

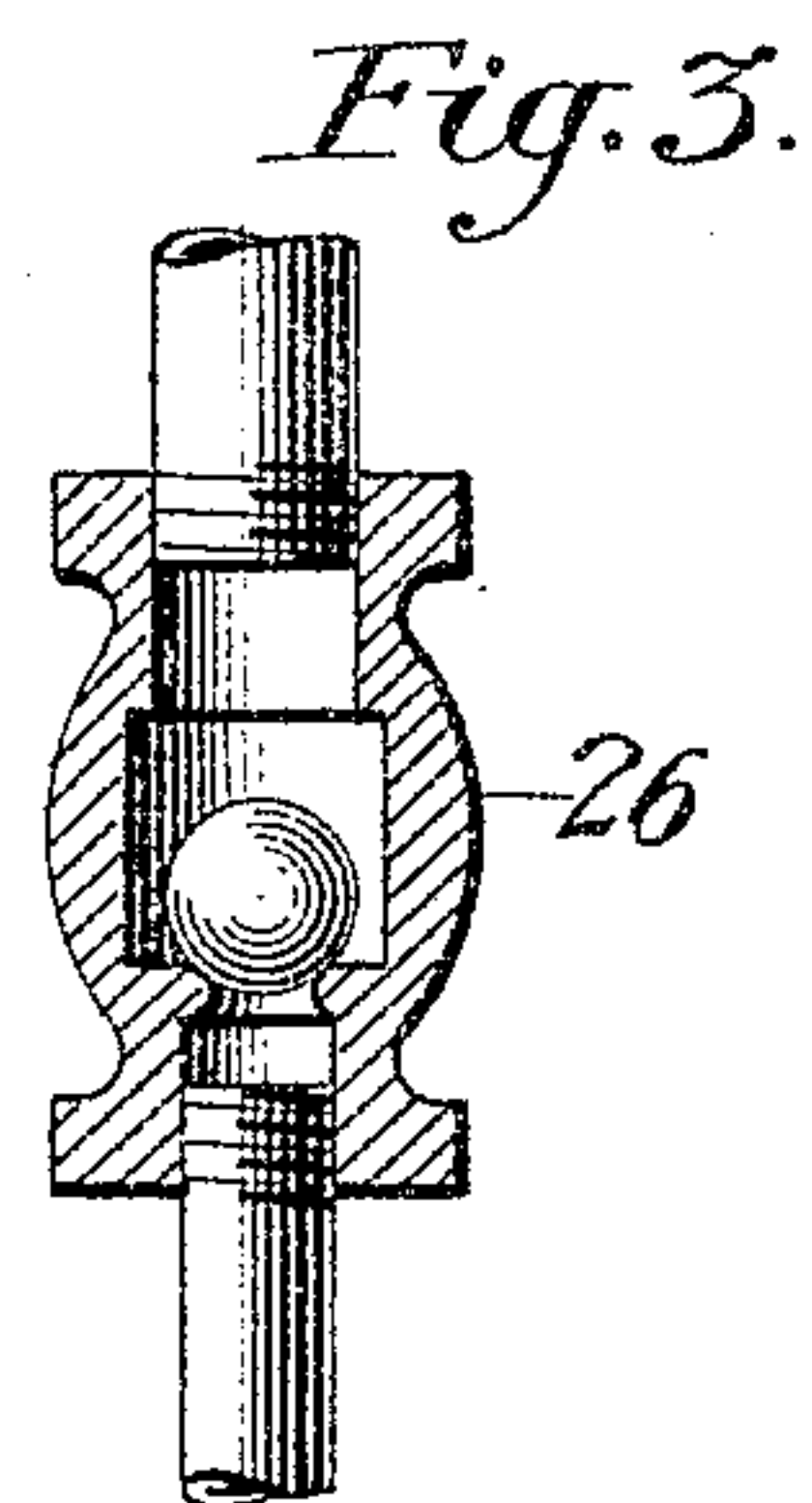
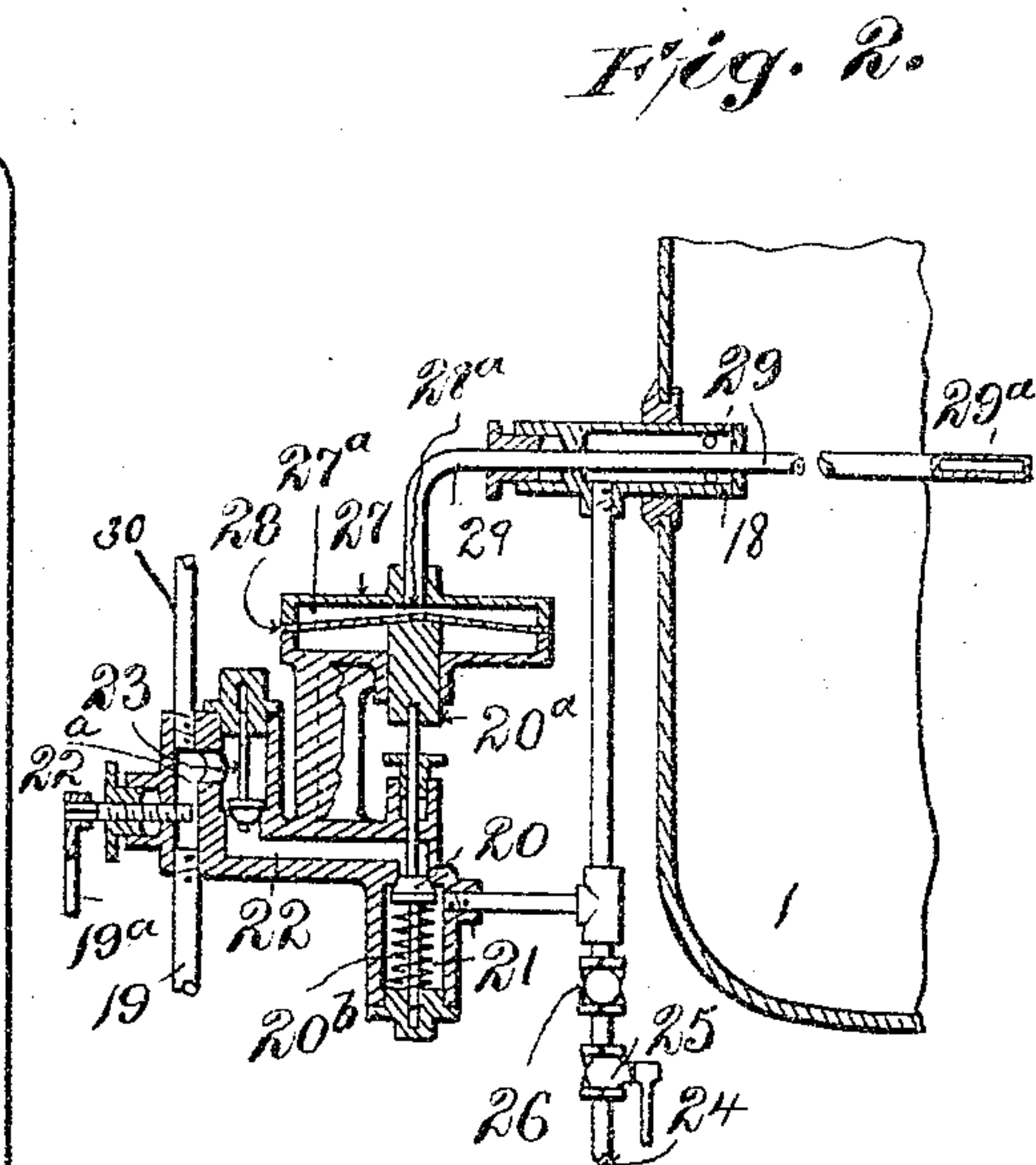
