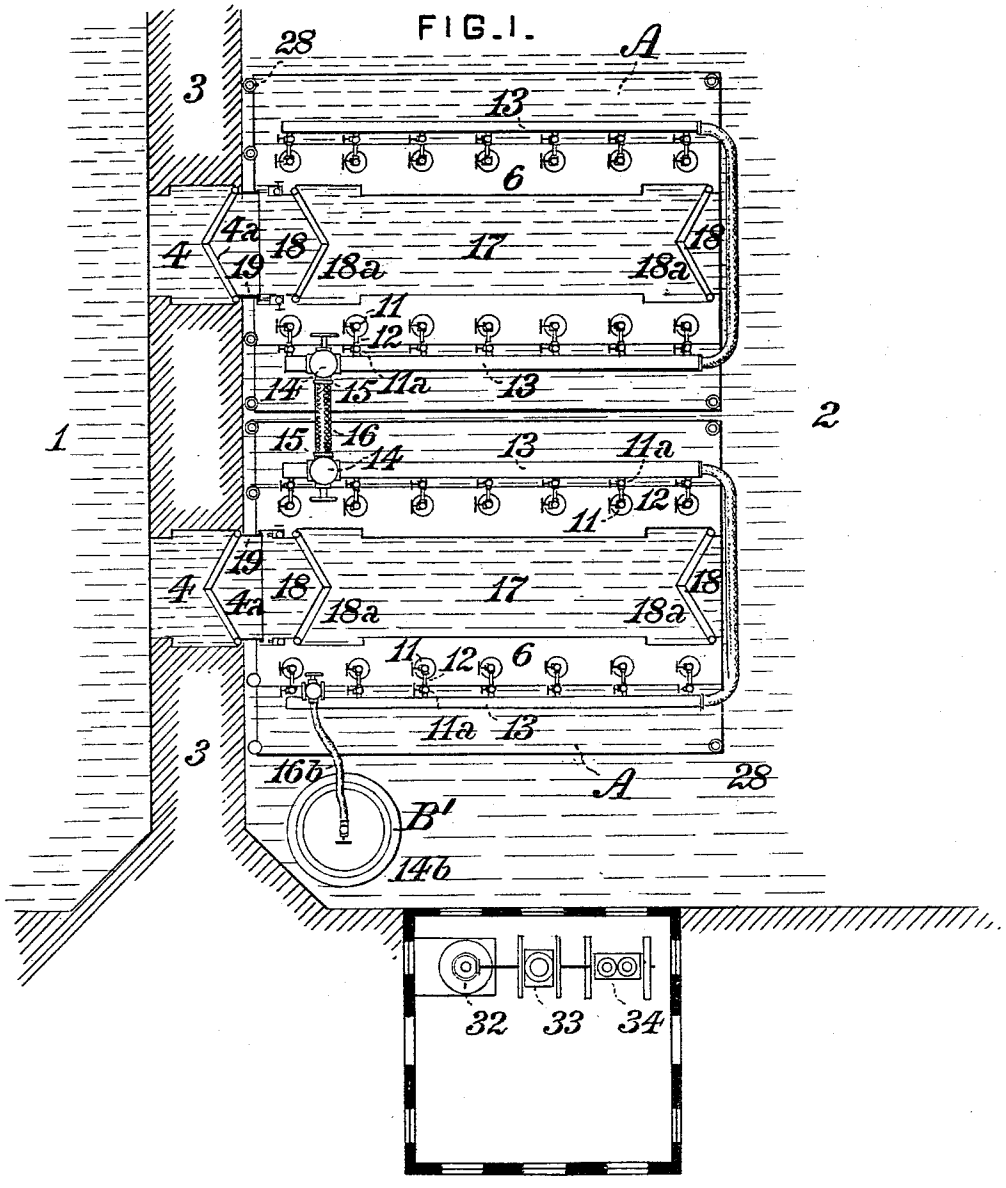
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C. N. DUTTON.

BALANCE LOCK FOR WATER WAYS.

No. 457,528. Patented Aug. 11, 1891.

FIG. 1.



