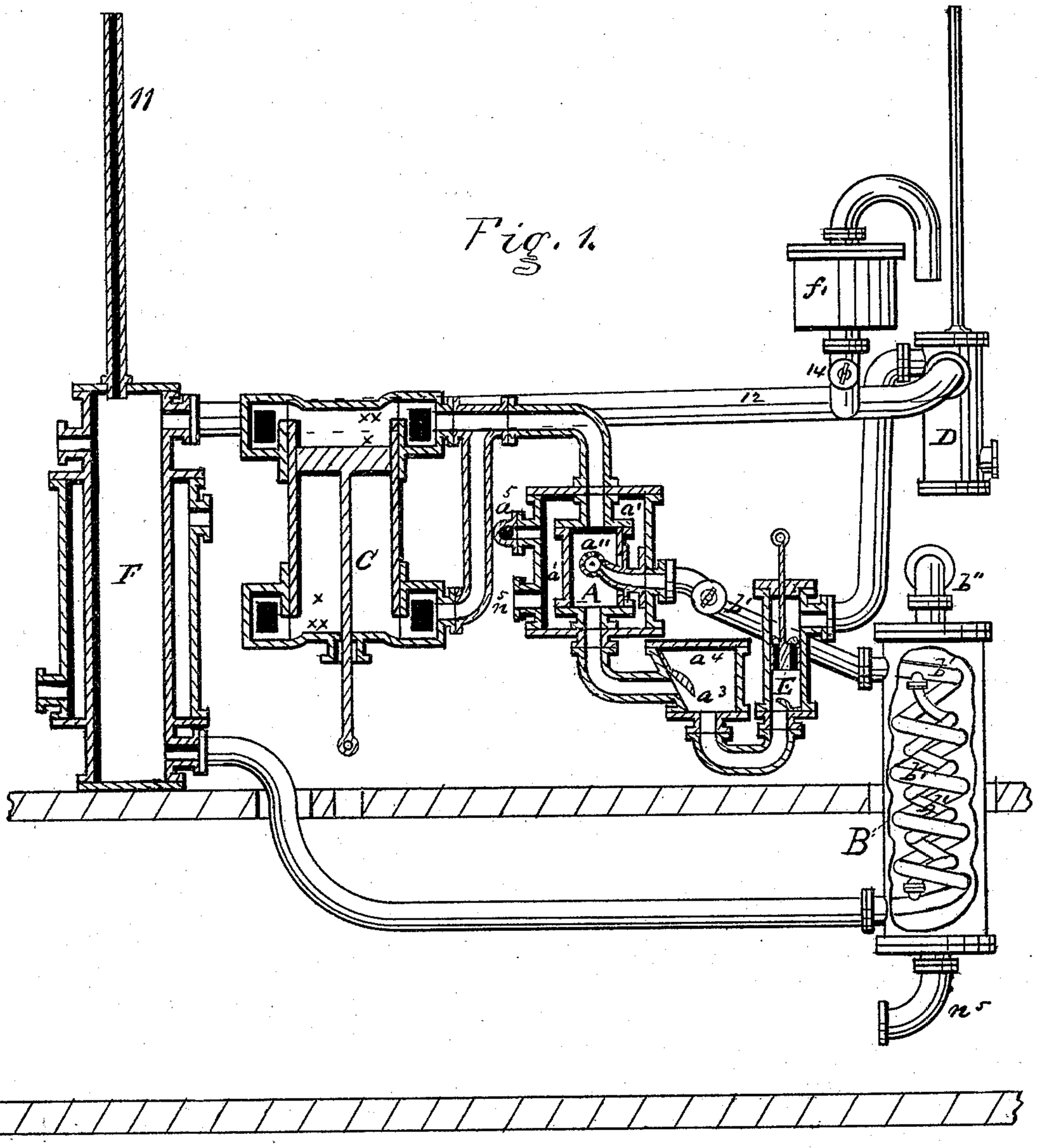
4 Sheets--Sheet 1.

J. HOUPT.

Condensing Apparatus for Marine Steam-Engines.

No. 144,203. Patented Nov. 4, 1873.

Fig. 1.



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4 Sheets--Sheet 2.