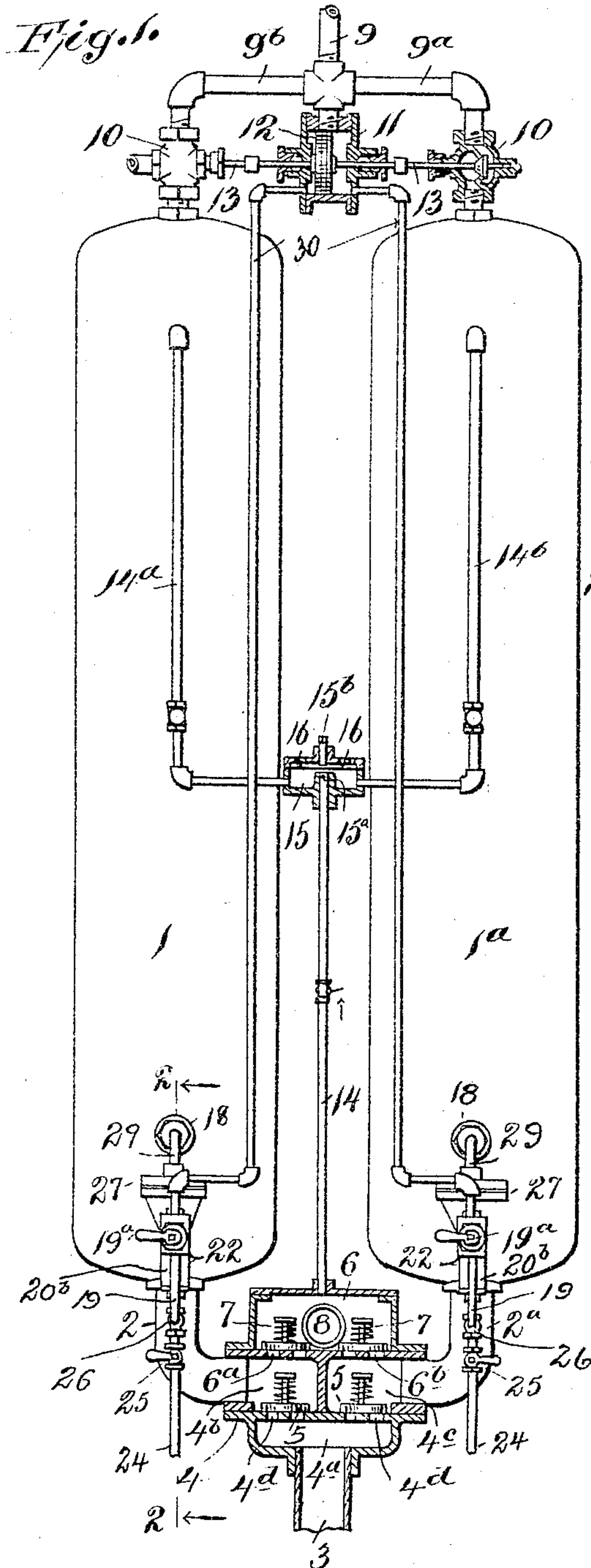
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A. G. WATERHOUSE.
STEAM AND VACUUM PUMP.

