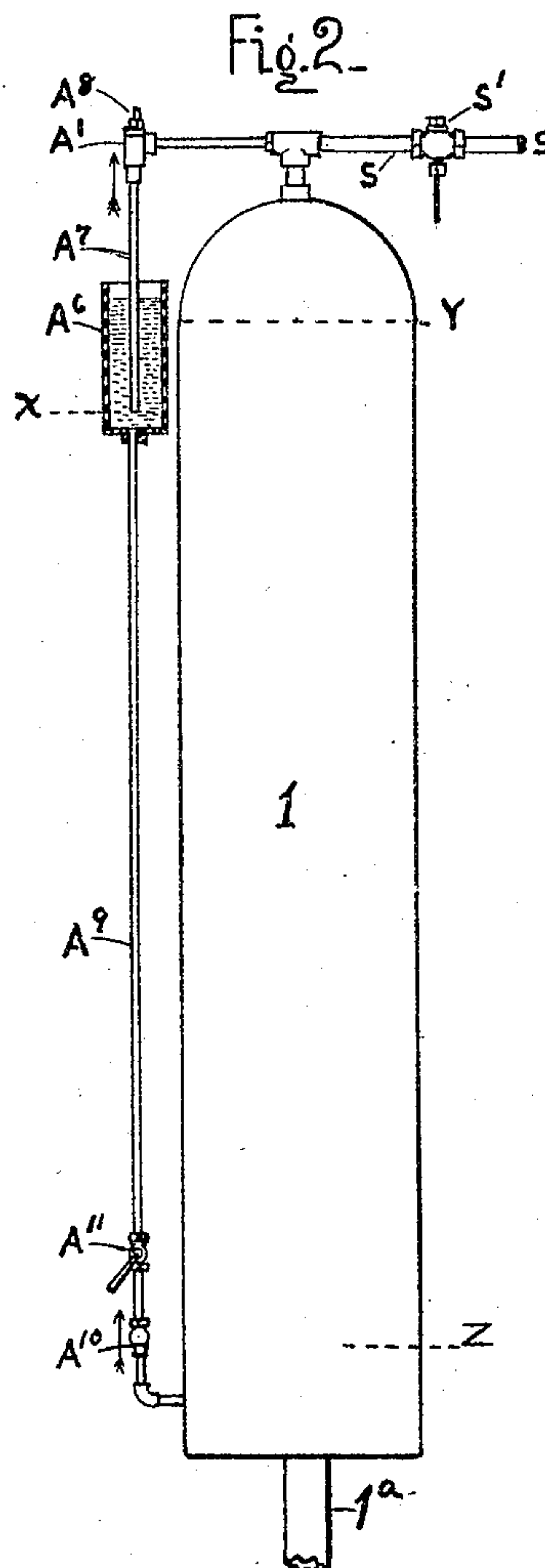
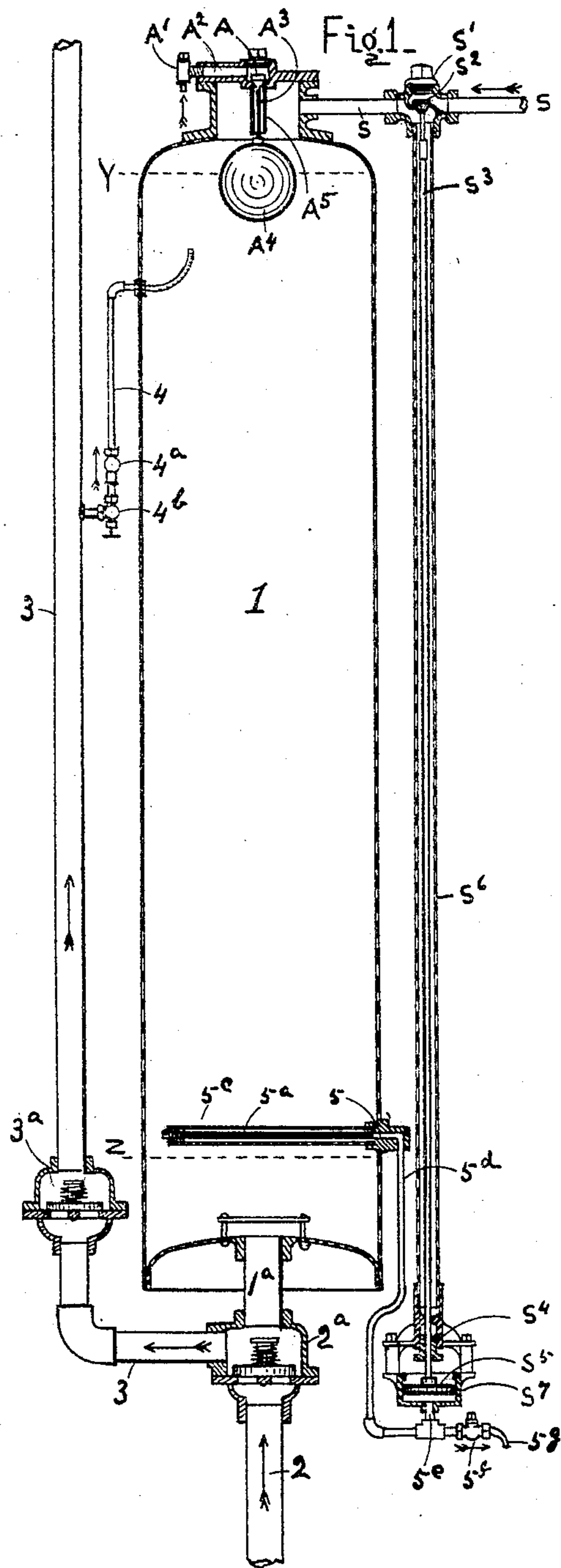


