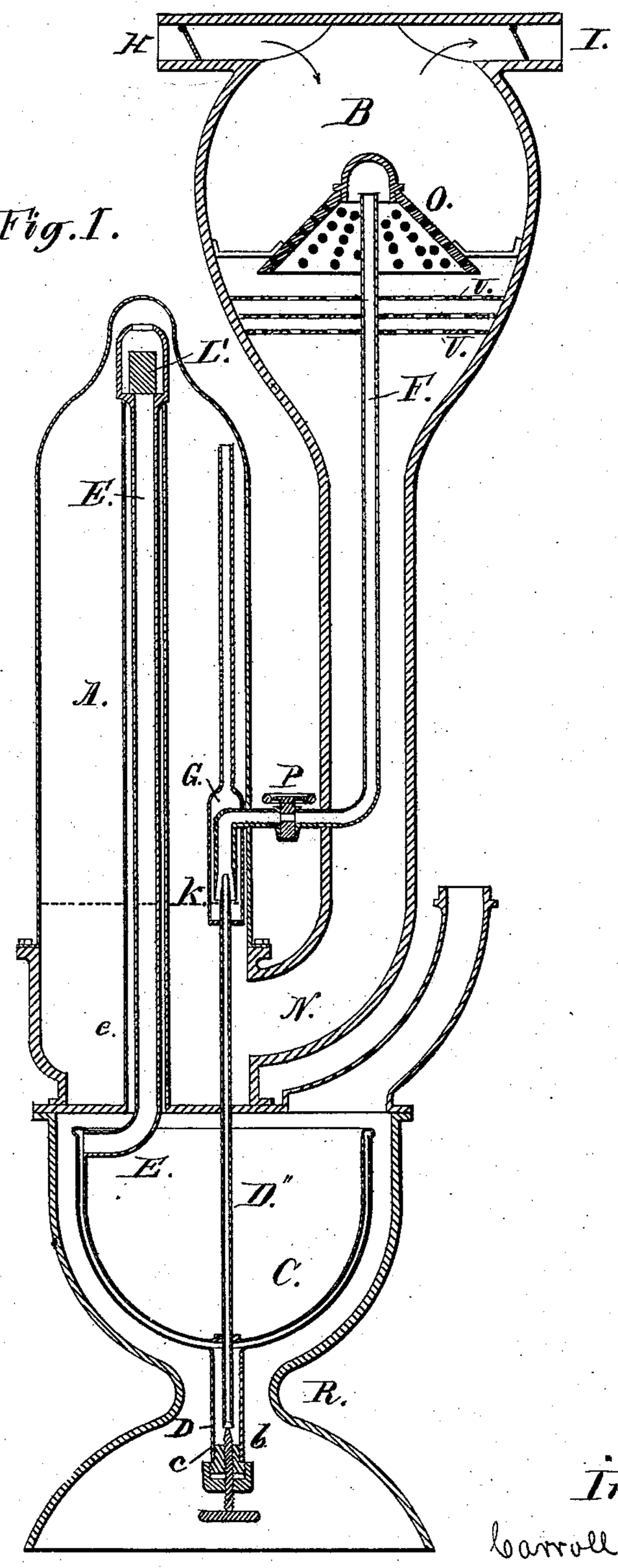
(No Model.) 2 Sheets—Sheet 1.

# C. L. RIKER.

## COMBINED BOILER AND STEAM VACUUM PUMP.

No. 287,579. Patented Oct. 30, 1883.

Fig. 1.




Witnesses
A. W. Steiger.
G. H. Spencer

Inventor:
Carroll L. Riker
By David A. Burr
Attorney.

N. PETERS, Photo-Lithographer, Washington, D. C.

(No Model.) 2 Sheets—Sheet 2.