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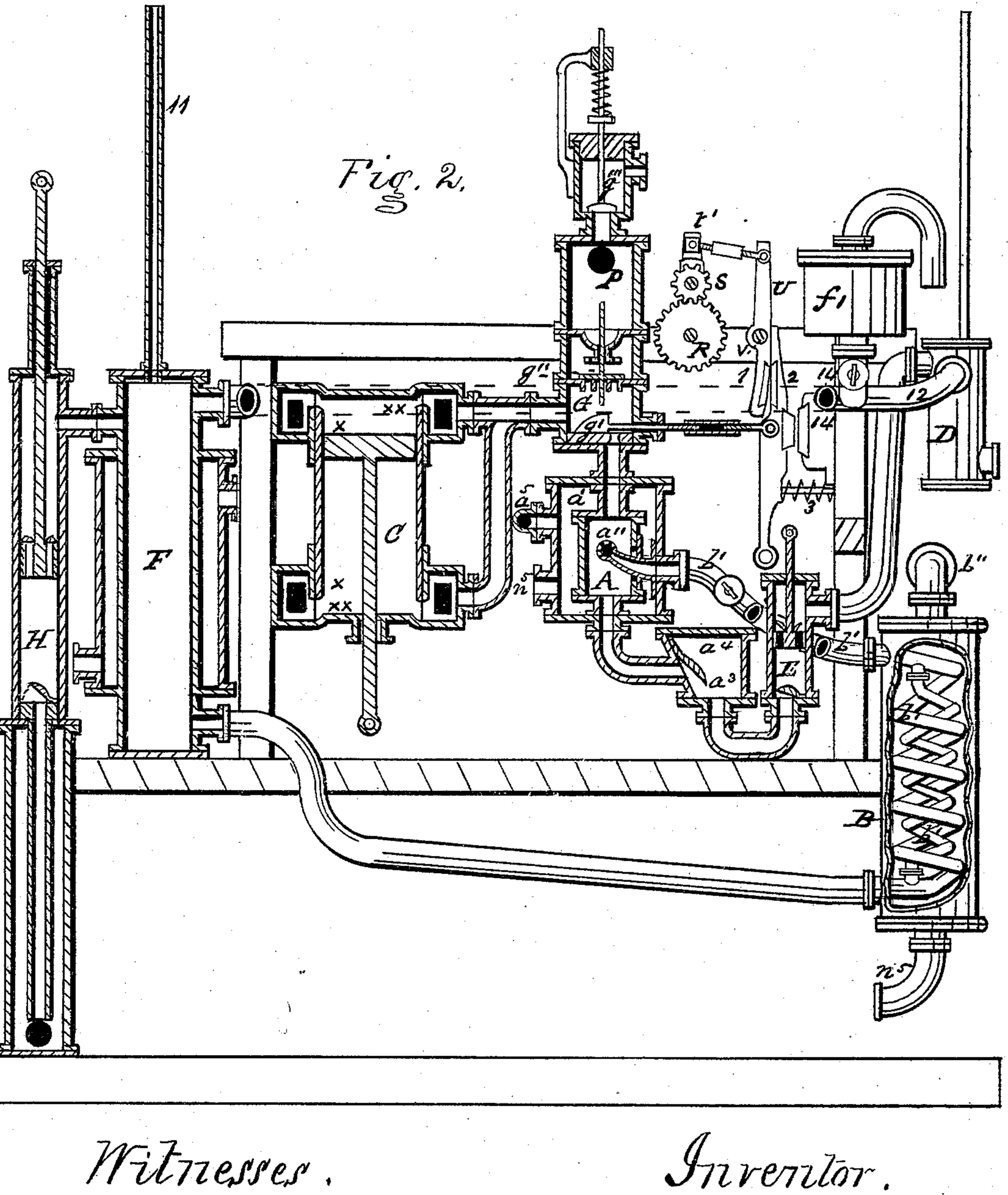
Fig. 2.



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Condensing Apparatus for Marine Steam-Engines.

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Fig. 3.