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NO MODEL.



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# UNITED STATES PATENT OFFICE.

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TO WATERHOUSE STEAM AND VACUUM PUMP COMPANY, A CORPORATION OF MAINE.

## STEAM AND VACUUM PUMPING APPARATUS.

SPECIFICATION forming part of Letters Patent No. 773,907, dated November 1, 1904.

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*To all whom it may concern:*

Be it known that I, ADDISON G. WATERHOUSE, a citizen of the United States, residing in Rockland county, New York, have invented certain new and useful Improvements in Steam and Vacuum Pumping Apparatus, of which the following is a specification.

My invention relates to that class of pumps wherein liquid is drawn into a receptacle by means of a partial vacuum produced by the condensation of steam therein and from which liquid is expelled by being directly displaced by steam under pressure.

Heretofore steam and vacuum pumps have been operated by employing a vacuum formed within the receptacle or receptacles by the condensation of steam therein for drawing in liquid and a limited volume of air has been admitted to the receptacle to lie upon the surface of the liquid in order to prevent undue condensation of the steam used for expelling the liquid from the receptacle; but in order to secure the best results a certain proportion of air should be employed, because if too little air is drawn in then when the steam is admitted to the surface of the liquid rapid condensation follows to an extent which causes a loss of steam which exceeds the value of the work accomplished, and if too much air is admitted then the extent of the vacuum formed is so limited that the receptacle or receptacles become only partly filled with liquid, whereupon the receptacle must be completely filled with steam to expel the liquid, and as the same volume of steam is required to discharge a receptacle partially charged as one fully charged with liquid the reason of the loss of steam efficiency in the former case is obvious. To overcome such loss of steam and to cause the apparatus to work uniformly, an approximately exact proportion or complement of air should be admitted into the receptacle for each liquid charge. Where such air has been admitted to the receptacle through a regulating-valve or adjustable aperture during the time liquid is being drawn into the receptacle the operation is accompanied by

inherent disadvantages, one being that the degree of vacuum constantly grows less as liquid is drawn in and air fills the remaining space, so that the degree of vacuum is not constant, but gradually dies out, whereby the motion of the liquid lifted or drawn in slows up or stops, generally before the receptacle is properly charged, while the air continues to enter and fill the space which should be occupied by liquid. Another cause is that any adjustment of the air-intake remains constant, while the liquid-intake is subject to variations due to changes of level or pressure at the point of liquid-supply, together with many other causes that may impede or restrict its flow.