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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 PUMP.

SPECIFICATION forming part of Letters Patent No. 773,905, dated November 1, 1904.

Application filed November 18, 1903. Serial No. 181,625. (No model.)

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 Pumps, of which the following is a specification.

My invention relates to the class of pumping apparatus in which liquid is caused to enter a receptacle by reason of the condensation of steam therein and is expelled from the receptacle by the pressure of steam upon the liquid. In such pumps when the steam is admitted to the surface of the relatively cold liquid in the receptacle undue condensation follows. To avoid this, a proper proportion or complement of air must be admitted with the liquid each time the receptacle is refilled in order to form an insulating stratum between the steam and liquid, and the volume of such air must be limited to insure a required vacuum for drawing in a proper proportion of liquid. This air must be suddenly discharged upon the liquid reaching approximately the low level in the receptacle independent of the discharge for the liquid, so that the pressure in the receptacle will be reduced by the discharge of the air and the steam be brought into direct contact with the liquid remaining in the receptacle, whereby a rapid condensation is started and a partial vacuum is produced.

The object of my invention is to obtain these results and to overcome objections that are well known in this class of pumps, and to these ends I have illustrated apparatus by which said objects may be carried out, as more fully hereinafter set forth.

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

Figure 1 is a side elevation, partly broken, of a pumping apparatus embodying my invention. Fig. 2 is an enlarged detail sectional view of part of the apparatus, and Fig. 3 is a detail section of check-valve 26.

Similar numerals of reference indicate corresponding parts in the several views.

In the drawings the numerals 1 1^a indicate

liquid receptacles or tanks provided with liquid induction and eduction means and means for admitting steam thereto. In the example illustrated pipes 2 2^a lead into the lower part of the receptacles and communicate with a pipe 3, to be connected with any suitable liquid-supply. I have shown a casing 4, having a chamber 4^a, to which pipe 3 leads, and chambers 4^b 4^c, that communicate with chamber 4^a through passages 4^d, controlled by suitable valves 5, the pipes 2 2^a leading to the chambers 4^b 4^c. The chambers 4^b 4^c communicate with a chamber 6 through passages 6^a 6^b, controlled by valves 7, the outlet-pipe 8 being connected with chamber 6. The foregoing arrangements permit liquid to pass separately into and from receptacles 1 1^a; but any suitable arrangements for this purpose may be provided.

At 9 is indicated a steam-supply pipe, that is connected by branches 9^a 9^b with the upper portion of the receptacles 1 1^a and controlled by valves 10. In the example shown I provide a cylinder or chamber 11, containing a piston 12, having stems 13 projecting in opposite directions and connected with the valves 10, whereby when the piston 12 is moved back and forth the valves 10 will alternately open and close. The valves 10 I have shown are so arranged that when closed the steam will press the valve to its seat and when open will not be influenced by the passing steam. This is for the purpose of allowing the valves to remain in set positions; but other mechanism for operating the valves may be provided if preferred. Liquid for condensing the steam in the receptacles is preferably admitted to the same near the upper portion thereof. To this end I have shown a pipe 14 leading from chamber 6 and connected with branches 14^a 14^b, that respectively communicate with receptacles 1 1^a. In the arrangement shown the pipe 14 leads into a chamber 15 at the opening 15^a, provided with a flexible diaphragm 16, which can close the opening 15^a, the movement of the diaphragm being regulated by the screw 15^b, limiting the lift of the diaphragm 16 above the opening 15^a. The

branches 14^a 14^b, with their check-valves, also lead from the chamber 15. Said diaphragm is adapted to close opening 15^a when a vacuum has formed in either receptacle sufficient to draw liquid through their respective pipes 14^a or 14^b faster than it can flow through opening 15^a. This causes atmospheric pressure to force the diaphragm 15 down and close the opening 15^a and keep it closed as long as such vacuum remains in either receptacle sufficient to draw water from its source of supply; but as soon as pressure forms in either receptacle 11^a then the pressure of liquid in pipe 14 from the discharge liquid raises the diaphragm from the opening 15^a and opens a free passage from pipe 14 to pipes 14^a and 14^b to their respective receptacles.

The arrangements above described illustrate a form of mechanism with which my improvements may be used; but it will be understood that the invention may be carried out in connection with other equivalent mechanism.

As before noted, my invention contemplates the utilization of a layer or stratum of air between the liquid and steam in the receptacle and the discharge of such air from the receptacle at the required time. The means I have shown for this purpose are as follows:

The receptacle is provided with an air opening or passage located at or near the predetermined low level for the contained liquid, and such opening I have shown in Fig. 2 in the form of a perforated or screen-like pipe 18, extending into the receptacle and communicating with an air-discharge, (indicated at 19,) the passage from 18 to 19 being controlled by a valve 20, arranged to normally close the passage to prevent the escape of air from the receptacle. In the arrangements shown the pipe 18 communicates with a chamber 21, containing valve 20, a passage 22 leading therefrom to the discharge-pipe 19, as through a chamber 22^a, and in said passage 22 is a check-valve 23, adapted to permit the free flow of air and liquid from 22 to 19, but to prevent return flow and back pressure. The pipe 18 is also adapted to permit the flow of air into the receptacle, and to this end is shown communicating with an air-inlet 24. (Shown provided with a cock 25 to regulate the quantity of air admitted to the receptacle and with a check-valve 26 to prevent the escape of air through 24.) Thus under normal conditions when pressure from the receptacle is in pipe 18 valves 20 and 26 will be closed; but when a partial vacuum is formed in the receptacle air can flow past check-valve 26 into the receptacle through pipe 18. By having outlet 18 in the form of a perforated tube or screen any particles that may collect at the openings thereof during expulsion of liquid or air from the receptacle will be cleaned out when air is drawn into the receptacle through such openings, as

