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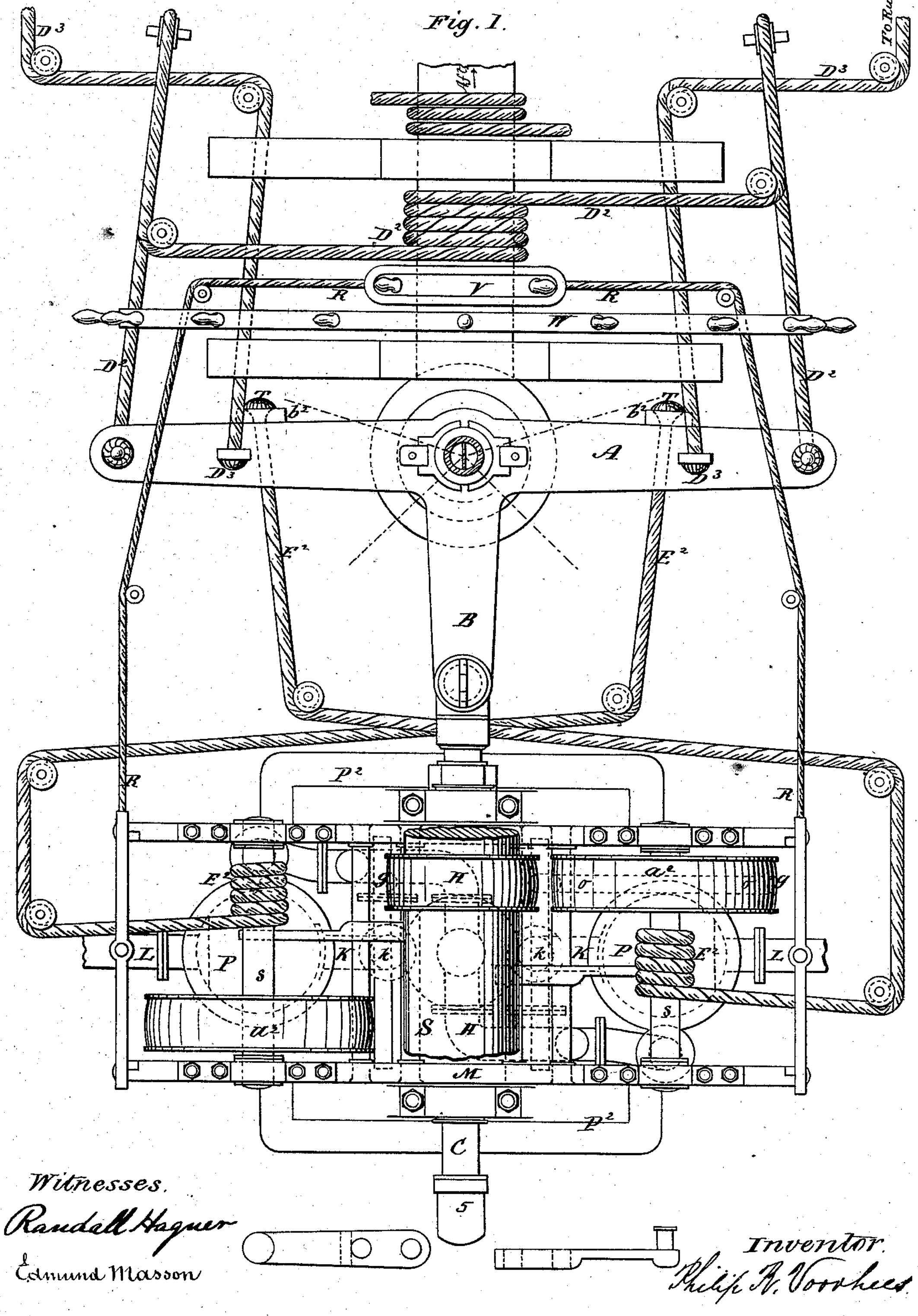
P. R. VOORHEES.

Steering-Apparatus.

No. 162,720. Patented April 27, 1875.



Witnesses.

Randall Hagner

Edmund Masson

Inventor.

Philip R. Voorhees.

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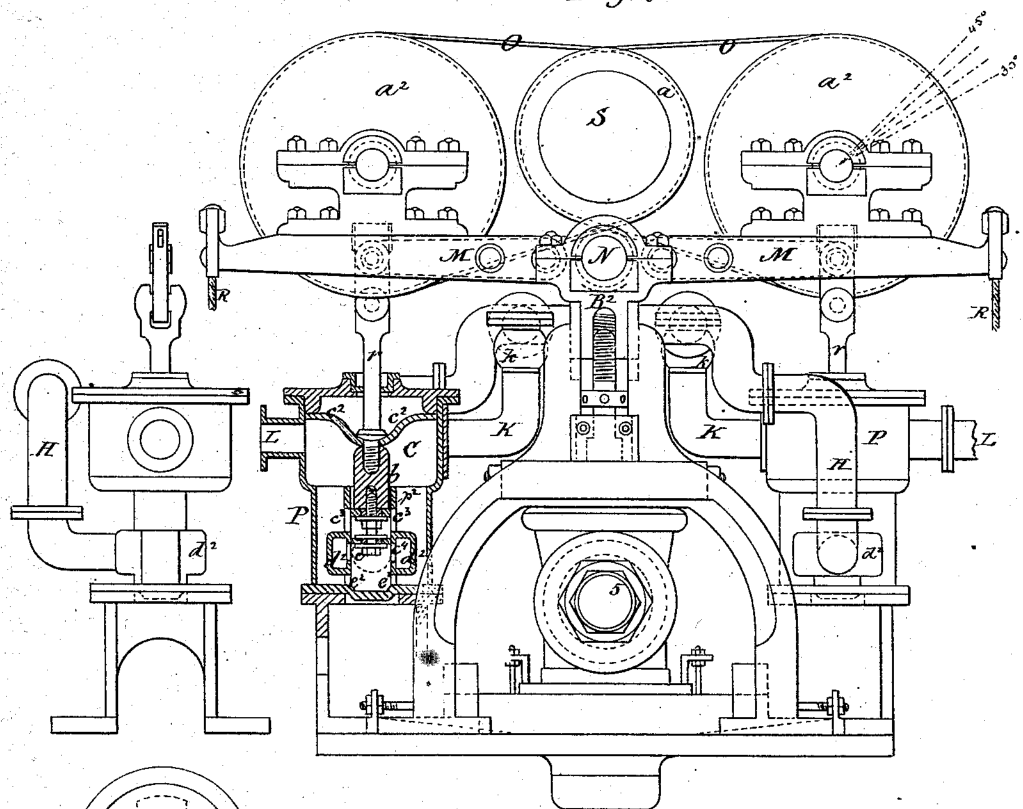
Fig. 2



