No. 617,750. Patented Jan. 17, 1899.

S. LAKE.

DIVING BELL.

Application filed June 21, 1897.

(No Model.) 2 Sheets—Sheet 1.

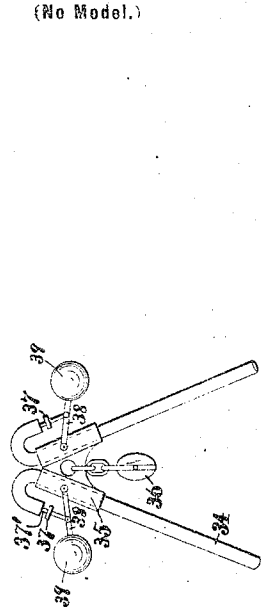


Fig. 1.

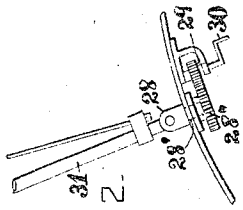


Fig. 2.

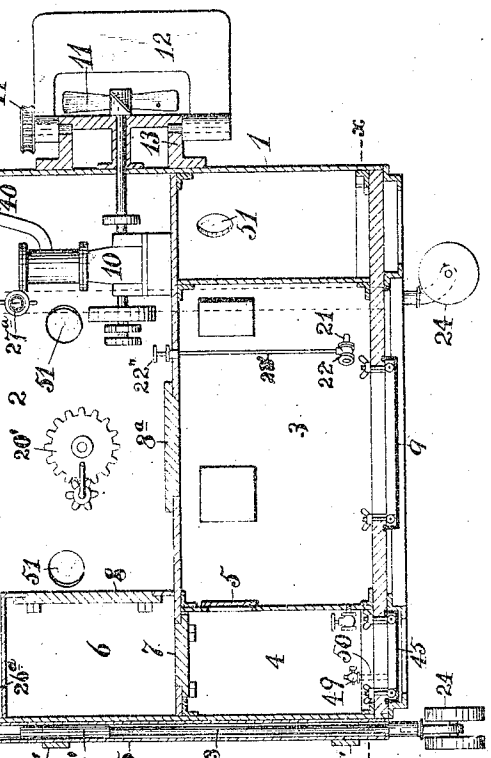


Fig. 4.

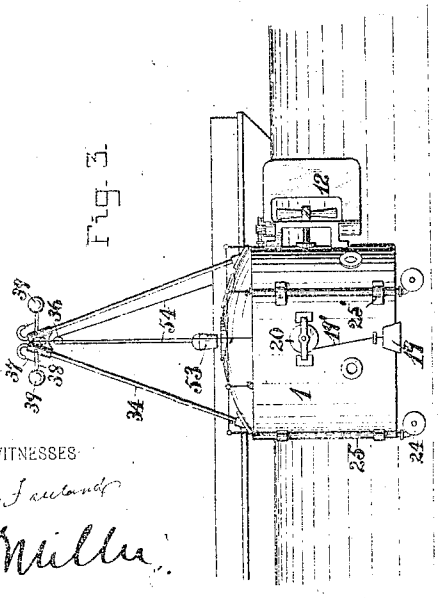


Fig. 3.