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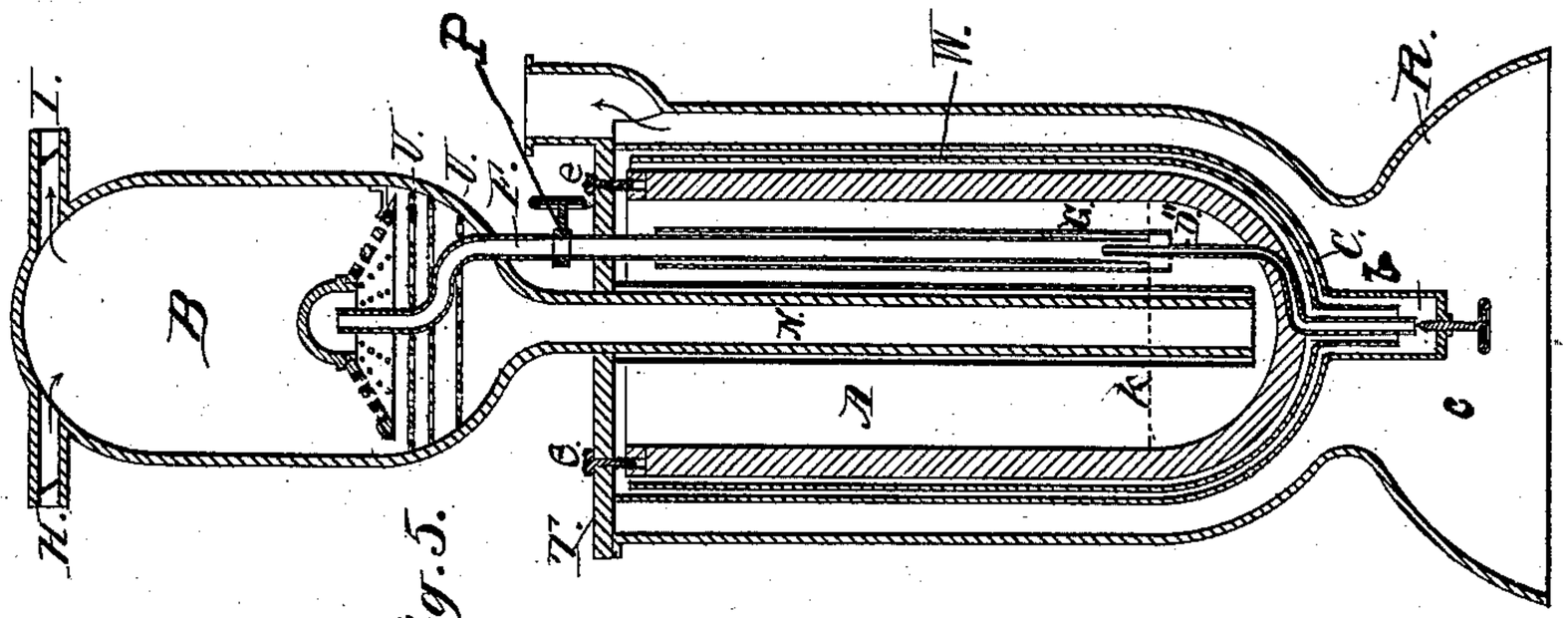


Fig. 5.