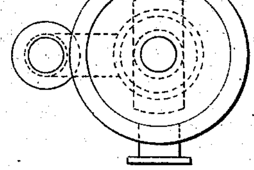
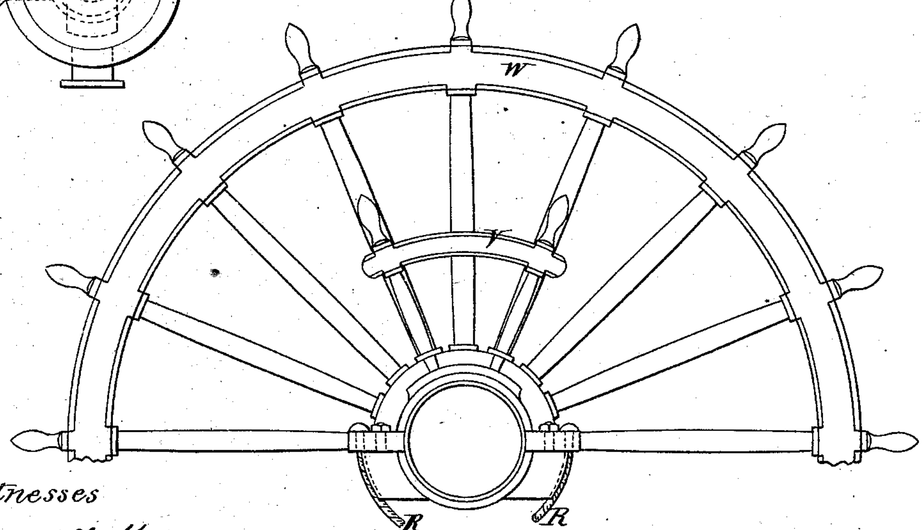


Fig. 3.



Witnesses

Randall Hagner

Edmund Masson

Inventor.

Philip R. Voorhees

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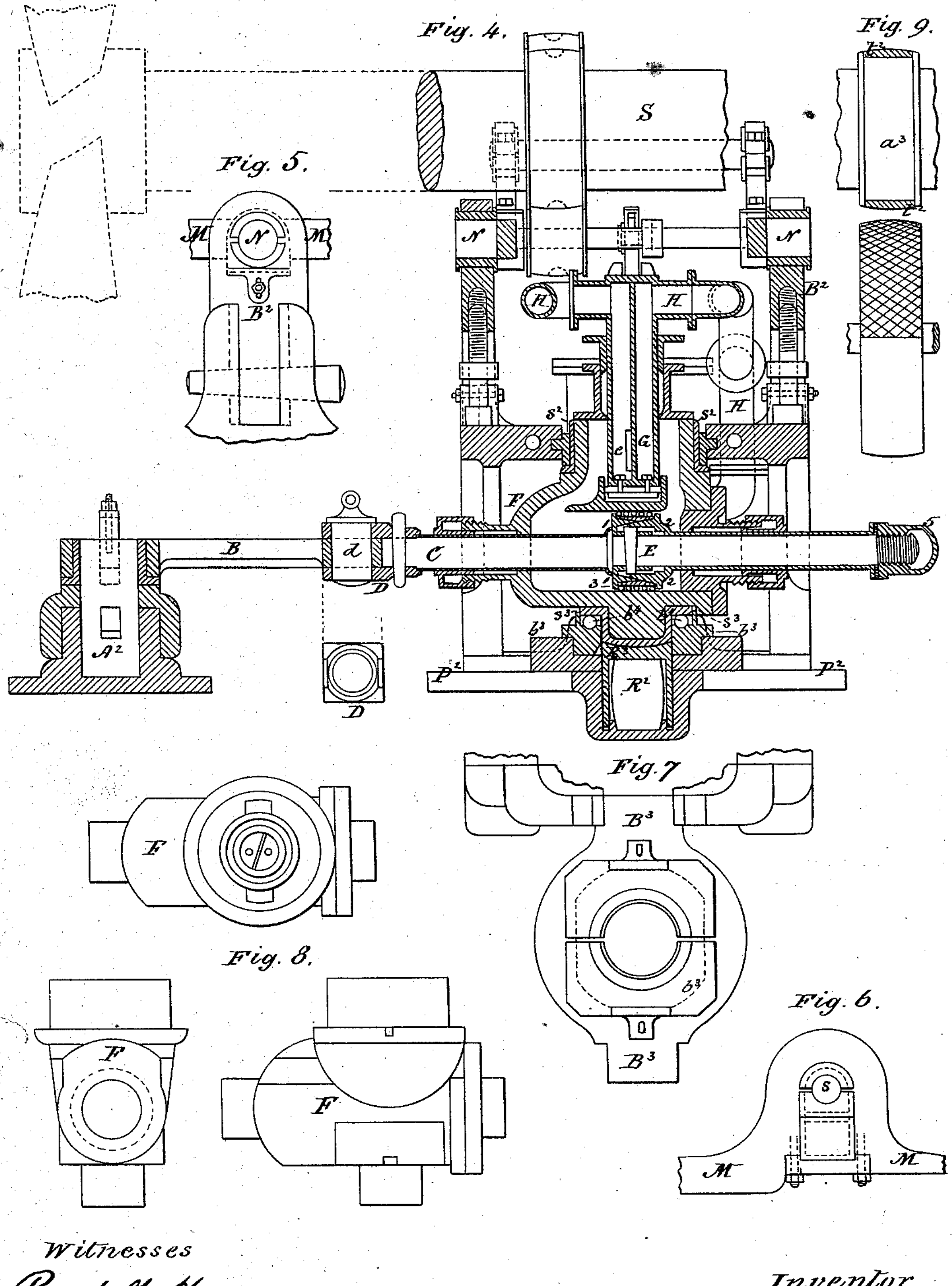

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Randall Hagner

Edmund Masson

Inventor.