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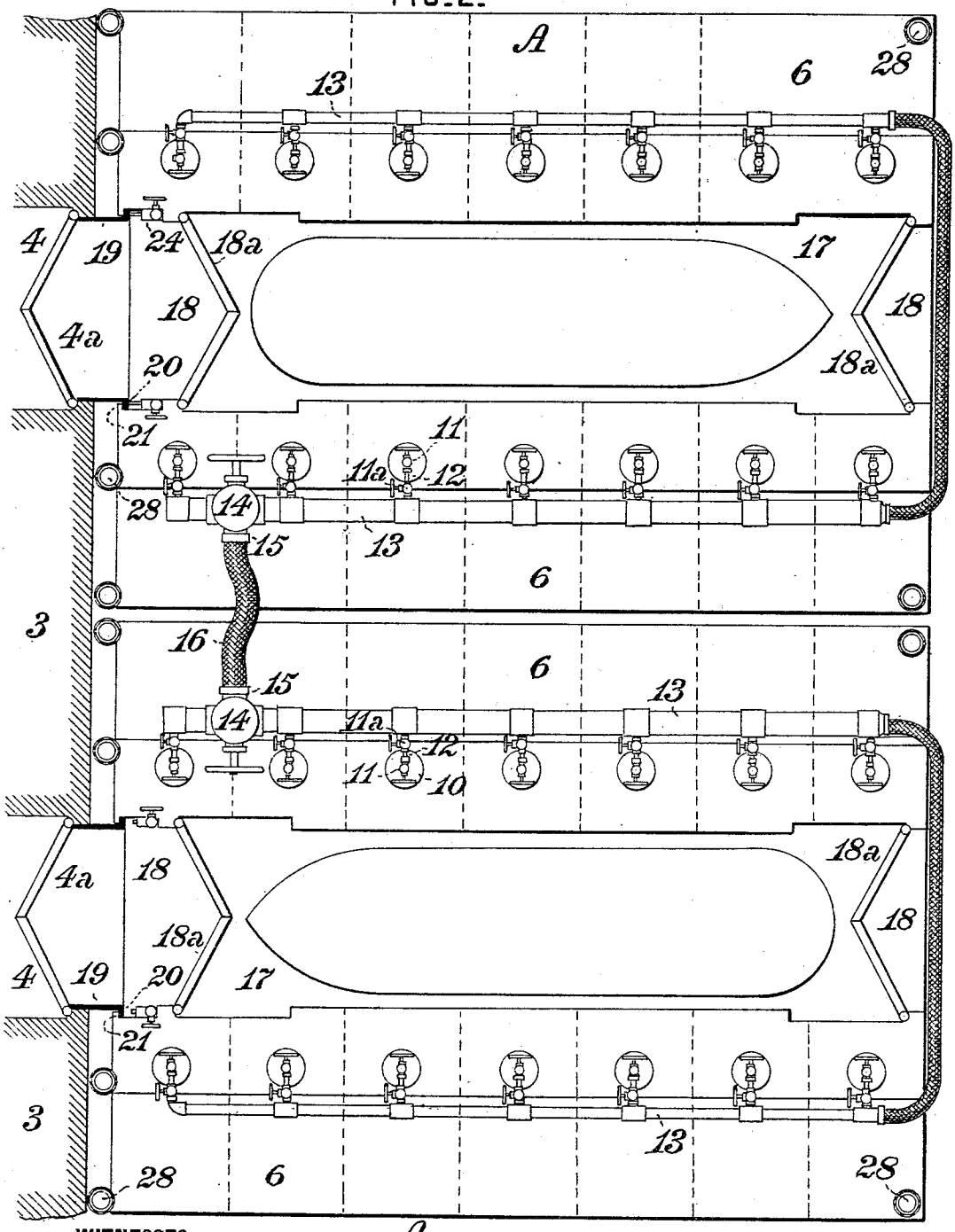
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C. N. DUTTON.

BALANCE LOCK FOR WATER WAYS.

No. 457,528. Patented Aug. 11, 1891.

FIG. 2.



WITNESSES:

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(No Model.) 5 Sheets—Sheet 3.

C. N. DUTTON.

BALANCE LOCK FOR WATER WAYS.

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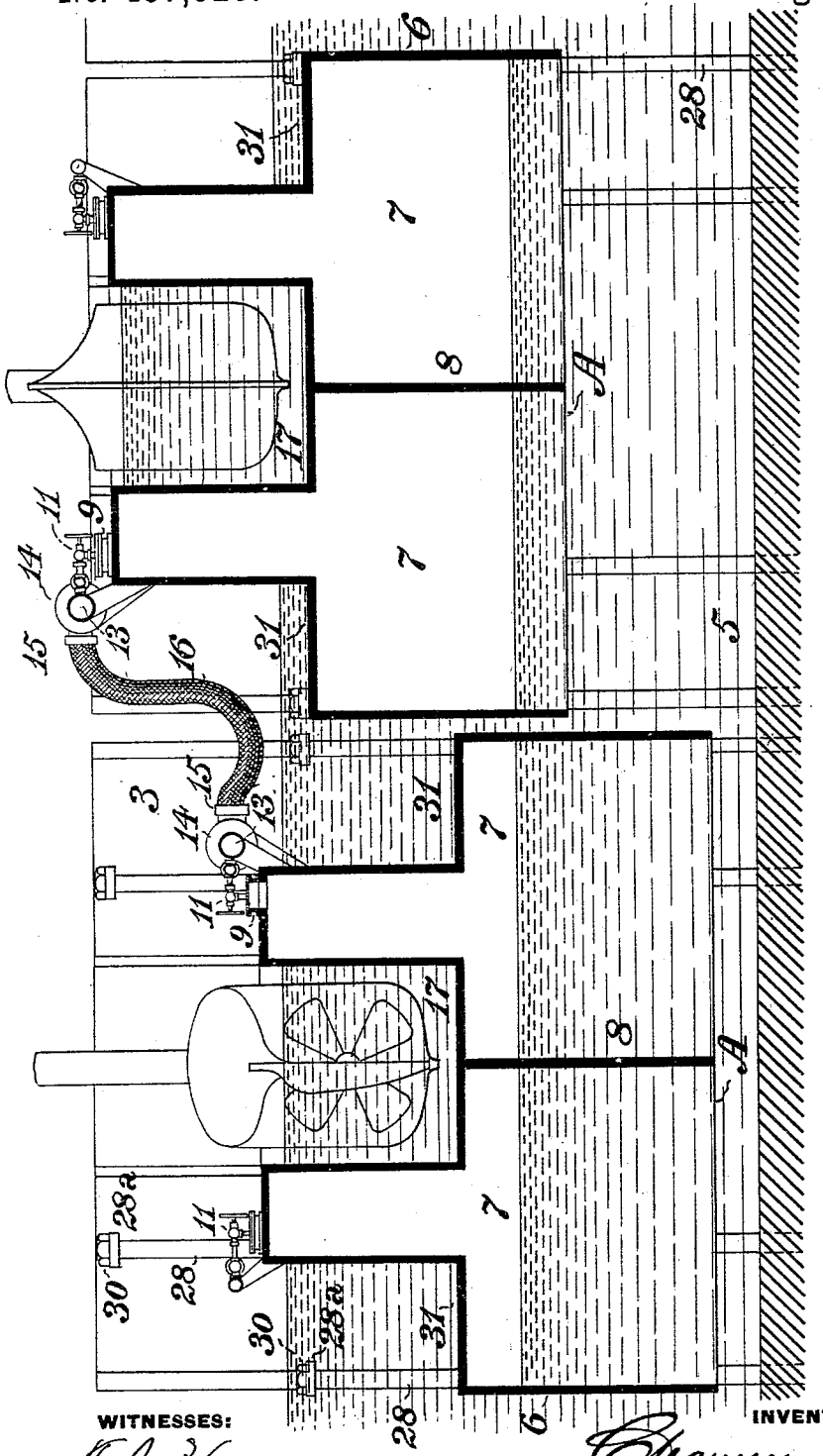


FIG. 3.