The object of my invention is to overcome the above-noted objections and to obtain such conditions and effects in such apparatus as are necessary in securing the highest efficiency and practical requirements and for securing in the receptacle of such apparatus a proper complement of air and a full or desired charge of liquid at each operation irrespective of the time or conditions under which liquid is drawn into the receptacle.

In carrying out my invention I provide a receptacle having means for admitting liquid and steam and causing condensation of steam therein, with means for suddenly admitting air to the receptacle after it receives its full charge of liquid or when the liquid in the receptacle reaches a predetermined level, so that such air will fill the remaining space in the receptacle, whereby I am enabled to accurately control the admission to the receptacle of an approximately exact volume of air that may be required for forming an insulating stratum upon the surface of the liquid to protect the steam from direct contact with the liquid while the steam is forcing liquid from the receptacle.

My invention also has reference to improved means for controlling the operation of the valve for admitting steam to the receptacle, and it further contemplates the novel details of improvement that will be more fully



hereinafter set forth, and then pointed out in the claims.

Reference is to be had to the accompanying drawings, forming part hereof, wherein--

5 Figure 1 is a sectional elevation of a steam and vacuum pumping apparatus embodying my invention, and Fig. 2 is a side elevation of such an apparatus provided with a modified form of device for controlling the inflow  
10 of air to the receptacle.

Similar characters of reference indicate corresponding parts in both views.

In the drawings, the numeral 1 indicates a receptacle for liquid, shown provided with a  
15 liquid-inlet pipe 2, which may lead from a suitable source of supply, and a check-valve 2<sup>a</sup>, connected by a pipe 1<sup>a</sup> with the receptacle, and at 3 is indicated a discharge-pipe having a check-valve 3<sup>a</sup>.

20 At S is indicated a steam-supply pipe communicating with receptacle 1 and shown leading to the top of the receptacle.

At 4 is indicated a pipe connected with pipe 3 and leading into the receptacle 1 for  
25 supplying condensing liquid or water thereto and provided with a check-valve 4<sup>a</sup> and a regulating-cock 4<sup>b</sup>, permitting the passage of liquid from pipe 3 into the receptacle and preventing return flow.

30 The foregoing parts illustrate an apparatus with which my improvement may be utilized and which may be of any well-known construction.

In Fig. 1 my improved means for controlling the admission of air to the receptacle are  
35 arranged as follows: At A is indicated an air-inlet valve adapted to control the flow of air into the receptacle, as through a pipe A<sup>5</sup>, and the valve A is shown connected by a stem  
40 A<sup>3</sup> with a float A<sup>4</sup>. At A' is an air-check valve adapted to permit the flow of air through passage A<sup>2</sup> into the receptacle past valve A and prevent the backflow, while the valve A  
45 when closed prevents inflow of air, but permits such inflow when opened. Said valve is normally held upon its seat in the construction shown by the weight of the float A<sup>4</sup>, and  
50 no pressure in receptacle 1 will raise valve A, owing to the check-valve A' being back of it. Valve A is intended to open to admit air to  
55 receptacle 1 only when the liquid in the receptacle rises approximately to a predetermined level and lifts the float, and thereby the volume of air admitted to the receptacle is accurately controlled.

At 5 is an outlet or aperture leading from receptacle 1, near its lower part, for the  
60 outflow of air, steam, or water, which outlet communicates with a pipe 5<sup>d</sup> and is located approximately at or slightly above the predetermined low level for liquid in the receptacle (indicated at Z) to permit the outflow of air when the liquid has reached such level. While any well-known means may be used