Philip R. Voorhees

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Fig. 10

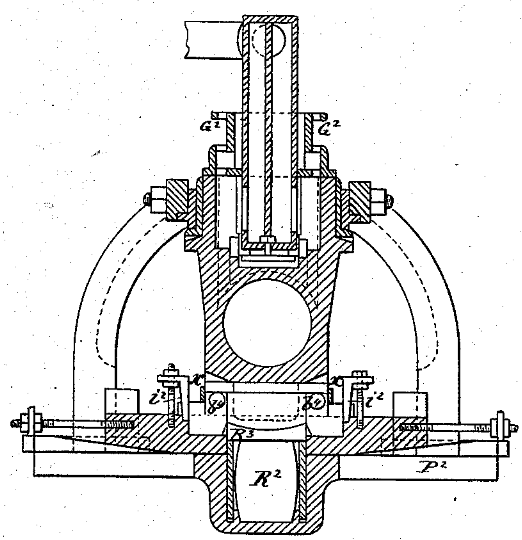


Fig. 12

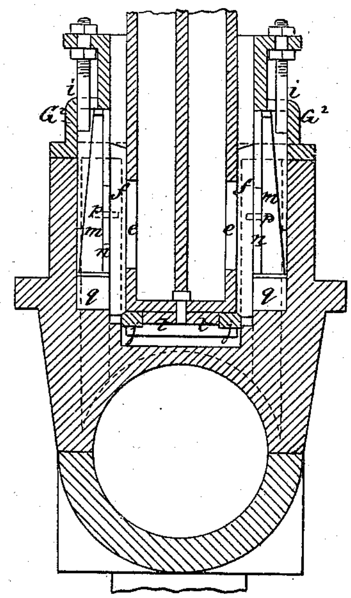


Fig. 11.

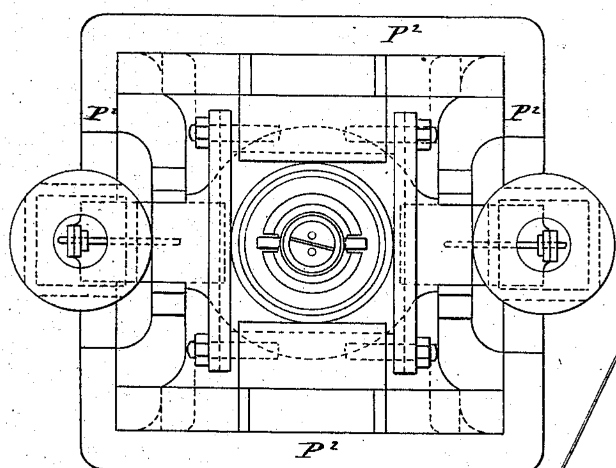


Fig. 13

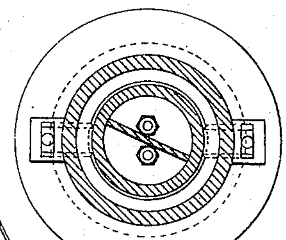


Fig. 14.

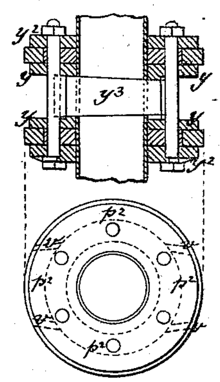
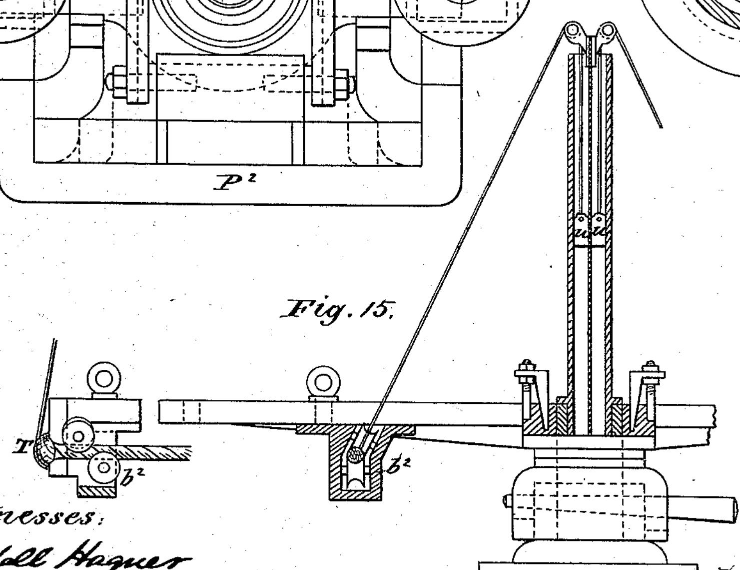


Fig. 15.



Witnesses:

Randall Hagner

Edmund Masson

Inventor:

Philip R. Voorhees

UNITED STATES PATENT OFFICE.

PHILIP R. VOORHEES, OF WASHINGTON, DISTRICT OF COLUMBIA.

IMPROVEMENT IN STEERING APPARATUS.

Specification forming part of Letters Patent No. **162,720**, dated April 27, 1875; application filed January 21, 1875.

To all whom it may concern:

Be it known that I, PHILIP R. VOORHEES, of Washington, in the District of Columbia, have invented a Steering Apparatus for Ships and other navigable vessels, of which the following is a specification:

The object of this invention is to move a ship's rudder easily and quickly, and to have it under as complete control as volition itself. In order to accomplish this object, this invention utilizes both hand and hydraulic or pneumatic power, and also that of steam.

The said invention consists of a winding mechanism and a hydraulic or pneumatic engine operated by said mechanism, or by an ordinary hand steering-wheel and ropes, or by both. The winding mechanism itself is operated by power transmitted from a revolving shaft by means of belts, or by the frictional contact of a pinion on said shaft with the pulleys or gear-wheels, which form part of said mechanism.

The operation of this winding mechanism is directly controlled by an auxiliary hand steering-wheel, and also by the main steering-wheel, through the intervention of the hydraulic engine.

The main steering-wheel may be used alone to actuate the rudder, as well when connected either to the winding mechanism or to the hydraulic engine, or to both of them, as when disconnected therefrom, and the auxiliary steering-wheel may be used in conjunction with either the main wheel, the winding mechanism, the hydraulic engine, or all of them, as is hereinafter fully described.