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5 Sheets—Sheet 4.

C. N. DUTTON.

BALANCE LOCK FOR WATER WAYS.

No. 457,528. Patented Aug. 11, 1891.

FIG. 4.

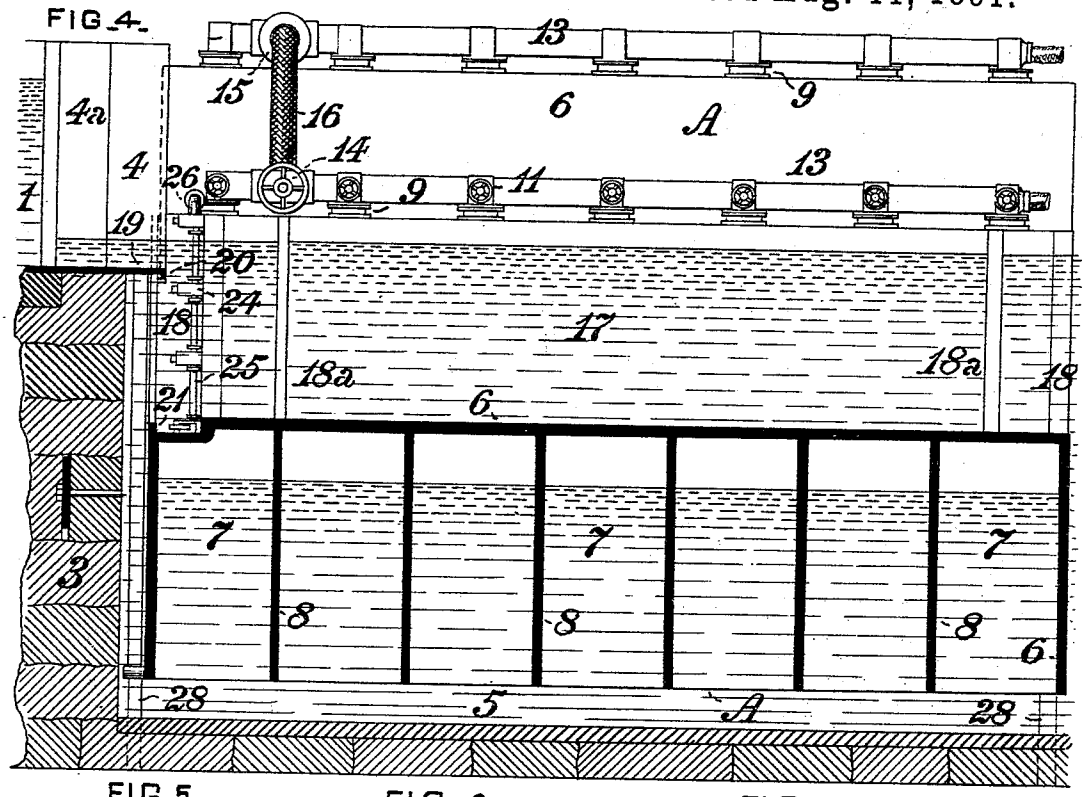


FIG. 5.

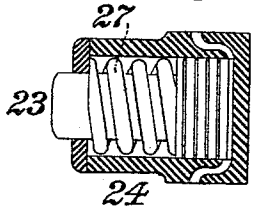


FIG. 6.

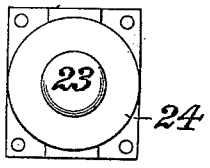


FIG. 7.

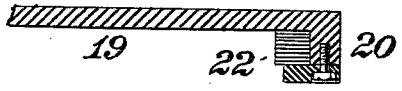
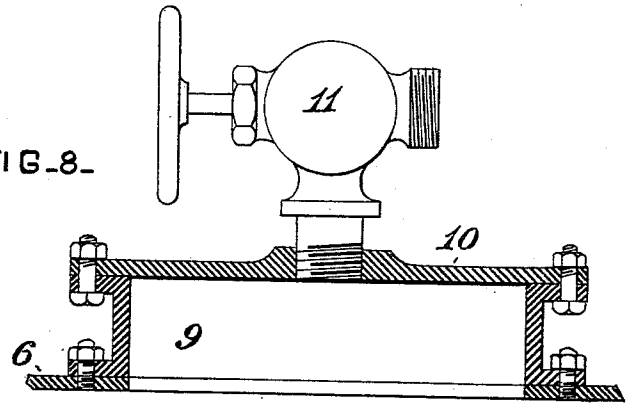


FIG. 8.



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C. N. DUTTON.