for preventing the outflow of air from the re- 65 ceptacle until approximately the predetermined low level of liquid therein has been reached, I have shown a thermostatic device for controlling the outlet 5, which comprises a heat-expanding rod 5<sup>a</sup>, located within re- 70 ceptacle 1, and shown within a perforated tube 5<sup>c</sup>, and arranged so that when the rod 5<sup>a</sup> is expanded by heat it will close the outlet 5, and when said rod is cold it will contract and open such outlet to thereby allow air, steam, 75 or liquid to flow from the receptacle through pipe 5<sup>d</sup>. The pipe 5<sup>d</sup> is shown provided with a check-valve 5<sup>f</sup> and a small drip or spout 5<sup>g</sup> to keep back the pressure in pipe 5<sup>d</sup> to cause such pressure to be transmitted through the 80 branch pipe 5<sup>e</sup> into a cylinder or chamber S<sup>7</sup> under a movable piston or diaphragm S<sup>5</sup>. The latter is shown connected by a rod S<sup>3</sup> with the movable member S<sup>2</sup> of valve S' and contained within a pipe S<sup>6</sup>, the rod S<sup>3</sup> passing through 85 a stuffing-box S<sup>4</sup>, whereby when the piston or diaphragm S<sup>5</sup> is forced up the steam-valve S' is opened to admit steam to receptacle 1, and when said piston or diaphragm moves down by gravitation or other cause the steam-valve 90 will be closed.

The operation of the apparatus above described is as follows: When the receptacle 1 is filled with steam, the liquid in it is forced out down to the low level, (indicated at Z,) and 95 then the steam heats and expands the thermostat-rod 5<sup>a</sup> and causes the same to close outlet 5, so that what pressure there is in pipe 5<sup>d</sup> and under the piston S<sup>5</sup> is relieved by the drip 5<sup>g</sup>, which allows the piston to move down 100 by gravitation to close the steam-valve S'. Condensation of steam in the receptacle then takes place and is completed by liquid returning from discharge-pipe 3 through pipe 3 into the receptacle, wherein a partial vacuum is 105 produced, which draws liquid into the receptacle through pipe 2. Such liquid upon entering the receptacle cools off the thermostat-rod 5<sup>a</sup>, which opens the outlet 5, so that the vacuum in the receptacle is communicated to 110 the space S<sup>7</sup> under the piston or diaphragm, (check 5<sup>f</sup> preventing return of air through 5<sup>g</sup>,) which keeps the piston down and causes the steam-valve to remain closed so long as the vacuum continues in the receptacle. When 115 the liquid thus drawn into the receptacle reaches the predetermined high level, as that represented by the dotted line Y, the liquid raises the float A<sup>4</sup>, opens the valve A, and admits air suddenly through the check-valve 120 A' into the receptacle, which air fills the space above the liquid and breaks the vacuum. Then owing to the weight of the liquid in the receptacle some of it flows out through the aperture 5, pipe 5<sup>d</sup>, and drip 5<sup>g</sup>, but creates 125 a pressure in the chamber S<sup>7</sup>, which raises the piston S<sup>5</sup> and opens the steam-valve S', admitting steam to the receptacle, which expels



the contained liquid through the discharge-pipe 3. During such time the steam-valve S' is held open by the pressure exerted under the piston S<sup>5</sup>; but when the surface of the liquid in the receptacle falls below the level of the thermostat 5<sup>a</sup> the air upon the surface of the liquid suddenly passes out through the aperture 5, allowing the steam to descend upon the liquid remaining in the receptacle, and then the heat of the steam expands the thermostat-rod 5<sup>a</sup> and closes the aperture 5, whereupon the drip at 5<sup>b</sup> immediately removes the pressure from under the piston S<sup>5</sup> and allows the steam-valve S' to close, and the operations before described are repeated. It will be thus understood that the air is admitted to the receptacle only upon the liquid therein reaching an approximately high level, and that therefore a substantially predetermined volume of air is admitted, which is practically equal at all times, and the full benefit of the vacuum in the receptacle is utilized for raising liquid therein to a substantially constant level; also, that such air is discharged at about the time liquid reaches the predetermined low level, so that an undue accumulation of air in the receptacle is prevented.