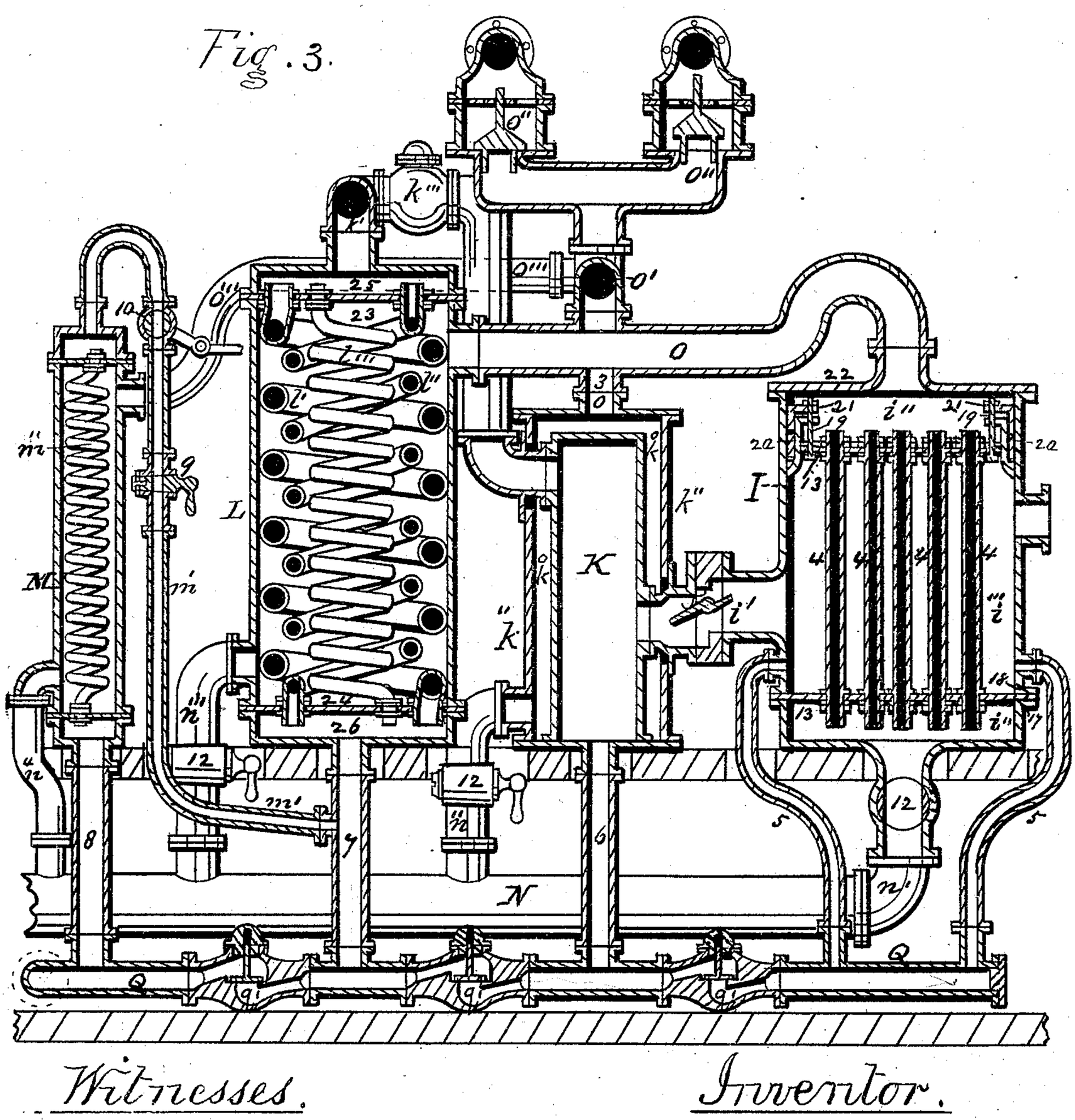

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Fig. 4.