Beyond providing for the prevention of shocks to the mechanism and helmsman from the violent action of heavy seas upon the rudder by the use of the hydraulic engine above mentioned, the connections of the several moving parts of this machine consist only of ordinary flexible hide or other rope, and chains and rods where desired, so that, whatever shocks may occur, there can be no rigid connections to be broken, jammed, or worn, such as are usually found in steam and other tooth-geared steering mechanisms.

In the drawing forming part of this specification, Figure 1 is a general plan of the whole mechanism. Fig. 2 is an elevation looking aft, omitting the main and auxiliary hand steering-wheels. Fig. 3 is an elevation, looking forward, of the hand steering-wheel and its auxiliary wheel or sector. Fig. 4 is a longitudinal vertical section through the steering-engine, omitting the main and auxiliary hand steering-wheels.

The remaining figures illustrate details, to be hereinafter described.

The principal working parts of this apparatus will now be described, in order that the principles governing its construction and operation may be clearly understood; it will afterward be described more in detail.

To the stock of the rudder may be attached drums, yokes, or tillers, all of these devices being common attachments for obtaining leverage for moving the rudder.

In the drawing, A is a yoke or two-ended lever, mounted in suitable bearings on a vertical shaft, A^2, and moving in a horizontal plane through part of a circle. This yoke may be placed in any convenient part of the ship, but, if in a steamer, preferably in the shaft passage or alley, or in some part of the ship easily accessible from the engine-room and close upon the keelson. B is an arm of yoke A, connected to the piston-rod C by a pin, *d*, which passes through the end of the arm B, held between the jaws of the socket D on the end of the piston-rod C. This piston-rod, with its piston E, reciprocates in cylinder F, oscillating in a horizontal plane upon vertical trunnions.

If preferred, the oscillating cylinder may be connected by its piston-rod directly to a tiller attached to the rudder, instead of to the intermediate yoke A; but such a plan is not thought advisable. The upper trunnion of cylinder F is bored out; in it is placed and from it rises a stand-pipe, G, divided longitudinally by a partition into two compartments or pipes. Near the base of the stand-pipe are two ports, *e e*—one in each division of it. These ports are kept in communication alternately with each end of the cylinder as it oscillates by means of the packed plates or valves *f f*. At the top of the stand-pipe G two pipes, H H, branch off—one to starboard and the other to port; and each pipe connects with one of the hydraulic elevators or pumps

P P. Two other pipes, K K, provided with check-valves *k k*, form another connection between the pipes H H and the pumps P P. From these pumps also two pipes, L L, lead overboard. The sea-water flooding the upper chambers *c c* of the pumps through the pipes L L passes on into pipes K K, thence through the check-valves *k k* into pipes H H, and through them into each division of the stand-pipe G, and thence into each end of the cylinder F, which is thus always kept flooded. This being the case, it can readily be seen that the traverse of the piston E will expel the water alternately from each end of the cylinder through one or other of the pipes H H, into one or other of the elevating-pumps P P, when it will raise one or other of their pistons *b b*—each check-valve closing as the piston E approaches it. The pistons *b b*, being connected by their rods *r r* and links to the vibrating pulley-frame M, will elevate one of its ends and depress the other. These check-valves might possibly be dispensed with, for the water always flooding the pump-chambers can enter the cylinder through the pipes H H when the frame M is in mid-position, or when either of the pistons *b b* is raised above its mid-position; but when moving the rudder rapidly, the water might not fill the oscillating cylinder, through the various ports and passages, fast enough from this source; hence, as a matter of precaution, the check-valves *k k* have been provided. S is a revolving shaft; in the drawing it represents the propeller-shaft of a steamship; but a shaft driven by a separate and smaller engine than the main engine or engines may be used if desired. On this shaft are either forged or keyed pulleys *a a;* or the shaft alone may be used instead of the pulleys, if it have sufficient diameter. For this reason but one of these pulleys is shown in the drawing. Below the shaft S, provided with bosses and end journals N, mounted in bearings on top of the two pillow-blocks B^2 B^2, is the vibrating frame M above mentioned, in which frame are journaled, in suitable bearings, the winding-pulleys a^2 a^2. Upon any deck of a vessel, in any convenient position, either forward or aft, is placed an ordinary hand steering-wheel, W, having its axis or drum mounted in suitable bearings. On its axis is fitted an additional or auxiliary smaller wheel or sector, V, the hub of which fits loosely upon the axis of the wheel W, so that the latter can freely revolve within it. Ordinary rawhide or other wheel-ropes D^2 D^2 connect the hand-wheel W with the arms of the yoke A, and suitable tiller-ropes D^3 D^3 connect said yoke with the rudder. All of these ropes are passed through necessary fair-leaders.

Rawhide or other suitable ropes E^2 E^2 also connect the arms of the yoke A with the winding-shafts *s s*, to which one end of each rope is secured. The other ends of these ropes, attached to the arms of yoke A, may, instead of being rigidly secured thereto, be passed through double-sheave leading-blocks b^2, attached to the arms of the yoke. The ropes in such case will be provided with stops or toggles T T and weights *u u*, so that, when unwinding from one of the shafts *s s*, the ropes cannot foul or kink, but will overhaul through the sheaves in the arms of the yoke, and pass over fair-leaders into any case or tubes that may be provided for them. Thus all slack rope due to its stretching, or to non-use of the winding-shafts *s s*, will be taken up. The drawing shows such weights suspended in a divided tube affixed to the yoke-center or vertical shaft A^2, upon which the yoke turns; but these tubes may be attached, if desired, to any suitable part of the ship, and will then act just as efficiently as when arranged as shown in the drawing. Belts O O, of any suitable material, or, instead of belts, rawhide or other ropes *o o*, running in grooves *g g*, connect the pulleys a^2 a^2 on winding-shafts *s s* with the driving-pulleys *a a* on the main shaft S. Two other ropes, R R, of wire or other suitable material of small cross-section, now connect the ends of the vibrating frame M with the smaller wheel or sector V, and the apparatus is complete.

