No. 799,089. PATENTED SEPT. 12, 1905.

G. C. RALSTON.

HYDRAULIC MECHANISM FOR OPERATING BULKHEAD DOORS.

APPLICATION FILED APR. 1, 1904.

7 SHEETS—SHEET 1.

FIG. 1.

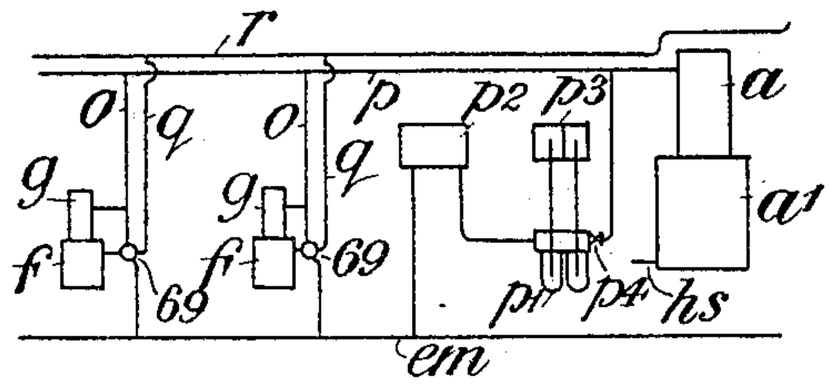


FIG. 2.

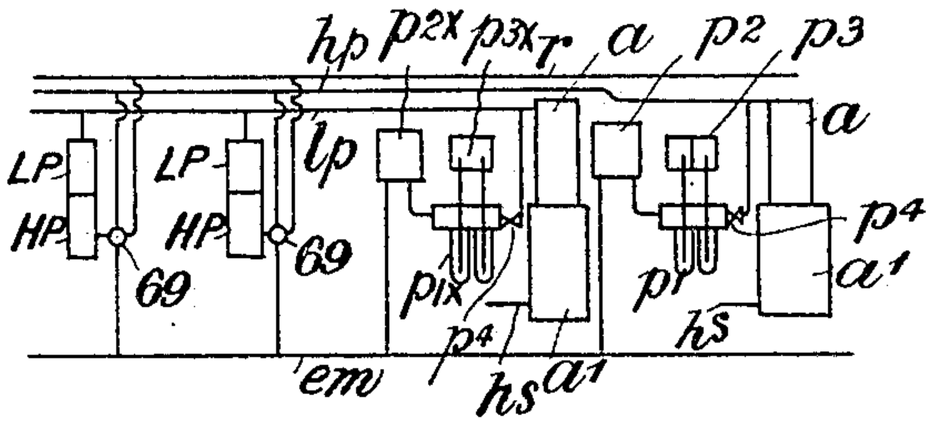


FIG. 3.

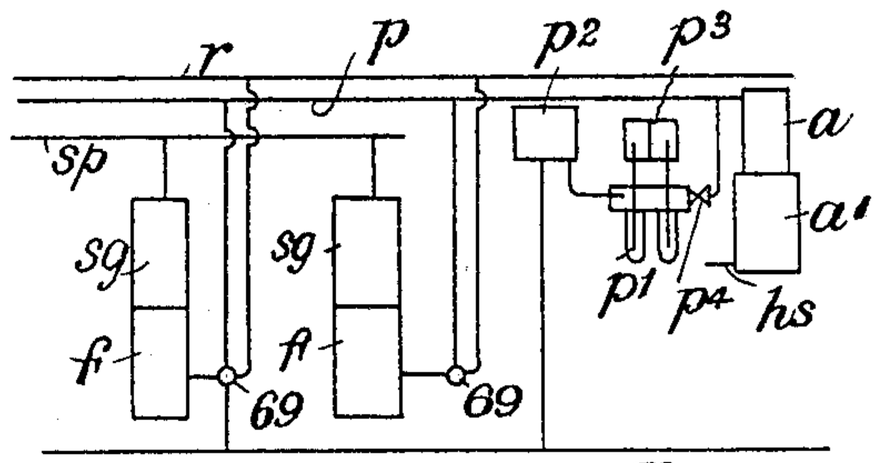
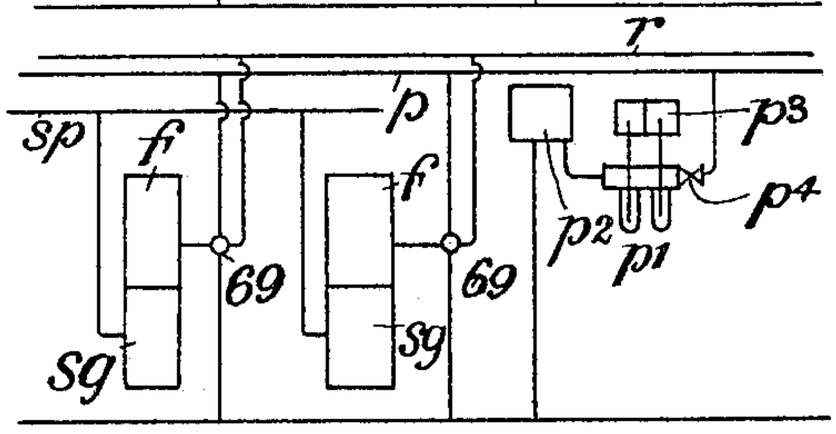


FIG. 4.



Witnesses.

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B. Donmeyer

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Gavin Carlyle Ralston.

by Henry Orth & Son attys.

ANDREW. B. GRAHAM CO., PHOTO-LITHOGRAPHERS, WASHINGTON, D. C.

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7 SHEETS—SHEET 2.

FIG. 5a

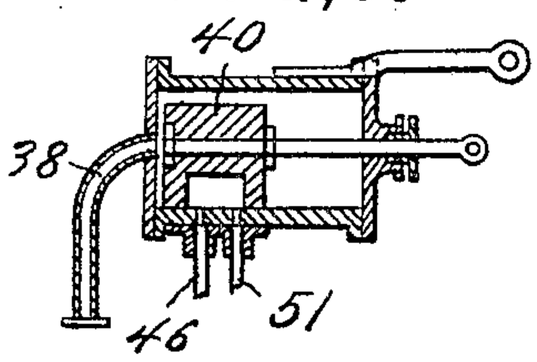

FIG. 5.

Witnesses

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No. 799,089. PATENTED SEPT. 12, 1905.

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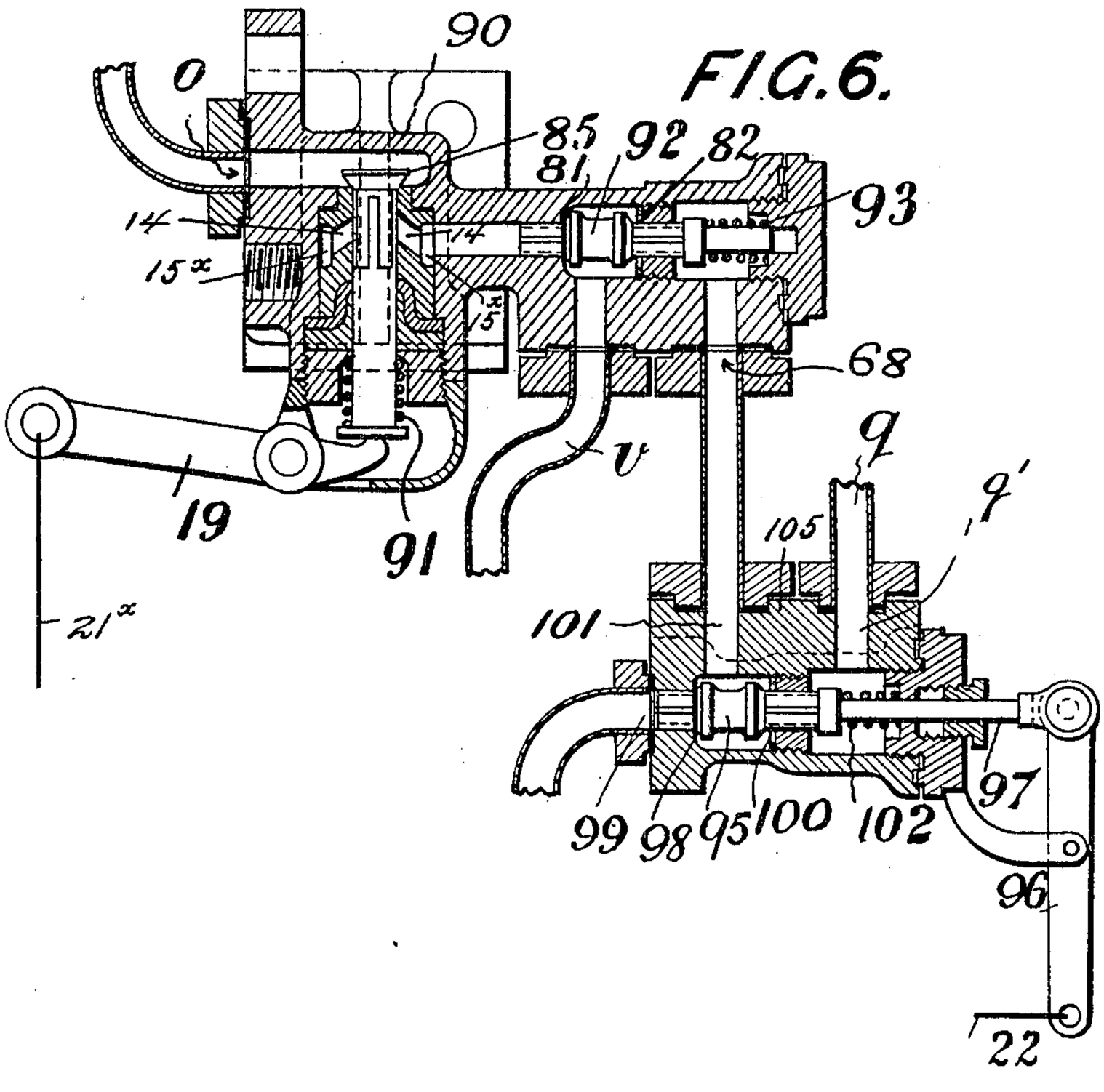
7 SHEETS—SHEET 3.