It will be understood that in the event that air should remain in the receptacle so that a full charge of liquid should not be drawn in, then no more air will enter the receptacle until such surface air is expelled, whereby a substantially full charge of liquid is secured at each action of the apparatus, and in case the water does not rise high enough to admit air into the receptacle so as to break the vacuum, then the condensing water will continue to flow until the vacuum is discharged, so that steam can be again let on until the air is discharged from the receptacle and a proper volume of fresh air is admitted.

In Fig. 2 is indicated part of a steam and vacuum pump, which may be substantially like that shown in Fig. 1, with respect to the inlet and discharge of liquid and the controlling of the steam-valve to accord with the extreme rise and fall of liquid in the receptacle caused by the condensation and pressure of the steam therein; but in this figure a modified form of means for controlling the inlet of air is illustrated. In this figure a vent box or receptacle is indicated at A<sup>6</sup>, into which extends an air-pipe A<sup>7</sup>, leading to the receptacle 1 and provided with an air-check valve A' to permit the passage of air to the receptacle, and said air-check is shown provided with a set-screw A<sup>8</sup>, capable of adjustment to regulate the volume of air which can pass the receptacle, while none is allowed to return through said check. At A<sup>9</sup> is indicated a pipe connecting receptacle 1 near its lower part with the vent-box A<sup>6</sup> and shown provided with a check-valve A<sup>10</sup>, permitting outflow of liquid, and a regulating-cock A<sup>11</sup>, whereby

the vent-box A<sup>6</sup> may be charged with liquid, as steam forces liquid from receptacle 1 while the liquid therein is under steam-pressure. While steam is shut off from the receptacle 1 or during the time that liquid is being drawn through pipe 1<sup>a</sup> into the receptacle, the liquid in box A<sup>6</sup> is also being drawn into receptacle 1 through A<sup>7</sup> until the liquid in said box falls sufficiently low to uncover the inlet into pipe A<sup>7</sup>, and thereupon air will be drawn into receptacle 1 to the same effect that air enters through valve A, as in Fig. 1. The capacity of box A<sup>6</sup> and the adjustment of its air-valve A' are such that no air will be drawn into the receptacle until after such time as will allow the receptacle to be charged with its proper or predetermined volume of liquid or up to about the level represented by the dotted line Y. When steam next enters the receptacle 1, liquid will be again forced into box A<sup>6</sup> and close the inlet-opening of pipe A<sup>7</sup>, which will not open again until the liquid has been drawn from such box, as before described. It is obvious that the box A<sup>6</sup> can be supplied with liquid from a source other than the receptacle 1, the liquid being withdrawn from said box, as described.

In this application I have illustrated a simplex or single-receptacle steam and vacuum pump, but my improvements may be used in connection with a steam and vacuum pumping apparatus of the duplex form or those having two or more liquid-receptacles. My invention is not limited to the particular means shown for securing the operations set forth, especially those for controlling the admission of air to the receptacle, as my invention is applicable to any apparatus wherein a vacuum caused by the condensation of steam is employed for drawing liquid into a receptacle to the exclusion of air until a substantially predetermined volume of liquid is admitted, after which air is admitted to break the vacuum.

Having now described my invention, what I claim is—

1. An apparatus of the character described comprising a receptacle provided with liquid induction and eduction means, means to admit steam to the receptacle and control the flow of same to accord with the rise and fall of the liquid in the receptacle, means to admit air into the receptacle made dependent upon the liquid having first reached a predetermined high level in said receptacle, and means for discharging such air from the receptacle at a point near the surface of the liquid above the level at which liquid is discharged from the receptacle, said means being dependent for action upon the surface of the liquid reaching the lower extreme of its motion in the receptacle, substantially as described.

2. An apparatus of the character described comprising a receptacle provided with liquid



induction and eduction means, means for admitting steam to the receptacle, means for condensing steam within the receptacle, means for admitting air to the receptacle after liquid has been admitted thereto, means for discharging such air from the receptacle at a point above the level at which the liquid is discharged, said means being dependent for action upon the surface of the liquid in the receptacle reaching approximately the lower level of its movement, and means for controlling the flow of steam to the receptacle made dependent for action upon the air being admitted to and discharged from the receptacle, substantially as described.

