(No Model.) 5 Sheets—Sheet 1.

C. E. BERGMAN.

FLUID PRESSURE STEERING GEAR.

No. 588,946. Patented Aug. 31, 1897.

Fig. 1.

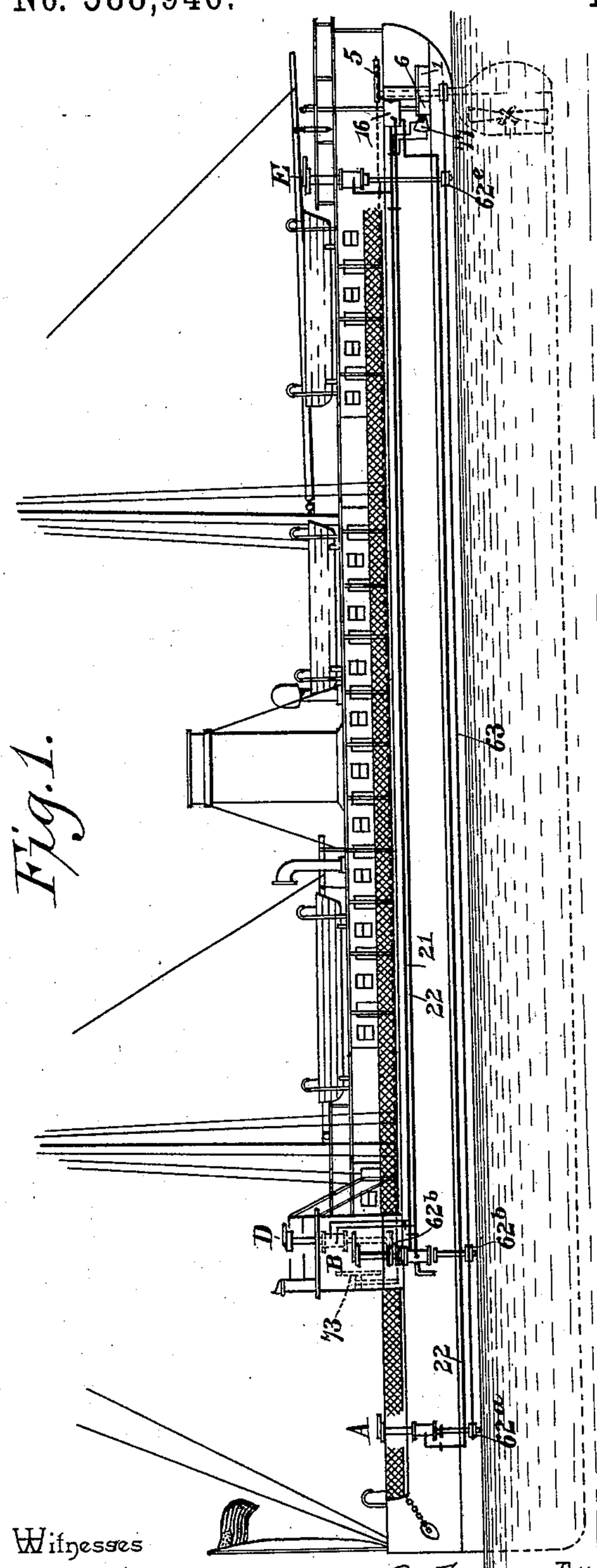
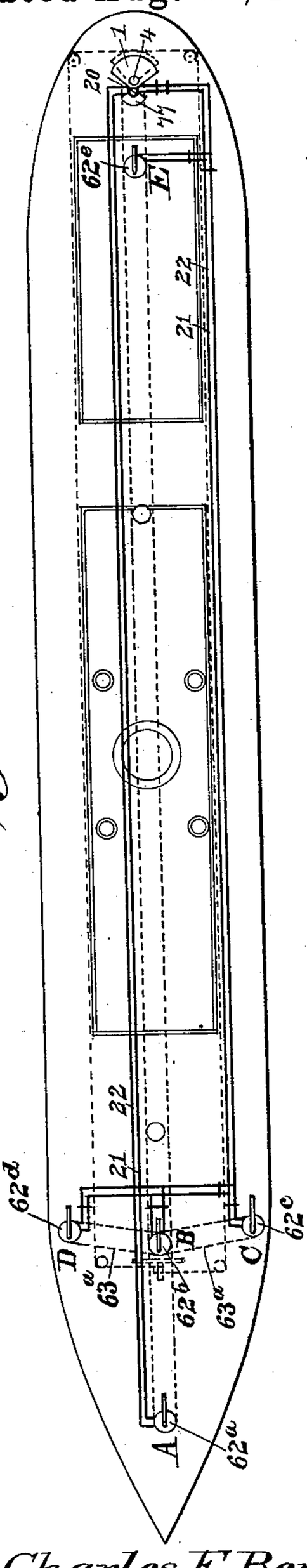


Fig. 2.



Inventor

Witnesses

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C. E. BERGMAN.

FLUID PRESSURE STEERING GEAR.

No. 588,946. Patented Aug. 31, 1897.

Fig. 3.

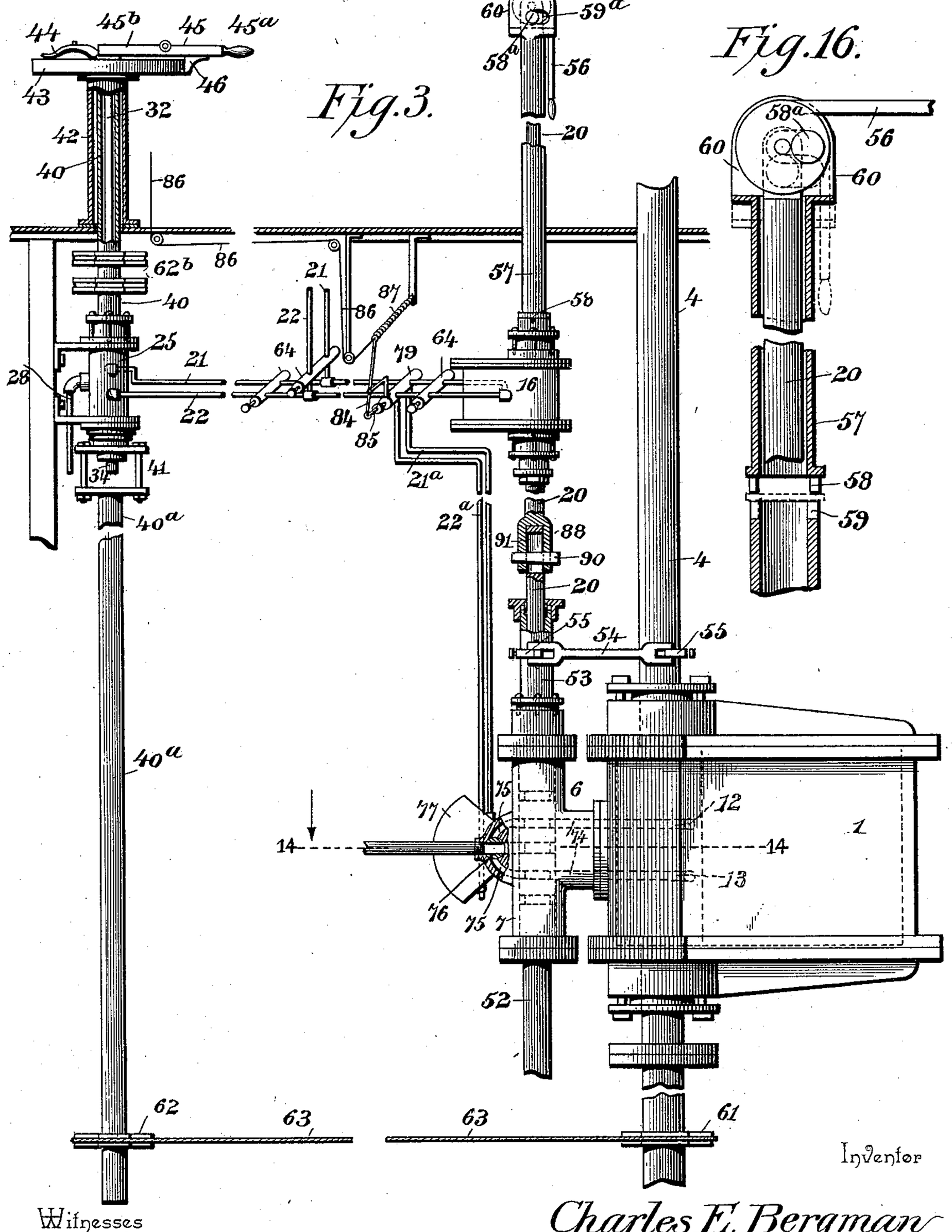

Fig. 16.

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FLUID PRESSURE STEERING GEAR.

No. 588,946. Patented Aug. 31, 1897.

Fig. 1.