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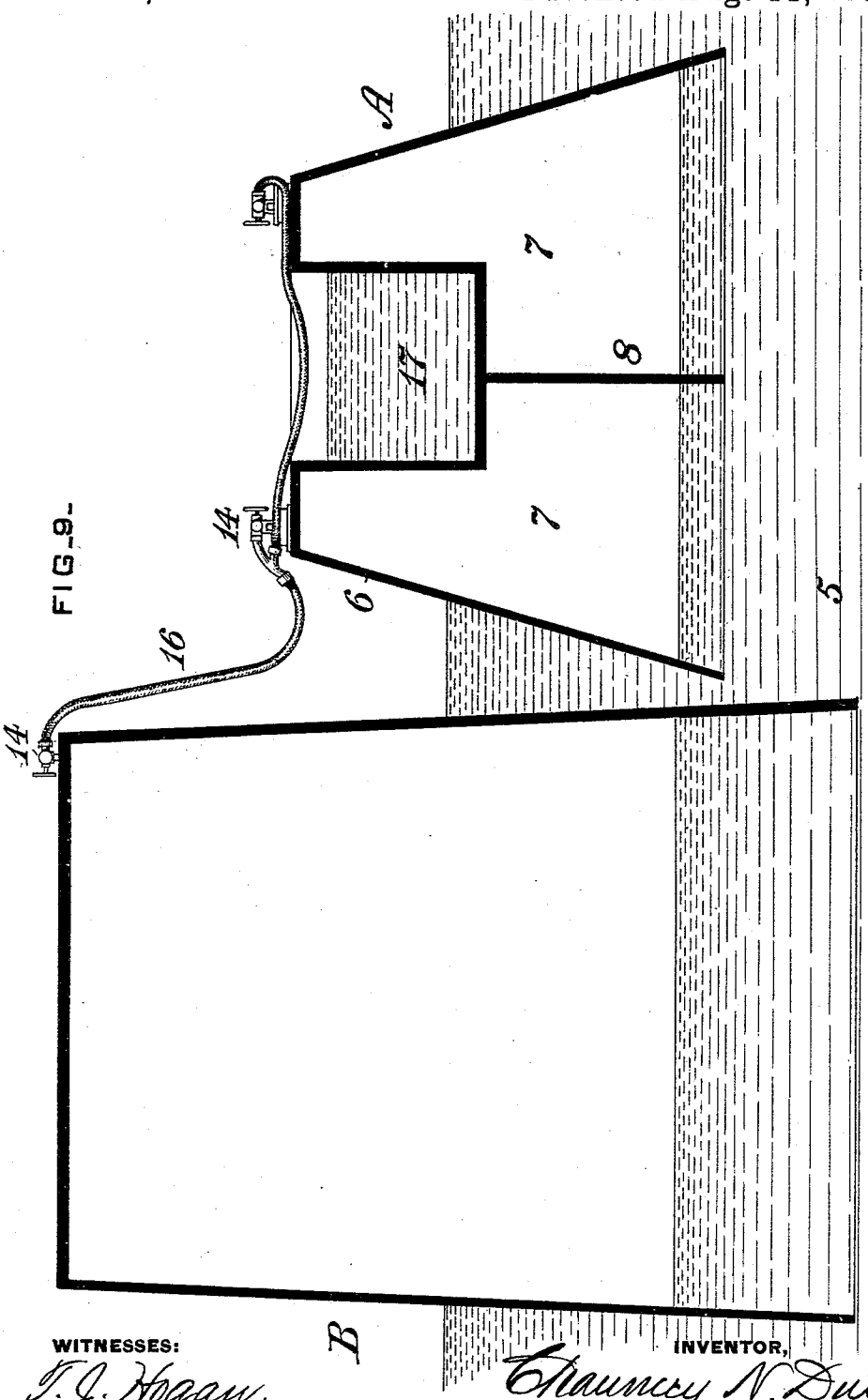


FIG. 9.

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UNITED STATES PATENT OFFICE.

CHAUNCEY N. DUTTON, OF PITTSBURG, PENNSYLVANIA.

BALANCE-LOCK FOR WATER-WAYS.

SPECIFICATION forming part of Letters Patent No. 457,528, dated August 11, 1891.

Application filed November 25, 1890. Serial No. 372,576. (No model.)

To all whom it may concern:

Be it known that I, CHAUNCEY N. DUTTON, a citizen of the United States, residing at Pittsburg, in the county of Allegheny and State of Pennsylvania, have invented or discovered a certain new and useful Improvement in Balance-Locks for Water-Ways, of which improvement the following is a specification.

My invention relates to balance-locks or elevators for raising and lowering vessels from one to another level in water-ways; and its object is to provide a lock of any desired capacity which shall embody the advantages of capability of quick operation, ready control, economy in the use of water, simplicity of construction, low cost of construction and maintenance, and facility of repair when in operation.

The essential features of my invention constitute the elements of a balance in which there are substituted for the ordinary scale-pans two or more inverted tanks containing a determined charge of air under pressure and connected by valve-controlled conduits to provide for the passage of air from one tank to another by the manipulation of an operator in the working of the lock. The charge of air under pressure acts in the manner of the ordinary scale-beam, and by variation of its pressure within a lock relatively to the weight thereof the tank and the vessel to be locked therein are caused to ascend or descend, as the case may require.

The improvement claimed is hereinafter set forth.

The leading and characteristic features of my invention may be generally described as follows: At any desired and convenient point in a canal or other water-way a retaining or head wall is built, dividing it into upper and lower levels. Gates closing openings in the head-wall retain the water in the upper level and open to permit the passage of vessels therefrom into the locks. The lower level of the water-way is expanded and deepened at and for a distance from the head-wall somewhat greater than the length of the locks desired to form a water-well for the reception of two or more air receptacles or tanks which are adapted to float and move vertically in the water contained in the well. These tanks are closed at top and open at bottom, and are charged with air under pressure, a determined volume of which is divided between the several tanks and is retained therein by the immersion of their lower walls in the water of the well, serving to give them the requisite buoyancy by expelling water from the interior of each tank. The several tanks are connected by a system of pipes and valves which control the passage of air from one to another. Where two, four, or any other even number of tanks are employed, each tank may be provided with an upper trough or lock-chamber, having openings controlled by gates for the admission and discharge of vessels to be locked or passed from one level of the water-way to the other and for retaining the vessels and the water in which they float, and these lock-chamber tanks are preferably, though not necessarily, arranged in pairs, the members of each pair, with their valve-controlled air connection, constituting a complete balance-lock system. In the use of one, three, or any other uneven number of locks one of the open-bottomed tanks before mentioned is unprovided with a lock-chamber, and serves to balance the other tank or tanks, each of which carries a gated trough or lock-chamber. This balance-tank is connected by independent valve-controlled conduits with the several lock-chamber tanks, and the construction provides a balance-lock or a syetem of balance-locks, as the case may be.