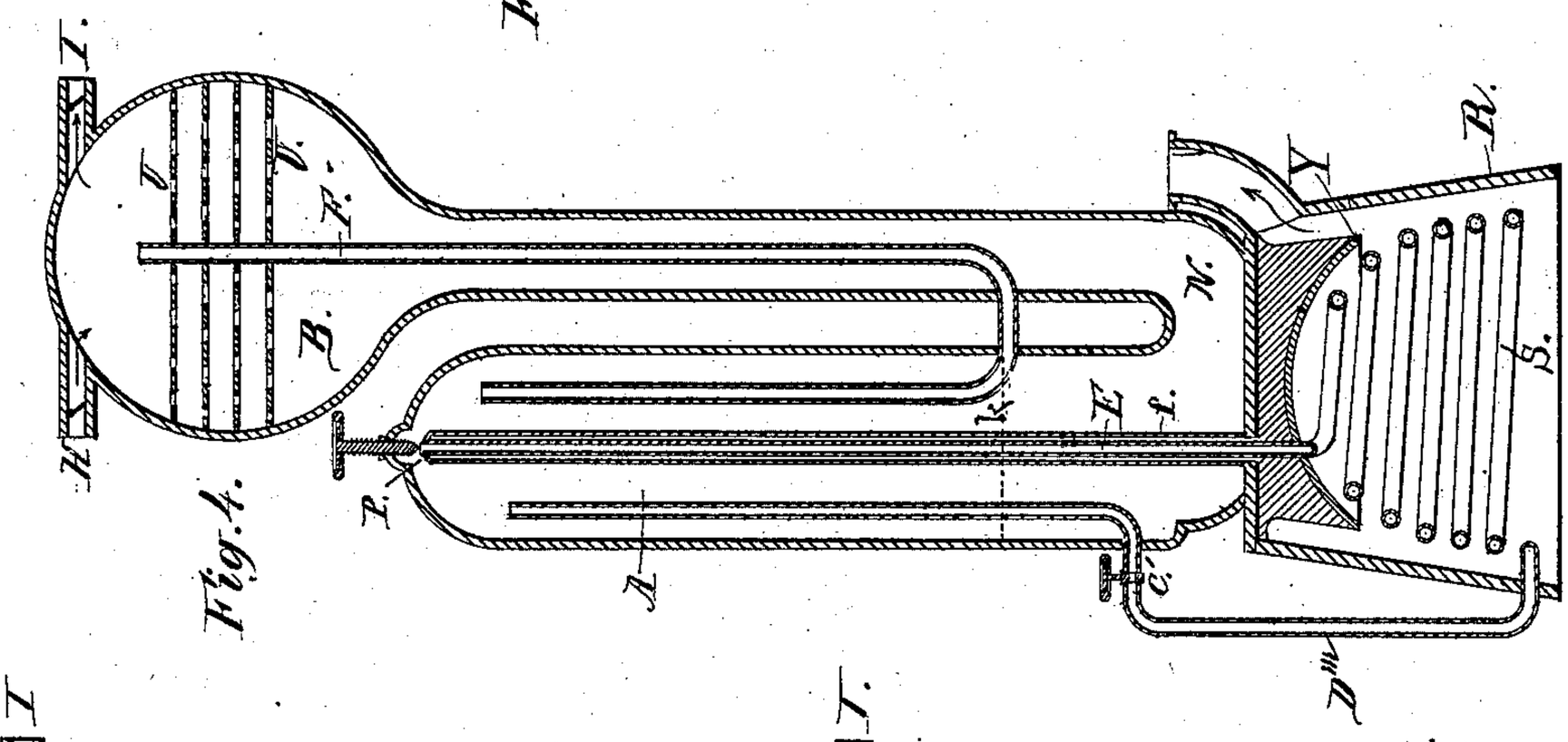


Fig. 4.

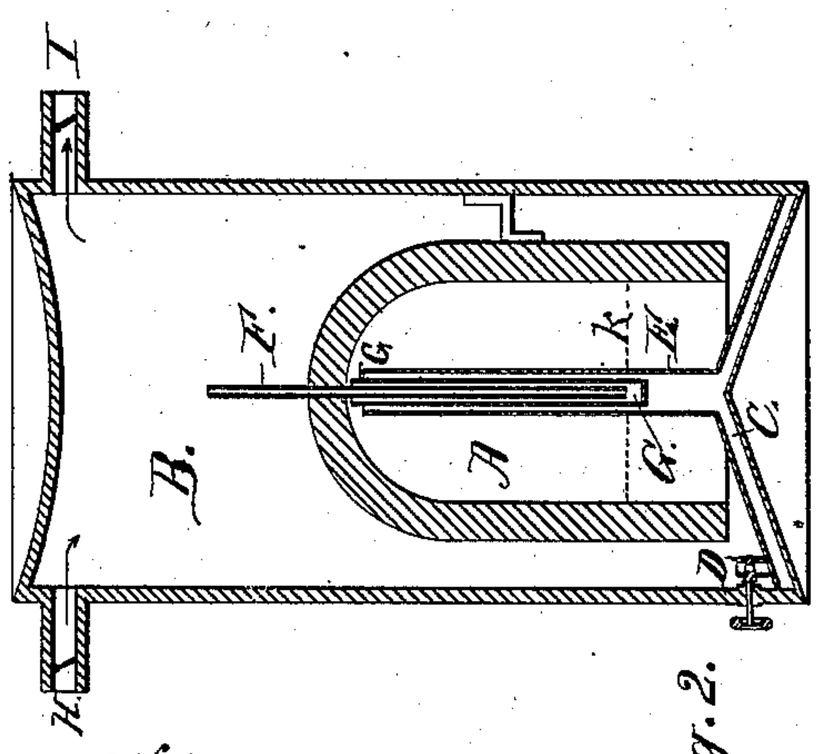


Fig. 2.