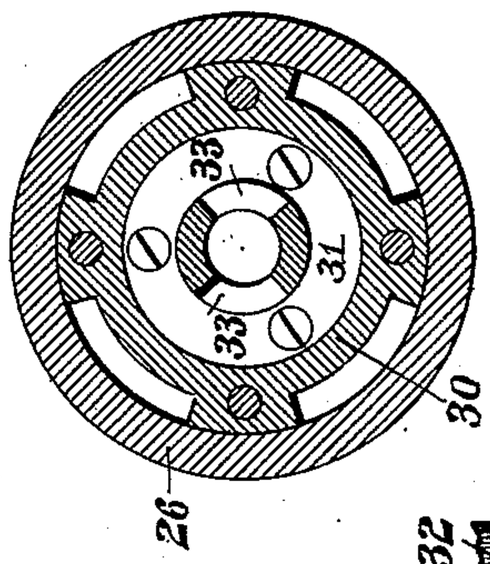


Fig. 9.

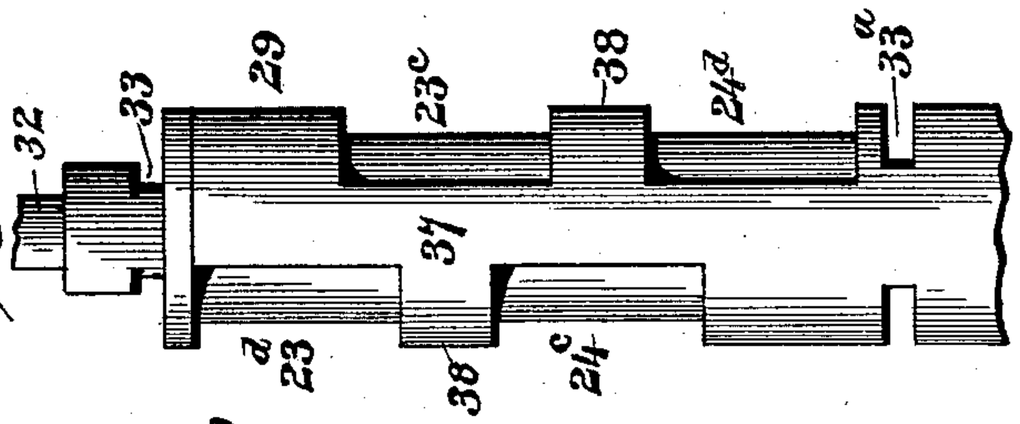


Fig. 6.

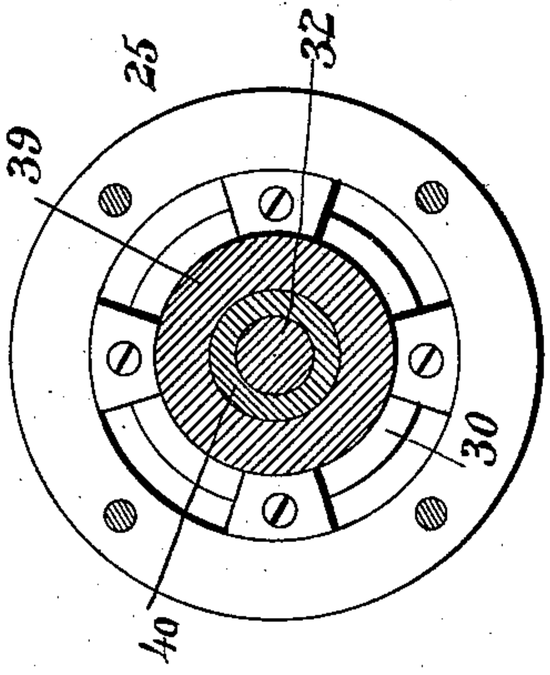


Fig. 8.

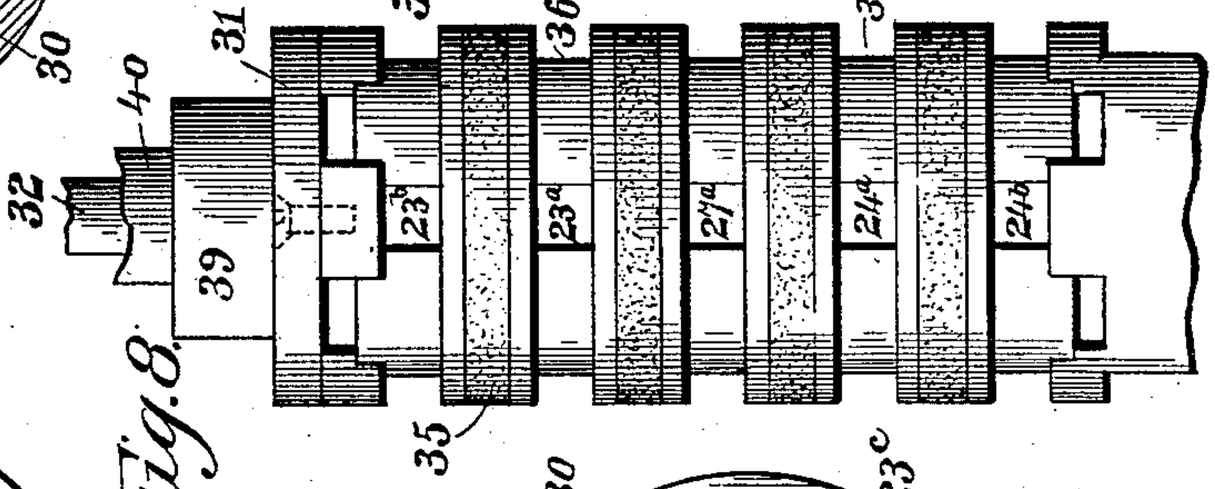


Fig. 5.

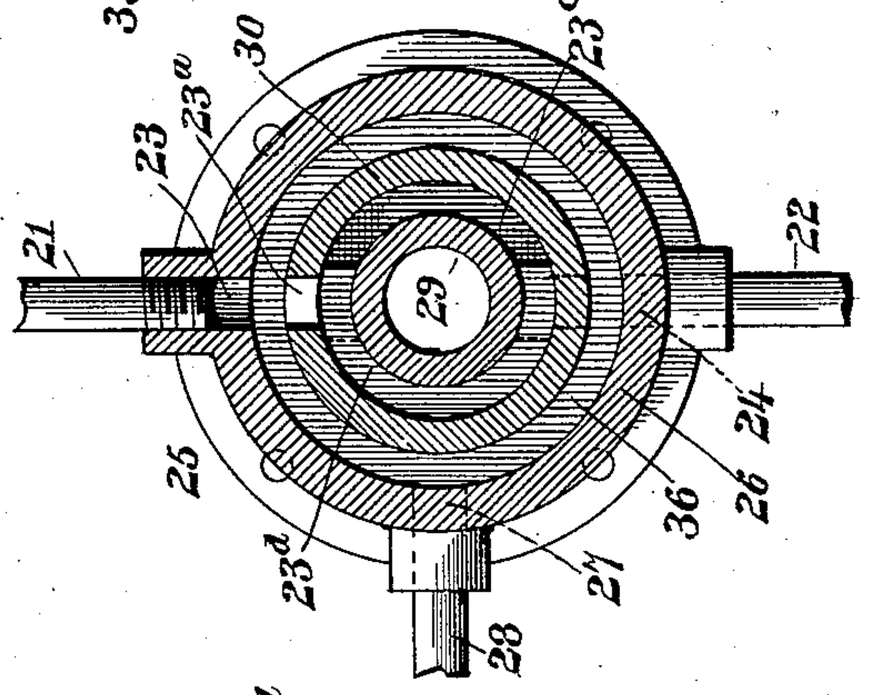
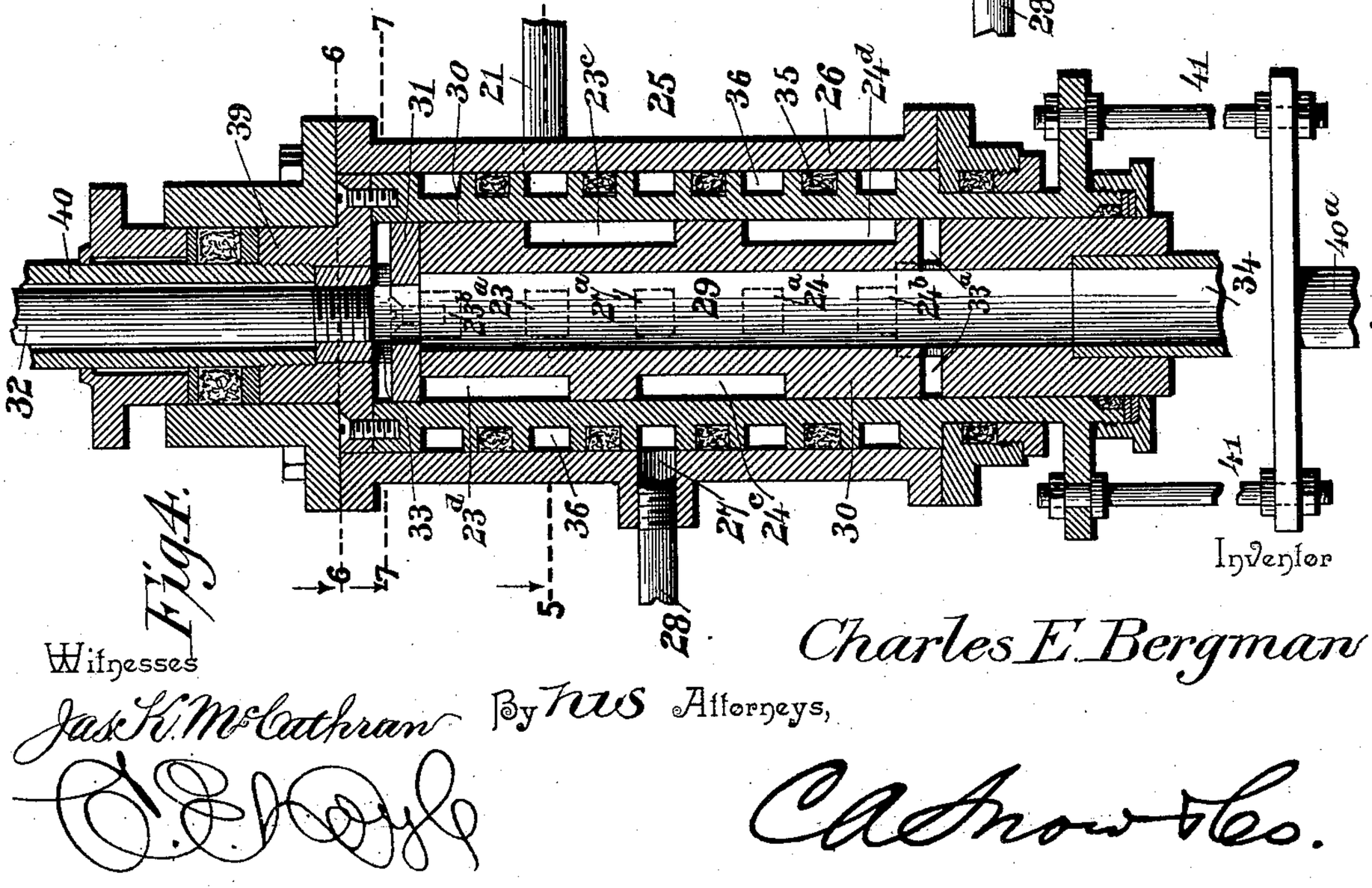