the flow is in both directions through said openings. 65

Means are provided to cause the sudden discharge from the receptacle of the insulating air between the liquid and the steam therein at about the time the air reaches the outlet 18. While any suitable means may be provided for accomplishing this result, I have shown devices operating by thermostatic action due to the difference in temperature between the outflowing liquid and the steam or heated air or surface liquid in the receptacle. To this end I have shown a casing 27 provided with a flexible diaphragm 28, forming a chamber 27^a and an outlet 28^a, communicating with a tube 29, that passes into the receptacle and is closed at its inner end 29^a. Within the chamber 27^a and tube 29 is placed material adapted to expand or be converted into vapor to create a pressure in chamber 27^a for opening valve 20 at the desired time, and said material should be such as will expand or form vapor at the temperature of the steam or surface liquid in the receptacle. When water is to be pumped, I find spirits or aqua-ammonia suitable for the purpose, because it boils at a lower temperature than water. The pipe 18 and tube 29 are located approximately at the same level, and to this end I have shown tube 29 passing through pipe 18. At 20^a is indicated a plunger guided in casing 27 and bearing against diaphragm 28 and also against the stem of valve 20, spring 20^b serving to hold valve 20 normally closed and the plunger 20^a against diaphragm 28. With the arrangement above described when the liquid fills the receptacle the material in chamber 27^a and pipe 29 will be relatively cool; but when such liquid has been forced by the steam to such a level that the heated surface liquid or air therein or the steam about reaches the tube 29 it expands the material therein or converts part of it into vapor and forms a pressure which bulges the diaphragm 28 outwardly, and thus causes valve 20 to open, which allows the air in the receptacle to suddenly pass from the surface of the liquid through outlet 18, chamber 21, passage 22, and past check-valve 23 to the outlet 19. The speed at which the air passes through outlet 19 may be regulated by an adjusting screw or cock 19^a. When the air is thus discharged from between the liquid and the steam in the receptacle, the steam instantly is precipitated upon the liquid, and condensation of the steam takes place to form a partial vacuum in the receptacle, and when the steam-pressure in the receptacle thus becomes reduced liquid for the condensation enters the receptacle to further assist in condensing steam therein. Other thermostatic arrangements or other devices may be provided for producing the same results of suddenly discharging the air from the surface of the liquid 125

in the receptacle upon the liquid reaching a predetermined level in the receptacle.

By means of the arrangements set forth I am enabled to utilize the pressure due to the sudden discharge of the air through outlet 18 to operate the steam-valve 10, and to this end I connect the cylinder or chamber 11 by a pipe 30 with passage 22 on the side beyond the check-valve 23, the pipe 30 also communicating with the outlet 19. In the arrangement shown the pipes 19 and 30 communicate with chamber 22^a. By the means shown the outlet through 19 may be restricted as respects the area of the bore of pipe 30, so that when the air from the receptacle is first discharged through outlet 18 it will pass through passage 22, unseating valve 23, and into chamber 22^a, from whence part of it will pass under pressure through pipe 30 into cylinder 11 and shift the piston 12 to operate valves 10, the remainder of the air passing through outlet 19. The valve 23 prevents back pressure from pipe 30 from entering the receptacle or unseating valve 20.

In the duplex form of apparatus shown each receptacle is provided with the air-discharge and controlling devices above set forth, and the pipes 30 from such devices respectively lead to cylinder 11 on opposite sides of its piston, the arrangement being such that when the air is discharged from one receptacle it will cause the steam-valve of that receptacle to close while opening the steam-valve of the other receptacle, and vice versa, to alternately control the flow of steam to the receptacles.