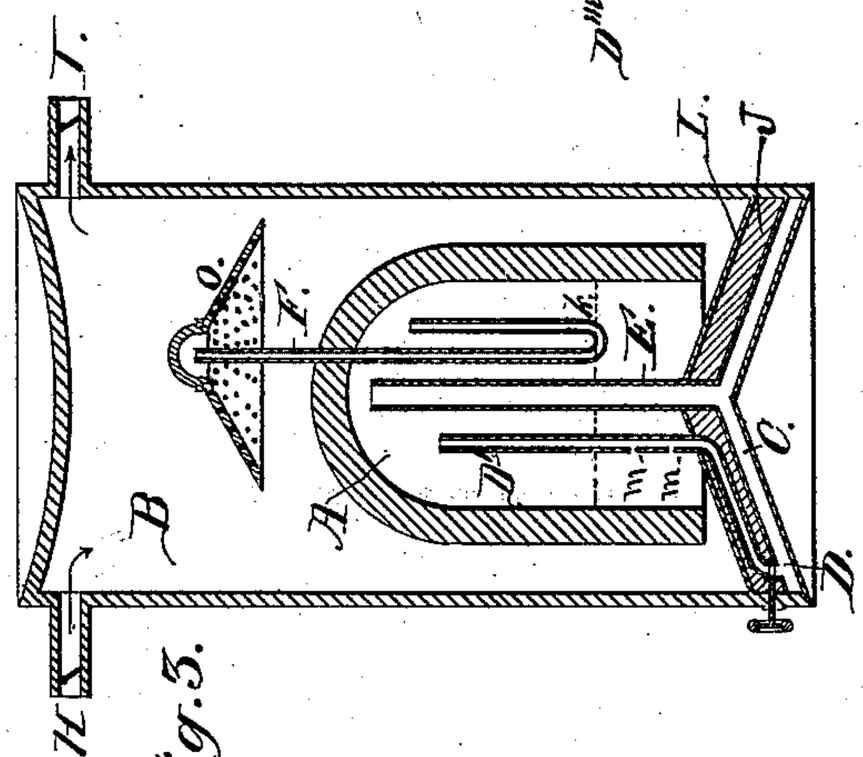


Fig. 3.

Witnesses
A. W. Stiger.
G. H. Spencer

Inventor.
Carroll L. Riker
By David A. Burr
Attorney.

N. PETERS. Photo-Lithographer. Washington. D. C.

# UNITED STATES PATENT OFFICE.

CARROLL L. RIKER, OF BROOKLYN, NEW YORK.

## COMBINED BOILER AND STEAM VACUUM-PUMP.

SPECIFICATION forming part of Letters Patent No. 287,579, dated October 30, 1883.

Application filed April 26, 1883. (No model.)

*To all whom it may concern:*

Be it known that I, CARROLL L. RIKER, a citizen of the United States, residing at Brooklyn, in the county of Kings and State of New York, have invented a new and useful Improvement in a Combined Boiler and Steam Vacuum-Pump, of which the following is a specification, reference being had to the accompanying drawings, made a part thereof.

This invention relates to improvements in the methods of operating and in the manner of constructing that class of steam water-elevators known as "steam vacuum-pumps," in which, without the intervention of any moving part other than the check-valves, the steam is automatically made to force water out of the apparatus, and by subsequent condensation to cause its replenishment.

It consists in an improved method of exhausting the steam from the working-chamber of the pump and from the steam-generator connected therewith, of determining automatically the water-level in the generator, of regulating the water-supply thereto, and of exhausting the water therefrom in the operation of the pump, and also in improved devices for effecting these operations, all as hereinafter fully described.

The apparatus which I employ consists, in general, of a pumping or working chamber into which the steam-pressure is brought to bear upon a column of water; a second water-chamber, (which may be used also as a steam-condensing chamber,) which communicates freely with the bottom of the working-chamber, and is connected, preferably, at its upper end with the water-supply and the discharge pipes of the pump, each fitted with a check-valve; a quick-acting steam-generator of maximum evaporating-surface and of a minimum cubical capacity less than that of the working-chamber, to which it is connected by a steam-discharge pipe opening into its upper end; a water-trapped steam-exhaust tube, of which one arm terminates in the working-chamber, preferably immediately below the open end of the steam-supply pipe, and whose opposite arm opens freely into the water-chamber, the delivery-pipe, or a separate condenser; and a feed-orifice or feed-pipe for supplying water to the generator, either from the water-chamber, the working-chamber, or other source in which the pressure is equivalent to that within said chambers, and whose capacity is so limited or admits of being so adjusted as not to supply the generator with water except as required, nor faster than the supply is vaporized.