Fig. 4.



Witnesses

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C. E. BERGMAN.

FLUID PRESSURE STEERING GEAR.

No. 588,946. Patented Aug. 31, 1897.

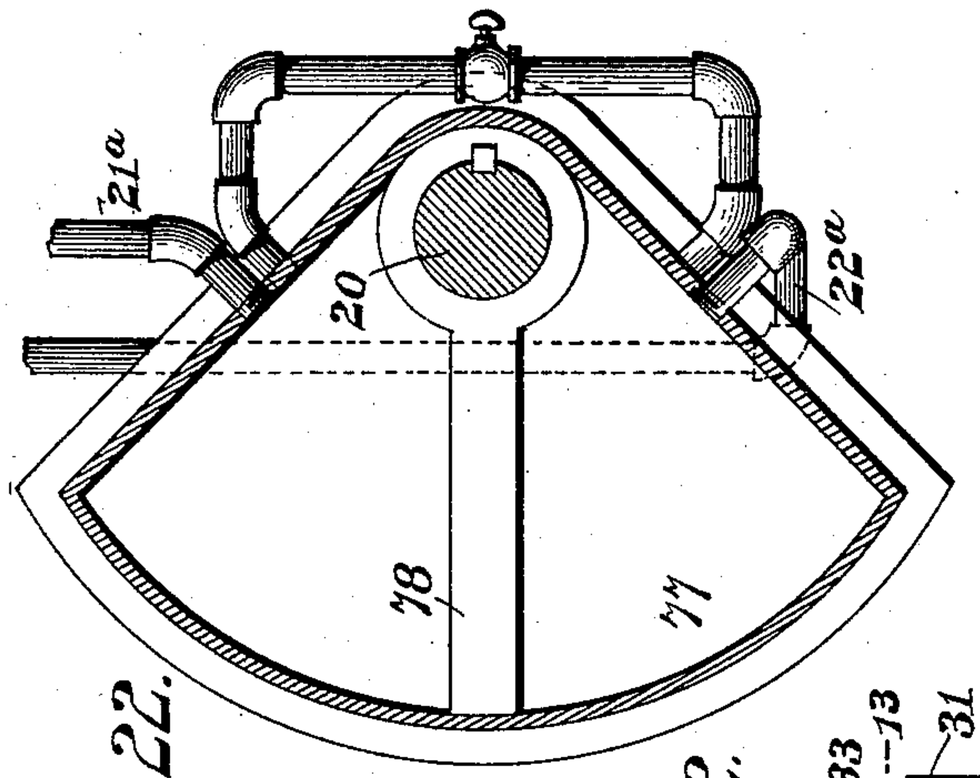

Fig. 22.

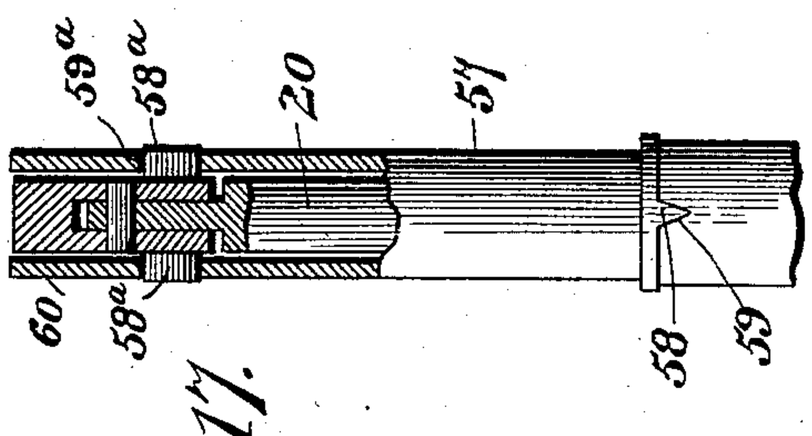

Fig. 17.

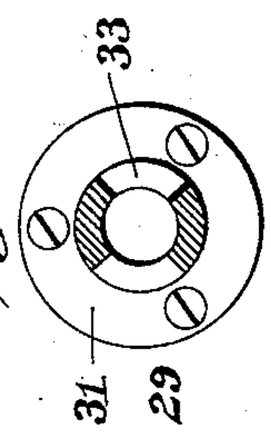

Fig. 13.

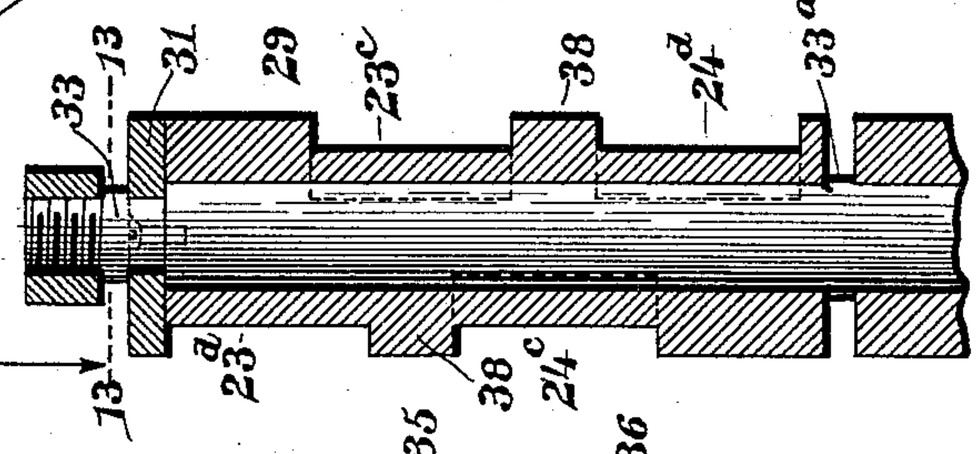

Fig. 12.

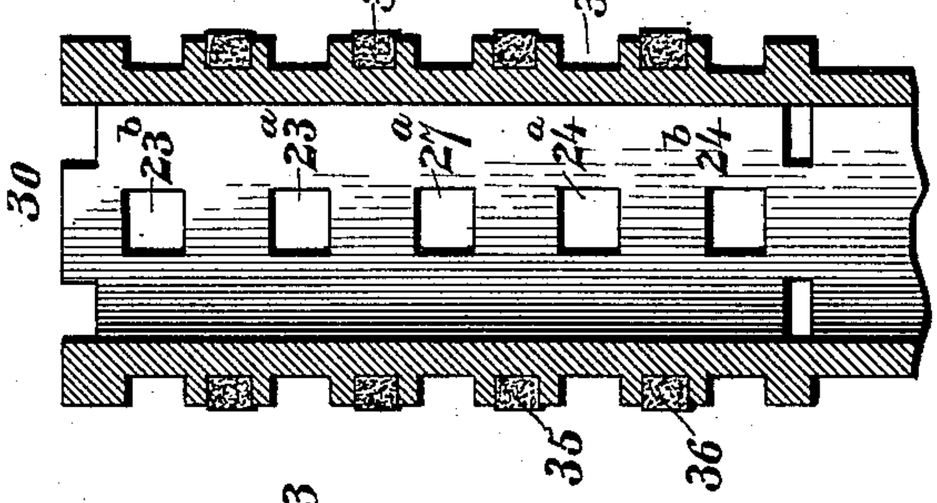

Fig. 11.