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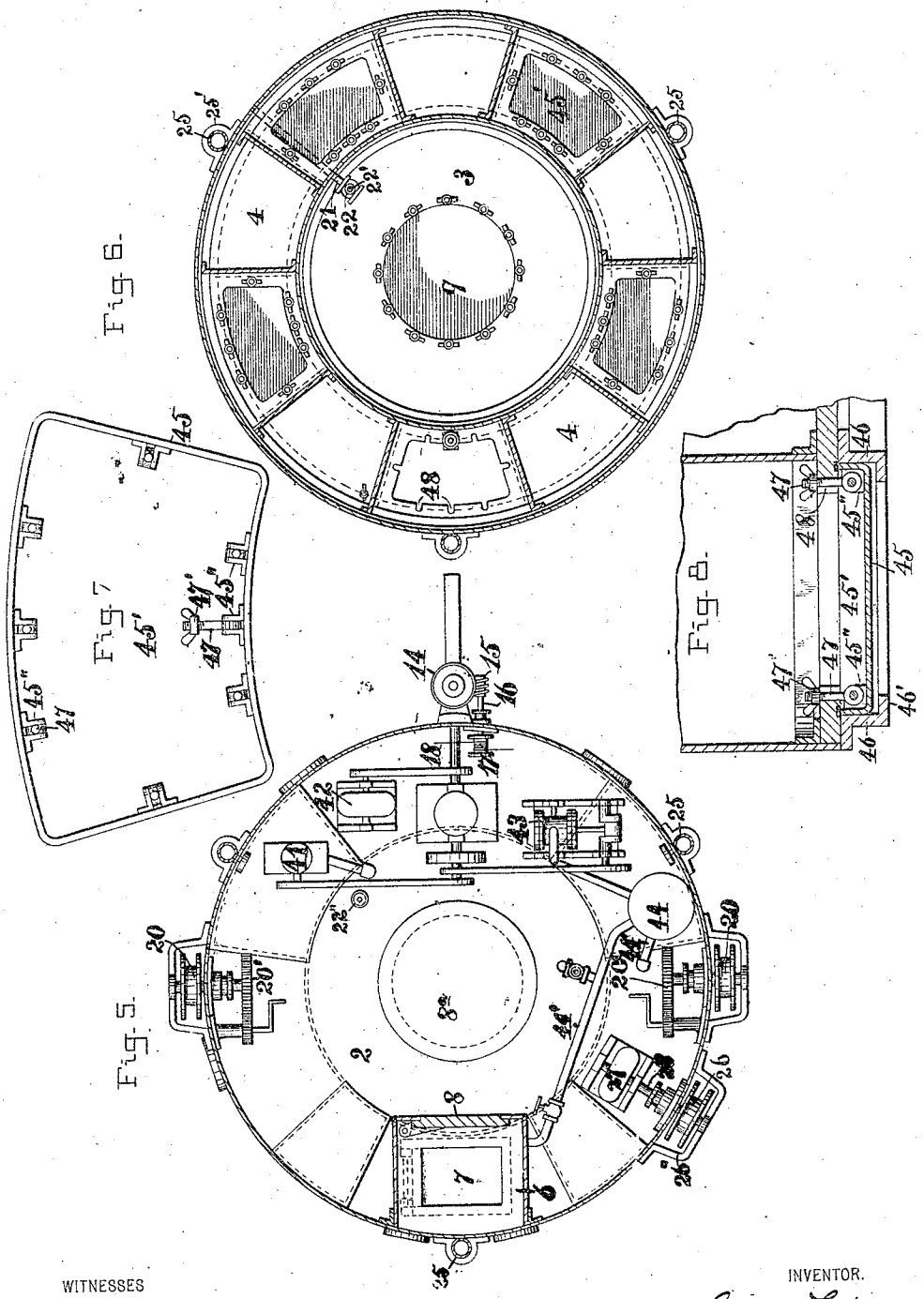
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(No Model.) 2 Sheets—Sheet 2.



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DIVING-BELL.

SPECIFICATION forming part of Letters Patent No. 617,750, dated January 17, 1899.

Application filed June 21, 1897. Serial No. 641,562. (No model.)

To all whom it may concern:

Be it known that I, SIMON LAKE, a citizen of the United States, and a resident of Baltimore city, in the State of Maryland, have invented certain new and useful Improvements in Diving-Bells, of which the following is a specification.

This invention has for its object to provide a diving-bell which may be readily operated by means of contained apparatus, so as to dispense with the employment of an attendant vessel upon the surface for rendering such assistance as has been heretofore commonly required in the performance of submarine work, and to provide a structure of this class of such character as to be easily movable upon the water-bed while operatively engaged.

The present improvement is designed especially for use in laying submarine foundations and in pearl, coral, and sponge fishing and other operations wherein it is important that the apparatus for lifting and carrying the objects to be operated upon be movable during the working of the same.