In operation a lock-chamber tank is connected with one of the gated openings in the head-wall, a vessel is admitted from the upper level to the lock-chamber, the gates are closed, and the lock-chamber tank is disconnected from the head-wall opening. At the same time a vessel is admitted to the lock-chamber of the other tank, if a pair of lock-chamber tanks is employed, the water-level in said chamber corresponding with the lower level of the water-way, and the gates of the chamber are closed. The vertical movements of the lock-chamber tanks are so adjusted that when any one of them stands at the lower level its chamber contains a minimum supply of water—as, for example, a depth of ten feet—and when connected at the upper level to the gated opening of the head-wall its chamber contains a maximum supply of

water—as, for example, a depth of ten feet six inches. The weight of the lock-chamber tank which is at the upper level is thus greater than that of the tank at the lower level to the extent of the weight of the excess of water which it contains. These conditions are unaffected by the vessels to be locked, as the weights of the latter are equivalent to those of the volumes of water which they respectively displace. The weight of the elevated lock-chamber tank will therefore cause an excess of pressure to be exerted upon its charge of compressed air above that exerted on the air in the depressed tank. Under such conditions, if the valves are opened, establishing communication between the interiors of the elevated and depressed tanks, air will pass from the former into the latter and will allow the former to descend and cause the latter to ascend, thereby reversing their relative positions.

In a system in which a balance-tank unprovided with a lock-chamber is employed the average pressure of the air contained in the balance-tank is constant and intermediate between the pressure in a lock-chamber tank when elevated and when depressed, respectively, so that the lock-chamber tank when elevated and containing its maximum charge of water will exert the greatest pressure and will force the air into the balance-tank, raising the latter and permitting the lock-chamber tank to descend, while the lock-chamber tank when depressed and containing its minimum charge of water will exert the least pressure and the balance-tank will force the air into the depressed and lightened lock-chamber tank and will raise it to the upper level.

My invention is more fully exemplified and detailed in the accompanying drawings, in which—

Figure 1 is a plan or top view of a balance-lock system embodying my invention; Fig. 2, a similar view, on an enlarged scale, of the lock-chamber tanks and their air connections; Fig. 3, a transverse section through a pair of lock-chamber tanks; Fig. 4, a vertical longitudinal section through a lock-chamber tank; Fig. 5, a longitudinal section, and Fig. 6 an end elevation, showing one of the pressure cylinders and pistons for insuring close contact between the mouths of the lock-chambers and of the head-wall openings; Fig. 7, a sectional view, on an enlarged scale, through a lip and packing of a head-wall mouth; Fig. 8, a view partly in elevation and partly in section of a flanged man-hole cover and valve, and Fig. 9 a transverse section through a balance-tank and lock-chamber tank.

In the practice of my invention I locate my improved balance-lock system at any suitable point in the line of a water-way, at which I construct a substantial transverse retaining or head wall 3, which separates the upper level 1 of the water-way from the lower level 2. Channels or passages 4, of sufficient width and depth to accommodate the largest vessels which are to be transferred from one level to another, are formed in the head-wall 3, said channels being provided with gates 4^a for retaining the water in the upper level at periods other than those when vessels are being passed into and out of said level. The lower level is enlarged and deepened at and adjacent to the head-wall 3 to form a water well or pit 5 for the reception of a series of floating lock-chamber tanks A, either with or without a balance-tank B. The tanks are adapted to move vertically without any substantial degree of longitudinal or transverse motion in the water-well 5, which is preferably made with sloping sides and cemented, so that it may be scoured and kept clean by a jet of water at high pressure.

The lock-chamber tanks A are open-bottomed chambers or casings 6, of steel or other suitable material, and are of rectangular form and preferably of cellular structure—that is to say, divided into a series of internal cells or compartments 7 by longitudinal and transverse vertical partitions 8. The adoption of a cellular structure is desirable, for the reason that it strengthens the tanks, diminishes liability to serious accident, and facilitates repairs when required. Several cells might be perforated or otherwise injured without impairing the operativeness of the lock, which, on the other hand, if the tank were undivided, would be liable to be disabled by a single leak or perforation.

Each of the cells 7 of the tanks 6 is provided with a man-hole opening having a flanged nozzle or mouth-piece 9, closed by a cover 10, which is secured to make a tight joint, with the capacity of ready detachment and replacement when required. A suitable stop-valve 11 controls an opening in each cell of the tank structure, preferably in its man-hole cover, and the outlet-openings of said valves are connected by pipes 12, controlled by valves 11^a, with a main pipe 13, controlled by a valve 14, which is provided with a suitable detachable coupling 15 to admit of being quickly connected with and disconnected from a flexible pipe or hose 16, by which the main pipes 13 of two lock-chamber tanks are connected when said tanks are to be balanced in a pair, or which serves to connect the interior of a lock-chamber tank with that of a balance-tank B when the latter is employed as a balance in lieu of another lock-chamber tank.