FIG. 6.



Witnesses:
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No. 799,089. PATENTED SEPT. 12, 1905.

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7 SHEETS—SHEET 4.

FIG. 7.

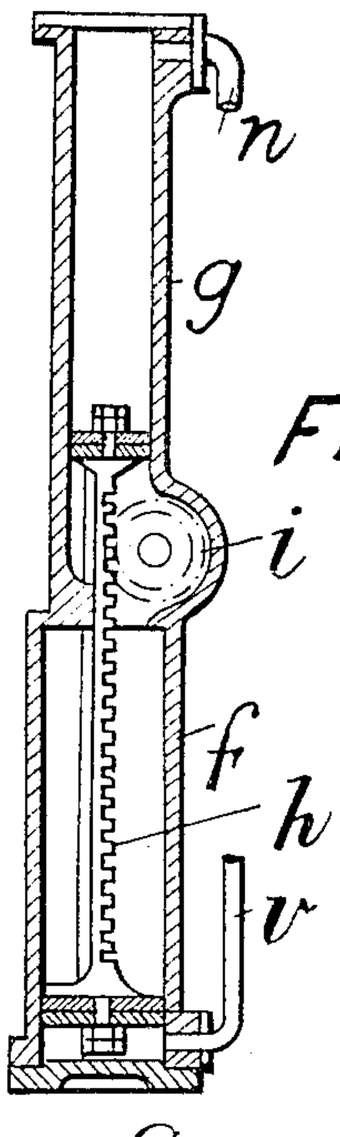


FIG. 8.

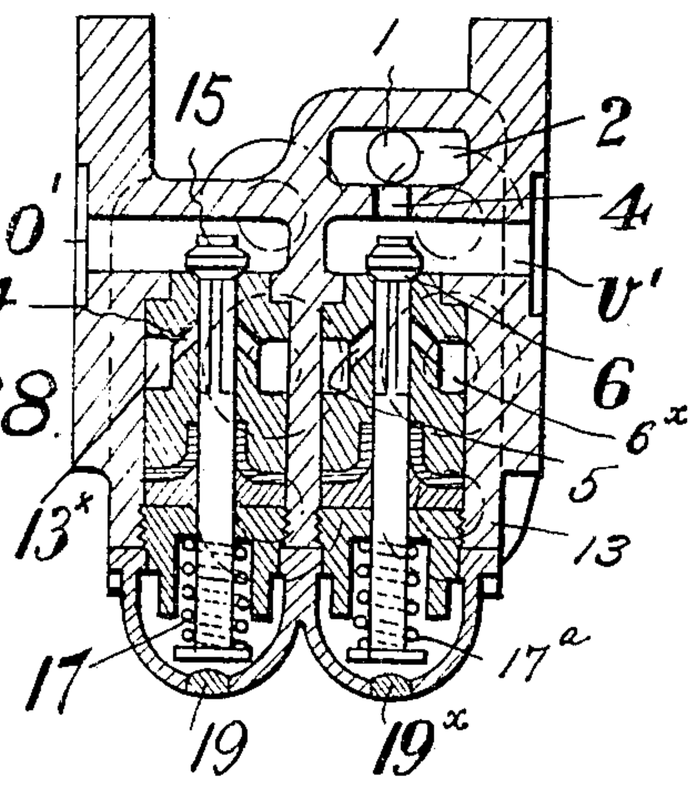
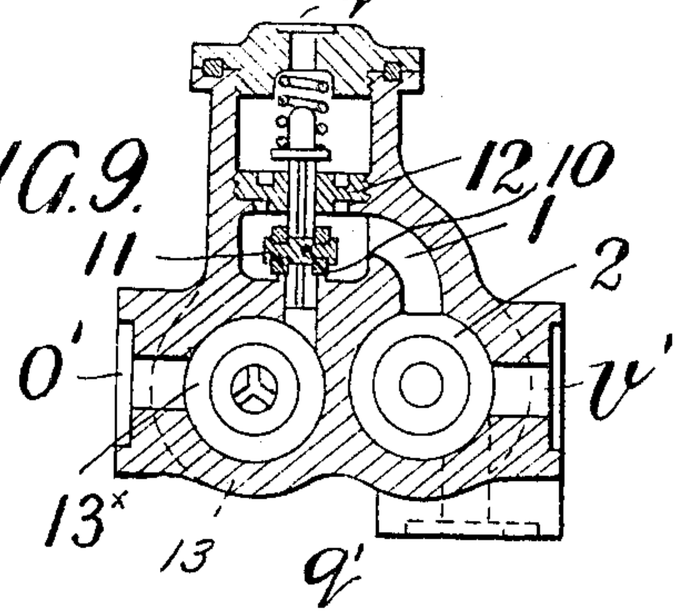


FIG. 9.



Witnesses:
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7 SHEETS--SHEET 5.

FIG. 10.

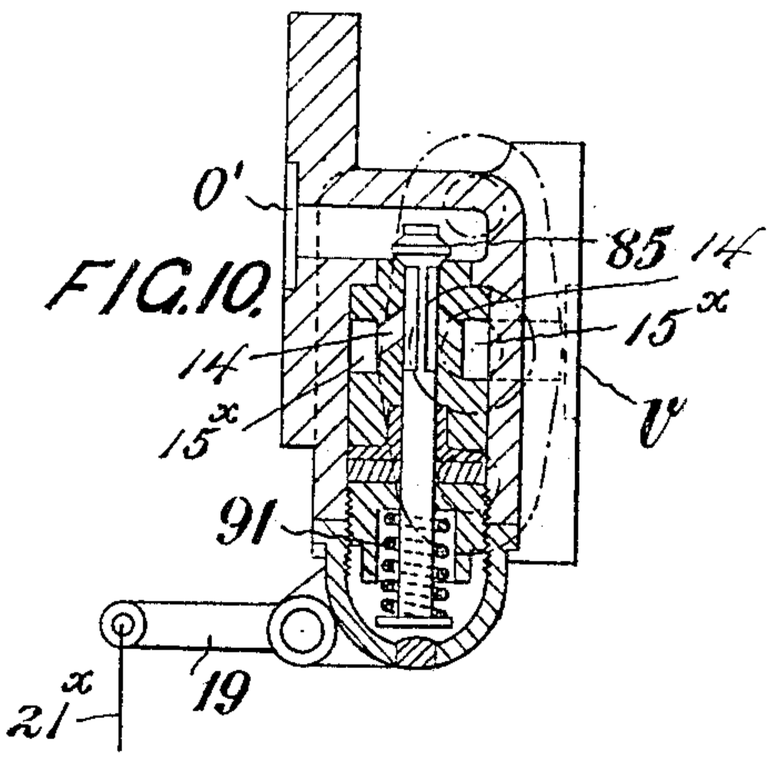


FIG. 11.