The invention consists, primarily, in the application to the diving-bell of depending wheels for supporting it while resting upon the water-bed, whereby it may be moved not only for the purpose of shifting its position intermediate to series of operations in a given locality, but during its actual working, as in lifting and transferring blocks of stone in laying submarine foundations.

The invention consists also in the application to the exterior of such structure of a winch and boom for use in lifting heavy objects from the water-bed and placing them in some predetermined relation.

The present improvement further includes means for adjusting the height of the structure above the water-bed upon its supporting-wheels, means for effecting its submergence, means for supplying the same with atmospheric air and carrying away the spent air, a special arrangement of working compartments, and various other specific details of construction to be described hereinafter.

In the drawings annexed, Figure 1 is a sectional elevation of a diving-bell embodying my present improvements. Fig. 2 is a detail view showing the base of the boom and the mechanism within the bell for turning the same into different axial relations. Fig. 3 is an elevation of the structure floating upon the surface of the water in the operation of unloading a cargo upon a scow alongside, and Fig. 4 a similar view of the apparatus employed while resting upon the water-bed in the building of a submarine foundation. Fig. 5 is a sectional plan of the diving-bell with the top of the operating or motor chamber or compartment removed to expose the contained apparatus. Fig. 6 is a similar view taken on the line $x\,x$ in Fig. 1, showing the lower compartments of the bell in plan view. Fig. 7 is a representation of the upper side of one of the bottom doors of the diver's compartment, and Fig. 8 a vertical section illustrating the mode of application of such doors to their respective doorways within the supporting-guideway therefor.

The diving-bell is shown constructed of a cylindrical shell 1, closed at the top and bottom and divided into an upper operating or motor compartment 2, a lower central compartment or chamber 3, surrounded by a concentric diver's compartment 4, and an air-lock compartment 6 above the latter and communicating therewith and with the operating-compartment by means of doors 7 and 8, respectively. The lower central compartment 3, which is designed to afford space for both cargo and water ballast, is provided with a bottom door 9 for access thereto from below in addition to its lateral doors 5 and upper door 8^a. The operating-compartment is preferably furnished with a motor, such as the gas-engine 10, whose shaft is projected through the shell and provided external thereto with a propeller-wheel 11. The rudder 12, carried by suitable bearings 13 adjacent to the propeller-screw, is provided with a vertical pivot having a worm-wheel 14, meshing with a worm 15, whose shaft 16 carries upon its inner end a drum 17, from which are led the lines 18 for connecting the same with the steering-wheel commonly provided for actuating the rudder.

To effect the submergence of the bell, the external weights 19, which are suspended by cords 19′ from suitable hoisting-drums 20, mounted upon shafts extended through the shell into the compartment 2 to receive the actuating crank-gearing 20′, are first lowered

to the water-bed, and water is then admitted to the water-ballast chamber 3 through the inlet-pipe 21, having a valve 22, whose stem 22′ projects upwardly through the top of the said chamber to receive the hand-wheel 22″. In case the external water-pressure is not such as to effect the compression of the contained air sufficiently to admit the required volume of water to nearly destroy the buoyancy of the structure the doors 5 may be opened for the reception of such confined air into the diver's compartment, or the entire expulsion of such air may be effected through a suitable air-exit pipe provided for the purpose, leading outward from the top of the chamber. The buoyancy of the diving-bell having been nearly destroyed by the admission of water-ballast and the water-inlet pipe closed; the hoisting-drums 20 may now be actuated to wind in their lines, which operate to draw the structure down to the water-bed, the slight buoyancy of the same remaining being insufficient to support the weights.

In order to maintain the shell movably upon the bottom, so that the weights may be drawn upwardly off the water-bed to insure the stability of the structure in its operative position beneath the surface, the upright bars or standards 23 are provided, each having at its lower end a caster-wheel 24 and formed at its upper end with a cylindrical head 23′, fitted closely to the bore of a hydraulic cylinder 25, having its closed upper end connected with a water-supply pipe by means of a three-way valve 26ª and with a pressure-gage 27ª for indicating the water-pressure therein. The several pressure-gages not only serve to show the weight of the cargo with which the structure is being loaded or that of the objects lifted by its hoisting apparatus, but they together serve to indicate whether the load is uniformly distributed, so as to adapt the bell to float with the floors of its compartments level when caused to rise to the surface.