A lock chamber or trough 17, having its end openings or mouths 18 controlled by gates 18^a and of capacity sufficient to admit of the floatation of the largest vessels which are to be transferred from one level to another, is formed upon the top of each of the tanks 6. The ends of the mouths 18 adjacent to the head-wall 3 are adapted to be connected to those of the mouths 4 of said wall, so as to make tight joints therewith, with the capacity of ready connection and disconnection.

To this end the mouths 4 of the head-wall are extended outwardly therefrom by throats 19, on the outer ends of which are formed laterally and downwardly projecting lips or flanges 20. Corresponding inwardly and upwardly projecting lips or flanges 21 are formed on the outer ends of the adjacent mouths 18 of the tanks. Either or both of the flanges 20 and 21 are provided with packing-strips 22, Fig. 7, of soft lead or copper. To insure close contact of the flanges 20 and 21 and packing-strips 22 when the mouths 18 and throats 19 are first connected in order to prevent leakage of water from the upper to the lower level, a series of fluid-pressure cylinders 24 is fixed to the walls of the lock-chambers 17, adjacent to the ends of their mouths 18 nearest the head-wall. Each of the cylinders 24 is fitted with a piston 23, the outer end of which is adapted to abut against the flange 20 of the throat 19 of a head-wall mouth 4 and to press the flanges 20 and 21 closely together. The pistons 23 are forced outwardly for this purpose by air or water under-pressure, which is admitted to the cylinders through pipes 25, controlled by valves 26, and are retracted by springs 27 to release the pressure upon the flanges when the valves are adjusted to exhaust the actuating motive fluid. It will be seen that hydrostatic pressure upon the lock-chamber, when opened to the water in the upper level, acts from the upper toward the lower level, or in the direction of the end of the lock-chamber farthest from the head-wall, and thereby tends to increase the tightness of the joint between the mouths of the head-wall and lock-chamber by pressing their flanges closely upon the packing-strips. The gates which close the mouths of the head-wall openings and lock-chambers may be of any suitable and preferred type, provided with the requisite valves or wickets, and not forming in and of themselves any part of my present invention, need not be herein at length described.

In order to prevent any substantial degree of lateral movement of the tanks 6, as well as to properly limit their range of vertical movement, vertical guides and stays 28 are provided. These are preferably cylinders anchored at the bottom and to the head-wall 3, when adjacent thereto, and fitting freely in corresponding lateral openings or passages in the tanks 6. The end stops 28^a of the stays 28 are made longitudinally adjustable by nuts 30, engaging threads on the stays. A further function of the stays is to admit of a restrained excess of buoyancy when a lock-chamber tank A is raised to its elevated position. At this period the lock-chamber contains its minimum charge of water and receives an accession which raises the charge to the maximum, when the gates are opened to establish communication between the lock-chamber and the upper level. In the absence of an excess of buoyancy such accession would cause the lock to descend somewhat and abrade the packing of the joint between the mouths of the lock-chamber and head-wall.

The provision of a man-hole opening in each chamber or cell of the tank enables repairs to be readily made, when required, in different portions of the lock structure without interfering with its operation. For this purpose a man-hole cover is removed and an air-lock fixed in its place. The cell is then filled with compressed air and workmen are enabled to enter and make the repairs desired. In this instance the air-pipes, connections, and valves are all exterior to the tank and completely exposed, so as to be at all times accessible for renewal or repairs. Such construction is desirable as attaining simplicity of structure and facility of inspection and repair. It will, however, be obvious that any other preferred form of controlled-air connections would be fully applicable and operative and within the scope and governing principle of my invention.

Inasmuch as the buoyant effect necessary to support a floating tank varies relatively to its vertical position and the proportion of its structure which is submerged, it becomes necessary to compensate for such variation as is induced in and by the vertical movements of the tanks. To this end equalizing devices are provided, two forms of which are exemplified. That which is shown in Figs. 1 to 4, inclusive, consists in horizontal lateral extensions of the walls of the tank at such height thereon as to be normally below the surface of the water in which the tank floats. Said lateral extensions form equalizing-faces 31, the upper sides of which are subject to the downward pressure of the superincumbent water and their under sides to the buoyant internal air-pressure. The upward internal air-pressure being constant, or substantially so, and the downward water-pressure varying with the depth of immersion, it will be seen that by suitably proportioning the parts a practically-perfect balance will be attained.

As shown in Fig. 9, the tanks are provided with side walls which converge from the bottom toward the top, so that both the upward pressure of the contained air and the downward pressure of the exterior water are exerted upon surfaces the horizontal projection of which varies with the degree of immersion of the tank, thus equalizing the buoyant effect of the charge of air and the downward effort of the structure. The construction previously described is, however, deemed preferable for structural reasons.

The operation of a balance-lock system in accordance with my invention is as follows: Assuming, first, a balancing pair of lock-chamber tanks to be employed. One of the locks is elevated and one of its mouths connected to the throat of the adjacent mouth of the head-wall, the head-wall gates and the adjacent gates of the lock-chamber are opened, a vessel is passed into the lock-chamber, and the gates are closed. A vessel is at the same

time admitted to the lock-chamber of the other tank, which is in depressed position, or at the lower level, and the gates of this chamber are closed. The relative vertical positions of the lock-chambers when elevated and depressed, respectively, are so adjusted that the elevated chamber contains a maximum quantity of water and the depressed chamber a minimum quantity—that is to say, when the elevated and depressed lock-chambers communicate freely with the upper and lower levels, respectively, of the water-way the depth and volume of water in the lock-chamber of the elevated tank exceed the depth and volume of water in the lock-chamber of the depressed tank. The weight of the vessel or vessels in the chambers need not be considered, being equal to that of the water displaced. The excess of water in the elevated lock-chamber will therefore effect an increase of pressure of the air contained in the tank which carries said chamber above the pressure in the depressed tank. The elevated chamber is now detached from the head-wall and the valve or valves opened, which establish communication between the interiors of the two tanks, whereupon the excess of pressure in the elevated tank, due to the greater weight of water contained in its lock-chamber, will cause compressed air to flow from the elevated into the depressed tank, thereby raising the latter and permitting the former to descend, thus reversing their relative positions. The excess of water contained in the lock-chamber which was originally elevated is discharged therefrom when its tank is depressed to the lower level. The motion of the tanks is at all times completely under the control of the operator, who can accelerate, retard, or suspend it at will by the manipulation of the valve controlling the flow of air between the tanks.