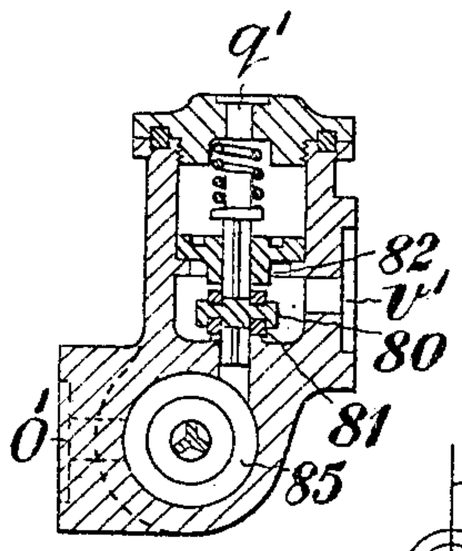


FIG. 12.

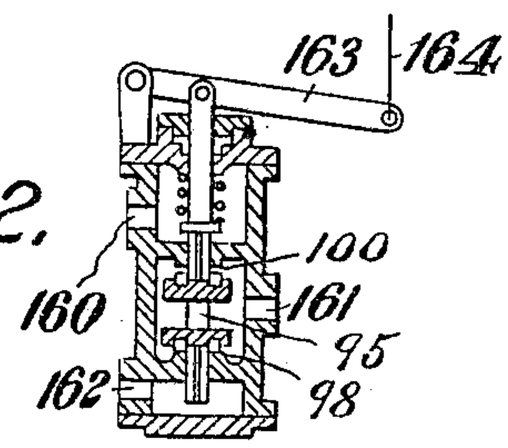
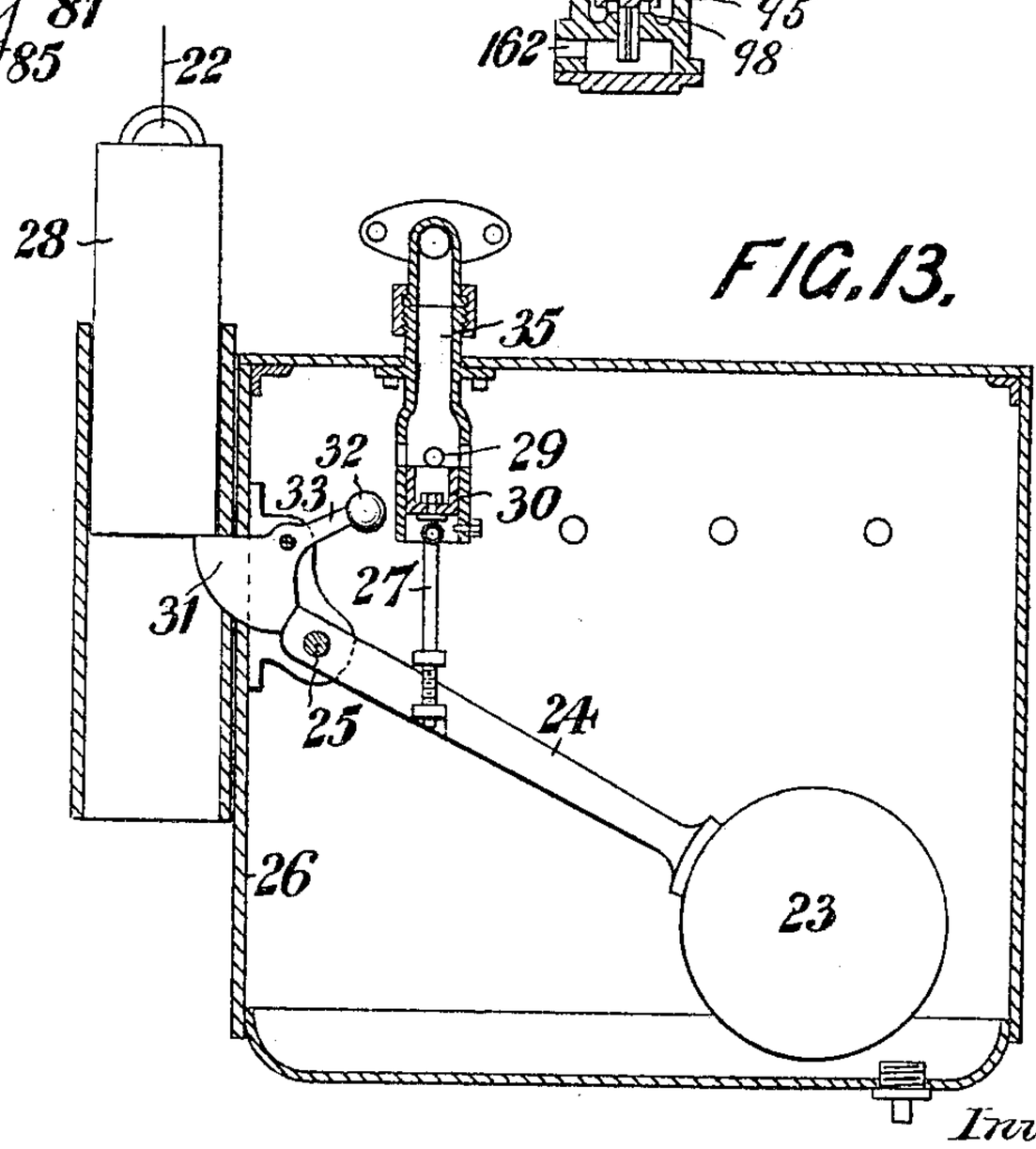


FIG. 13.



Witnesses.

Harry L. Amer.

B. Sommers

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ANDREW B. GRAHAM CO. PHOTO LITHOGRAPHERS, WASHINGTON D. C.

No. 799,089. PATENTED SEPT. 12, 1905.

G. C. RALSTON.

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7 SHEETS—SHEET 6.

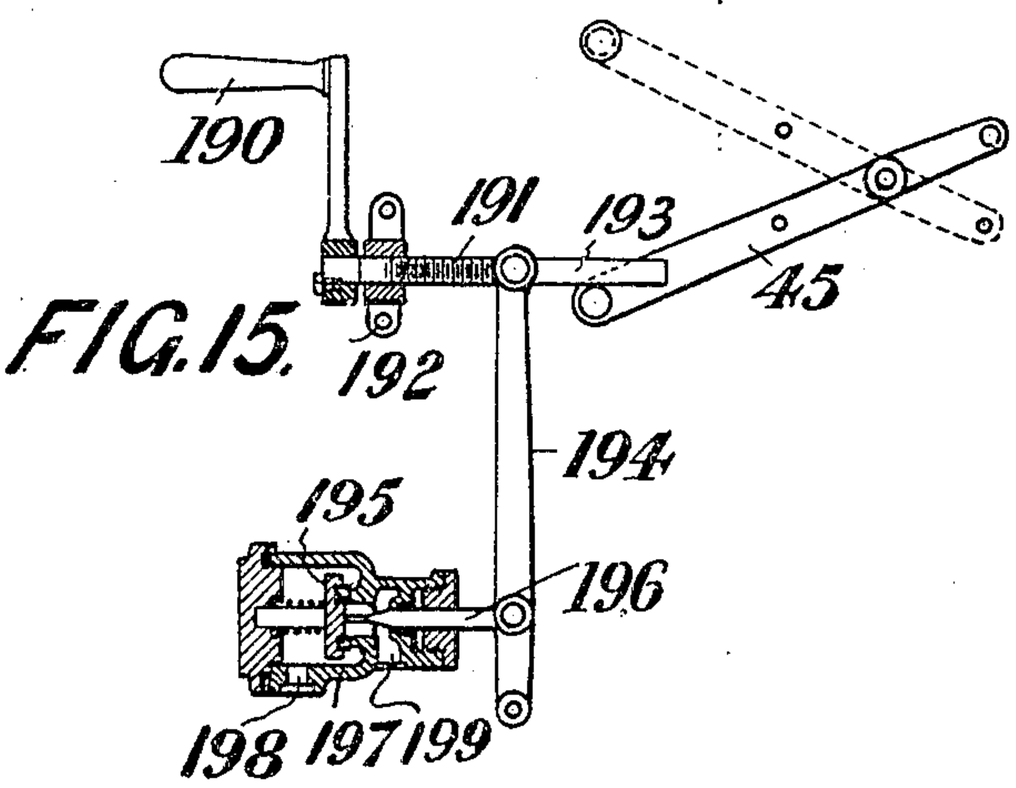

FIG. 15.