The hydraulic cylinders 25 are secured to the exterior of the shell by straps 25′ or other suitable means. It is obvious that the admission and expulsion of water to and from these cylinders serves to vary the adjustment of the shell 1 above the water-bed and that by their independent connection with the water-supply pipe they may be made to compensate for any unevenness in the water-bed and to maintain the floors of the several compartments in a level position.

To enable the diving-bell to handle heavy objects in its operations beneath the surface, the shell is provided externally with a winch 26, the shaft 26′ of which is journaled at its outer end in a suitable bearing in the bracket 26″, and the inner end is projected through the shell and coupled to an electric motor 27 for actuating the same. A swivel-head 28 is applied to the top of the bell near the edge, with its pintle 28′ projected through the same and provided with a gear 28″, meshing with a similar gear upon the crank-shaft 29, with crank 30 for actuating the same, and to this swivel-head is pivoted the base of the swinging boom 31, carrying at its outer end the pulley-block 32, over which the hoisting-line 33 from the winch 26 is passed to the object to be lifted.

An upright frame is provided upon the top of the shell 1 by the erection thereon of a series of two or more pipes 34 from points near the edge and converging at the upper ends, which are secured together by a union-piece or yoke 35, from which depends a pulley-block 36 for use in removing the cargo, as hereinafter explained. A suitable stay-line 31′ connects the top of this frame with the outer end of the boom for sustaining the latter at the desired angle of elevation in the performance of its function. This stay-line may obviously be provided with the usual means for varying its effective length for changing the angle of elevation of the boom when desired.

Each of the upright pipes 34 is shown in communication with the interior of the bell at its lower end and provided at the opposite end (which is reflexly bent, as indicated in the drawings) with a valve 37, whose stem 37′ is connected to and actuated by a lever 38, pivoted at one end to the union-piece 35 and carries at its opposite end a float 39 of spherical form. The exhaust-pipe 40 from the gas-engine 10 is connected with the inner end of one of the upright pipes 34, through which the products of combustion are led to the surface, above which latter the frame is designed to project for the purpose. Fresh air is supplied to the interior of the bell through one or more of the pipes 34. In case the upper extremities of these supply and exhaust pipes are temporarily submerged by waves upon the surface or other causes the floats 39 are raised and their respective valves thus automatically closed until the surface of the water drops below the mouths of the said pipes, when they serve to open the valves in a similar manner.

The operating or motor compartment is furnished with a hydraulic pump 41, driven from the gas-engine shaft by a belt-and-pulley connection for supplying power to actuate the hydraulic cylinders 25, a dynamo 42, similarly driven, for supplying current for the motor actuating the winch 26, and an air-compressor 43, also similarly connected with the gas-motor-engine shaft, for storing compressed air in the reservoir 44, from which pipes 44′ are led to the cargo-compartment 3 and the air-lock compartment 6. Each of these members of the apparatus, as well as the motor, may obviously be of any suitable type and construction.

To provide for the egress and ingress of the occupants of the structure when the latter is resting upon the water-bed, the bottom of the annular diver's compartment is formed with a series of doorways, each adapted to be closed by a door 45, having a recess or depression 45′ in its upper side. Each of these doors is fitted movably within a guideway ex-

tending along the opposite sides of said doorways, upon the under side of the shell, and formed of angle-irons 46, whose depending webs have the inwardly-projecting flanges 46′, overhanging the edges of the doors 45, so as to support them close to the bottom of the shell when not secured in their normal positions. Each door is fastened in position for closing its respective doorway by means of bolts 47, hinged at one end to suitable lugs 45″ in the recess or depression 45′ in the door and provided at the other end with clamp-nuts 47′, notches 48 being formed in the edges of the doorway to receive the shanks of said bolts, as shown in Figs. 1, 6, and 8.