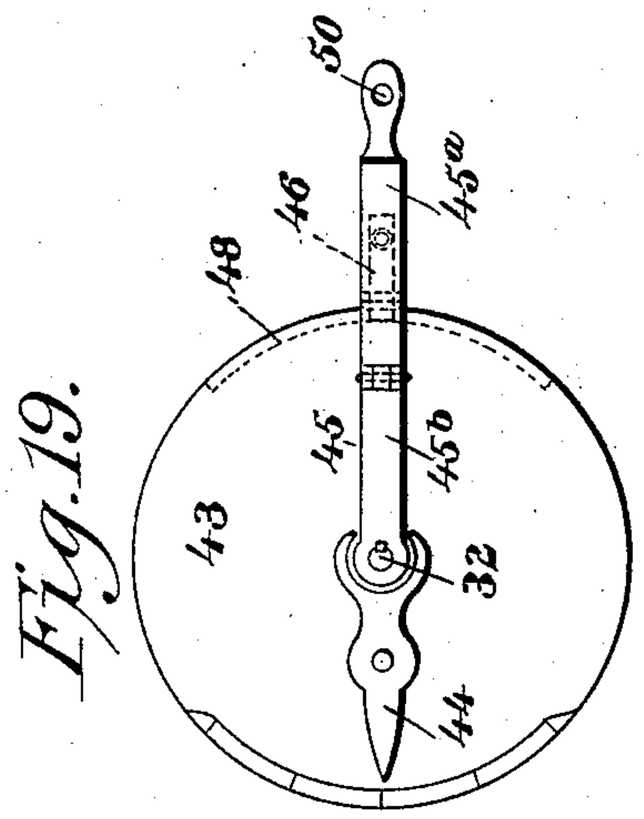

Fig. 19.

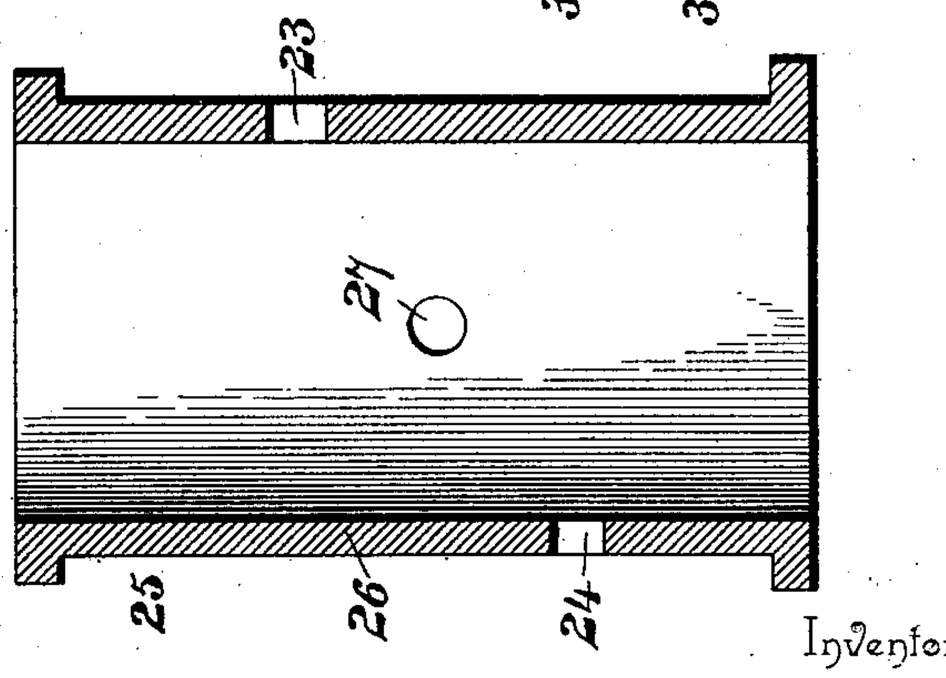

Fig. 10.

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FLUID PRESSURE STEERING GEAR.

No. 588,946. Patented Aug. 31, 1897.

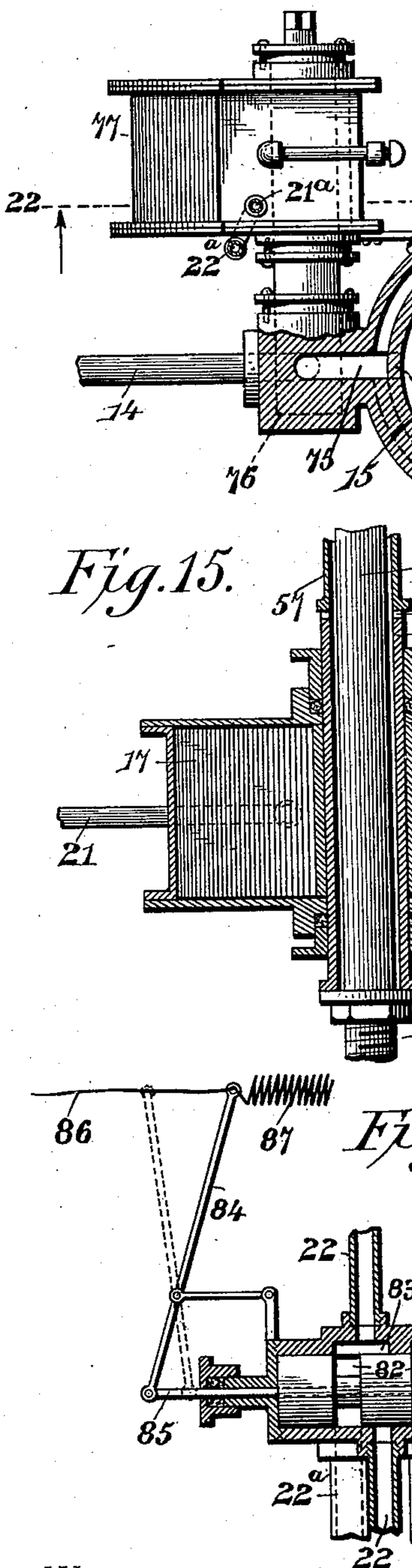


Fig. 14.

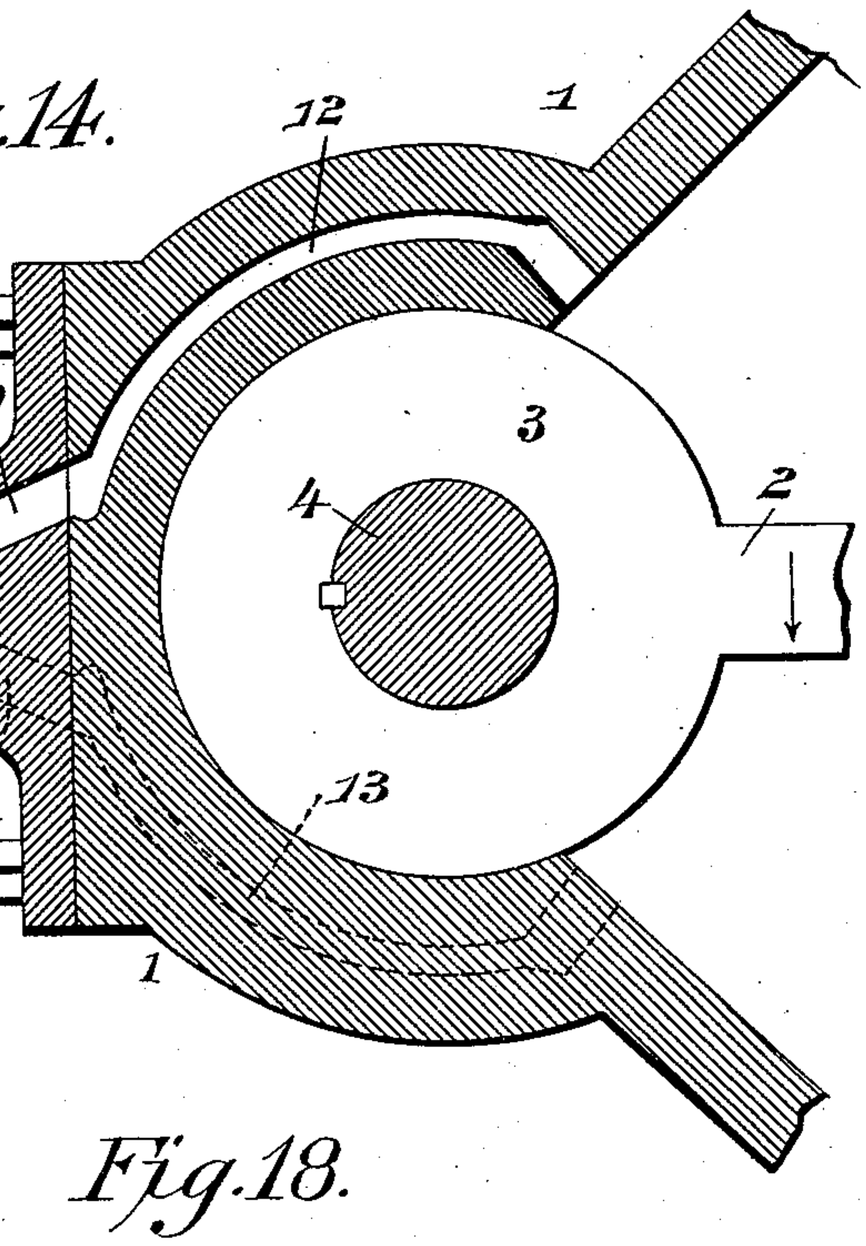


Fig. 15.