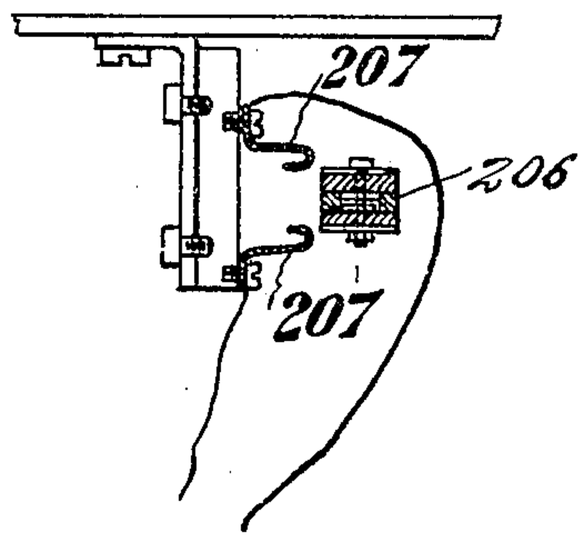

FIG. 16.

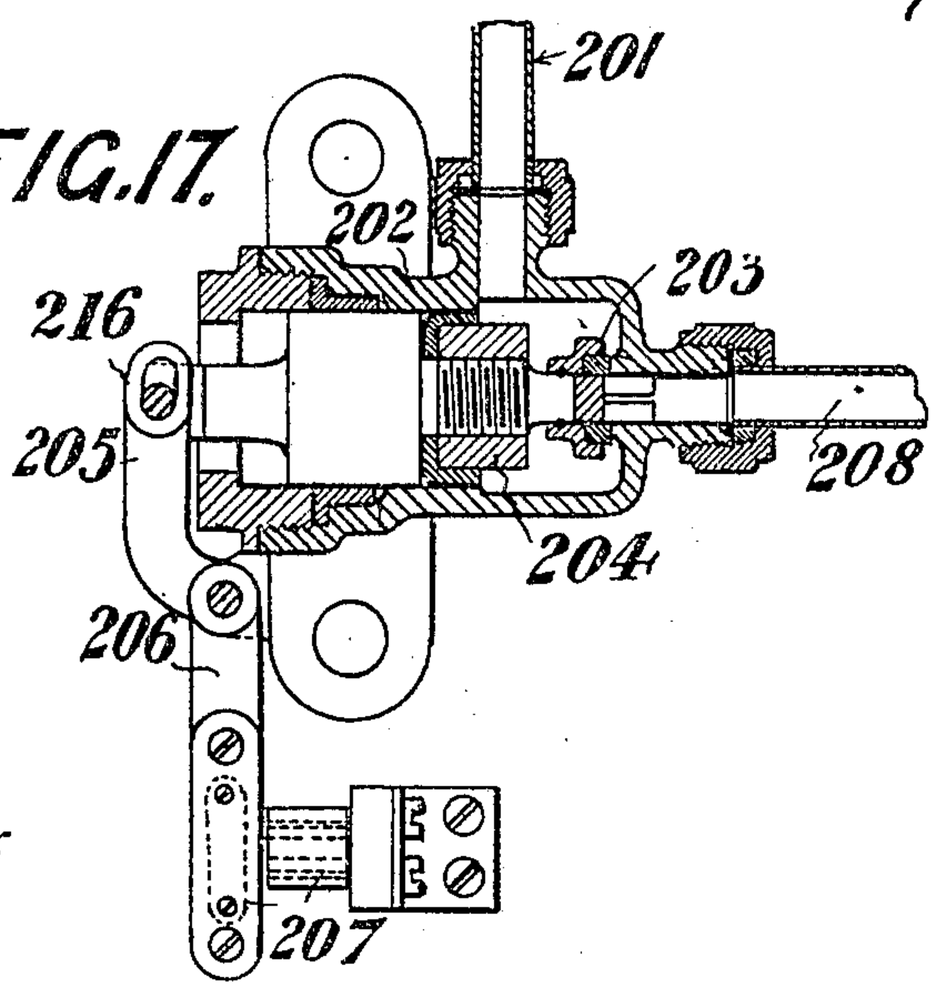

FIG. 17.

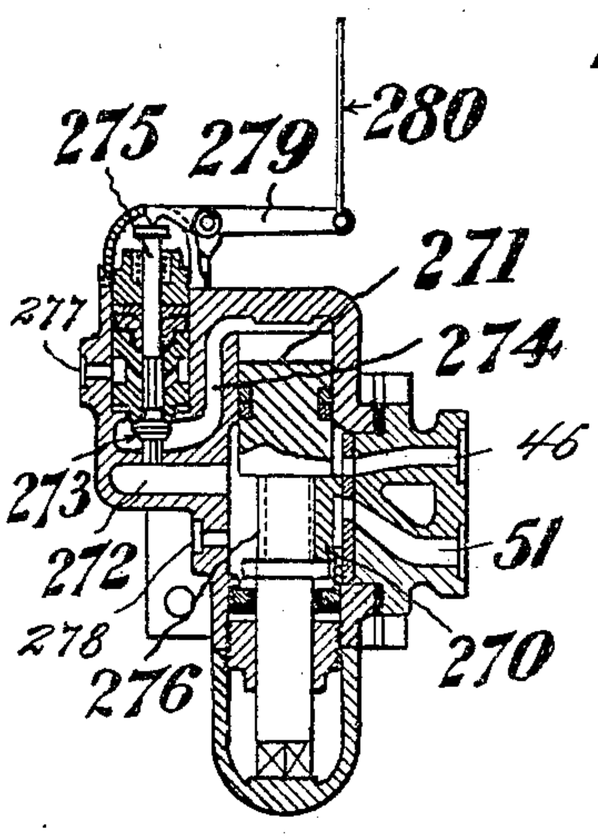

FIG. 14.

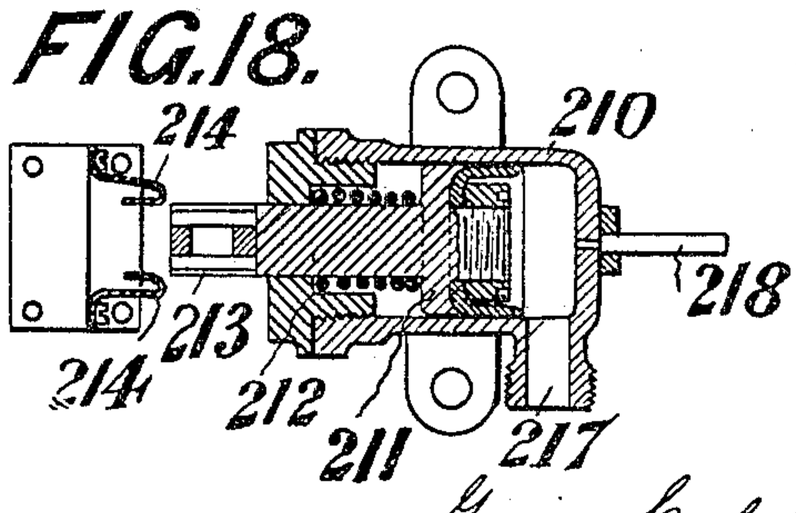

FIG. 18.

Witnesses:
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B. F. Sommers

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Attys

No. 799,089. PATENTED SEPT. 12, 1905.

G. C. RALSTON.

HYDRAULIC MECHANISM FOR OPERATING BULKHEAD DOORS.

APPLICATION FILED APR. 1, 1904.

7 SHEETS—SHEET 7.

FIG. 20.

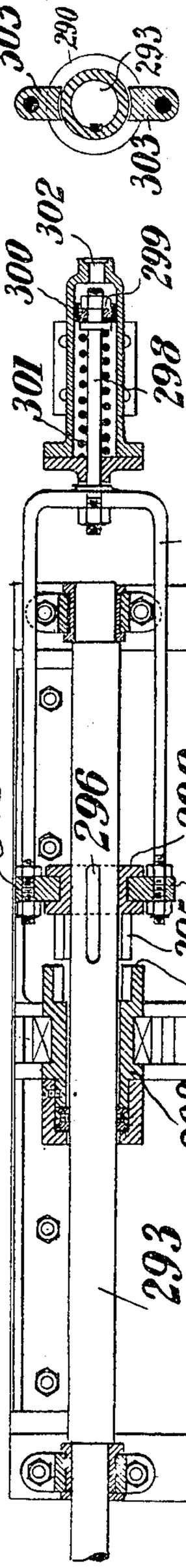

FIG. 19.

Witnesses:
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UNITED STATES PATENT OFFICE.

GAVIN CARLYLE RALSTON, OF LEWISHAM, ENGLAND.

HYDRAULIC MECHANISM FOR OPERATING BULKHEAD-DOORS.

No. 799,089. Specification of Letters Patent. Patented Sept. 12, 1905.