In the operation of my improved apparatus, the steam, rapidly produced in the steam-generator, is at once discharged into the upper end of the working-chamber, where, by its pressure upon the upper surface of the water therein, it will force this water out until the water-level in the steam-exhaust tube has dropped below the sealing-point of the trap, and thus opened a free vent for the steam up into the water-chamber or condenser. The water thus forced out of the working-chamber into the water-chamber will displace and drive out through the discharge-pipe an equal volume of water from the latter. The steam escaping through the exhaust-tube, will, by its condensation as it is emitted from the tube, create a draft or suction therein which will operate to draw out all of the steam, not only from the working-chamber, but also from the generator, creating a void, which the water previously forced into the water-chamber will be compelled to flow back therefrom to fill, the consequent void in the water-chamber being supplied by an inward flow of fresh water from the supply-pipe. When the working-chamber is refilled, the exhaust-tube will also refill and be sealed with water, to prevent an escape of steam, until the water-level is reduced, as above described.

My invention embraces various modifications in the general plan, arrangement, and construction of the improved apparatus and in its several details. In one form of the apparatus the working-chamber is formed or placed within the bottom of the water-chamber, so as to be surrounded thereby at top and sides, its walls being made non-conducting of heat. In another form the working-chamber is apart from the water-chamber, the two being connected by a pipe leading from the bottom of the one to the other. In one form of my apparatus the steam-generator consists of

a tubular coil. In another I employ a generator composed of concentric, dished, or concaved copper plates, united at their edges, leaving a very shallow narrow interval between the two in which to vaporize the water. The steam-generator may be placed wholly under the working-chamber, or constructed to encircle it, the outer wall of the chamber being made in such cases, as far as possible, non-conducting. In some instances I use a simple bent tube and in others an inner tube within an outer concentric case, to form the trapped steam-exhaust leading from the working to the water chamber.

In the accompanying drawings, Figure 1 is a vertical section of my improved steam vacuum water-elevator in the form which I deem best adapted for general use. Figs. 2 and 3 are sectional views illustrating my invention in simplest form; and Figs. 4 and 5 are similar views illustrating modifications therein, as hereinafter described.

My invention admits of exemplification in two general forms—viz., with the steam pumping or working chamber and the water-chamber apart from each other, the two being connected by suitable steam and water pipes, as shown in Figs. 1, 4, and 5, or with a pumping or working chamber completely inclosed within the water-chamber and communicating freely therewith, as shown in Figs. 2 and 3.

In each of the figures, A represents the working-chamber, and B the water-chamber.

In the simple form of apparatus shown in Fig. 2 the working-chamber A consists of a cylindrical vessel constructed with thick walls of non-conducting material, and which is closed at top and open at bottom. This vessel is supported within an outer cylindrical water-chamber, B, also closed at the top, and whose lower end is fitted upon a steam-generator, C, preferably constructed of sheet metal, in a conical or concavo-convex form, with an exceedingly narrow or shallow interval between its upper and lower plates, so as to present the largest possible area of surface with the smallest containing capacity. A small supply-opening, D, controlled by a valve, connects the bottom of the water-chamber B with the lowest portion of the conical steam-generator C. An open pipe, E, (see also Fig. 3,) projects from the upper portion or apex of this generator upward within the working-chamber A, nearly to the top thereof. An open exhaust-tube, F, extends from a point at about one-quarter of the height of the working-chamber above its lower end up into the water-chamber, and terminates at or about the middle thereof. This exhaust-tube F is trapped by means of a concentric encircling-tube, G, closed at the bottom, and which extends up nearly to the top of the chamber A; or it may be trapped by bending it and extending its inner end upward within the working-chamber, as shown in Figs. 3 and 4. This simple pumping apparatus is completed by fitting to the upper end of the water-chamber B a feed or suction pipe, H, to connect it with a suitable source of supply, and with a discharge-pipe, I, for the delivery of water therefrom, these pipes being fitted with suitable check-valves, to prevent a reflow of the water therein. It is made ready for use by placing a gas-furnace or other suitable calorific device under the steam-generator C.