When one or more lock-chamber tanks A are used in connection with a balance-tank B, the operation is substantially similar to that above described, differing only in the minor particular that the pressure in the balance-tank averages an intermediate between the maximum and minimum pressures in the lock-chamber tank. The employment of the balance-tank B attains greater freedom of operation than the disposition of lock-chamber tanks in pairs, as the lock-chamber tanks when combined in pairs necessarily move oppositely and synchronously, while when combined with a balance-tank they may be operated independently, all ascending or all descending simultaneously, or one or more ascending and one or more simultaneously descending, in any desired order or relation.

It will be seen that the volume of water expended in transferring a vessel from the upper to the lower level of a water-way and (simultaneously in a pair of lock-chamber tanks or at a subsequent period when a lock-chamber tank and a balance-tank are employed) transferring another vessel from the lower to the upper level is only the comparatively slight excess of water contained in the elevated lock-chamber, and that consequently the quantity of water required for locking two vessels is only a small fraction of that required for locking one vessel in the ordinary practice.

It is desirable that an air-compressing mechanism should be located conveniently adjacent to the locks for effecting the original compression of the buoyant charge of the tanks at the installation of the apparatus for supplying losses due to leakage or other causes, and for use in connection with an air-lock in making repairs. Fig. 1 illustrates in general plan upon a small scale an apparatus proper for this purpose, in which an air-compressor 33 is actuated by a turbine-wheel or other suitable motor 32. The motor may also actuate a pump 34 for cleaning out the water-well 5. Communication between the air-compressor and pump and the tanks and water-well is established, when required, by detachable hose or connections. Inasmuch as the necessity for the use of this apparatus is only occasional and its necessary operation comparatively small in degree, it may, if desired, be made portable and mounted upon a vessel or vehicle, so as to be transported from place to place, as desired, in accordance with the requirements of its use. A single apparatus may thus serve for all the lock systems of a canal or other water-way.

In addition to the normal balancing function of the balance-tank when operating in connection with a lock-chamber tank, it may also be employed to equalize the effect of changes of density in the adjacent atmosphere—*i. e*, barometric and thermometric changes. In certain conditions and with locks of certain proportions this latter function may become an important one, as the successful operation of the lock-tanks is dependent upon the displacement of determined volumes of water from their interiors. As is well known, the volume of any given quantity of air varies with changes in temperature and barometric pressure, or in that atmospheric density of which the barometric reading is the indication. The original charge of air in the lock-tanks will therefore tend to expel a greater or less volume of water therefrom in accordance with variations in atmospheric density, as above mentioned, and such a variation may be as great as five per cent. This variation is compensated for by the balance-tank B, which moves freely upwardly and downwardly, maintaining a pressure upon its contained air which remains constant at a certain degree above the atmosphere, however the density thereof may vary. The balance-tank consequently serves to perfectly equalize the atmospheric variation, as if the atmospheric density or temperature should increase or decrease, and as a result the lock-chamber tanks should have too little or too great floatation the opening of the valve establishing com-

munication will immediately effect an equalization and restore the conditions of relative pressures requisite for the normal and successful operation of the apparatus. When used merely for this purpose, the balance-tank may be of small capacity relatively to the lock-chamber tanks A, as, say, about ten per cent. of their volume. A small equalizing balance-tank B′ is shown in Fig. 1 in connection with a pair of lock-chamber tanks, with which it is connected by suitable flexible pipes or hose 16^b, controlled by valves 14^b. The function of the balance-tank in this connection being comparatively limited, it may, if desired, be replaced by an air compressor or blower which would constitute its mechanical equivalent in its combination with a lock-chamber tank.

I claim as my invention and desire to secure by Letters Patent—

1. In a balance-lock apparatus, the combination of a floating and vertically-movable tank or casing adapted to contain a charge of compressed air, a gated lock-chamber fixed on said casing, a second floating and vertically-movable tank or casing adapted to contain a charge of compressed air, and a valve-controlled air-passage connecting said tanks or casings, substantially as set forth.

2. In a balance-lock apparatus, the combination of a floating and vertically-movable tank or casing adapted to contain a charge of compressed air, a gated lock-chamber fixed on said casing, a second floating and vertically-movable tank or casing adapted to contain a charge of compressed air, a gated lock-chamber fixed on said casing, and a valve-controlled air-passage connecting said tanks or casing, substantially as set forth.

3. In a balance-lock apparatus, the combination of a floating and vertically-movable balance tank or casing adapted to contain a charge of compressed air, two or more floating and vertically-movable lock-chamber tanks or casings, each adapted to contain a charge of compressed air and having a gated lock-chamber fixed upon it, and independent valve-controlled air-passages connecting the several lock-chamber casings with the balance-casing, substantially as set forth.