Application filed April 1, 1904. Serial No. 201,127.

To all whom it may concern:

Be it known that I, GAVIN CARLYLE RALSTON, engineer, a subject of the King of Great Britain and Ireland, residing at 159 Hither Green Lane, Lewisham, in the county of Kent, England, have invented certain new and useful Improvements in and Connected with Hydraulic Mechanism for Opening Bulkhead-Doors, of which the following is a specification.

The object of this invention is to provide improved simple and efficient means for simultaneously opening and for simultaneously closing all the bulkhead or compartment doors in a ship or other structure, while also affording facilities for momentarily opening any one door by operating a handle to allow any person inclosed in the compartment to escape therefrom, and so that the door closes itself after him or them, and whereby also each door after it along with all the other doors has been opened can be closed by the use of another handle.

Another object is to provide means for signaling or indicating from the bridge or other part of the ship just before all the doors are to be closed, so that the men below may stand clear of the doors; also, means for indicating whether any door has not been closed in order that the captain or person in charge may ascertain the cause and act accordingly; also, means for indicating when a door has been closed automatically by a float in the bilge being raised through the inrush of water into a compartment; also, means for automatically closing all doors in case of damage by shot or otherwise to the pressure-piping or the accumulators or pumps.

The invention is applicable to that described in the specification of my patent dated July 14, 1903, No. 733,745, where a special source of power is applied—viz., the steam-pressure in the boiler in connection with specially-constructed accumulators, but is also applicable in wholly hydraulic systems. The application in a combined steam and hydraulic system has, however, the great advantage that a single door can be opened for a few minutes even when the pumping to the accumulator from some cause has ceased, whereas that advantage is not obtained in connection with a wholly hydraulic system unless another pump is provided to supply what in a combined steam and hydraulic system would be the steam-connected end of the cylinder.

According to this present invention I employ door-operating cylinders with greatly-differing total fluid-pressure on opposite piston sides, the weaker side, being under constant pressure, tending to keep the door closed, and the other or stronger side having pressure admitted thereto for opening the door and released therefrom for closing, or, vice versa, the weaker side may be under constant pressure, tending to keep the door open. In connection therewith various valves are provided, including reversing-valve devices, one for each door, each device comprising a spring-loaded two-seated valve, a spring-loaded pressure-fluid-admitting valve, and a valve for exhaust.

In the accompanying drawings, Figure 1 is a diagram showing one mode of carrying the invention into effect according to what may be called "System No. 1." Fig. 2 is a diagram showing a second mode, or System No. 2. Fig. 3 is a diagram showing a third mode, or System No. 3. Fig. 4 is a diagram showing a fourth mode, or System No. 4. Fig. 5 is a general arrangement view according to System No. 1, where the door-cylinders have differential area with pressure constantly on the small end. Fig. 5^a is an enlarged detail vertical sectional view of the captain's valve. Fig. 6 is a detail view of a controlling or reversing valve and a bilge-valve. Fig. 7 is a sectional view of a door-cylinder. Figs. 8 and 9 show another form of reversing-valve. Figs. 10 and 11 show yet another form of same, and Fig. 12 a double-seated valve used in connection therewith. Fig. 13 is a sectional view of a bilge-float-tank device. Fig. 14 is a sectional view of a directing-valve. Fig. 15 shows a lever-handle with locking device in connection with signaling devices, and Figs. 16, 17, and 18 show details of the signaling devices. Figs. 19 and 20 show a clutch device for the automatic closing of a vertically-moving door in case of damage to the piping, the accumulator, or the door-cylinders.

In Fig. 1 the accumulator is indicated by a high-pressure hydraulic cylinder a, which communicates with the pressure-main p and is supplied with pressure, say, at five hundred pounds pressure per square inch from pumps p', that are supplied with water from a tank p^2 and driven by steam-cylinders p^3 and a low-pressure cylinder a', which by the pipe $h\,s$ communicates with the steam-boiler under a pressure of, say, two hundred pounds per square inch. The piston in the small end g of the door-cylinder is at all times exposed to

the five hundred pounds pressure in the pressure-main p, while the large end f is charged with that pressure when the door or doors are to be opened and is exhausted when the door or doors are to be closed, or, vice versa, charged with pressure for opening and exhausted for closing. r is a reversing-main, and 69 a reversing-valve, the action of which will be fully described farther on. e m is the exhaust-main. The areas of the door-cylinders are such that the end f has about double the total pressure of the end g. p^4 is a relief-valve for the purpose of preventing the pressure from rising above a predetermined limit.

In Fig. 2 the small cylinder a of the accumulator is supplied with water under, say, five hundred pounds pressure through a high-pressure main h p from pumps p', while the large cylinder a' of the accumulator is by the pipe h s in communication with the steam-boiler under, say, two hundred pounds pressure. l p is a low-pressure main, which is supplied from a pump $p'^{\times}$ with pressure of, say, two hundred and fifty pounds per square inch and which communicates constantly with the low-pressure ends of the door-cylinders, while the high-pressure ends of the door-cylinders are supplied with high pressure from the high-pressure main h p. p^4 is a relief-valve to prevent the pressure rising above a predetermined limit.

In Fig. 3 the door-cylinder end s g communicates constantly with the steam-pipe s p from the boiler, while the other end f is supplied by the pressure-main p from the hydraulic cylinder a of the accumulator at, say, five hundred pounds pressure. The cylinder a' of the accumulator communicates constantly by the pipe h s with the boiler under a pressure of, say, two hundred pounds per square inch. r is the reversing-main. p^4 is a relief-valve.

In Fig. 4 the steam-pressure is used to close the doors, and separate accumulators will then not be wanted. The end s g of the door-cylinder communicates constantly by the pipe s p with the boiler at, say, two hundred pounds pressure and serves to close the door, while the end f of the cylinder is supplied with hydraulic pressure at, say, five hundred pounds by the pressure-main p from the pump p'. r is the reversing-main. p^4 is a relief-valve.

Referring next to Fig. 5, which shows an arrangement according to what I call "System No. 1," (illustrated by the diagram Fig. 1,) the parts being in the position that they occupy when the doors are closed, the accumulator is here shown with a small high-pressure hydraulic cylinder a, which is supplied with pressure by the pipe 36 from a pump at, say, five hundred pounds pressure per square inch, and with a large low-pressure cylinder a', which by the pipe h s communicates with a branch from the boiler-feed-pump delivery-pipe, and thus also with the boiler, all in the same manner as described in my patent specification No. 733,745, so that the feed-water and not the steam comes in contact with the packings in the accumulator, or the form of the accumulator may be that shown in Fig. 11 of that patent. p is the pressure-main, and r a reversing-main, both passing through all the bulkhead-compartments. The cylinders are connected by rods d and have rams c and c', respectively. The cylinder a serves to close the bulkhead-doors. The reversing-main can in this system be of small diameter. The pressure of the steam in the boiler forms, as described in my aforesaid specification, a store of power available for emergencies and whereof any man inclosed behind a closed bulkhead-door can avail himself, so as to open the door and escape, the door closing itself after him. e is the bulkhead-door, worked by wheel-gearing from the cylinders f g. (Shown in detail in Fig. 7.) It will be observed that a considerable saving and simplification in piping is effected as compared with Fig. 14 of the aforesaid patent, inasmuch as I now use only one pipe from the bridge to the door instead of two, and the number of small pipes leading from the mains to the reversing-valve is greatly reduced; but a further saving in piping may, as here shown in Fig. 5, be effected by placing the captain's valve 40 below decks at or near the main line of pressure-piping p and operating it from the bridge by wire halyards or rods 43 and 44. This directing or captain's valve, to be operated by the captain or other person in charge on the bridge, may, as shown, be an ordinary slide-valve 40, in connection with a pipe 38 to the pressure-main p and by branch o to the reversing-valve in the box 90, presently to be referred to, a pipe 46, leading to the controlling or reversing main r, and an exhaust-pipe 51, leading to a cistern 53. The slide-valve works over ports to the pipes 46 and 51. The hydraulic pressure is always on the small area or piston g, and pressure is admitted to and released from the large area or piston f. As the exhaust is normally taken through the reversing-main r to the bridge or other central station, no separate exhaust-main is required, and accordingly the aforesaid cistern 53 is placed immediately under the pipe 51 from the directing-valve 40 on the bridge, and the hydraulic pump draws therefrom by the pipe 54. The door-cylinder may be of the form shown in Fig. 7, where the two pistons are united by a toothed rack h, which engages with a pinion i, which by usual tooth-wheel gearing transmits motion to the tooth-rack 291 on the door e.