Fig. 18.

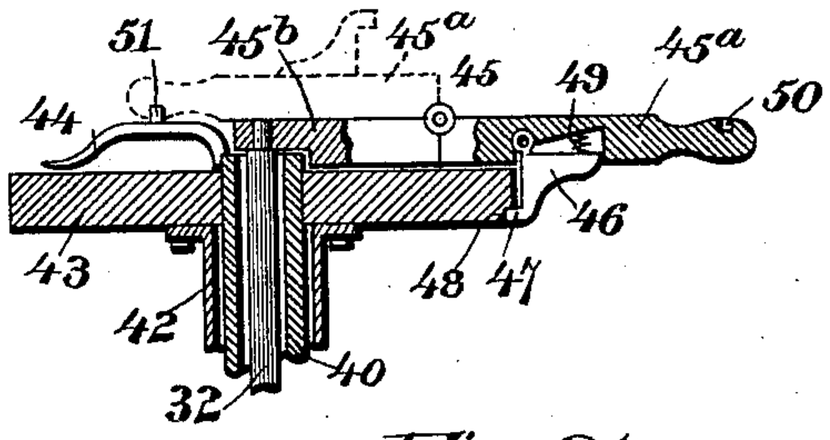
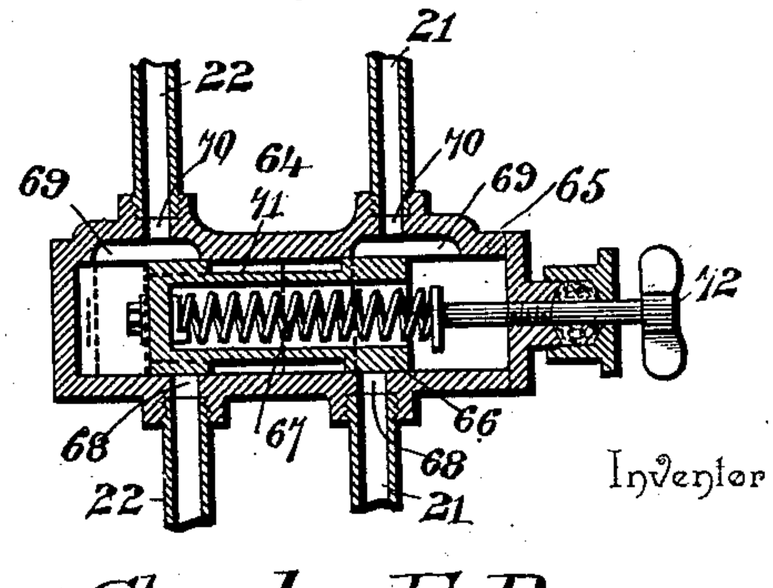


Fig. 21.

Fig. 20.



Inventor

Witnesses

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UNITED STATES PATENT OFFICE.

CHARLES E. BERGMAN, OF EVERETT, WASHINGTON.

FLUID-PRESSURE STEERING-GEAR.

SPECIFICATION forming part of Letters Patent No. 588,946, dated August 31, 1897.

Application filed November 12, 1896. Serial No. 611,839. (No model.)

To all whom it may concern:

Be it known that I, CHARLES E. BERGMAN, a citizen of the United States, residing at Everett, in the county of Snohomish and State of Washington, have invented a new and useful Fluid-Pressure Steering-Gear, of which the following is a specification.

My invention relates to mechanism for utilizing and controlling hydrodynamic forces, and particularly to fluid-operated steering apparatus designed to facilitate the repeated adjustment of the rudder of a vessel and to give to the pilot increased control with the minimum effort, the present embodiment of my invention consisting in an improvement upon that shown and described in my former patents, No. 553,150, granted January 14, 1896, and No. 557,539, granted April 7, 1896.

The object of the invention is to provide a simple and efficient construction of valve mechanism whereby the equalization of pressure upon opposite sides of a piston connected to the operating shaft or spindle is accomplished automatically and whereby the closing of the ports of the operating-valve occurs without effort on the part of the operator when such equalization of pressure is accomplished.

A further object of the invention is to provide an efficient arrangement of connections and means for operating the valves of the system whereby a rudder-shaft may be actuated from either of a plurality of stations located in different parts of a vessel, whereby the pilot is enabled to operate the vessel from either of a plurality of points to suit the exigencies of the occasion.

Further objects and advantages of this invention will appear in the following description, and the novel features thereof will be particularly pointed out in the appended claims.

In the drawings, Figure 1 is a diagrammatic side view of a vessel to show the location of the various operating-stations and indicating the relative positions of the connections whereby pressure is communicated to the main cylinder. Fig. 2 is a diagrammatic plan view of the same. Fig. 3 is an enlarged detail view, partly in section, of the operating-valve mechanism, the operating-cylinder, and connections. Fig. 4 is a detail axial section of the operating-valve. Fig. 5 is a transverse sectional view of the same on the line 5 5 of Fig. 4. Fig. 6 is a transverse section of said operating-valve on the line 6 6 of Fig. 4. Fig. 7 is a transverse sectional view of the same on the line 7 7 of Fig. 4. Fig. 8 is a side view of the operating-valve plugs or members detached from the casing. Fig. 9 is a similar view of the main-valve plug or member. Fig. 10 is a vertical section of the operating-valve casing. Fig. 11 is a similar view of the operating-valve auxiliary plug detached. Fig. 12 is a similar view of the operating-valve main plug detached. Fig. 13 is a detail transverse section of the operating-valve main plug on the line 13 13 of Fig. 12. Fig. 14 is a transverse horizontal section of the main valve and the contiguous portion of the main cylinder on the line 14 14 of Fig. 3, showing in side view the valve-actuating cylinder. Fig. 15 is a vertical sectional view of the operating-cylinder and the contiguous portion of the main-valve-operating-plug stem. Fig. 16 is a detail vertical section of the clutch mechanism for connecting the stem of the main valve-plug to the hub of the operating-piston. Fig. 17 is a detail sectional view of the same, taken at right angles to the plane of Fig. 16. Fig. 18 is a detail sectional view of the operating-lever, pointer, and dial to show the connections thereof with the stems of the main and auxiliary plugs of the operating-valve. Fig. 19 is a plan view of the same. Fig. 20 is a detail sectional view of the switch-valve. Fig. 21 is a similar view of one of the check-valves. Fig. 22 is a transverse vertical section of the valve-actuating piston and cylinder on the plane indicated by the line 22 22 of Fig. 14.

Similar numerals and letters of reference indicate corresponding parts in all the figures of the drawings.

The object and function of the apparatus embodying my invention is to utilize fluids, particularly of the class known as "non-elastic," for communicating pressure to a piston or movable part, whereby a driven or operated shaft, such as that of a rudder, may be actuated or moved in one direction or the other by varying the pressure upon the opposite sides thereof, as by reducing the pressure upon one side and proportionately increasing it upon the opposite side, and while

in practice I prefer to employ fluids which are known as "non-compressible" or "non-elastic," such as water, oil, or their equivalents, it will be understood that elastic fluids, such as steam, atmospheric air, and the like, may be employed with satisfactory results. Water, however, being the most convenient fluid for use upon shipboard, I preferably make connection with a boiler below the water-level, thus utilizing steam-pressure in the boiler to insure the prompt communication of the actuating fluid to the various parts of the apparatus. The advantage in using a non-elastic fluid is that its condition is practically static, not being subject to expansion and compression, and hence the moment the supply is cut off the parts affected by the pressure come to rest and are so held by the equilibrium of pressure applied to the opposite faces thereof.

In the present embodiment of my invention I employ a main cylinder 1, which is constructed and arranged substantially as described in my said former patent, No. 553,150, the same containing a piston 2, of which the hub 3 is secured to the operated or driven shaft 4, which in this case consists of the rudder shaft or stem, this rudder shaft or stem being extended above the cylinder 1 and preferably to a point on the after main deck of the vessel for manipulation by means of a tiller-arm 5 (see Fig. 1) in case the fluid-pressure-operating mechanism becomes disarranged or disabled.