4. In a balance-lock apparatus, the combination of a head-wall dividing a water-way into upper and lower levels, a gated mouth or passage-way formed in said head-wall, a tank or casing adapted to contain a charge of compressed air, said casing floating and being vertically movable in the lower level of the water-way adjacent to the head-wall, a lock-chamber fixed upon said casing and provided with gated mouths or end openings, one of which is fitted to make a joint with the mouth of the head-wall, a second floating and vertically-movable tank or casing adapted to contain a charge of compressed air, and a valve-controlled air-passage connecting said tanks or casing, substantially as set forth.

5. In a balance-lock apparatus, the combination of a head-wall dividing a water-way into upper and lower levels, gated mouths or passage-ways formed in said head-wall, one or more pairs of tanks or casings adapted to contain charges of compressed air, said casings floating and being vertically movable in the lower level of the water-way adjacent to the head-wall, lock-chambers fixed upon said casings, each provided with gated mouths or end openings, one of which is fitted to make a joint with a mouth of the head-wall, and valve-controlled air-passages connecting the casings of such pair, substantially as set forth.

6. In a balance-lock apparatus, the combination of a head-wall dividing a water-way into upper and lower levels, gated mouths or passage-ways formed in said head-wall, two or more lock-chamber tanks or casings, each adapted to contain a charge of compressed air and floating and being vertically movable in the lower level of the water-way adjacent to the head-wall, lock-chambers fixed upon said casings, each provided with gated mouths or end openings, one of which is fitted to make a joint with a mouth of the head-wall, a floating and vertically-movable balance tank or casings adapted to contain a charge of compressed air, and independent valve-controlled air-passages connecting the several lock-chamber casings with the balance-casing, substantially as set forth.

7. In a balance-lock apparatus, the combination of a floating and vertically-movable tank or casing adapted to contain a charge of compressed air, a gated lock-chamber fixed on said casing, a second floating and vertically-movable tank or casing adapted to contain a charge of compressed air, a valve-controlled air-passage connecting said tanks or casings, an air-compressing mechanism, and a detachable valve-controlled pipe or passage connecting said air-compressing mechanism with one of the casings, substantially as set forth.

8. In a balance-lock apparatus, a floating and vertically-movable tank or casing adapted to contain a charge of compressed air, said casing being provided with outwardly-projected walls increasing its lower width relatively to its upper width in order to equalize the buoyant effect of the charge and downward effort of the casing at different levels of floatation, substantially as set forth.

9. In a balance-lock apparatus, a floating and vertically-movable tank or casing adapted to contain a charge of compressed air, said casing being provided with horizontal outward extensions of its walls forming equalizing-faces, which are normally located below the level of the water in which the casing floats, substantially as set forth.

10. In a balance-lock apparatus, the combination of a head-wall dividing a water-way into upper and lower levels, a gated mouth or passage-way formed in said head-wall, a tank or casing adapted to contain a charge of compressed air, said casing floating and being

vertically movable in the lower level of the water-way adjacent to the head-wall, a lock-chamber fixed upon said casing and provided with gated mouths or end openings, one of which is fitted to make a joint with the mouth of the head-wall, and vertical guides entering recesses or guide-openings in the casing to prevent undue lateral or longitudinal movement thereof, substantially as set forth.

11. In a balance-lock apparatus, the combination of a head-wall dividing a water-way into upper and lower levels, a gated mouth or passage-way formed in said head-wall, a tank or casing adapted to contain a charge of compressed air, said casing floating and being vertically movable in the lower level of the water-way adjacent to the head-wall, a lock-chamber fixed upon said casing and provided with gated mouths or end openings, one of which is fitted to make a joint with the mouth of the head-wall, and vertical guides provided with end stops to prevent undue vertical movement of the casing, substantially as set forth.

12. In a balance-lock apparatus, the combination of a head-wall dividing a water-way into upper and lower levels, a gated mouth or passage-way formed in said head-wall and provided with laterally and downwardly projecting flanges on its end, a tank or casing adapted to contain a charge of compressed air, said casing floating and being vertically movable in the lower level of the water-way adjacent to the head-wall, a lock-chamber fixed upon said casing and provided with gated mouths or openings, lips or flanges projecting from the end of the mouth of the lock-chamber adjacent to that of the head-wall parallel with and adjacent to those of the head-wall flanges, packing-strips interposed between the head-wall flanges and lock-chamber flanges, and mechanism for pressing said flanges closely against said packing-strips, substantially as set forth.

13. In a balance-lock apparatus, the combination of a head-wall dividing a water-way into upper and lower levels, a gated mouth or passage-way formed in said head-wall and provided with laterally and downwardly projecting flanges on its end, a tank or casing adapted to contain a charge of compressed air, said casing floating and being vertically movable in the lower level of the water-way adjacent to the head-wall, a lock-chamber fixed upon said casing and provided with gated mouths or openings, lips or flanges projecting from the end of the mouth of the lock-chamber adjacent to that of the head-wall parallel with and adjacent to those of the head-wall flanges, packing-strips interposed between the head-wall flanges and lock-chamber flanges, and fluid-pressure cylinders provided with pistons by which pressure is exerted upon said flanges for pressing them closely against said packing-strips, substantially as set forth.

14. In a balance-lock apparatus, the combination of an open-bottomed tank or casing, internal partitions dividing the casing into a series of air-tight cells or compartments, and valve-controlled air-passages, each leading into one of said compartments, substantially as set forth.

15. In a balance-lock apparatus, the combination of an open-bottomed tank or casing, internal partitions dividing the casing into a series of air-tight cells or compartments, valve-controlled air-passages, each leading into one of said compartments, a main air-pipe, valve-controlled connections coupling the air-passages of the several compartments to said main air-pipe, and a valve controlling said main air-pipe, substantially as set forth.

In testimony whereof I have hereunto set my hand.

CHAUNCEY N. DUTTON.

Witnesses:
J. SNOWDEN BELL,
W. B. CORWIN.