The casing 90 of the reversing-valve (shown clearly in Fig. 6) contains a pressure-fluid-admitting valve 85, which receives its supply from the pipe and opening o and is normally kept on its seat by a spring 91. The lever 19, which by a wire cord $21^{\times}$ is connected to a hand-

lever 21 at the door, serves to open it when it is required to open the door from below. The fulcrum-spindle of the lever 21 carries a similar lever on the other side of the bulkhead. 92, Fig. 6, is a double valve, which can seat itself either on the seat 81 or the seat 82, but is normally kept on the former by a spring 93. The opening and pipe *v* connect with the large end *f* of the cylinder. The opening 68 connects by a pipe and through an exhaust-valve casing 105 (or it might be called a "bilge-valve casing") with the pipe *q*, coming from the reversing-main *r*. In the casing 105 there is a double valve 95, which can seat itself either on the seat 98 or the seat 100, but normally is kept on the former by a spring 102. The exhaust-pipe 99 leads to the bilge. To the spindle of the valve 95 is connected a lever 96, which by pulling a cord 22 can be operated so as to bring the valve onto its seat 100, and thereby close the door.

In the bilge of each compartment I provide a perforated cistern, such as 26, Figs. 5 and 13, and provide therein a float 23 on one end of a lever 24, which at the other end is provided with a catch 31, that normally upholds a weight 28, which by the cord 22 is connected to the lever 96 of the bilge or exhaust valve just named. 33 is a handle with weight for automatically resetting the catch after it has released the weight, and thereby pulled the valve 95 onto its seat 100. The falling weight insures a more certain and powerful action than the arrangements heretofore proposed, where a little dirt settling on the bilge float valve or seat may cause a leak, so that the door gradually opens again; but I may also in the cistern 26 provide a pipe 35, which leads to an adjoining bulkhead-compartment. This latter might advantageously be a coal-bunker compartment, where it would not be convenient to fit a perforated bilge-float cistern. In the lower part of the pipe 35 is fitted a piston 30, which by a rod 27 is connected to the float-lever 24. A hole 29 is provided in the pipe 35. If there is an inrush of water in the compartment, the cistern 26 will fill and the float 23 rise, and if there is an inrush of water in the adjoining or coal-bunker compartment it will, through the hole 29, enter the cistern 26 and also raise the float, whereby the piston 30 will cover the hole or holes 29 and prevent further entry of water from the pipe 35 to the cistern 26 and its bulkhead-compartment.

The action of the arrangement Fig. 6 is as follows: First, to open the doors from the bridge, the pressure must be put into the reversing-main *r*, and for this purpose the lever 45 is depressed, whereby pressure fluid from the main *p* enters the main *r* by the pipe 46 and thence through *q* to the reversing-valve by way of pipe *q*, port *q'*, seat 100, opening 101, pipe 68, seat 82, and pipe *v* to the large end *f* of cylinder and overcoming the smaller total pressure in the cylinder end *g*; second, to close the doors from the bridge, the reversing-main *r* is exhausted through pipes 46 51, and for this purpose the lever 45 is raised to the position shown, whereby the large end *f* of the cylinder is exhausted through the pipe *v*, seat 82, pipe 68, opening 101, seat 100, port *q'*, pipes *q*, *r*, 46, and 51, into the tank 53, while the constant pressure in the small end serves to close the door; third, to open a door from below the valve 85 is lifted by handle 21, thus pulling cord $21^{\times}$ and putting the pressure into large end *f* of cylinder by way of pipe *o*, valve 85, passages 14, annular chamber $15^{\times}$, the pressure closing the valve 92 onto its seat 82 and pipe *v*; fourth, to close the door from below by pull of cord 22 and lever 96, closing the valve 95 onto its seat 100, cutting off the pressure from the reversing-mains *r* and opening to the pipe 99, so as to exhaust the large end *f* of cylinder by way of pipe *v*, seat 82, pipe 68, port 101, seat 98, and pipe 99; fifth, when the bilge-float comes into action by a leak the cord 22 is pulled, moving the lever 96, and the double valve 95 is closed upon its seat 100, so that the pressure is cut off from the reversing-main and the large end *f* of the cylinder is exhausted through *v*, 82, 68, 101, and 99, as above described.

Instead of the reversing-valve Fig. 6 I may use the one shown in Figs. 8 and 9, where the pressure-valve 15 and the double-seated exhaust-valve 6 are arranged side by side in the same casing 13, which also contains a double-seated spring-loaded valve 10, answering to the double-seated valve 92 in Fig. 6 and which can seat itself on the seat 11 or on the seat 12, being normally held on the former by a spring, as shown. The valve 15 is kept down on its lower seat by a spring 17; but the exhaust-valve 6 when lifted from its lower seat against the effort of its spring 17^{a} is pressed against its upper seat 4, thus cutting off the reversing-main from the pipe *v*. The valves 15 and 6 are lifted by levers 19 $19^{\times}$, respectively, the ends of which are shown in section in Fig. 8. The left-hand lever 19 is connected with the lever 21 at the door, and the right-hand lever $19^{\times}$ is connected with the bilge-float. The seat 4 leads to a passage 2, which by way of 1 and $13^{\times}$ and valve 10 can establish communication between the opening *v'* and the opening *o'*, which openings lead, respectively, to the pipe *v* and the pipe *o*. The normal position in Figs. 8 and 9 is as shown, where the valve 10 is on the seat 11, the large end *f* of cylinder being open and exhausting to the reversing-main *r* through *v v'*, 4 2 1, seat 12, *q r* 46 51, to tank 53, and in this position the door is closed. The action is the same as just described, viz: First, to open the doors from the bridge pressure is by the valve 40 admitted to the reversing-main *r*, which through the pipe *q* and passage *q'* shuts the valve 10 on its seat 11 and passes by seat 12, passages 1 2 4 *v'*, pipe *v*, and enters

the large cylinder end *f*, thus opening the door, because the pressure on the large piston area *f* overcomes that on the small area at *g*; second, to close from the bridge, the reversing-main *r* is exhausted and also the large end *f* of cylinder by way of *v v'* 4 2 1 12 *q*, whereby the door closes owing to the permanent pressure in the other end *g*; third, to open the door at the door, the valve 15 is lifted by raising the lever 19, and the pressure from the main *p* enters at *o'* and passes through valve 15, the passages 14 15×, seat 11, closing the valve 10 on its seat 12 and cutting off the exhaust of the reversing-main *r*, the pressure then passing through the passages 1 2 4 *v'* and pipe *v* to the large end *f* of cylinder, as in operation 1; fourth, the action of the bilge-float in closing the door is by pulling the cord 22, connected to the lever 19×, which operates the valve 6, the water escapes from the cylinder end *f* by *v v'* 5 6 6× to the exhaust; fifth, to close the door at the door, the valve 6 is lifted by means of the cord 22, connected to lever 19×, thus shutting off the pressure at the upper valve-seat 4. The large end *f* of cylinder then exhausts through pipe *v*, opening *v'*, the valve 6, and passage 5, and the door closes.

Another simple form of reversing-valve is shown in Figs. 10 and 11. The pressure-inlet *o* is in communication with the end *g* of the door-operating cylinder. The inlet *q'* from the reversing-main *r* is fitted with a spring-loaded valve 80, having seats 81 and 82, the former communicating with the under side of the pressure-valve 85, on the upper side of which the pressure from the main pressure-pipe *p* and branch *o* acts. The space between the valve-seats 81 and 82 communicates laterally by the pipe *v* and opening *v'* with the opening end *f* of the door-operating cylinder. The normal position of the reversing-valve is as shown—viz., the valve 85 closed to the pressure and the opening end *f* of the cylinder open to the exhaust through *v* and *q*; the door open. The valve 85 is normally kept closed by a spring 91. In connection with this valve device, Figs. 10 and 11, I use a double-seated spring-loaded valve 95, as shown in Fig. 12, where the opening 161 is between the two valve-seats 98 and 100 and is by a pipe connected with the opening *q'*, Fig. 11, the opening 160 connected by a pipe *q* with the reversing-main *r*, and the opening 162 connected by a pipe with the exhaust. The action of this arrangement is as follows: First, to open the doors from the bridge, pressure is admitted to the reversing-main *r*, which passing by pipe *q* to opening 160 closes the valve 95 onto its seat 98 and passes by passage 161 to opening *q'*, closes the valve 80 onto its seat 81, and passes through the opening *v'* and pipe *v* to the end *f* of cylinder, so as to open the door; second, to close the doors from the bridge, the reversing-main *r* and the large end *f* of cylinder are exhausted through the pipes and openings *v*, *v'*, 82, and *q'*, 161, 100, 160, *q*, and *r*, whereby the door will be closed, due to the permanent pressure in the small cylinder end *g*; third, to open the door at the door the valve 85 is lifted by the lever 19, and pressure will then pass from the pressure-pipes *p* and *o* to *v* by way of *o'*, valve 85, passages 14 15×, seat 81, the valve 80 closing on its upper seat 82 and cutting off the exhaust of the reversing-main *r*, the pressure then passing to the large end *f* of cylinder, as in 1; fourth, the action of the bilge-float is as just described, the float lifting the valve 95; fifth, to close the door at the door, the double-seated valve, Fig. 12, is operated by lever 163 and cord 164, which latter corresponds to cord 22, connected to weight 28, so that the valve closes upon its upper seat and cuts off the pressure of the reversing-main *r*, which is connected to the opening 160 and allows the large end *f* of the cylinder to exhaust through *v*, *v'*, *q'*, 161, and 162, whereby the door will be closed by the permanent pressure in the small end *g* of the cylinder.