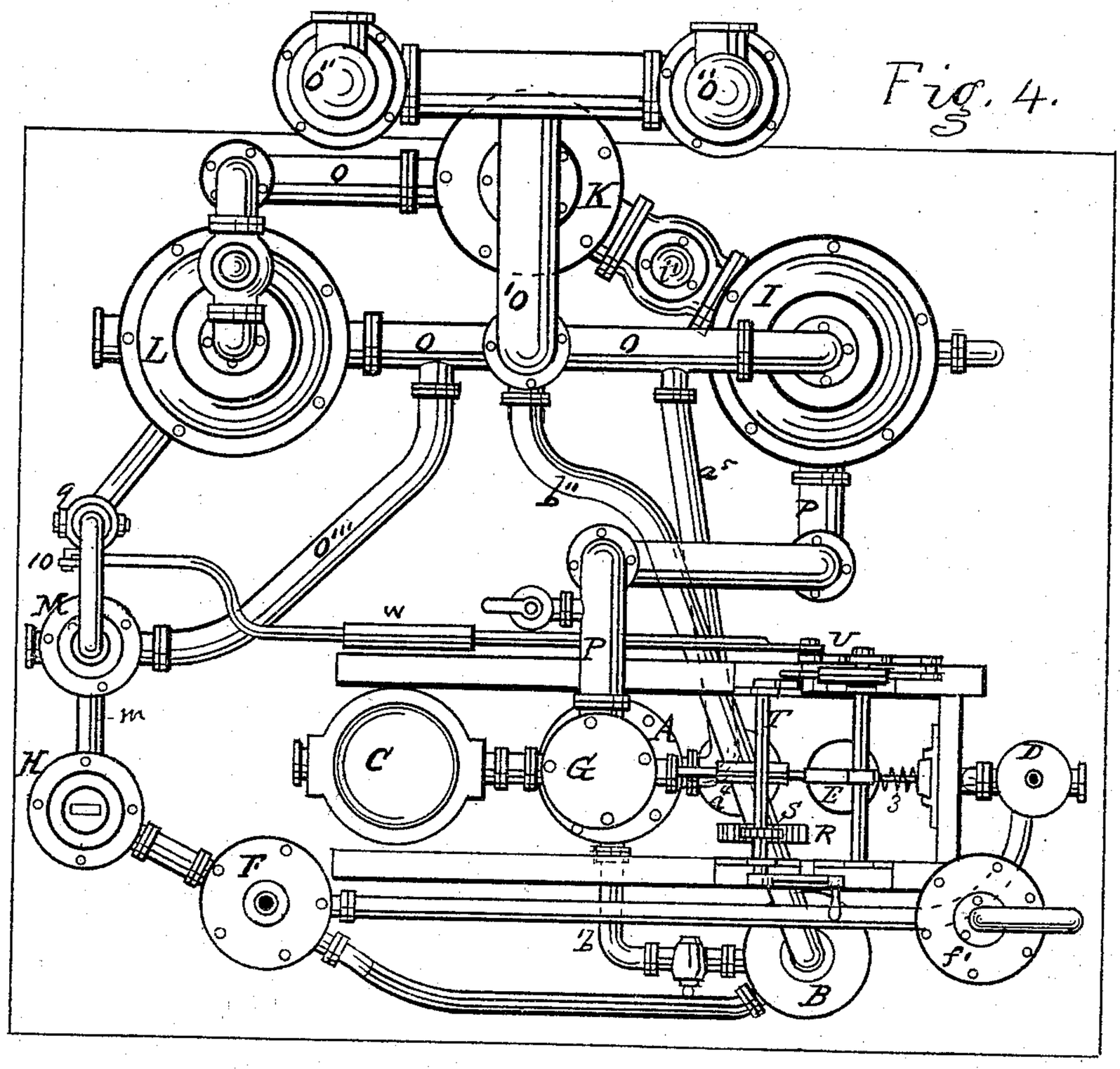


Fig. 5.

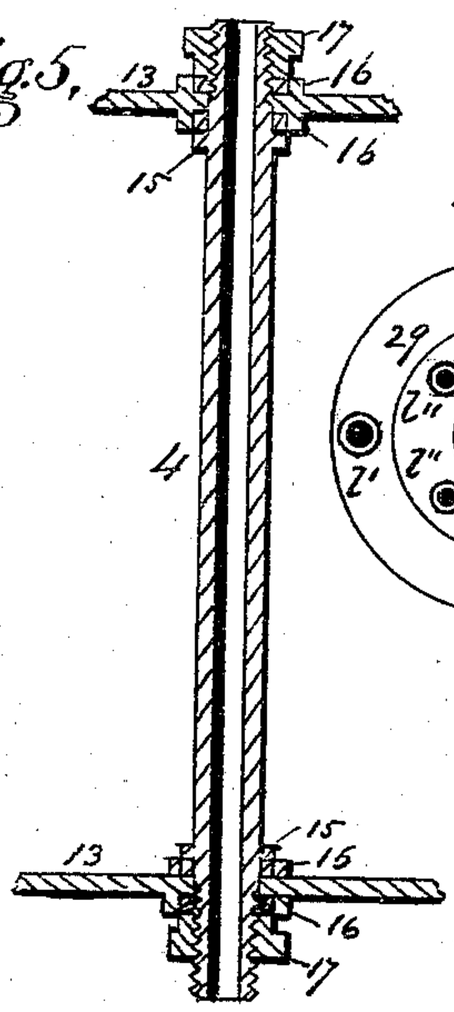


Fig. 6.

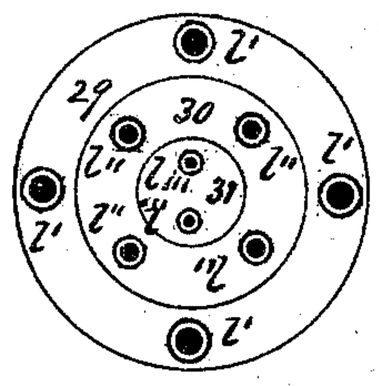
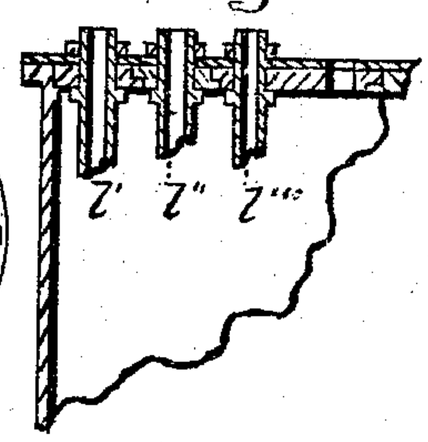


Fig. 7.



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UNITED STATES PATENT OFFICE.

JOHN HOUPT, OF SPRINGTOWN, PENNSYLVANIA.