The diving-bell having been propelled upon the surface to the vicinity in which it is to be operated and its submergence having been effected to enable it to rest upon its supporting-wheels on the water-bed, as already described, the divers or other operators enter the compartment 4, and the doors having been closed compressed air is admitted from the reservoir 44. By opening a petcock 49 in a pipe 50, projected from the bottom and communicating with the exterior of the compartment, it may be readily ascertained when the pressure of the air within is equal to that of the surrounding water, as the water will cease to flow in through the cock as soon as such equilibrium between the internal and external pressures is reached. When the inner and outer pressures have become equalized, as described, each door may be opened by first loosening the clamp-nuts 47′ and turning their respective fastening-bolts upon their pivots into the recess 45′, thereby releasing the door and permitting it to drop down upon the supporting-flanges 46′ of the guideway, upon which it may be slid laterally to expose the doorway normally closed by it, the bolts 47, lying within the recess, being obviously retained out of interference with the under side of the bell at such time.

When the apparatus is employed in pearl, coral, or sponge fishing and other operations of like character, a diver may stand upon the water-bed beneath each doorway, with the upper portion of his body within the compartment 4, and reach down with his hands to the bottom for the objects for which he is in search, placing them upon the section of the floor intermediate to the doorways and slowly pushing the diving-bell along in a given course upon its supporting-wheels as the area of the water-bed beneath becomes cleared. As the cargo accumulates in the outer compartment 4 it may be transferred from time to time through the lateral doors 5 into the cargo and water-ballast compartment 3, where it may be retained for delivery after the structure ascends to the surface.

In cases wherein the employment of the winch and boom are required these may both be actuated from the interior by an occupant of the operating or motor compartment, suitable dead-lights 51 being provided at convenient points in the shell for inspection of the work as it progresses.

It often happens that the materials to be handled in the building of submarine foundations are not deposited sufficiently near the site of the foundation for being placed in position by hoisting apparatus in a fixed position. The present improvement provides for such emergency in its adaptability for being moved while sustaining the object to be so placed, its supporting-wheels enabling it to traverse the water-bed to compensate for the necessarily limited length of the boom. The hydraulic cylinders for governing the height of the shell upon its supporting-standards also provide means for conveniently elevating a foundation-stone or other heavy object without the necessity of shortening the effective lateral reach of the boom by the common expedient of changing its angle of elevation for such purpose. This feature is obviously of importance in the construction of piers in which the base is of greater area than the upper portion, as in Fig. 4 of the drawings.

When it is desired to cause the diving-bell to rise to the surface, the doors 45 are slid back in the guideway under their respective doorways and their fastening-bolts secured in place, when the water contained in the compartment 3 may be expelled through the pipe 21 by the admission of compressed air at a sufficient pressure, so as to partially restore the buoyancy of the structure. The hoisting-lines 19′ are then unwound to enable the bell to rise to the surface, the remaining water ballast expelled from the compartment 3, and the weights 19 wound up to their normal positions adjacent to the shell, when the structure is ready for propulsion to a place for the transfer of its cargo. The latter operation is effected by removing the doors or hatches 8ª and 52 in the tops of the cargo and operating compartments, respectively, and raising the cargo by means of a bucket 53 or other receptacle fixed to a hoisting-line 54, passing over the pulley-block 36, suspended from the upright frame 34 35, as indicated in Fig. 3.

From the foregoing description it will be observed that the frame 34 35 serves a threefold purpose—that of affording an abutment for the stay-line attached to the head of the boom 31, of providing inlet and exhaust passages or conduits for the air employed within the diving-bell, and of supporting the pulley-block 36, used in unloading the cargo from the compartment 3. By suitably staying the boom 31 the winch 26 and line 33 may be used in connection with the pulley-block 36 in the operation of transferring the cargo.

While the frame 34 35 is shown herein as constructed of two upright pipes only, which are all that are required for conducting the air and gases to and from the interior of the structure, it is preferable in practice to add at least one more, so as to form a tripod for

conferring the requisite stiffness to withstand the lateral strain to which it is subjected by the stay-line 31'.