In connection with the main cylinder I employ a main valve 6, which is provided with a cylindrical shell or casing 7 and inclosed concentric main and auxiliary valve-plugs 8 and 9, of which the detail construction will be explained hereinafter. This valve-casing is provided with cylinder-ports 10 and 11, which communicate by means of channels 12 and 13 (see Fig. 14) with the quadrant cylinder 1 upon opposite sides of the plane of the wing-piston 2, which is arranged therein. It is obvious that by connecting one of the cylinder-ports with a pressure-supply port and the other with an exhaust-port pressure upon one side of the piston may be increased over that upon the other side to swing the piston in either direction and thereby vary the position of the rudder. The pressure-supply conveyer 14 communicates with the supply-port 15 of the main-valve casing 7.

As hereinbefore indicated, it is my object to provide means whereby the operation of the rudder may be controlled from a plurality of stations, and in order to simplify the mechanism I employ an operating-cylinder 16 of the quadrant construction similar to that of the main cylinder 1 and inclosing a wing-piston 17, which is fixed to a tubular stem 18, mounted in suitable bearings in the upper and lower walls of the cylinder and extending through stuffing-boxes 19. Through this hollow stem of the operating-piston extends a stem 20 of the main plug 8, forming one member of the main valve 6, whereby the movement of the operating-piston is communicated to said stem 20 to actuate the main plug 8 of the main valve, as hereinafter fully explained.

Pressure is communicated to the interior of the operating-cylinder upon opposite sides of the plane of the operating-piston therein through feed-ports communicating, respectively, by means of feed-pipes 21 and 22 with cylinder-ports 23 and 24 in the shell or casing of the operating-valve 25, this operating-valve being duplicated at various points in the vessel to form a number of "stations," which may be located, as shown in the drawings, Figs. 1 and 2, upon the forecastle-deck, in the pilot-house, at opposite ends of the bridge or quarter-deck and upon the after-deck, (preferably the after hurricane-deck,) and at such other points as may be desired. These stations are indicated, respectively, upon the drawings by the letters A, B, C, D, and E, and will be so designated in the following description. Inasmuch, however, as the construction of these stations or operating-valve mechanisms is identical, each having communication with the operating-cylinder 16 by means of feed-pipes, whereby the position of the operating-piston may be adjusted from any part of the vessel, it will be necessary to describe in detail the construction of only one of the operating-valves, which is shown in the drawings in Figs. 4 to 13, inclusive, and, referring thereto, 26 represents a cylindrical valve-casing provided with the lateral or starboard and port cylindrical ports 23 and 24 and a supply-port 27, communicating with a suitable supply-pipe 28. Mounted concentrically within the casing are the main and auxiliary valve-plugs 29 and 30, the former of which is provided at its upper end with a collar 31, to which is attached an operating stem or spindle 32, adapted to be actuated by means controlled by the pilot. This collar 31 is provided with lateral ports 33, in communication with the bore of the main valve-plug, said bore being in open communication with the exhaust 34, which extends through the lower head of the casing. The auxiliary valve-plug, which incloses the main plug, is provided with a central inlet-port 27^a, upper and lower feed-ports 23^a and 24^a, arranged in communication with the cylinder-ports 23 and 24 of the casing, and exhaust-ports 23^b and 24^b, annular packing-rings 35 being disposed between the planes of said ports and fitting snugly in the bore of the casing. Between these packing-rings the exterior surface of the auxiliary valve-plug is cut away to form intermediate annular channels 36, which are respectively in communication with the said supply, feed, and exhaust ports of the auxiliary plug and the corresponding ports of the casing. In other words, the supply and feed channels of the auxiliary valve-plug are permanently in communication, in all positions of the said valve-plug,

with the supply and feed ports of the casing, and the exhaust-channels of the auxiliary valve-plug, which are in communication, respectively, with the exhaust-ports 23^b and 24^b, are in permanent communication with the exhaust-ports 33 in the collar at the upper end of the main valve-plug and corresponding ports 33^a at the lower end of said main valve-plug, as shown clearly in Fig. 4.

The main valve-plug is provided with a closing face 37, which is adapted to simultaneously close all of the ports in the auxiliary valve-plug, said face being of a width slightly in excess of said ports and the ports being arranged in vertical alinement to facilitate the simultaneous closing thereof. Upon opposite sides of this face are arranged inlet cavities 23^c and 24^c, which are separated by interposed packing rings or webs 38 from opposite exhaust-cavities 23^d and 24^d, and when this main valve-plug is turned to bring the cavities 23^d and 24^c into operative relation with the ports of the auxiliary valve-plug the steam-inlet port 27 of the casing is in communication, though the steam-inlet port 27^a of the auxiliary valve-plug, with the feed-port 24^a of said auxiliary valve-plug, and hence with the feed or cylinder port 24 of the casing, while the cavity 23^d of the main valve connects the feed-port 23^a of the auxiliary valve-plug with the exhaust-port 23^b of said auxiliary valve-plug, and hence connects the feed-port 23 of the casing with the exhaust-port 34 of the main valve-plug.

Secured to the upper end of the auxiliary valve-plug, by means of an interposed collar 39, is a tubular valve-plug stem 40, through which extends the main-valve-plug stem 32. In the same way the auxiliary-valve-plug stem is extended below the casing, as shown at 40^a, the same being of sectional construction with its parts connected by a yoke 41 or its equivalent to allow the exhaust 34 to be carried laterally for communication with a condenser or for discharge into the atmosphere, as may be preferred.

Inclosing the upwardly-projecting portions of the main and auxiliary valve-plug stems 32 and 40 is a tubular standard 42, which supports a dial 43, traversed by a pointer or indicator 44, which is fixed to the auxiliary-valve-plug stem and is designed to indicate the position of the auxiliary valve-plug. Attached to the contiguous extremity of the main-valve-plug stem is an operating-lever 45, which is preferably of jointed construction, having a hinged arm 45^a, which is adapted to fold upon the main arm 45^b and is normally held in its extended or operative position by means of a friction-clutch 46, having a nose or terminal extension 47, which operates in a groove 48 in the periphery of the dial and is normally held in such engagement by means of an actuating-spring 49. This friction-clutch is designed to hold the operating-lever in any position to which it may be moved by the operator. The hinged or swinging arm 45^a performs the additional function of a lock for securing the valve-plug stems 32 and 40 in fixed relative positions, said arm 45^a being provided with a depression 50 to interlock with a stud 51 on the pointer or indicator 44, as clearly illustrated in Fig. 18. The object in so locking the stems of the main and auxiliary valve-plug stems for simultaneous operation will be explained hereinafter.

The main valve 6 above referred to as controlling the cylinder-ports 10 and 11, which are in communication with the main cylinder 1 at opposite sides of the plane of the main piston 2, is constructed identically as above described in connection with the operating-valve 25, and hence it will be seen that by actuating the operating-piston 17 the main-valve-plug stem 20 may be turned to open either of the ports 10 and 11 for the admission of fluid-pressure introduced by the supply-pipe 14 and open communication between the other of said cylinder-ports and the exhaust, which is illustrated in Fig. 3 at 52. As above described, the stem 20 is attached to the main valve-plug of the main valve 6, while concentric with said stem is an auxiliary-valve-plug stem 53, which corresponds with the auxiliary-valve-plug stem 40, above described in connection with the operating-valve, and this auxiliary-valve-plug stem 53 is connected by means of links 54 or their equivalents to a cross-head 55 on the operated or driven shaft 4. Hence, in operation, when the main-valve-plug stem 20 is turned to open ports in the auxiliary valve-plug and thus allow fluid-pressure to pass to one side of the main cylinder, as through the cylinder-port 10, (see Fig. 14,) the movement of the main piston 2 in the direction indicated by the arrow in Fig. 14 will be communicated through the links 54 to the stem 53 of the auxiliary valve-plug, thereby communicating to said auxiliary valve-plug a motion in the same direction as and equal in extent to that which has been imparted to the main valve-plug. Thus when the stem of the main valve-plug has been turned through an arc of, for instance, ten degrees, thereby opening the main cylinder at one side to supply-pipe pressure and at the opposite side to the exhaust, motion will be communicated to the piston until the auxiliary valve-plug has been moved in the same direction as the main valve-plug a distance sufficient to again close the ports of the auxiliary valve-plug, thereby securing equilibrium of pressure upon opposite sides of the piston. Obviously, when the piston reaches that position in which the auxiliary valve-plug again occupies its normal position with relation to the main valve-plug, said piston will come to rest and will remain in such position until a succeeding operation of the main valve-plug has caused a non-equalization of pressure upon opposite sides of the piston, this non-equalization being followed, as before, by a movement of the piston, which motion is communicated to the auxiliary

valve-plug to again close the ports when the piston has reached a position corresponding with the last adjustment of the main valve-plug.