The operation of my invention as embodied in the apparatus illustrated may be described as follows: The receptacles being charged with liquid and a limited volume of air, steam is then let into one receptacle, as 1, by shifting its valve 10, (and closing the steam-valve of the other receptacle.) When the steam mingles with the air therein, some of the steam comes in contact with the liquid and is condensed, leaving the air an insulating stratum upon the surface of the liquid, which air prevents further appreciable condensation of the steam. The steam then forces the liquid in the receptacle down to about the level of tube 29 of the thermostat, and when the steam or heated air or surface water reaches said tube it forms a pressure, as before described, in chamber 27^a to act on plunger 20^a and open valve 20, which allows the air in the receptacle to suddenly escape from between the liquid and steam through the pipes and passages 18, 21, and 22 to the chamber 22^a, where it divides, part passing up pipe 30 into one end of cylinder 11, where the air-pressure shifts the piston 12, which closes the valve 10 of receptacle 1 and opens valve 10 of the other receptacle, and the excess of such air passes through outlet 19, screw 19^a providing such a resistance to the passage of the air through 19 as to cause the required pressure in cylinder 11 for operating

the piston. This operation of piston 12 by the arrangement shown will permit a full and quick operation of valve 10. As soon as the air is discharged from receptacle 1, as stated, the steam comes in contact with the liquid remaining in the receptacle and is immediately condensed so that its pressure falls, and by this time the steam-pressure in the other receptacle causes condensing liquid to flow therefrom into receptacle 1 through pipes 14 14^a under a pressure above the now reduced pressure in receptacle 1, and thus completes the condensation of steam in the latter, whereby a partial vacuum is formed therein and liquid and its complement of air again drawn therein. The steam having been admitted to the other receptacle, 1^a, causes similar operations to occur, and so on alternately. It will thus be understood that the operations can be so timed by adjusting the valves and passages that one receptacle will be charged with liquid and its complement of air before the other receptacle is discharged.

The operation of piston 12 is not dependent upon steam which flows from the receptacle; but the use of the air for operating piston 12 is highly advantageous over the use of steam, for the reason that such steam would condense in the pipes and passages and not form a pressure sufficient to properly work the valve until all parts were heated, and this would cause such a delay in the cycle of operations as might cause the apparatus to stall or be attended by other objectionable results interfering with the desired working. The arrangements I have shown permit air to be discharged under pressure from the receptacle freely and suddenly and at a constant level irrespective of the pressure, speed, or frequency at which the liquid in a receptacle is moved, such air having the advantage of not condensing while brought into contact with the pipes, passages, &c., through which it passes and upon which it has to operate.

Having now described my invention, what I claim is—

1. An apparatus of the character described comprising a receptacle provided with means for admitting liquid and its complement of air thereto to form a stratum of air on the surface of the liquid, means for permitting liquid to be discharged from the receptacle, means for admitting steam to the receptacle, means for suddenly discharging air from the surface of the liquid to the open air upon the liquid reaching an approximately predetermined level within the receptacle, and means for condensing the steam in the receptacle, substantially as described.

2. An apparatus of the character described comprising a receptacle provided with means for admitting liquid and its complement of air thereto to form a stratum of air on the surface of the liquid, means for permitting liquid to be discharged from the receptacle, means for ad-

mitting steam to the receptacle, means for discharging air from the surface of the liquid to the open air upon the liquid reaching an approximately predetermined level within the receptacle, and means for causing the air discharged from the receptacle to operate the means for admitting steam to and shutting it off 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 thereto and for shutting steam off therefrom, means for admitting air to the surface of the liquid in said receptacle to provide an insulating stratum between the liquid and steam, and means independent of the liquid-eduction means for causing said air to be suddenly discharged to the open air from the surface of the liquid upon the liquid reaching an approximately predetermined level in the receptacle, substantially as described.

4. An apparatus of the character described comprising a receptacle provided with liquid induction and eduction means, and means for admitting steam thereto, means for admitting air to the surface of the liquid in said receptacle to provide an insulating stratum between the liquid and steam, a valve to control the discharge of said air from the receptacle, and a thermostat arranged to operate said valve when the heated surface liquid, air or steam in the receptacle causes the actuating member of the thermostat to operate, substantially as described.