Fig. 14 shows a valve which advantageously can take the place of the slide-valve 40, Fig. 5, the valve 40, with heavy hydraulic pressure pressing on the back of it, requiring some exertion of power to move it. Now for the purpose of lightening this labor I construct the slide-valve 270, that works over ports to the pipes 46 and 51, with a piston 271, the under side of which by a passage 272 communicates with the one side of a double-seated valve 273 and by a passage 274 with the other side of the valve. A spring tends to hold the valve in the raised position shown. The piston has a stem 276 on its lower side, so that an annular pressure area is thereby produced. Ports 277 and 278 connect with exhaust and with pressure-main *p*, respectively. The lever 279, which by wire rope 280 connects with the lever 45, Fig. 5, on the bridge, serves to depress the stem 275 of the double-seated valve 273, thus closing the passage 272 to the pressure-inlet 278 and connecting the passage 274 with the outlet 277 to the exhaust. The pressure on the annular area of the piston 271 moves the latter upward, the slide-valve thereby covering the port 46 and opening connection to the exhaust-port 51 and cutting off the pressure from the inlet 278. The controlling-main is thus exhausted through ports 46 and 51 to the tank 53, Fig. 5. In the position shown the controlling-main *r* is open to the pressure through pressure-inlet 278 and port 46.

In order to advise the men below when the bulkhead-doors have to be closed, so that no one shall be found in the doorways, the operating handle or wheel on the bridge is held in a locked position till a signal has been given to every compartment. Fig. 5 shows one such arrangement, the details of which

are illustrated by Figs. 15, 16, 17, and 18. Fig. 15 shows the position of parts when the doors are open, while Fig. 5 shows the position when the doors are closed. Before the officer on the bridge can move the handle 45, which is connected with the slide-valve 40, with the intention of closing all the doors he must first unwind a handle 190, Fig. 15, fixed on a screw-spindle 191, which works in screw-thread in a bracket 192, that is fixed to the bulkhead or other convenient part. The screw-spindle 191 has a prolongation or locking-bar 193, and when this is screwed so far to the left as to be free of the boss on the end of the handle 45 a lever 194, attached thereto, has opened a small valve 195 by its spindle 196. The valve 195 is inclosed in a casing 197, into which pressure is conducted from the main pressure-pipe *p* to the upper side of the valve by the inlet and pipe 198. When the valve is opened, the pressure passes to its under side and by the outlet and pipe 199 into a small main 200, which I call the "warning-bell" main and which runs the length of the compartments and in each has a branch 201, Figs. 5 and 17, to the closed end of a small cylinder 202, Fig. 17, arranged close to each bulkhead-door and fitted with a valve 203 on a piston 204, which at the open end of the cylinder is connected to one arm 205 of a double-armed lever, the other arm 206 forming a block (see Fig. 16) adapted to make contact with springs 207, these latter being in an electric circuit with a battery and electric alarm 149, shown at the door. When the officer on the bridge desires to close all the doors, he first opens the small valve 195 in the casing 197 to the small pipes 199, 200, and 201, whereby the pressure is admitted to the inner end of the aforesaid small cylinder 202, Fig. 17, near the door in each compartment, and depresses all the pistons 204, whereby the blocks 206 make contact with the springs 207, thus closing the circuit and setting all the bells ringing for the purpose of warning the men below to stand clear of the doorways. At the same time by the movement of the piston 204 the valves 203 are opened, thus admitting pressure from the pipe 201 to the pipes 208 and thence through the small main 209, which I call the "signal-main" and which also runs the length of the ship. A branch 217 from the main 209 leads to a cylinder 210, Figs. 5 and 18, on the bridge, the piston 211 of which is forced out against the spring 212. The block end 213 of the piston thus engages with the contacts 214, thereby closing a circuit on the bridge and ringing a bell 144 on the bridge. By moving the handle 190 for the signal-valve 195 the handle 45 is unlocked. After the lapse of a reasonable time—say half a minute, which, in fact, it takes to turn the screw 191—the captain closes all the doors by moving the handle 45 connected to the slide-valve 40. When the captain has again at some time opened all the doors by bringing the handle 45 back to its original position, he should bring the locking-bar 193 of the screw-spindle 191 back into engagement with the boss on the end of the handle 45. As each door closes a tappet 215 on the door *e*, Fig. 5, comes in contact with the outer end 216 of the piston 204 and forces the piston back against the pressure, thus moving the arm 206 of the double-armed lever 205 206 away from the spring-contacts 207 and breaking the circuit, so that the bell 149 at the door ceases to ring. By the same action the valve 203 is closed and the pressure from the pipes 201 200 is prevented from passing by the pipes 208 and the return signal-main 209 to the cylinder 210 on the bridge. The spring 212 is thus able to force back the piston 211, withdraw the block 213 from between the spring-contacts 214, and break the circuit, so that the bell 144 on the bridge ceases to ring; but as long as a door remains open the spring 212 will not be able to force back the piston 211. A small branch pipe 218 serves to relieve the water on the back of the piston 211. The supply-pipe 201 is connected by a pipe 156 to a casing 154, containing a small automatic bilge float-valve 153, to the under side of which the pipe 156 is connected and the upper side of which by a pipe 153^a is connected to the pressure-main *p*, so that on the rise of water in the compartment the float 155 will be raised and will, by means of the lever 154^b and rod 154^a, raise the valve 153 from its seating and allow the water from the pressure-main *p* and pipe 153^a to pass by the pipes 156 and 201 to the back of the piston 204 in the valve 202 and will depress it and cause it to ring the bell at the door as described, exactly as if the captain were about to close the door, and will pass water to the return signal-main 209 to ring the bell, as before described. A non-return valve 157 is fitted in the pipe 201 to prevent the alarms for the other doors from ringing. Thus the compartment where in-rush of water has taken place is clearly indicated without the necessity for close examination of various parts of the ship. If the alarm on the bridge continues ringing, it is a signal that the door has not been closed, say, because of being jammed; but should it commence to ring and then cease ringing in a very short space of time, the captain on the bridge not having moved the bridge-valve to close the door, he would conclude that there was water in the compartment and that the door had been automatically shut and that thereby the bell had been set ringing. If the small bilge float-valve 153 is placed at a lower level than the float 23 for closing the door, an audible signal will be given by the alarm before the float comes into operation.

Another object of this invention is to insure that all the doors shall be automatically closed in case the main pressure-pipe *p* or any

other part of the pressure-pipe system or accumulators or pumps are damaged or carried away in battle or collision. For this purpose means are provided at each door for disconnecting the operating-gear. Figs. 19 and 20 show an arrangement adapted for vertically moving bulkhead-doors, a clutch 290 being provided for disconnecting the operating-gear. The rack 291 on the door *e* engages with a pinion 292 on a cross-shaft 293, not fixed thereon, as in Fig. 5, but free to rotate thereon. This pinion is fitted with clutch-teeth 294, and the clutch 290 has corresponding teeth 295. This clutch slides on a feather 296 on the cross-shaft 293, and is, by a link 297 with blocks 303 and rod 298, connected with a piston 299 in a cylinder 300, a spring 301 on the piston tending to keep the clutch out of gear with the pinion clutch-teeth 294, while the pressure entering from the main *p* by the inlet 302 normally keeps the clutch in gear and the spring 301 compressed. When the pressure from any accidental cause disappears, the spring 301 forces the piston 299 back and disconnects or uncouples the operating gear or clutch. The door then is free to fall and close by its own weight. Where, as in the case of horizontally-sliding doors, which are generally used in ships of war, or where sufficient head-room is not available, the weight of the vertically-sliding doors cannot be availed of for closing in case of accidental disappearance of the pressure, I close the doors by a store of steam-pressure, as described in my Patent Specification No. 733,745, said pressure then coming into operation automatically.