Its mode of operation and the method of controlling its operation are as follows: When the sector V stands vertically, it is in the center of its extreme movement on the axis of wheel W, and both the pulleys a^2 a^3 are in their mid-position also, and so remain until either one is thrown in gear, in the manner now to be described. It will be here observed that, the chambers *c c* of the elevating-pumps P P being always flooded by the sea, the pressure of the sea upon the diaphragms c^2 c^2 in said chambers always keeps the vibrating frame M and sector V in mid-throw, whenever the frame M is not forcibly depressed upon one side or the other. The frame M, being thus held *in equilibrio*, requires very little power to move it, for, when depressed on one side, the upward pressure of the sea on the other compensates for most of the power which would otherwise be required to depress it. By a very slight expenditure of hand-power, therefore, through a very small arc of a circle upon the axis of wheel W, the sector V will be depressed, either to starboard or to port, and raise or depress correspondingly one end of frame M, so that the pulleys a^2 a^2 will be thrown, the one toward shaft S, the other away from it, the latter motion tightening one of the belts O O. Now, either belt being thus tightened will, by the revolution of shaft S, communicate its motion to its own pulley, which, in turn, will wind up its rope E^2, and unwind its opposite fellow rope E^2 from the other winding-shaft *s*, through the intervention of the yoke A. This movement of the yoke will, through the connection of the tiller-ropes D^3 D^3, move the rudder either to starboard or to port, as may be desired.

The yoke A, being also connected to the wheel W on deck by the ropes D^2 D^2, will cause it at the same time to revolve without any manual labor whatever. This hand-wheel W, by thus revolving, will act as a tell-tale of the speed of movement of the rudder, as well as of its angle. But just as the rudder comes hard over to either side, the helmsman will feel the full winding force of the engine, (the rudder having ceased to move,) drawing the frame M up, and slacking the belt, and thus compelling him to yield his pressure upon sector V until one of the belts O O becomes slack. The winding-ropes E^2 E^2 should lead each from its winding-shaft at an angle between twenty-two and a half and forty-five degrees from the horizontal, when the ship is on an even keel. If leading horizontally, there would be but little or no strain upon the helmsman due to the winding of the rudder; if vertically, the whole strain of the rudder's resistance would be upon the helmsman. The best angle would, therefore, be that so far removed from the horizontal as to bring a heavy strain when the rudder comes hard over to either side, sufficient to remind the helmsman of the fact. The helmsman will thus be prevented, both by sight and feeling, from breaking the winding-ropes by continuing the winding action—indeed, if he be able to do so—after the rudder has come hard over.

It will be observed that when the rudder is hard over to either side the piston E is at the end of its stroke, and that, therefore, the auxiliary lifting action of the pumps P P upon the vibrating frame M ceases. It will thus be seen that either the wheel W or the sector V may be used in steering, or both, as may be preferred. They reciprocally interact, for motion in the sector moves the wheel through the intervention of the winding mechanism, which moves yoke A, to which the wheel is attached, and the wheel W moves the sector, through the intervention of the yoke A and the hydraulic engine, which together move the frame M, to which the sector is attached. By lashing the sector and wheel together, when the ship comes to anchor, very little motion could take place in the rudder from the force of the sea, but it would be more prudent to lash the wheel to some fixed support. The sector V may be placed either forward of or abaft the wheel W, on its axis; and, in addition to or instead of its spokes, rods may depend from the hub to the deck, which, passing through suitable guides, should be provided with pedals beneath the large wheel W, and near the deck, so that the helmsman can conveniently, even in heavy weather, brace himself, and still bear upon the pedals with his foot, while tending with his hands the wheel W. If preferred, however, rods or lines may be led from the vibrating frame M to the deck, and there be connected to any hand or foot gear convenient to the helmsman, and not connected to the axis of wheel W. Similar lines, wires, or rods may also lead from the frame M to any convenient part of the ship, such as to the bridge or to horse-blocks, for the use of the officer of the deck, independently of the helmsman.

It is believed that, with a little practice, great dexterity in managing this steering mechanism can be acquired, for should the piston E be forced into too rapid motion by the violent action of the rudder in a heavy sea, it can be instantly checked in its movement by a slight depression of the sector V, or one end of frame M itself, which, by depressing one end of frame M, causes one of the pistons *b b* to lap the ports c^3 c^3 and c^4 c^4 in one elevating-pump, permitting of the escape of no more water therefrom, and thus effectually stopping, or, if desired, only retarding, the action of the rudder.

Thus it will be seen that the helmsman need have no charge of this steering mechanism, other than to turn the sector V a part of a revolution, or the large wheel itself a certain number of revolutions, either to starboard or to port, just as has been the custom among seamen since the wheel and axle were first applied to actuate the rudder. Should the wheel W not instantly respond to the movement of the sector V, it can be immediately moved by hand the required number of spokes, though of course this will require a greater manual effort, without any regard to the sector, which may be abandoned at any moment by entirely ignoring it. The helmsman has no concern as to whether the shaft S be backing or revolving ahead, for the pulleys work in perfect harmony, whether the shaft revolve to the right or to the left, so that he can port or starboard the helm to move the ship's head without regard to the forward or backward motion of the screw-propeller or its shaft, though, of course, not without regard to the fact of the ship's having either headway or sternboard. His movements in these cases are precisely the same as with the ordinary hand steering-gear. For those steamships at times under sail alone, and which then drag their screws revolving, this apparatus is quite as efficient as if they were steaming; for a very few revolutions of the screw per minute would furnish ample power to turn the pulleys with sufficient speed to move the rudder fast enough for the headway of the ship. If desired, a smaller screw-propeller and shaft may be especially provided for this purpose. By this means, whenever the ship had sufficient headway, ample power would be furnished by this dragging screw-propeller and its revolving shaft to actuate the pulleys, no matter how that headway was obtained, whether by the use of sails or steam. While this whole steering mechanism should be under the charge of the engineer department of the ship, (if a steamer,) and under the constant inspection of the engineer officer of the watch, it can be managed by any man of ordinary intelligence; and should it be necessary, for any reason, to dispense with its use, it can instantly be disconnected, leaving the hand steering-gear intact, by simply withdrawing the pin *d* from its socket D. When once properly erected, the durability of this steering mechanism would be very great, and its adjustments few and very simple, and but seldom would either be required. If a separate steam-engine be used for actuating the winding-pulleys a^2 a^2, its shaft need, of course, revolve in but one direction, and a belt may be led from its shaft to a counter-shaft placed above the propeller-shaft, from which counter-shaft belts may lead to the winding-pulleys and to the propeller-shaft, by which common method of arranging pulley-shafts either the propeller-shaft or the shaft of the special engine may be used, as desired, for actuating the winding mechanism. In this case a rod or line should connect the frame M or sector V with a common throttle-valve in the steam-pipe of such engine. This throttle-valve should have no seat, but, like an ordinary damper, should revolve in either direction. When athwart the pipe, it should leak enough to keep the engine moving slowly, and when either arm of the throttle were pulled by either end of frame M, it would then instantly open full wide, giving steam enough to drive the pulleys while one belt remained tight; and when the belt was slacked up, the throttle would be brought again athwart the steam-pipe, and the engine be slowed to the ordinary consumption of steam for pumping or other purposes.