Each of the rotating shafts piercing the outer shell would in practice obviously be surrounded with a suitable stuffing-box to prevent leakage around the same during the submergence of the diving-bell, and such stuffing-boxes are shown at certain points upon the annexed drawings, but omitted at others as immaterial to the present improvement. Numerous other details of construction have also been omitted from the accompanying drawings, as they form no part of the present invention and their illustration in connection herewith would serve no useful purpose.

While the several operative members of the apparatus contained within the compartment 2 have been described at some length herein, it is to be understood that they are not essential to the present invention, which consists, primarily, in a diving-bell mounted upon supporting-wheels, so that it may be readily pushed from place to place by the occupants while resting upon the water-bed.

Having thus set forth the nature of the invention, what I claim is—

1. A diving-bell mounted upon supporting-wheels revoluble independently of mechanism contained within said bell, and adapted to be moved freely from place to place while resting upon the water-bed.

2. A diving-bell mounted upon supporting-wheels each of which is revoluble independently of the others and of mechanism contained within said bell, and adapted to be moved freely from place to place while resting upon the water-bed.

3. A diving-bell mounted upon caster-wheels and adapted to be moved freely in any direction by the occupants walking upon the water-bed while resting thereupon.

4. A diving-bell provided with a series of upright supporting-bars secured adjustably thereto as described and provided each with a caster-wheel upon its lower end whereby said diving-bell is adapted to be moved freely in any direction while upon the water-bed and in any of the adjustments of its supporting-bars.

5. A diving-bell provided with a series of upright hydraulic cylinders, a corresponding series of supporting-bars provided each with a caster-wheel upon its lower end and having its upper end fitted in one of said hydraulic cylinders to serve as a plunger therefor, and means for supplying water to said cylinders and maintaining said bars at the required height therein.

6. A diving-bell provided externally with a series of upright hydraulic cylinders, a corresponding series of supporting-bars provided each with a caster-wheel upon its lower end and having its upper end fitted in one of said hydraulic cylinders to serve as a plunger therefor, and means for independently supplying said cylinders with water for maintaining each of said bars at the required height in its respective cylinder.

7. A diving-bell provided externally with a series of upright hydraulic cylinders, a corresponding series of supporting-bars provided each with a caster-wheel upon its lower end and having its upper end fitted closely within one of said hydraulic cylinders to serve as a plunger therefor, a system of pipe connections and valves for manipulating said cylinders individually, and a water-gage connected with each of said cylinders to indicate the pressure therein.

8. A diving-bell provided with depending wheels for supporting the same movably upon the water-bed, valves for the admission and expulsion of water ballast, hoisting-drums mounted exterior to said diving-bell and means for actuating the same, and weights suspended by suitable cables from said hoisting-drums, as and for the purpose set forth.

9. A diving-bell provided with depending wheels for supporting the same movably upon the water-bed, valves for the admission and expulsion of water ballast, hoisting-drums mounted upon shafts journaled in brackets secured to the exterior of said diving-bell and projected through stuffing-boxes within the same, weights suspended by suitable cables from said hoisting-drums, and crank-gearing within the diving-bell for actuating said drums, as and for the purpose set forth.

10. A diving-bell provided with a winch mounted externally to and actuated by means within the diving-bell, a boom swiveled in the top of said bell and provided with a pulley-block, and a line leading from said winch over said pulley-block.

11. A diving-bell provided with a winch mounted externally to and actuated by a motor within the said diving-bell, a boom having its base pivoted to a swivel-bearing whose pintle is projected through the wall of the bell, mechanism within the latter and applied to said pintle for turning the same, a pulley-block applied to the outer end of said boom, and a line leading from said winch over said pulley-block.

12. A diving-bell provided with a winch mounted externally to and actuated by a motor within said diving-bell, a boom having its base pivoted to a swivel-bearing whose pintle is projected through the wall of said bell and actuated by mechanism within the latter, a pulley-block at the outer end of said boom, an upright frame projected from the top of the bell, a stay-line connecting the top of said frame with the outer end of said boom, and a line running from said winch over said pulley-block.

