said conduit, a motor for driving said pump in opposite directions, a normally closed valve in said conduit, and means responsive to the power rotation of said propeller pump in each direction for effecting the opening of said valve.

10. A boat dry-docking system comprising a floating dry dock having a plurality of buoyancy-regulating compartments, reversible and reversible-flow pumps associated with said compartments for admitting water into and discharging water from said compartments, a reversible driving motor for each pump, a motor circuit common to said motors, starting and stopping means controlling the connection of each motor independently of all other motors with said circuit, means for reversing the power flow in said circuit to reverse conjointly the direction of rotation of said pumps and associated motors when the latter are connected to said circuit, a control center overlooking the dock, control means for each starting and stopping means grouped in arranged order at said center, control means for said reversing means associated with said first control means at said center, motor operating indicating means associated with its respective control means, reverse-condition indicating means associated with said reversing control means, and a water-level indicating means responsive to the water level in each compartment associated with the control means for the pump of its compartment.

11. A floating dry dock comprising a hollow water tight structure having its interior divided into a series of approximately water tight compartments, a separate single conduit leading from the exterior to the interior of each compartment, a reversible pump in each said conduit for pumping water into the compartments and also for pumping water out of the compartments, power means for reversibly operating the pumps, and a valve in each said conduit between the pump and the exterior of the compartment for controlling both inflow and outflow through said conduit and pump when the pump is not driven by said power means, and means responsive to the operation of said power means for opening said valve when said power means is operating and effecting the closing of said valve when the power means is not operating to drive the pump.

12. A floating dry dock and operating system therefor including a floating dry dock having a bottom hollow section and a hollow wing section rising vertically above the bottom section along each side thereof, bulkheads dividing the interiors of the bottom and wing sections into a series of water compartments, each compartment having extent both in the bottom section and in a wing section, a reversible pump in each said compartment having its flow passage open at one end into its compartment and open at its other end to the exterior of the dry dock, separate driving means for each pump located exteriorly on a said wing section, a control center, control means extending from all the pump driving means to said control center and operable there to selec-

tively control the drive of all of the pumps, and means also at the control center for indicating the level of water in each said compartment.

13. In a floating dry dock having a series of separable hollow dry dock units secured together to provide a composite dry dock, each said unit having interior bulkheads dividing its interior into a plurality of water compartments, a reversible pump in each compartment of each unit, separate reversible driving means for each pump, a control center common to all dock units, and control connections from all of the driving means extended between at least some dock units to said control center including means there for selectively controlling the operation and direction of operation of said pump driving means.

14. In a floating dry dock having a series of connected dock units each having a water compartment, a reversible-flow pump in each said compartment having its flow passage open at one end into its compartment and open at its other end to the exterior of the dry dock, a separate reversible electric driving motor for each pump located on the associated unit, motor starting switch means on each dock unit having connections with its associated pump, a control center for all dock units, electric circuit connectors extended between the dock units having connections with said motor starting switch means, a power circuit, power reversing switch means connecting said circuit connectors with said power circuit in two different ways to obtain rotation of said motors all in one and selectively all in the opposite directions, control connections from said individual motor starting switch means and from said power reversing means to said control center, and separate means at said center for selectively operating said connections to effect control of the switch means connected therewith.

15. In a water ballast floating dry dock having a plurality of buoyancy regulating compartments and a single conduit for each compartment for inflow of water to and outflow of water from each compartment, means in each said conduit for propelling water in either direction therethrough selectively, means at a remote location for selectively starting, stopping and reversing said propelling means in the individual conduits thereby to control list and trim independently of operation of manual valves, and means for automatically conditioning a said conduit, prior to each reversal of its propelling means, for minimizing the torque imposed upon the propelling means.

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