IMPROVEMENT IN CONDENSING APPARATUS FOR MARINE STEAM-ENGINES.

Specification forming part of Letters Patent No. **144,203**, dated November 4, 1873; application filed August 2, 1873.

To all whom it may concern:

Be it known that I, JOHN HOUPT, of Springtown, in the county of Bucks and State of Pennsylvania, have invented certain Improvements in Condensing Apparatus for Marine Steam-Engines, of which the following is a specification:

The first part of my invention relates to the combination of a refrigerator with an ordinary jet-condenser in such a manner that while cold sea-water is used in condensing the exhaust steam of the engine the said sea-water is prevented from mingling therewith, and all the water within the condenser is discharged therefrom, entirely fresh or free from any saline matter, for using over and over again in the steam-generator, and in the jet-sprinkler of the said condenser.

Another part of my invention relates to the combination, with the said combined jet-condenser and refrigerator, of a dividing-valve chamber, and a plurality of surface condensers having self-closing check-valves, and being connected with an air-pump in such a manner that, as soon as the puff of high-pressure exhaust-steam has passed through the dividing-chamber toward the surface condensers, by raising the self-closing valve in said chamber an inlet-valve, between the chamber and condenser, operated by the engine, suddenly opens to the remnant of steam, which, expanding, enters the vacuum produced and supported by the constantly-running jet-spray in the condenser, and thus the required vacuum before the piston of the steam-cylinder is produced. The larger portion of the puff of exhaust high steam having previously passed through the now closed check-valve into the surface condensers is ultimately condensed therein by cold sea-water without mingling therewith, and the succeeding puffs of high steam, aided by the exhausting action of an air-pump, drive any contained steam and air forward through suitable check-valves, which immediately afterward close and prevent any return of the steam or air, while the water of condensation, free from any saline matter, passes into the hot-well and reservoir for subsequent use, over and over again, in the jet-condenser and steam-generator in the same manner; the said surface condensers are, therefore, partially self-clearing in their operation.

Figure 1 is a vertical section of the jet-condenser and refrigerator in connection with the steam-cylinder, pump, hot-well, and reservoir, with short portions of the entrance and exit-pipes for cold sea-water of refrigerator. Fig. 2 is a vertical section of the same parts that are shown in Fig. 1, and of the dividing-valve chamber communicating with the jet-condenser and the pipe leading to the surface condensers, and showing, also, the air-pump connected to the reservoir for hot water. Fig. 3 is a vertical section of the several surface condensers and a steam expander and cooler, connected together by pipes for supplying cold sea-water for condensing the steam, and pipes for conveying the fresh water of condensation to the reservoir, and showing also the pipe and valves of a circulating-pump, which is not shown. Fig. 4 is a plan view, showing the relative arrangement of the several parts shown in Figs. 1, 2, and 3. Fig. 5 is an enlarged central section of one of the cold-water-condensing tubes, and sections of the tube-plates, and fastening of the same in the surface condenser, which is provided with straight tubes. Fig. 6 is a plan view of the steadying-rings of the tube-plates of the surface condenser, which has the plurality of spirally-coiled steam-tubes therein. Fig. 7 is a vertical section of Fig. 6 and the tube-fastenings.

Referring to Fig. 1, A is the jet-condenser; B, the refrigerator; C, the steam-cylinder of the engine; D, the hot-well for supplying the steam-generator, (not shown;) E, the air-pump for elevating the water discharged from the jet-condenser A to the hot-well D; F, the hot-water reservoir; and *f'*, a "primer," to fill up the reservoir should there be a deficiency of fresh water therein for starting the engine, the said primer to be supplied with fresh water by the condensation of steam generated by a supplementary steam-generator and furnace. (Not shown.)

Referring to Fig. 2, the same parts referred to above will be seen, with the addition of the dividing-valve chamber G and its valves in communication with the jet-condenser A and

steam-cylinder C, and with the addition also of the air-pump H.

Referring to Fig. 3, I is a capacious surface condenser, containing numerous straight condensing-water tubes 4 4, passing through an inclosing steam-space within the said condenser I, which communicates, through a pipe, P, with the dividing-valve chamber G, (see Fig. 4,) and, through a check-valve, i', with the steam-space in the steam expander and cooler K, which, through pipe k', communicates with the upper and lower steam-spaces in the ends, respectively, of the surface condenser L, through a plurality of spirally-coiled steam-pipes, l', l'', and l''', which communicate with another surface-condenser, M, which, being the final condenser, I name "save all." It contains a spirally-coiled steam-tube, l, between two end spaces which communicate with pump H through pipe m. (See Fig. 4.) N is a cold-water supply-pipe, which is intended to communicate, through one side of the ship, with the sea, and, through branch pipes n' n'' n''' n^4, with the condensing-water tubes and spaces, respectively, of the surface condensers I K L M, and circulation of said cold sea-water upward through the said condensers, and finally overboard—produced by means of any suitable double-acting circulating-pump, (not shown,) connecting with the valve-chambers o'' o'', and with the condensing-water spaces of the surface condensers. Q is a horizontally-arranged conduit-pipe, which, by means of branches 5 5 6 7 8, receives the fresh water of condensation from the surface condensers, and conveys it to the air-pump H, whereby it, with whatever air it contains, is lifted up into the reservoir F, from which the air escapes through pipe 11.