13. A diving-bell provided with a winch mounted externally to and actuated by a motor within said diving-bell, a boom mounted externally upon said bell and carrying a pulley-block, a frame projected upwardly from the top of said bell and formed of pipes open

at their upper ends and communicating at their lower ends with the interior of said bell, a stay-line connecting the top of said frame with the outer end of said boom, and a line running from said winch over said pulley-block.

14. A diving-bell constructed with an upwardly-projecting pipe in communication at the lower end with the interior of the bell and provided at the upper end with a valve having a suitable stem, an actuating-lever for said valve pivoted at one end upon said pipe and carrying at the other end a suitable float, and a connection between said valve-stem and its actuating-lever.

15. A diving-bell constructed with upwardly-projecting pipes extending from the outer edges of the top and secured together at their upper ends to form a rigid frame, said pipes communicating at their lower ends with the interior of the bell and having their upper extremities reflexly bent and provided with valves having suitable stems, actuating-levers for said valves each pivoted at one end to a suitable fulcrum and carrying at the opposite end a float, and connections between said valve-stems and their respective actuating-levers.

16. A diving-bell constructed with two upwardly-projecting pipes each provided at its upper end with an automatically-closing valve actuated by means of a suitable float and having its lower end in communication with the interior of said bell, and a gas-engine within said bell drawing its air-supply directly from the interior of the same and arranged to exhaust through one of said valved pipes.

17. A diving-bell provided with means for effecting its submergence and with independently-revoluble wheels for supporting it upon the water-bed, a doorway in its bottom, and a door for maintaining the same normally closed and provided with means for fastening the same detachably to enable it to be wholly removed from said doorway.

18. A diving-bell provided with means for effecting its submergence and with depending wheels for supporting it upon the water-bed, doorways in the bottom of the same, and doors fitted movably to suitable guideways and adapted to maintain said doorways normally closed.

19. A diving-bell provided with means for effecting its submergence and with depending wheels for supporting it upon the water-bed, a circular series of doorways in the bottom concentric guides adjacent to and inclosing said doorways, and a series of sliding doors fitted movably between said guides and adapted to maintain said doorways normally closed.

20. A diving-bell provided with means for effecting its submergence, and with depending wheels for supporting it upon the water-bed, doorways in the bottom, guides applied to the under side of the bell upon opposite sides of said doorways and extending beyond the same, said guides being formed of angle-bars with overhanging flanges as described, and doors fitted movably between said guides and supported adjacent to the bottom of the bell by said overhanging flanges, as and for the purpose set forth.

21. A diving-bell provided with means for effecting its submergence and with wheels for supporting it upon the water-bed, doorways in the bottom, guides upon the under side of the bell extending along the opposite sides of said doorways and beyond the same, said guides being formed of angle-bars with overhanging flanges as described, doors each having one side recessed fitted movably between said guides and supported by said overhanging flanges with their recessed sides adjacent to the under side of the bell, and fastening-bolts provided with suitable clamp-nuts hinged within the recessed sides of said doors and adapted to engage notches therefor in the edges of the doorways, as and for the purpose set forth.

22. A diving-bell provided with an upper operating-compartment, a lower central cargo-compartment and surrounding diver's compartment provided with a series of bottom doors, doors establishing communication between said cargo and diver's compartments, and doors in the tops of said cargo and operating compartments for use in removing the cargo, as and for the purpose set forth.

23. A diving-bell provided with an upper operating-compartment, a lower central cargo-compartment, and a surrounding diver's compartment provided with bottom doors, doors establishing communication between said cargo and diver's compartments, central doors in the tops of said cargo and operating compartments, a frame projected upwardly from the top of the bell, and a pulley-block suspended from said frame over said central doors of the operating and cargo compartments, as and for the purpose set forth.

Signed at Baltimore city, in the State of Maryland, this 25th day of May, A. D. 1897.

SIMON LAKE.

Witnesses:
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J. C. LAKE,
FELIX R. SULLIVAN.