In the operation of the apparatus the cock D is opened, so that the generator C is supplied with water from the chamber B. The water, spread out in a very thin sheet between the walls of the generator, is thereby exposed to a comparatively large heating-surface, so as to become very quickly converted into steam. The steam thus rapidly generated passes freely upward through the pipe E to the top of the working-chamber A, and, bearing with its full pressure upon the upper surface of the water therein, will force this water down and out of the bottom of said chamber into the water-chamber B, causing an outward flow of the water already in said chamber B through the discharge-pipe at I. As the water is forced out from the working-chamber A, it will also be driven out simultaneously from the trapped exhaust-tube F until the bend or sealing-point of the exhaust-tube is reached at the level *k*, whereupon, as the tube becomes unsealed by the removal of the water, an upward vent is thereby supplied, through which the steam confined under pressure in the working-chamber will instantly escape, and, issuing into the water-chamber B, will be condensed by contact with the fresh water therein. The rapid exhaust of the steam through the exhaust-tube will create a void in the working-chamber, which the water in the bottom of the water-chamber will rush back to fill, creating thereby a vacuum in the latter, which will create an inward flow of fresh water thereinto from the supply-pipe.

It will be observed that a large proportion of the water forced out of the working-chamber will be drawn back into it again, while the fresh water drawn from the supply-pipe will be forced out through the discharge-pipe without entering the working-chamber. The volume of water thus forced in and out of the bottom of the working-chamber becomes heated, and serves as a non-conducting fluid-piston between the steam and the fresh water flowing through the pumps.

It will also be observed that slight condensation takes place in the working-chamber, but that the steam is drawn out therefrom with a powerful draft through the exhaust-tube when the latter is unsealed, by reason of the condensation which takes place at the outer end of the tube and of the pressure of the column of water entering at the bottom of the working-chamber, due to the momentary difference in level between said chamber and the water-chamber, from which the water flows. When the entire volume of steam in

the apparatus is thus condensed, and the exhaust-tube and its trap refilled with water, the apparatus is restored to the condition at which it started, and the operation of generating steam, and thereby displacing the water, is renewed and continued, as before, until the point of condensation is again reached.

In the apparatus illustrated in Fig. 3 modifications are introduced tending to an economy in the generation of the steam. These consist, first, in removing the steam-generator C, constructed as above described, far enough below the bottom of the working-chamber to admit of the interposition of a non-conducting lining, or of an air-space, J, between them, the bottom of the working-chamber being closed by an independent plate, L; second, in connecting the feed-opening into the steam-generator with the interior of the working-chamber A by means of a feed-tube, D′, extending and opening into the upper portion of said chamber, so that the feed-water supplied through the tube to the generator shall be drawn from the upper heated strata in the working-chamber, the length of the feed-tube being so adjusted with reference to the trapped exhaust-tube F as that the supply of water to the generator shall almost cease by reason of the fall of the water-level below the upper end of the tube just before the condensation of steam in the apparatus takes place by the operation of the exhaust, as above described. To prevent a possible cessation of the operation of the pump under conditions in which the supply of water through the upper end of the tube M might prove inadequate, one or more small perforations, *m m*, may be made in said feed-tube D′, near the bottom of the chamber B, as shown in Fig. 3. In Fig. 3 the exhaust-tube is represented as bent to form its own seal, instead of being left straight and encircled by a concentric trap, as shown in Fig. 2. A cap or deflecting-plate, O, is also fitted over its upper end, to diffuse the steam escaping therefrom, and (by presenting it to the cold water in smaller quantities around the edge of said plate or through minute perforations therein) to effect its condensation more rapidly and with less noise than when the tube is left uncovered.

In the form of my apparatus illustrated in Fig. 1 the working-chamber is in the shape of an upright cylinder closed at the top, and which communicates freely at the bottom through a large pipe or passage, N, with the bottom of a separate water-chamber, B, elevated above it. An exhaust-tube, F, extends from near the bottom of a concentric trap, G, in the working-chamber up into the water-chamber B, its upper end terminating beneath a conical deflecting-plate, O. It may be led from the one chamber to the other either by way of the connecting-pipe N, as shown in positive lines, or more directly through the top of the working-chamber, as shown in Fig. 5. In either case it may be controlled by a valve, P, interposed therein between the two chambers, although this is by no means essential.

The water-chamber B and the working-chamber A are mounted together upon a suitable base or pedestal, R, adapted to contain or inclose the steam-generator.

The steam-generator may consist of a coil of pipe, (see Fig. 4,) or, preferably, of a concavo-convex metallic shell, C, Fig. 1, whose concentric walls are separated by a very narrow or shallow interval, and which is supported within the base R of the apparatus, with its convex side downward. At the lowermost point in this cup-shaped generator a depression or pocket, *b*, is formed, and an open water-supply tube, D″, is carried from near the bottom of this pocket up into the exhaust-tube F of the working-chamber above its trap. This tube is controlled by a cock or valve, *c*, therein, whereby the flow or feed from the pipe is adjusted at pleasure.