By keeping this engine always turning its centers slowly when not driving the pulleys, all danger of condensation of steam in its cylinder and pipes will be avoided.

In adapting this winding mechanism to shafts of high velocities, care must be taken to so proportion the diameters of the pulleys and winding-shafts as not to force the rudder too suddenly into motion from a state of rest, or too quickly over from one side to the other.

It is evident that steam or water from the bottom of a boiler having sufficient steam-pressure within it might be introduced through suitable valves in the stand-pipe G of the oscillating cylinder, and the rudder could thereby be actuated, thus dispensing entirely with the winding mechanism and the elevating-pumps; but the size of the oscillating cylinder would thereby be necessarily increased, involving a loss of economy in consumption of steam. Provision would also be required to be made for starting the rudder by hand when amidships, for then, the piston being on its center, it could not be moved by any force within the cylinder until thrown off its center by moving the cylinder, by some force external to it, to either one side or the other.

The following is a description of a special adaptation of the hydraulic engine forming a part of this invention: It has already been observed that said engine can be used independently of the winding mechanism by moving the rudder by hand alone. It then acts as a most efficient "relieving-tackle," or, rather, as an automatic substitute therefor. Ropes can be passed from either a hand-tiller directly attached to a rudder, or from a wheel, to a yoke similar to A, of any size suitable for a large yacht or coaster, as well as for a steamer or sailing-ship. Now, by moving this hand tiller or wheel, the yoke would move, and in moving would move the piston in the oscillating cylinder, which action would elevate one end of a simple beam connecting the piston-rods of the elevating-pumps and depress the other, thereby depressing one of said pistons, and causing it to lap the ports in one of the elevating-pumps. A perfectly automatic substitute for either hand-tiller ropes or relieving-tackles is thus constituted, which could be placed below in the hold of the vessel, in any convenient position, ready to be hooked on by the ropes passing through the deck upon the approach of bad weather. Thus a yacht could conveniently carry a hand-tiller instead of a wheel, quick handling being very desirous for such vessels.

It is obvious that if a small wheel or reel be attached to the end of the tiller grasped by the helmsman, and a simple band or hub similar to that of sector V be placed upon the rudder-head, and ropes from it be led to the reel, and to the beam connecting the elevating-pumps P P, the beam can be operated independently of the tiller, for, in a following sea, it might be important to "meet" the helm; and by operating the beam independently of the tiller the advance of the rudder from amidships can be checked as readily as its retreat toward amidships is checked by operating the tiller itself. But this hydraulic engine need not necessarily be hydraulic. By simply letting the pipes L L open into the atmosphere instead of into the sea, a perfectly automatic pneumatic engine is substituted for a relieving-tackle. In such case, however, a greater displacement of piston might be required.

The ropes D^4 D^4 lead directly from the axis of the main steering-wheel W to the rudder as extra or spare wheel-ropes, if it be desired to use them.

Thus it will be seen that this steering mechanism has an automatic hydraulic or pneumatic relieving-tackle always hooked on, if desired, and as many wheel-ropes and tiller-ropes as any occasion may require. Several ropes may break, and yet the integrity of the machine be in no wise impaired, nor the safety of the ship endangered. Should a small screw-propeller and shaft be specially used for actuating the driving mechanism by dragging the screw revolving, a cheap power is always at hand, either to be used in steering when under even moderate headway or in sheering when the ship is at anchor in a tideway. The screw-propeller could be placed under the counter of either a steamer or sailing-vessel, quite out of the way, or it might be placed low down under the bows; the consequent retardation of the vessel would be inappreciable.

The following is a description of certain details of this apparatus which are considered essential to its greatest efficiency, though, for some of them, ordinary and simpler substitutes may be used, in the discretion of the constructing engineer, accordingly, as seen in Fig. 12. I prefer to use the valves *f f*, which are intended to be simple plates of either wood, such as lignum-vitæ, or metal, packed at their backs by a sheet or strip of india-rubber or other elastic packing. They are in shape nearly parallelograms, and are adjusted by the keys *i i* and gibs *m m* at their backs. These valves and their packing are contained in the recesses cast for them in the upper trunnion and stand-pipe stuffing-box G^2, and, as packed, are capable of ready and accurate adjustment, for their upper edges may be pressed upon by the packing in said stuffing-box, or the bottom of the stuffing-box may be entirely closed, if preferred. Their bottom edges rest upon the stand-pipe packing-ring *j* at a slight bevel. The gibs *m m*, back strips of gum *n n*, and through them by pins *p p*, are connected to the valves *f f*, and rest upon blocks of gum *q q*, with metal washers interposed between the bottoms of the gibs and the blocks of gum. It will be observed that the valves *f f* do not lap the ports *e e* in the stand-pipe in width when the arm B of the yoke A is amidships, but only in length. The object of this "negative lap" is to allow the cylinder to oscillate; for it is obvious that if—with this position of arm B—the cylinder were full of water and the ports *e e* entirely closed, the piston could not be moved, and hence the cylinder could not oscillate. The stand-pipe packing which I prefer to use consists of a rubber disk, abutting the bottom of the stand-pipe, backed by a metal disk of similar shape, through both of which two bolts pass from the outside, and are secured by nuts in the inside of the stand-pipe at its base; one of these nuts is in each division of the stand-pipe. This rubber disk *t* is compressed by and reacts upon a ring of wood, *j*, such as lignum-vitæ, or of metal. This ring is cut into segmental pieces, as shown by the lines *v v* in Fig. 14, in order that as it wears the reaction of the gum disk *t* may set it out against the bore of the trunnion and the edges of the valves *f f*, which it meets at a bevel. The elasticity of the whole of this packing in the trunnion will allow of any wearing down of the cylinder, and admit of perfect adjustment, and little or no leakage can take place through this source from one side of the piston to the other.