Referring to Fig. 4, the letters thereon indicate the same parts referred to by like letters in the figures just described. The condenser A (see Fig. 1) is an ordinary jet-condenser, surrounded by a cold-water case, a', through which cold sea-water is intended to pass upward continually. The refrigerator B is a case containing a plurality of spirally-coiled tubes, b' b', for supplying cold fresh water to the jet-sprinkler a''. The cold sea-water is intended to be drawn from the sea by means of any suitable circulating-pump (not shown) attached to the refrigerator and to the cold-water space around the condenser by means of suitable conduits b'' n^5, so that the said cold sea-water will be constantly flowing upward through the said refrigerator-case, and through the space a' of the condenser, to the circulating-pump, and thence overboard, thus cooling down the hot fresh water coming from the reservoir F, and serving also the two-fold purpose of supplying cold sea-water to cool the jet-sprinkler a'' and the space a' of the condenser. The water of condensation, together with the condensing water in the condenser A, passes, by gravitation, down through a check-valve, a^3, into a receiver, a^4, from whence it is forced upward, by the air-pump E, into the hot-well D, from which latter the steam-generator (not shown) is supplied with fresh water. Any deficiency of the supply of fresh water in the reservoir F, at the starting of the engine, is intended to be supplied from the primer f', the said primer to be kept supplied by means of a small supplementary furnace and boiler (not shown) capable of generating enough steam to be condensed for the purpose of making up any deficiency of fresh water which may escape from leaking or otherwise, the condensation being effected by discharging the steam from said supplementary boiler directly into the condensing apparatus, and from thence, by suitable connecting-pipes and stop-cocks, into the primer f', by means of the air-pump E. The said supplementary boiler may also afford steam enough to work a donkey-engine, and the exhaust steam thereof condensed to supply fresh water for the steam-generator of the main engine when the latter is not at work or stopped for repairs.

The parts constituting the apparatus shown in Fig. 1, and just fully described, are sufficient for steamers of the smaller class, but for steamers of the larger class, which afford ample room or space for the addition of a plurality of large surface condensers, I construct and apply the latter, substantially as shown in Figs. 2, 3, and 4.

The upper end of the jet-condenser A is provided with a communicating-chamber, G, and valves g' and g'', whereby the exhaust high steam from the steam-cylinder C is divided or separated into two parts, the larger portion of the puff of steam passing up through the self-closing check-valve g'', and onward, through a pipe, P, toward the surface condensers I K L M, and immediately afterward the valve g' is suddenly opened to the vacuum maintained in the jet-condenser by the constant discharge of cold fresh water from the jet-sprinkler, as before stated, and thus the vacuum before the piston is produced, as required, by the expansion and condensation of the smaller portion or remnant of the puff of steam; and immediately before the next puff of exhaust high steam is discharged from the cylinder the valve g' closes, the water of condensation, together with the condensing water, passing ultimately to the hot-well D or reservoir F, as before described. The pipe for conducting fresh water to the primer f' is intended to communicate with the pipe 12, which connects the reservoir F to the hot-well D, each being also provided with a stop-cock, 14, to control the direction of the said water forced upward by the air-pump E.

The valves g' and g'' are respectively constructed, arranged, and operated as follows, viz: The check-valve g'' is self-closing, and has a short up-and-down motion, the first being produced by the puff of steam from the cylinder C entering the chamber G, and the second or downward motion by its gravitation toward

the condenser A the instant that the valve g' opens to the vacuum in the said condenser. The valve g' is caused to open and close communication between the chamber G and the condenser A by sliding motions produced by means of a rotating cog-wheel, R, in gear with a pinion, S, which latter has exactly half the number of teeth or cogs contained in the wheel R, and is fixed on a crank-shaft, T, the arm t' of which oscillates a cross-arm, U, on the end of a rock-shaft, V. The lower end of the arm U is connected by an adjustable rod, W, (see Fig. 4,) to a governor-valve, 10, in the steam-tube m', Fig. 3, which enters the "save-all" condenser M, and is operated, as will be hereinafter explained, to prevent the impulse of the puff of steam from passing into the said save-all M or blowing through the same, so as to drive out any steam that may have reached the latter and remained uncondensed therein. The upper end of the said cross-arm U, Fig. 4, is connected to the arm t' of the crank-shaft T; and rock-shaft V, which has the arm U, has another arm, 1, which is slightly curved, and during one direction of the rocking motion of the shaft V suddenly and rapidly presses backward a lever, 2, which is of the second order, and connected by an adjustable rod to the sliding valve g', and thus suddenly closes the said valve, and, receding, the lever 2 as suddenly opens the valve, the lever being caused to follow closely the arm 1 by the force of a spring, 3.