In the operation of the apparatus constructed and arranged in manner as last described, when the steam, flowing from the generator, has forced the water out of the working-chamber A down to the sealing-level *k* of the trap in the exhaust-tube F, and, unsealing the trap, escapes with great force up the tube, the strong current flowing over the mouth of the feed-pipe D″ will, upon the principle of an injector, create a strong draft in said pipe, which will operate to draw all the water in the generator into the pocket *b*, and thence up into the pipe D″, so that the generation of steam will be thereby automatically arrested for want of water during the interval of exhaust in the working-chamber. So soon, however, as the reflowing water fills the trap and again seals the exhaust-pipe F, the hot water in the feed-pipe D″ and pocket *b* will drop back into the generator and be quickly converted into steam, to renew the pressure in the working-chamber.

In view of the changes in the flow of water from the supply-pipe, and other circumstances which may tend to produce irregularities of action, I deem it expedient to combine a check-valve, L′, with the upper end of the steam-pipe E, to prevent an admission of water to the generator through said pipe. The weight of this valve may be adjusted to maintain a constant definite pressure of steam in the generator, and will prevent an outflow of water with the steam.

In Fig. 4 the steam-discharge pipe E is illustrated as led from the upper end of the generator to the top of the working-chamber through an inclosing tube or case, *f*, which protects the steam-pipe from radiation and from contact with the cold water in said chamber. Its upper end is fitted with a valve, P, to control the size of its outlet. By thus controlling the size of the outlet for the steam from the generator the feed of water to the generator may be so controlled as that it shall supply automatically the exact quantity of water required to

produce the amount of steam needed in the working of the pump, for by closing the valve, so as to limit the discharge of the steam, the pressure accumulating within the generator while the steam is generated faster than it can escape will force back the feed-water in the feed-pipe against the pressure exerted thereon from the working-chamber or other source whence it is supplied, and thus stop the feed, and by reason of the consequent deficiency of water in the generator arrest the generation of steam until the pressure is so far reduced as that it will no longer counterbalance the feed-pressure, and a new supply of water is allowed to enter. The pump itself is thus made to dictate the feed of water to the generator. I contemplate making this automatic feed device the subject-matter of a separate application for Letters Patent, to which I hereby reserve my right.

Fig. 4 illustrates the use of a coil of pipe, S, as a generator. The coil S, arranged within the base R, may be heated by a gas or coal furnace or other calorific device, the working-chamber above being protected from the heat by means of a plate, Y, and interposed non-conducting material. The coil is supplied with water by means of an independent pipe, D‴, controlled by a valve, *c'*, and which is led outwardly from the bottom of the coil to the lower end of the working-chamber, and thence up within the chamber nearly to the top thereof.

The valve P (shown in Fig. 4) and the valve L', (shown in Fig. 1,) both as controlling the steam-pipe E from the generator, may be combined to operate as one device.

In the modification shown in Fig. 5 the base R is extended up solidly, or as a frame, to inclose the working-chamber, and upon it rests a strong metal plate, T, which supports the other parts of the apparatus. The walls of the concavo-convex steam-generator C, constructed in same manner as shown in Fig. 1, are extended upward in cylindrical form, to encircle the working-chamber, which is made with a thick wall of non-conducting material, whose outer surface constitutes the inner surface of the steam-generator. The outer wall of the generator is connected by a steam-tight joint to the plate T. The working-chamber A is suspended from said plate by means of set-screws *e e*, which permit of an adjustment of the annular opening left between the top of the chamber and the plate above, and which establishes communication with the upper end of the steam-generator. The water-chamber B is supported centrally over and upon the plate T, and the connecting-pipe N therefrom is carried centrally through said plate down nearly to the bottom of the working-chamber. The water-supply pipe D″ to the generator is led from the trap of the exhaust-pipe down into the pocket *b* at the bottom of the generator.

A concentric vessel, W, of thin metal, is inserted within the steam-generator, to form a partition therein, extending from near the top to the bottom thereof, for the purpose of permitting a return through the inner compartment, formed by the partition, of any water which may be carried up with the ascending steam, leaving the steam to pass up into the working-chamber by way of the outer compartment perfectly dry.