Having thus described my invention, what I claim as new therein, and desire to secure by Letters Patent, is—

1. In a system for operating bulkhead and other doors, the combination for each door, of two cylinders, pistons therein with greatly-differing total piston-pressures, connections between the doors and the pistons, a pressure-main, pipes therefrom for constant communication with all the weaker cylinders, a reversing-main, a directing-valve common to both mains, means for operating said valve from a central station, pipes between said valve and the pressure and reversing mains, an exhaust, said directing-valve adapted to admit fluid-pressure from the pressure-main to the reversing-main and thence to all the stronger cylinders, or from the latter to the reversing-main and thence to the exhaust, for the purpose of simultaneously opening or closing all the doors, substantially as set forth.

2. In a system for operating bulkhead and other doors, the combination for each door, of two cylinders, pistons therein with greatly-differing total piston-pressures, connections between the doors and the pistons, a pressure-main, pipes therefrom for constant communication with all the weaker cylinders, a reversing-main, a directing-valve common to both mains, means for operating it from a central station, pipes between the said valve and the pressure and reversing mains, an exhaust, local valve mechanism provided with a loaded pressure-admitting valve and a loaded double-seated automatic valve, means at each door for operating the former valve, said local valve mechanism interposed by pipe connections between the pressure-main and the reversing-main, said directing-valve mechanism constructed to close or open all the doors from the central station, and said local valve mechanism constructed to open a single door from below after all the doors have been closed, the pressure-fluid in the former case flowing freely through the local valve-casing but not through the valves themselves, substantially as set forth.

3. In a system for operating bulkhead and other doors, the combination for each door, of two cylinders, pistons therein with greatly-differing total piston-pressures, connections between the doors and the pistons, a pressure-main, pipes therefrom for constant communication with all the weaker cylinders, a reversing-main, a directing-valve common to both mains, means for operating said valve from a central station, pipes between the said valve and the pressure and reversing mains, an exhaust, local valve mechanism provided with a loaded pressure-admitting valve and a loaded automatic valve, means at said door for operating the same, said local valve device interposed by pipe connections between the pressure-main and the reversing-main connection to the stronger cylinder, a double-seated valve, pipes from its casing to the local valve mechanism and to the reversing-main, a pipe connection from said valve to the bilge, a bilge float device, and connections between it and the double-seated valve, for the purpose of automatically operating the local valve device to close the door in case of inrush of water into the compartment, substantially as set forth.

4. In a system for operating bulkhead and other doors, the combination for each door, of two cylinders, pistons therein with greatly-differing total piston-pressures, connections between the doors and the pistons, a pressure-main, pipes therefrom for constant communication with all the weaker cylinders, a reversing-main, a directing-valve common to both mains, means for operating said valve from a central station, pipes between the said valve and the pressure and reversing mains, an exhaust from the stronger cylinders, local valve mechanism comprising a casing fitted with a spring-loaded two-seated automatic valve past which the fluid-pressure passes freely to and from the stronger cylinder when the doors are operated from the central station, said valve-casing also fitted with a spring-loaded valve for admitting fluid-pressure from the

pressure-main, a valve for exhausting the stronger cylinder, while excluding access from the reversing-main, the said two last-named valves being only operated when a door is to be separately closed or opened, means for manually operating the said valves at the door, the said local valve mechanism being interposed by pipe connections between the pressure-main, the reversing-main and the stronger cylinder, substantially as set forth.

5. In a system for operating bulkhead and other doors, the combination with door-operating cylinders, fluid-pressure and reversing mains, and pipe connections between the cylinders and the mains, of a directing-valve operated at a central station, pipes for connecting it with said mains and with an exhaust, means for locking said valve and for slowly performing the unlocking operation, electrical and hydraulic means for warning the men within the compartments to stand clear of the doorways or to pass out by them, and electrical and hydraulic means for announcing at the central station when all the doors have been closed, substantially as set forth.

6. In a system for operating bulkhead and other doors, the combination with door-operating cylinders, fluid-pressure and reversing mains, and pipe connections between the cylinders and the mains, of a directing-valve operated at a central station, pipes for connecting it with said mains and with an exhaust, a lever connected to the spindle of said valve, a lever-handle at the central station with suitable connections between the two for operating the directing-valve from the central station, a screwed rotatable spindle for locking and unlocking said lever-handle, an unlocking or signal valve, a connection from said spindle to the spindle of the unlocking or signal valve, a pipe from the upper side of said valve to the pressure-main, a pipe from the under side of said valve to a warning-bell main pipe, a return-signal pipe, a piston-actuated valve at the door, a pipe between the return signal-pipe and the said valve, a contact-block connected to the spindle of the said valve, spring-contacts to act therewith, an electric circuit wherein said contacts are inserted, an alarm in said circuit, the door, a tappet thereon for actuating the piston at the door, a spring-loaded piston at the central station, a contact on the spindle of the said valve, spring-contacts to act therewith, an electric bell-circuit wherein they are inserted, said bell at the central station, and a pipe from the cylinder of said piston to the return signal-pipe, substantially as set forth.

7. In a system for operating bulkhead and other doors, the combination with door-operating cylinders, fluid-pressure and reversing mains, and pipe connections between the said cylinders and mains, a common directing-valve, means for operating same at a central station, said valve connected with said mains and with an exhaust-pipe, local valve mechanism provided with a loaded pressure-admitting valve and a loaded double-seated, automatic valve, means for operating the former valve, said valve mechanism connected with said mains, said door-operating cylinder and the exhaust, of a bilge float-lever pivoted in a perforated cistern and provided with a catch device, a valve connected with the local valve mechanism, the reversing-main and an exhaust, a lever for operating said valve, a suspended weight connected to the said lever and resting on the catch device, which is tripped, when by inrush of water into the cistern the float end of the float-lever rises, thus releasing the weight which as it descends operates the valve connected thereto to close the door, substantially as set forth.

8. In a system for operating bulkhead and other doors, the combination with door-operating cylinders, fluid-pressure and reversing mains, a common directing-valve, means for operating same at a central station, said valve connected with said mains and with an exhaust-pipe, local valve mechanism provided with a loaded pressure-admitting valve and a loaded double-seated automatic valve, means at each door for operating the former valve, said valve mechanism connected with the door, the mains and the exhaust, of a bilge float-lever pivoted in a perforated cistern and provided with an automatically-resetting catch device, a valve connected with the local valve mechanism, the reversing-main and an exhaust, a lever for operating said valve, a suspended weight connected to the said lever and resting on the catch device, a pipe connecting the cistern with an adjoining compartment, said pipe perforated and provided in the cistern with a piston connected to the float-lever and adapted to cover the perforation in the said pipe when the float rises, so that when the water rises in the adjoining compartment it enters the cistern and raises the float, thus releasing the weight which as it descends operates the valve connected therewith to close the door, while the piston in its ascent covers the perforation in the pipe and thus cuts off further entry of water from the adjoining compartment, substantially as set forth.

9. In a system for operating bulkhead and other doors, the combination with door-operating cylinders, fluid-pressure and reversing mains, and pipe connections between the cylinders and mains, of a directing-valve device comprising a slide-valve adapted to work over ports to a reversing-main and an exhaust, a differential piston to which the slide-valve is attached, a double-seated valve, a passage connecting the ends of the differential piston-cylinder and controlled by the double-seated valve, a pipe connection from one side of the double-seated valve to the exhaust, a pipe connection from the fluid-pressure to the slide-

valve casing, and means for operating the double-seated valve by hand, thereby reversing the piston and slide-valve in one direction or the other by fluid-pressure, substantially as described.

10. In a bulkhead and other door operating system, the combination with fluid-pressure and reversing mains, and the bulkhead-doors, of means for operating and controlling the same, said means comprising provisions in virtue of which in case of disruption of the hydraulic-pipe connections the doors become disconnected and close automatically, substantially as set forth.

11. In a bulkhead and other door operating system, the combination with fluid-pressure and reversing mains, and the bulkhead-doors, of means for operating and controlling the same, said means comprising clutch-gear at the doors and a spring-loaded hydraulic piston between said clutch-gear and the hydraulic-pipe system, the pressure in which normally acts on the piston so as to keep the clutch connected with the door, but which when a disruption takes place in the hydraulic-pipe system disappears, whereby the piston is driven in the opposite direction by the spring and disconnects the clutch, so that the door drops and closes by its own weight, substantially as set forth.

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Witnesses:
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