The operation of the parts just described in connection with the chamber G, condenser A, and steam-cylinder C, will be understood by the following explanation: Suppose the piston of the steam-cylinder C to be moving in its upward course, and has arrived near x in the upper end of the cylinder. The cut-off slide-valve g' has now just commenced closing the communication between the said steam-cylinder and the small jet-condenser A, and by the time the said piston reaches x the communication will be entirely cut off; and by the time the said piston reaches $x\,x$ the main portion of the puff of the exhaust high steam coming from the cylinder C has raised the check-valve g'' on its way through the chamber G toward the surface condensers communicating therewith; and by the time the piston on its returning course has reached x the valve g' suddenly opens and allows the small remnant of steam to expand, in consequence of the vacuum maintained in the condenser A by the constant action of the jet-sprinkler a' therein, and the consequent closing down of the check-valve g'', thus producing the required vacuum before the piston as it is about to return to the opposite end of the cylinder, when the same conditions are produced in like manner and effect; and in both cases the water of condensation and the condensing water in the condenser A pass down into the receiver a^4, from whence it is elevated by the action of the air-pump E into the hot-well D, as before stated.

On the top of the chamber G there is a safety-valve, g''', which can be readily adjusted to any predetermined pressure of steam in the chamber G, if desirable.

I will now proceed to describe the surface-condensing apparatus, invented for the purpose of saving as much as possible of the fresh water of condensation of the steam, for supplying the steam-generators of the largest class of marine steamers with the same.

The surface condenser I is a capacious chamber containing numerous straight cold-water tubes, 4 4, secured steam-tight in tube-plates, which divide the chamber into two water-spaces, i'' i'', and a steam-space, i''', between the water-spaces. Steam which has puffed through the check-valve g'' passes through the pipe P into the steam-space i''' in I, where it is partly condensed by the cold-water tubes 4 4, and the water of condensation conveyed down through the tubes 5 5 into a horizontal conduit-pipe, Q, which leads to the air-pump H, while the uncondensed steam and air, under the impulse of the puff, pass onward through the self-closing check-valve i' into the expander and cooler K, the said check-valve i' closing, and thus preventing any return of the passed steam or air. The condensing water is drawn, by the exhaustive action of a circulating-pump, (not shown,) from the sea, through a large pipe, N, which is intended to enter the sea through a suitable part of the side of the ship, and open into the water-space i'' of the condenser I, the said sea-water then passing upward through the tubes 4 4 into the space i'' thereat, and onward through pipes o and o', and overboard through the circulating-pump before referred to.

The manner of securing the tubes 4 4 in the tube-plates of condenser I is more clearly shown in Fig. 5; and, therefore, referring to said figure, 15 15 are flanges around near the screw-cut ends of each tube 4, and 16 16 16 16 are flanges around the tube-holes in the two respective tube-plates, which leave flat surfaces between the flanges and hole for the bearings of respective packing-rings, which are compressed steam-tight by the flanges 15 15 of the said tube on one side of the plate, and by flanged screw-nuts 17 screwed firmly against the packing, and thus not only producing steam-tight joints between the ends of the tubes and the end plates 13 13, but providing, by means of the elastic packing-rings, for the usual expansion and contraction of the tubes from changes in their temperature. The lower tube-plate is secured steam-tight, in the usual manner, between the flanges 17 and 18 of the lower portion of the condenser I, (see Fig. 3;) and the upper plate 13 is secured, movably, steam-tight by means of draw-bolts 19 19, whereby the flange of a packing jam-ring, 21, is drawn down upon a packing, 20, which is applied around between the flanged rim of the said tube-plate and the inner side of the wall of the condenser, so as to cause the said packing