The pistons or valves *b b* of the elevating-pumps P P, which I prefer to use, are provided with packing of rubber disks and rings of wood or metal, similar to those at the base of the stand-pipe G; but, instead of two bolts being used, one central bolt only is used, which secures two sets of packing-rings in each piston. The main object of using two sets of packing-rings is to obtain length of valve with but little frictional surface. The washers next below the upper and lower rubber disks are adjustable upon the central bolts, and the central washer, in each valve, is fast upon or forms a part of its bolt. This arrangement and the threads on the bolts extended into the bodies of the pistons *b b* allow of perfect setting of the pistons for the purposes of valves.

The diaphragms c^2 c^2, to which the pistons *b b* are connected, as seen in the drawing, are of india-rubber and of a hemispherical shape. They are bolted to lugs on the inner side of the heads or bonnets of the elevating-pumps P P, and are subject to but little strain. They can, therefore, be made of thin gum or rubber, probably not exceeding one-quarter, or at most three-eighths, of an inch in thickness, and be molded to the proper shape, if desired.

These diaphragms exert some pressure as springs in supporting the frame M, in addition to the pressure of the sea; but the frame M may be provided with springs, acting upon its ends from any suitable support, if desired, although the joint action of the diaphragms and the sea or atmosphere is deemed quite sufficient to keep the frame M *in equilibrio* when not in use.

The ports c^4 c^4 are closed or shut off from the annular chambers d^2 d^2, surrounding the barrels of the elevating-pumps P P, and into which the pipes H H open by the packing-rings p^2 p^2 of the pistons *b b* when the pistons are depressed. The area of the holes or ports e^2 e^2 is but half, or less than, that of ports c^3 c^3, which are of equal area with ports c^4 c^4. Only a small portion of water, therefore, is discharged through ports e^2 e^2; the main body of it escapes through ports c^3 c^3 after elevating the pistons *b b*. The ports e^2 e^2 serve the double function of safety-outlets for great and sudden pressure of water, and also allow one of the pistons *b b* to descend, while the other rises, by permitting the water below it to escape through them into the chambers *c c* of the elevating-pumps, and thence overboard.

The cubic contents of the pump-barrels under the pistons *b b* should be so much less than the volume swept by the piston E in the oscillating cylinder that a very small traverse of the piston E would elevate to its full height either one of the pistons *b b*. Fig. 14 shows a piston and packing, which may be substituted for the piston and its packing shown in Fig. 4, presently to be described.

This piston and packing need no further description than that given for the packing at the base of the stand-pipe G, and for that of the pistons *b b*, except that as adapted for the piston-rod a sleeve having two flanges, *y y*, is keyed to a rod, and the gum disks and rings forming the packing are bolted to the end flanges *y y* by bolts passing through said disks and flanges, and through outer flanges y^2 y^2.

One of these bolts may rest upon the head of the key y^3, and thus prevent it from backing out.

To set out this packing the cylinder-head must be removed, which is not the case with the packing shown in Fig. 4, which has been designed expressly to obviate the necessity of removing the cylinder-head for the purpose of setting out said packing against the bore of the cylinder, it being particularly desirable for a steering mechanism to avoid, as much as possible, the necessity of stopping its operation to make adjustments of its parts. In this case the piston-rod is made of a larger diameter to about half of its length, and to it is keyed a recessed conical web or piston-head, 1, on the smaller diameter of the rod, which also abuts against a shoulder or collar on the rod at the junction of the two diameters. A tubular conical follower, 2, slides on the part of the rod of smaller diameter, and covers the key in the conical head, preventing said key from backing out. Over this conical head and follower is passed or slightly sprung the gum-cylinder 3, having its interior shaped like a double cone. Around this cylinder or sleeve of gum are the turns of packing of hemp, or rings of metal, if preferred, and two rings of either wood or metal at each end of the packing. The follower 2 is set up by means of the nut 5 on the end of the piston-rod, having a metal and rubber washer interposed between it and the end of the tubular part of the follower, which passes out of the stuffing-box on the cylinder-head. Thus the packing is set out, and all leakage between the piston-rod and the tubular follower prevented, without taking off the cylinder-head. The only object of making the piston-rod of differential diameter is in order to obtain an equal displacement of space on each side of the piston, and also that the stuffing-boxes on the cylinder-heads may be duplicates of each other, for it will be observed that the tubular part of the follower 2, added to the smaller part of the diameter of the piston-rod, just equals the larger diameter of said rod. If preferred, neither the main piston of the oscillating cylinder nor the pistons *b b* of the elevating-pumps need be packed, but a plain disk or disks of metal or wood may be used. Considerable durability would be thereby secured, and small leakage from one side of the piston to the other would not be of serious account, if friction were thereby diminished. For the same reason the lower edges of the valves *f f* need not necessarily be beveled to rest upon the packing-ring *j* at the base of the stand-pipe. These valves might be finished square, and the leakage due to a small interval between the valves and the ring would not be of serious account.

In the drawing the oscillating cylinder is supposed to be of brass, and its piston-rod is covered by a brass tube. The piston and its follower are of brass, also. This metal or copper is obviously desirable, because of the corrosive action of sea-water, if the cylinder be used as hydraulic and not pneumatic; but the cylinder may be of cast-iron lined with brass. In such case the passages leading to the upper trunnion would not be cast in the cylinder, but would be of brass pipe, like side pipes connecting the upper trunnion with each end of the cylinder.

The upper trunnion is cased within an iron or steel sleeve, s^2, in order to protect the trunnion from wear, and also because of the greater durability of such sleeve when turning in brass bearings. Such bearings and the frames and caps for securing them are clearly illustrated in the drawing.