This description of the operation of the main valve applies equally to the operating-valve 25, of which the ports 23 and 24 are in communication by means of the conveyers 21 and 22 with the operating-cylinder 16 upon opposite sides of the plane of the operating-piston 17, this intermediate or operating cylinder and its coöperating valve 25 being interposed between the operating-lever 45 and the main valve 6, in order to enable the main-valve-plug stem 20 to be operated, as hereinbefore mentioned, from a plurality of stations located at different parts of the vessel. This main-valve-plug stem may be turned to operate the main valve 6 without having recourse to the operating-valve mechanism by means of an operating-lever 56, attached to the upper extremity of the stem 20 above the operating-cylinder 16, and preferably located within reach from the after deck. Normally the sleeve or operating-piston stem 18 is locked to the valve-plug stem 20, in order to allow motion to be communicated from the operating-piston 17 to said valve-plug stem by means of a clutch mechanism consisting of a clutch-sleeve 57, mounted to slide vertically upon the valve-plug stem 20 above the upper end of the sleeve or piston-stem 18, said sleeves 57 and 18 being provided with interlocking clutch-faces consisting, respectively, of projections 58 and recesses 59, which are shown clearly in Figs. 16 and 17, and when it is desired to operate the valve-plug stem 20 directly by means of the lever 56 it is necessary to disengage these clutch members. In order to accomplish this disengagement, I preferably pivot the lever 56 upon the upper extremity of the stem 20 and provide it with concentric trunnions 58^a, which engage elongated openings or slots 59^a in a head 60 on the upper end of the clutch-sleeve 57. Normally this lever 56 depends vertically at one side of the valve-plug stem 20, as shown in full lines in Fig. 3 and in dotted lines in Fig. 16, in which position the clutch members are interlocked, and when it is desired to actuate the main valve without the use of the operating-valve mechanism this lever 56 is elevated to a horizontal position, (indicated in full lines in Fig. 16,) thus raising the clutch-sleeve 57 sufficiently to disengage the clutch-faces 58 and 59, thereby disconnecting the operating-valve mechanism from the main-valve mechanism.

As above described, the adjustment of the auxiliary valve-plug which forms a member of the main valve is accomplished by means of connections between said valve-plug and the operated or driven shaft, whereby after the adjustment of the main valve-plug the auxiliary valve-plug is turned in a corresponding direction until the normal relative positions of the valve-plugs are assumed, and in order that this coöperation may occur when the main-valve mechanism is actuated by the operating-valve mechanism through the intervention of the operating-piston 17 it is necessary to establish connections between the operated or driven shaft 4 and the stem extension 40^a of the auxiliary valve-plug, forming a member of the operating-valve. Hence I preferably connect quadrants 61 and 62, respectively attached to the shaft 4 and stem 40^a by means of a cable or endless chain or belt 63. This connection is common to all of the operating-valve mechanisms employed at the several stations, and hence in Figs. 1 and 2 it is shown extending from the rudder-shaft to quadrants 62^a, 62, and 62^e, located, respectively, at the stations A, B, and E, while corresponding connection between the auxiliary-valve-plug stems of the stations C and D and the station B is secured by means of transverse cables 63^a, connecting quadrant 62^c and 62^d with the quadrant 62^b. (Shown clearly in plan in Fig. 2.)

Obviously each operating-valve mechanism is provided with an indicating device embodying a dial 43 and an index 44, and also includes an operating-lever 45, whereby not only can the vessel be manipulated from either of the stations, but the position of her rudder is indicated. When the rudder is being operated from a given station, the operating-lever of that station must be in the position indicated in Fig. 3, but when the pilot is about to leave one station to operate another the operating-lever of the station which he is about to leave must be moved to the dotted position indicated in Fig. 18 to lock the main and auxiliary valve-plug stems together for simultaneous movement, and thus maintain the valves of that station closed in all positions of the index. It is obvious that the position of the rudder will be indicated at each station by reason of the communication of motion from the rudder-shaft through the intermediate connections to the stem of each auxiliary valve-plug. Thus the operating-lever of only one operating-valve—namely, that by which the vessel is being manipulated—is at one time in such a position as to allow independent movement of the main and auxiliary valve-plugs, and hence it is only through this operating-valve that fluid-pressure can be communicated to the operating-cylinder to actuate the stem 20 of the main-valve mechanism, each of the remaining operating-valves being locked with their main and auxiliary valve-plugs in their normal positions to exclude fluid-pressure without interfering with the simultaneous turning of said main and auxiliary valve-plugs to adjust the pointers of the indicating devices to agree with the position of the rudder.

In connection with the above-described mechanism I also employ check-valves 64, located, respectively, in the feed-pipes 21 and 22 and in various branches thereof, de-

signed to allow forward and prevent backward pressure, and the preferred construction of the check-valve is shown in detail in Fig. 21, which includes a casing 65, intersecting and common to both of the feed-pipes 21 and 22, and a sliding plug 66, located in the casing for axial movement transverse to the feed-pipes and connected to one end of a helical spring 67, which normally holds the plug in such a position as to close those ports 68 which are contiguous to the cylinder and which may be designated as "rear" ports. The casing is counterbored or cut away, as shown at 69, to leave the front ports 70 or those toward the supply permanently open, and it is obvious that when pressure is applied through the feed-pipe 21, for instance, the terminal pressure upon the plug will cause the latter to move to the position indicated by dotted lines in Fig. 21, thereby allowing a direct communication of pressure through the casing in the direction indicated by the arrows on said feed-pipe 21. The plug is exteriorly channeled, as shown at 71, and this channel is by the longitudinal adjustment of the plug brought into communication with the feed-pipe 22, thus allowing back pressure in the direction indicated by the arrows through said pipe. In the same way if pressure is admitted through the pipe 22 the valve-plug will be moved in the opposite direction to open communication through the end of the casing for supply-pressure, while back pressure is allowed through the channel 71 to connect the portions of the pipe 21. The spring 67, to one end of which the valve-plug is connected, is attached at the other end to an adjusting-screw 72, whereby the tension of said spring may be varied. It will be seen that inasmuch as the casing is not counterbored contiguous to the rear ports 68 back pressure applied therethrough will not affect the plug. Adjustment of the latter is caused only by supply-pressure through one of the ports 70 or from the operating-valve.

In case it should become necessary to operate the rudder by means wholly independent of the fluid-pressure mechanism above described, as by the usual hand-wheel 73, which is shown in dotted lines in the pilot-house in Fig. 1, it is desirable to employ means for disconnecting the rudder from the entire system and relieving the cylinder 1 of pressure, for, in addition to the fact that fluid-pressure is employed to operate the main piston and thereby adjust the rudder, the closing of the ports in the cylinder by the readjustment of the main valve prevents subsequent movement of said piston until the pressure upon one side thereof is reduced, as by the opening of an exhaust-port. In other words, the entire space upon both sides of the piston is occupied by the fluid, which is employed as the actuating medium, and in order to allow the rudder to be adjusted manually, as by the ordinary wheel and connections, it is necessary to relieve this pressure upon opposite sides of the piston 2, as by allowing a free communication of the fluid between the spaces upon opposite sides of the piston. In order to accomplish this, I employ an equalizing-channel 74, which may be formed in the casing of the main valve and connects the cylinder-ports 10 and 11, said equalizing-channel intersecting the supply-port 75 of said main-valve casing, and a controlling-valve 76 is located at this intersection and is adapted to open communication either from the supply-pipe 14, through the supply-port 75, or to open communication between the branches of the channel 74 and allow fluid upon one side of the piston to pass to the opposite side thereof as the rudder-shaft is turned by the manually-operated means. In order to provide for the adjustment of this controlling-valve from the pilot-house, I employ a quadrant-adjusting cylinder 77, having a piston 78, similar in construction to that employed in connection with the operating and main cylinders 16 and 1, and branch feed-pipes 21^a and 22^a, connecting the feed-pipes 21 and 22, respectively, with the cylinder 77 upon opposite sides of the plane of said piston. At the intersection of these branch pipes with the main feed-pipes 21 and 22 I locate a switch-valve 79, having a cylindrical casing 80, in which is arranged a sliding plug 81, provided with spaced channels 82 for respective arrangement in the planes of the pipes 21 22 and 21^a 22^a, the inlet side of the casing being counterbored, as shown at 83, to allow communication between the main portions of the feed-pipes 21 and 22 with the channels 82 in either position of the plug. Any suitable means for actuating this plug may be employed, such as a lever 84, connected to a plug-stem 85 and having a wire or flexible connection 86, adapted to extend to the pilot-house or within convenient reach of the pilot, said lever being yieldingly held in its normal position by means of a spring 87 or its equivalent.

Thus when it is desired to disconnect the operating-valve mechanism from the main-cylinder piston the switch-valve is operated to connect the adjusting-cylinder with the operating-valve, when, by admitting fluid-pressure through the operating-valve to one of the feed-pipes, the piston 78 may be moved in either direction to adjust the controlling-valve as desired, whereupon the switch-valve may be again released to maintain the adjusting-cylinder piston in the position to which it has been moved.