3. An apparatus of the character described comprising a receptacle provided with liquid induction and eduction means, means for admitting steam to the receptacle, means for condensing the steam in the receptacle; means for admitting air into the receptacle and discharging it therefrom to follow a predetermined rise and fall of the level of the liquid in the receptacle, and means for controlling the flow of steam to the receptacle made dependent upon the air being discharged from the receptacle to the open air, substantially as described.

4. An apparatus of the character described comprising a receptacle provided with liquid induction and eduction means, means for admitting steam to the receptacle, means for condensing the steam in the receptacle, means for admitting air into and discharging it from the receptacle dependent upon the surface of the liquid in the receptacle rising above and falling below predetermined levels above the level at which the liquid is discharged from the receptacle, means for employing the air when discharged for shutting steam off from the receptacle, and means controlled by the admission of fluid to the receptacle for letting steam into the same, substantially as described.

5. An apparatus of the character described comprising a receptacle provided with liquid induction and eduction means, means for admitting steam to the receptacle, means for condensing the steam in the receptacle, means for admitting air into the receptacle made dependent upon the liquid rising in the receptacle to a predetermined level, means for discharging the air from the receptacle to the open air through a passage other than that used for the main discharge of the liquid, means dependent upon the liquid reaching a predetermined low level in the receptacle for shutting steam off from the receptacle, and means for employing the pressure due to the weight of the water in the receptacle for letting steam into the same, substantially as described.

6. An apparatus of the character described comprising a receptacle provided with liquid induction and eduction means, means for admitting steam to the receptacle, means for

condensing the same, means controlled by the surface of the liquid in the receptacle reaching a predetermined low level for discharging the air from its surface, means for admitting air to the receptacle through a passage, a check-valve normally closing said passage and adapted to resist the passage of air from the receptacle, and a valve adapted for normally resisting the passage of air to the receptacle, and means for opening the latter valve made dependent upon the liquid in the receptacle rising to a predetermined level, substantially as described.

7. An apparatus of the character described comprising a receptacle provided with liquid induction and eduction means, means to condense steam therein, a steam-pipe provided with a valve communicating with said receptacle, a movable member connected with said valve, a pipe connecting the movable member chamber with the lower portion of the receptacle and provided with a check-valve and drip whereby the weight or pressure of liquid in the receptacle is utilized to open the steam-valve, and means to control the outflow of liquid and air from said receptacle through said pipe by causes due to the rise and fall of liquid in said receptacle, substantially as described.

8. An apparatus of the character described comprising a receptacle provided with liquid induction and eduction means, means to condense steam therein, said receptacle having an air-inlet provided with means for opening the same by causes due to the rise of liquid in the receptacle, a steam-pipe connected with said receptacle and provided with a valve, a chamber provided with a movable member connected with said valve, a pipe connecting said chamber with the lower portion of said receptacle and provided with a check and drip, and a thermostat located near the lower portion of the receptacle and arranged to control the flow of fluid from the receptacle into said pipe, substantially as described.

9. An apparatus of the character described comprising a receptacle provided with liquid induction and eduction means, means to condense steam therein, a steam-pipe having a valve to control the admission of steam to the receptacle, a chamber provided with a movable member connected with said valve, a pipe connecting said chamber with the lower portion of the receptacle, a heat-expanding rod located in the receptacle adapted to control the outlet to said pipe by causes due to the rise and fall of liquid in said receptacle, and a check-valve and drip connected with said pipe, substantially as described.

10. An apparatus of the character described comprising a receptacle provided with liquid induction and eduction means, an air-inlet valve normally closed and provided with means for opening the same upon an approximately predetermined volume of liquid entering the

receptacle, a steam-pipe provided with a valve  
to control the flow of steam to the receptacle,  
a chamber provided with a movable member  
connected with said valve, a pipe connecting  
5 said chamber with said receptacle, and a ther-  
mostat-rod adapted to control the flow of fluid  
from the receptacle to said pipe by causes due

to the rise and fall of liquid in said recepta-  
cle, said pipe being provided with a check-  
valve and drip, substantially as described.

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