The lower trunnion is covered by and rests in a brass sleeve or cup, s^3, in order to protect it from wear, and because the bearing-boxes b^3 below are made, preferably, of cast-iron, and also because the anti-friction balls b^4, resting therein and inclosed by the ring or band *x*, are of iron or steel. These balls, however, may be dispensed with, if desired, and the sleeve or cup s^3 be made of wrought-iron or steel, in which case the bearing-boxes b^3 may be made of brass. Below the lower trunnion, and supporting it in a chamber cast in the bed-plate P^2, is a spring, of rubber or other suitable material, R^2. This spring is covered by a cap, R^3, which is fitted into the chamber of the bed-plate, and made, preferably, of wrought-iron or steel, but of brass if the sleeve or cup s^3 be of iron or steel. Said cup prevents the spreading of the gum spring, as can be clearly seen in the drawing. This cap R^3 also forms a bearing for the base of the sleeve or cup s^3, covering the lower trunnion; but the main bearing of the lower trunnion, which carries the bearing-boxes b^3, is kept adjusted by the keys i^1 i^2, so that the depression of the spring R^2 more than, say, one-sixteenth of an inch will bring the whole weight of the cylinder upon said bearing and the balls in the boxes b^3, or upon the boxes b^3 direct if no balls be used. This main bearing B^3 may be supported by springs, if preferred, instead of the base of the lower trunnion. Instead of casting this chamber as part of the bed-plate P^2, a hole may be made therein and a chamber for the spring be separately made and placed either in this hole, or on the top of the bed-plate if there be room enough between the base of the trunnion and the bed-plate to accommodate the spring.

Fig. 9 shows a method of driving the winding mechanism by friction-gearing. The usual scored or V-groove gears may be used, if desired; but they are objectionable not only on account of their own grinding action upon each other and wear, but because of the great thrust likely to be thrown upon them due to their shape by the driving-shaft, should it be the propeller-shaft of the ship, some end thrust of such shaft being unavoidable, due to lost motion, practically never for any length of time totally excluded. Fig. 9 therefore shows on the pinion of the driving-shaft a band or tire,

t^2, of hard rubber, such as is used for the tires of the driving-wheels of traction-engines. The faces of the gears a^3 a^3 may be milled or roughened, if desired, as seen in the drawing, which, being thrown in contact with the rubber tire of the pinion, will cause the ropes E^2 E^2 to be wound up as long as that contact is enforced. Should, however, any system of friction-gears be used, the screw adjustment for the pillow-blocks B^2 B^2 for the end journals N (shown in Fig. 2) will keep the centers of the gears accurately in line with the center of the driving-shaft S, and if the winding-shafts *s s* be prolonged slightly beyond their bearings and be provided with end springs, such springs would take the thrust of shaft S from frame M, and would restore the friction-gears to their proper position when not in contact with their pinion, should the thrust of the shaft have displaced them when in such contact. The winding-pulleys a^2 a^2, driven by belts or ropes, as shown in the main figures of the drawing, have therefore been preferred, because of the less strain upon the frame M and its supports due to possible end thrust of the shaft S, which would be more or less with any kind of frictional gearing, but little or none with the pulleys and belts shown.

When friction-gears are used the winding-ropes E^2 E^2 should lead downward, in order that their winding action should draw them out of contact with the driving-pinion when all the rope is wound up. When the winding-ropes thus lead, the pillow-blocks for the winding-shafts should then be on top of the side pieces of the frame M, as seen in Fig. 2, for then there would be little or none of the winding strain upon the bolts of the pillow-blocks or their caps. For the same reason, when the winding-ropes lead downward the pillow-blocks B^2 B^2 should have caps and bolts, as seen in Fig. 2. But a better arrangement of pillow-blocks, when the winding-ropes E^2 E^2 lead upward, as they should do when pulleys with belts are used, is that shown in Figs. 5 and 6, where there are no bolts to bear any winding strain. The few bolts in the hanging pillow-blocks of frame M have only to bear the weight of the winding-pulleys a^2 a^2 and their shafts, except possibly a slight spring in the end of frame M, and there are no bolts or caps for the end journals N. The upward strain of these journals, due to the winding action of the pulleys, is borne by the crowns of their pillow-blocks, said pillow-blocks being slotted only sufficiently to admit of the insertion of necessary brasses, provided with inner flanges only, and necessary liners under the lower brasses, as clearly illustrated in the drawing.

Having thus fully described this whole steering mechanism, as of my invention, I claim—

1. A vibrating winding mechanism, constructed substantially as described, in combination with a rotary driving-shaft, a ship's rudder, and suitable ropes and levers, whereby the rudder is either moved and held by hand-power alone, or moved in either direction, but not held, by the assistance to the hand-power of power transmitted from the driving-shaft, without the necessity of reversing or stopping the motion of said shaft, all at the will of the helmsman, and in the manner substantially as described and set forth.

2. A cylinder and its piston, oscillating in a horizontal plane, in combination with a hand steering wheel or lever and a ship's rudder, through the intervention of a piston-rod, and suitable ropes and levers, whereby the rudder is actuated and controlled at the will of the helmsman, in the manner substantially as described and set forth.

3. The combination, with the winding-shafts *s s*, of the counterbalance-weights *u u* and toggles T T, attached to the winding-ropes E^2 E^2, whereby the said ropes are prevented from fouling and sudden winding action of the pulleys prevented, in the manner substantially as described and set forth.

4. The combination, with a ship's rudder, of the oscillating cylinder F and its piston, the elevating-pumps P P, connected by a beam, and suitable ropes and levers, whereby the movements of the rudder and its resistance to the helm are controlled by operating the helm itself, at the will of the helmsman, in the manner substantially as described and set forth.

5. The combination of the oscillating cylinder F and its piston with the stand-pipe G and elevating-pumps P P, provided with pipes H H, K K, L L, whereby the pistons of the pumps P P are actuated, in the manner and for the purposes substantially as described and set forth.

6. The combination of the elevating-pumps P P, constructed substantially as described, with the vibrating frame M and its winding mechanism, whereby said mechanism is thrown both in and out of winding operation, in the manner substantially as described and set forth.

7. The combination of the elevating-pumps P P, provided with piston-rods and diaphragms c^2 c^2, with the arms of a connecting-beam, whereby said beam is held *in equilibrio*, in the manner substantially as described and set forth.

8. The combination of the auxiliary steering sector or wheel V with the main steering-wheel W, in the manner and for the purposes substantially as described and set forth.

PHILIP R. VOORHEES.

Witnesses:

EDMUND MASSON,
RANDALL HAGNER.