to be pressed steam-tight against the latter. The cap 22 of the condenser I is bolted down water-tight upon the flanged upper edge of the wall of the condenser, in the usual manner. The expander and cooler K is a capacious surface condenser, consisting of an inner chamber, without any tubes within it, inclosed by another chamber, k'', which leaves a cold sea-water-space, k^0, around and above the said inner chamber, through which space the cold water passes upward from supply-pipe N through pipe n'', and thence outward through pipes o^3 and o^1 to the circulating-pump before named. The puff of exhaust high steam, passing through valve i', enters, and, expanding in the inner chamber of K, becomes rapidly cooled in consequence, and the water of condensation passes down through pipe C into pipe Q, and thence to the air-pump H, while the steam and air remaining, as such, are driven, by the impulse of the puff through k' and a check-valve at k''', into the upper end of condenser L. The condenser L is a capacious chamber, in which a plurality of spirally-coiled steam-tubes, l' l'' l''', are secured, in a steam-tight manner, in two tube-plates, 23 24, which are secured steam-tight between the flanged edges of the ends of the body and the closing cap and bottom, respectively, of the condenser, and thus divide the whole interior of the condenser into two shallow end spaces, 25 26, and a large middle space, 27. (See Fig. 3.) There are three series of concentrically-arranged spiral coils, l' l'' l''', in the middle space 27, the open screw-cut ends of which project through the said tube-plates, respectively, and are secured in the lower plate 24 by means of flanges around on the tubes, and screw-nuts on the projecting ends, with elastic-packing washers between them; and in the upper plate 23 substantially in the same manner, excepting that, in order to facilitate the application or withdrawal of either of the concentric series of tubes, and especially to hold them in proper relation to the holes in the upper tube-plate, when the same is not in place, I apply three concentric interlapping plates, 29 30 31, (see Figs. 6 and 7,) directly over or upon the flanges around the upper ends of the tubes l' l'' l''', the holes in said interlapping plates corresponding with the holes in the tube-plate 23, the lower elastic washer being placed between the concentric interlapping plates and the end plate 23, so that, when the screw-nuts are tightened, the tubes l' l'' l''' will be secured steam-tight in their respective plates 23 24. There are four of the tubes l' in the outer series, four, l'', in the next series, and two, l''', in the central series, as represented in Fig. 6, and the coils of the outer series are pitched to run the water of condensation down in the same direction, either to the right or left, as that in which the central series runs it, while the series between the outer and the central series are pitched to run it in an opposite direction; the object being to prevent any circular continuous motion in the cooling water through which the several series of the tubes pass. The water of condensation in the spiral tubes runs down into space 26, thence through tube 7 into pipe Q, and onward to the air-pump H, while the remaining steam and air, as such, in the said spiral tubes, pass upward through the branch pipe m' and its regulating-cock 9, and the governor-valve 10 therein, into the upper end of the spirally-coiled steam-tube m'' in the save-all condenser M; the cold condensing water passing from the supply-pipe N up through M, and thence through pipe o''' and onward to the circulating-pump; while water of condensation—if any steam or aqueous vapor shall have reached the said save-all condenser M—passes down through pipe 8 into conduit Q, and thence to the air-pump H.

The check-valves q' q' q', in the pipe Q, operate synchronously with the check-valves of the respective surface condensers, by yielding to the force of the puff of exhaust high steam, and immediately afterward closing, and thus preventing any return of either air, steam, vapor, or water of condensation which may have passed through the same; and the closing of the governor-valve 10, (by means of the devices which connect it with the movements of the sliding valve g' in the chamber G, as before described,) on the closing of the slide-valve in the chamber G, prevents the force of the puff of exhaust high steam from driving the steam or vapor, as such, through the save-all condenser M, and then, immediately afterward, opening gradually, the steam or vapor passes into the condenser M and is condensed to water. Thus the surface condensers I K L M, with their respective valves, operate together to effect the same result; *i. e.*, the preservation of all the fresh water of condensation that may be obtainable from the exhaust high steam of a marine engine.

In regard to the refrigerator B, whereby the warm fresh water of condensation coming from the hot-well or reservoir is refrigerated or cooled down for the jet-sprinkler a'' in A, it is intended that the said refrigerator be constructed of any size, form, and number of tubes therein, that may be required to produce the refrigerating effect upon the warm fresh water passing through it, in steamers of the largest class, which require that a proportionately larger amount of cold fresh water be used in the jet-condenser to produce the vacuum required before the piston of the engine.

In the medium class of marine steamers the surface condenser L may be detached, and the save-all condenser M attached directly to the condenser K, in applying the apparatus to a marine steamer.

I claim as my invention—

1. The combination, with a jet-condenser, A, of the refrigerator B, the reservoirs F and f', the hot-well D, and the pump E, the said parts being constructed and arranged together sub-

stantially as and for the purpose hereinbefore set forth and described.

2. The dividing-valve chamber G, with its dividing-valves g' and g'', in combination with the jet-condenser A, refrigerator B, hot-well D, surface condenser I, expander and cooler K, surface condenser L, save-all condenser M, air-pump H, the governor-valve 10, the self-closing valve i', and the check-valves q' q' in the pipe Q, the said parts being arranged to operate together substantially as set forth, for the purpose of saving all the fresh water of condensation, for using over and over again in the jet-condenser A and the steam-generator of a marine-engine, as described.

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