In order to allow for expansion and contraction of the valve-stem 20, it is preferably constructed of sections connected by a compensating joint 88, consisting of a stirrup on one section of the stem carrying a transverse pin 90, which engages a longitudinal slot 91 in the other section of the same.

In practice I prefer to employ a non-elastic fluid for operating the pistons in cylinders 16 and 77, while for actuating the main or oper-

ating piston 2 in cylinder 1 it is preferable to employ steam or other elastic fluid, in order to yieldingly hold the rudder in its adjusted position to relieve lateral strains applied thereto by contact with the water through which the vessel passes.

Various changes in the form, proportion, and the minor details of construction may be resorted to without departing from the spirit or sacrificing any of the advantages of this invention.

Having described my invention, what I claim is—

1. A valve having rotary main and auxiliary plugs and a casing provided with cylinder-ports and an intermediate supply-port, said main valve-plug being tubular with its bore in communication with an exhaust-port, and the auxiliary valve-plug being provided with supply, feed, and exhaust ports communicating with exterior annular channels, and the main valve-plug being provided with a face adapted to close said ports in the auxiliary valve-plug and also having chambers for establishing communication between certain of said ports, substantially as specified.

2. A valve having its casing provided with supply, cylinder and exhaust ports, rotary concentric main and auxiliary valve-plugs, the auxiliary valve-plug having supply, feed and exhaust ports in permanent communication with the corresponding ports of the casing, and the main valve-plug being seated within the auxiliary valve-plug and provided with a face to close all of said ports in the auxiliary valve-plug, and also provided with exterior channels adapted to establish communication between the supply and one feed port, and between the other feed-port and the contiguous exhaust-port of the auxiliary valve-plug, substantially as specified.

3. A valve having its casing provided with supply, cylinder and exhaust ports, and comprising a rotary auxiliary valve-plug provided with supply, feed, and exhaust ports in permanent communication with the corresponding ports of the casing, and a rotary main valve-plug adapted to be manually operated and arranged within and concentric with the auxiliary valve-plug, said main valve-plug having an interior exhaust in permanent communication with the casing exhaust-port and provided with an exterior face to close the ports of the auxiliary valve-plug, and chambers for establishing communication between the supply and feed ports, and between the feed and exhaust ports, of the auxiliary valve-plug, substantially as specified.

4. A valve having its casing provided with supply, cylinder and exhaust ports, and comprising a rotary tubular auxiliary valve-plug provided with supply, feed and exhaust ports in permanent communication with the corresponding ports of the casing, and a rotary tubular main valve-plug arranged within and concentric with the auxiliary valve-plug and having its bore arranged to connect the exhaust-ports of the auxiliary valve-plug with the exhaust-port of the casing, and provided with an exterior face adapted to close the ports of the auxiliary valve-plug, and with contiguous chambers adapted to establish communication between the supply and either feed port, and between the other feed-port and the contiguous exhaust-port of the auxiliary valve-plug, substantially as specified.

5. The combination with a main piston adapted to be attached to a rudder-shaft, of an operating-valve, means controlled by the operating-valve for applying fluid-pressure to opposite sides of said piston, said operating-valve having concentric rotary main and auxiliary valve-plugs adapted when in their normal relative positions to close the valve-ports, operating connections between the piston and the auxiliary valve-plug to secure coextensive angular movement thereof, an index fixed to the stem of the auxiliary valve-plug and traversing a dial, and means for manually operating the main valve-plug, substantially as specified.

6. The combination with a main piston adapted to be attached to a rudder-shaft, of a plurality of operating-valves, means controlled by said operating-valves for applying fluid-pressure to opposite sides of the piston, each operating-valve having an auxiliary valve-plug which is operatively connected with said piston to secure coextensive movement thereof, and each operating-valve having a main valve-plug for coöperation with said auxiliary valve-plug and adapted when in its normal position with relation thereto to close the valve-ports, indicating devices carried respectively by the auxiliary valve-plugs, and means for locking the main and auxiliary valve-plugs of either operating-valve in their normal relative positions, the main valve-plug of each operating-valve being adapted to be manually operated, substantially as specified.

7. The combination with a piston adapted to be attached to a rudder-shaft, of a plurality of operating-valves, means controlled by said operating-valves for applying fluid-pressure to opposite sides of the piston, each operating-valve having an auxiliary valve-plug which is operatively connected with said piston for movement coextensive thereof, and each operating-valve also having a main valve-plug concentric with and adapted when in its normal position with relation to the auxiliary valve-plug to close the valve-ports, indicating devices including an index carried by each auxiliary valve-plug and traversing a dial, and operating-levers connected to the main valve-plugs and having swinging arms adapted to be engaged with said indexes to secure the main and auxiliary valve-plugs in their normal relative positions, substantially as specified.

8. The combination with a main piston adapted to be attached to a rudder-shaft and a main valve for controlling the application

of fluid-pressure to opposite sides of said piston and having a rotary valve plug or member, of an operating-piston connected to the stem of said rotary valve plug or member, an operating-valve for applying pressure to opposite sides of the operating-piston, and indicating devices operatively connected with the main piston, substantially as specified.

9. The combination with a main piston adapted to be attached to a rudder-shaft, of a main valve for controlling the application of fluid-pressure to opposite sides of said piston and having a rotary valve-plug stem, an operating-piston mounted concentrically with the rotary valve-plug stem, clutch mechanism for connecting the operating-piston with said valve-plug stem, and an operating-valve for communicating pressure to opposite sides of the operating-piston, substantially as specified.

10. The combination of a main piston adapted to be attached to a rudder-shaft, of a main valve for controlling the application of pressure to opposite sides of said piston and having a rotary valve-plug stem, an operating-valve mounted concentrically with the valve-plug stem, an operating-lever attached to said stem, a clutch for connecting the operating-piston to said stem to operatively connect with said lever, and an operating-valve for controlling the application of pressure to opposite sides of the operating-piston, substantially as specified.

11. The combination with a main piston and a main valve for controlling the application of pressure to opposite sides of said piston, of an operating-piston operatively connected with said main valve, and a plurality of operating-valves for controlling the application of pressure to opposite sides of the operating-piston, each operating-valve having an indicating device which is operatively connected with the main piston, substantially as specified.

12. The combination with a main piston adapted to be attached to a rudder-shaft, and a main valve for controlling the application of pressure to opposite sides of said piston, of an operating-piston operatively connected with the main valve, a plurality of operating-valves connected with the cylinder of the operating-piston for communicating pressure to opposite sides of the latter, and check-valves located in the conveyers connecting said operating-valves with the operating-piston cylinder, each check-valve being adapted to be actuated by supply-pressure to open both the supply and the exhaust conveyers, substantially as specified.

13. The combination with an operating-piston, and an operating-valve having its casing in communication with the operating-valve cylinder by means of twin conveyers, of a check-valve having a casing in communication with both of said conveyers, and a valve-plug adapted to be adjusted by supply-pressure through either conveyer to open communication to both conveyers, substantially as specified.

14. The combination with an operating-piston and an operating-valve having its casing in communication by twin conveyers with the operating-piston cylinder, of a check-valve having a casing in communication with both conveyers, a valve-plug seated in said casing and exposed at opposite ends, respectively, to supply-pressure admitted through either conveyer, and normally held by yielding means in position to exclude back pressure through both conveyers, substantially as specified.

15. A check-valve having its casing in communication with twin conveyers to either of which supply-pressure may be admitted, and provided with an axially-movable plug exposed at opposite ends to supply-pressure admitted through said conveyers, respectively, resilient means, as a spring, for normally maintaining the plug in position to prevent the admission of back pressure through said conveyers, and means for adjusting the tension of said spring, substantially as specified.

16. The combination with a main piston, and a main valve for controlling the application of pressure to opposite sides of said piston, of an operating-piston operatively connected with the main valve, a controlling-valve for the supply-port of the main valve, an adjusting-piston connected to the controlling-valve, an operating-valve for controlling the application of pressure to opposite sides of the operating-piston, and a switch-valve for controlling communication between the operating-valve and the cylinder of the adjusting-piston, substantially as specified.

17. The combination with a main piston having a casing, a main valve for controlling the application of pressure to opposite sides of the main piston, the cylinder at opposite sides of its piston being connected by an equalizing-channel and the main valve being provided with a supply-port intersecting said equalizing-channel, of a controlling-valve arranged at the intersection of said equalizing-channel and supply-port, an adjusting-piston connected to the controlling-valve and arranged in the cylinder, an operating-cylinder operatively connected with the main valve, an operating-valve connected by main fluid-pressure conveyers with the operating-piston cylinder, branch conveyers connecting said main conveyers with the adjusting-piston cylinder, and a switch-valve located at the intersection of the main and branch conveyers and adapted to be manually adjusted, substantially as specified.

In testimony that I claim the foregoing as my own I have hereto affixed my signature in the presence of two witnesses.

CHARLES E. BERGMAN.

Witnesses:

WHEELER M. A. EDWARDS,

W. W. BLACK.