Perforated plates or diaphragms U U may be inserted horizontally in the water-chamber B of either form of the pump, to prevent circulation, so that the incoming cold water shall not mix with the warmer water, which, not being discharged at each stroke, remains pulsating up and down, as an intermediate hot fluid-piston or diaphragm interposed between the steam and the body of water, which, entering at the induction-port from the supply-pipe H, flows out on the same level through the eduction-port into the discharge-pipe I.

I claim as my invention—

1. The method, substantially as described, of exhausting the steam from the working-chamber of a steam vacuum-pump, which consists in applying to the steam in the working-chamber the pressure of a column of water contained in a separate water-chamber at a higher level by means of the open connection of said higher water-chamber with the lower portion of the working-chamber, and in providing for the steam subjected to said pressure an exhaust-vent so soon as it has forced the water out from the working-chamber to a given level by means of a water-trapped tube connecting the upper part of said chamber with a separate condensing-chamber, and which is automatically unsealed by the depression of the water therein to said level, substantially in the manner set forth.

2. The method, substantially as described, of automatically arresting the feed of water to the boiler of a combined boiler and steam vacuum-pump at the moment of exhausting the steam from its working-chamber, which consists in connecting the feed-water pipe with the exhaust-pipe, through which the steam is withdrawn from the working-chamber when the discharge from the pump is completed, substantially in the manner set forth.

3. The method, substantially as described, of exhausting the water from the boiler of a combined boiler and steam vacuum-pump, which consists in producing a vacuum in a tube connected with the lowermost level of the boiler by extending the open mouth of said tube into the steam-exhaust pipe of the working-chamber of the pump and allowing steam to escape around the same, substantially in manner as set forth.

4. The combination, with the steam-pressure or working chamber of a steam vacuum-pump, and with a separate condensing-chamber communicating freely with the bottom of said working-chamber, of a water sealed or trapped steam-exhaust pipe leading from the one to

the other, substantially in the manner and for the purpose herein set forth.

5. The combination, in a steam vacuum-pump, with its pressure and condensing chambers, of a steam-generator located below said chambers, and provided with a water-feed pipe supplied therefrom, and a steam-outlet pipe opening into the pressure-chamber, substantially in the manner and for the purpose herein set forth.

6. The combination, in an automatic steam water-elevating apparatus, with its steam-pressure or working-chamber, of a quick-acting steam-generator communicating freely with the top of the working chamber, and constructed with a maximum heating and vaporizing surface, and a capacity so small as to admit of being completely exhausted at each condensation of the steam in the working-chamber, a separate reservoir or water-chamber communicating freely with and extending above the bottom of the working-chamber, and suitable supply and discharge pipes controlled by check-valves opening into the water-chamber, substantially in the manner and for the purpose herein set forth.

7. The combination, with the steam pressure or working chamber in a steam vacuum-pump, a trapped steam-exhaust tube extending therefrom into a condensing-chamber, and a quick-acting steam-generator of small capacity communicating freely with the upper end of the working-chamber, of a feed-pipe extending from the lowermost portion of the generator into the steam-exhaust tube, and adapted to be itself exhausted by the escape of steam through said tube, substantially in the manner and for the purpose herein set forth.

8. The combination, with the steam-pressure or working chamber in a steam vacuum-pump, its steam-generator, and a steam-supply pipe led through the working-chamber and discharging into its upper end, of a concentric tube encircling said steam-pipe to form a non-conducting outer lining or covering and prevent condensation in the pipe, substantially in the manner and for the purpose herein set forth.

9. The combination, with the working and condensing chambers in a steam vacuum-pump, and with a trapped exhaust-tube leading from the one to the other, of a conical deflecting plate or cap superimposed over the upper end of said exhaust-tube within the condensing-chamber, substantially in the manner and for the purpose herein set forth.

10. The combination, with the condensing or water chamber in a steam vacuum-pump having its water supply and discharge pipes both connected thereto, and with the working-chamber communicating with the bottom of said condensing-chamber, of one or more perforated diaphragms interposed between the level of the supply and discharge pipes and the mouth of the working-chamber, and adapted to prevent circulation of the water within the condensing-chamber, substantially in the manner and for the purpose herein set forth.

11. The combination, with the steam-pressure or working chamber in a steam vacuum-pump, its steam-generator, and a steam-delivery pipe leading from the one to the other, of a check-valve in the upper end of said steam-pipe adapted to prevent a reflow of steam or water through the pipe, substantially in the manner and for the purpose herein set forth.

CARROLL L. RIKER.

Witnesses:
EDWARD RUSS,
C. GULLMANN.