5. An apparatus of the character described comprising a receptacle provided with liquid induction and eduction means, and means for admitting steam thereto, means for admitting air to the surface of the liquid in said receptacle to provide an insulating stratum between the liquid and steam, a valve connected with the air-inlet adapted to permit the admission of air to the receptacle and to prevent its discharge past said valve, a valve normally closed to control the discharge of air from said receptacle, and means to operate said valve when the liquid in the receptacle about reaches a predetermined low level therein, substantially as described.

6. An apparatus of the character described comprising a receptacle provided with liquid induction and eduction means, and means for admitting steam thereto, means for admitting air to the surface of the liquid in said receptacle to provide an insulating stratum between the liquid and steam, a valve connected with the air-inlet adapted to permit the admission of air to the receptacle and to prevent its discharge past said valve, a valve normally closed to control the discharge of air from said receptacle, means to operate said valve when the liquid in the receptacle reaches a predetermined low level therein, and a valve to pre-

vent the backflow of air past the second-named valve, substantially as described.

7. An apparatus of the character described comprising a receptacle provided with liquid induction and eduction means, and means for admitting steam thereto, means for admitting air to the surface of the liquid in said receptacle to provide an insulating stratum between the liquid and steam, a valve connected with the air-inlet adapted to permit the admission of air to the receptacle and to prevent its discharge past said valve, a valve normally closed to control the discharge of air from said receptacle, means to operate said valve when the liquid in the receptacle reaches a predetermined low level therein, a valve to prevent the backflow of air past the second-named valve, and a pipe connected with the air-discharge and with the means for controlling the flow of steam to the receptacle, means being provided to permit the escape of air from said pipe after the steam has been shut off from the receptacle, substantially as described.

8. An apparatus of the character described comprising two receptacles each being provided with induction and eduction valves and passages for liquid and independent induction and eduction valves and passages for air, means for limiting the volume of air induced, means for controlling the eduction of air so that its discharge will be free and sudden from each receptacle at a period which will accord with the liquid in each receptacle reaching a predetermined level, means arranged to operate by the discharge of the air for controlling the flow of steam to each receptacle, and means for condensing the steam in each receptacle, substantially as described.

9. An apparatus of the character described comprising two receptacles provided with independent induction and eduction valves and common induction and eduction passages, means for alternately admitting steam to one receptacle and shutting it off from the other, means for admitting a limited volume of air to each receptacle to form an insulating stratum upon the surface of the liquid, a valve to control the discharge of air from each receptacle, a thermostat arranged to operate such valve when the heated surface liquid or steam in each receptacle reaches the level at which the actuating members of the thermostat are placed, means for employing the air discharged from each receptacle for controlling the steam for both receptacles, and means for admitting condensing liquid to each receptacle after the air has been discharged therefrom, substantially as described.

10. An apparatus of the character described comprising two receptacles provided with liquid induction and eduction valves and passages, means for admitting steam to each receptacle controlled by valves connected to-

gether by means adapted for closing one as the other is opened, means for admitting a limited volume of air into each receptacle, means for suddenly discharging air from each receptacle
5 by the same passage through which it was admitted by means due to the surface of the liquid in each receptacle reaching the lower extreme of its motion, means for employing the discharged air for actuating the steam-valves,
10 and means for condensing the steam in each receptacle by liquid admitted through means due to the fall of pressure in each receptacle caused by the discharge of air therefrom, substantially as described.

15 11. An apparatus of the character described, comprising two receptacles, each provided with liquid induction and eduction valves and passages, and separate air induction and eduction valves and passages, means for regulating the volume of air admitted through the
20 induction-passages, normally closed valves for controlling the passage of air through the air-eduction passages, thermostats in each receptacle located near their lower portions adapted
25 when reached by the heated surface water or steam to operate to open the corresponding valves and thereby discharge the air from the surface of the liquid, means for causing the air discharged from each receptacle to close its
30 corresponding steam-valve and admit steam to the other receptacle, and means for admitting condensing-water to each receptacle after the steam has been shut off therefrom, substantially as described.

35 12. An apparatus of the character described comprising a receptacle provided with liquid induction and eduction means, means for admitting steam thereto and shutting it off therefrom, an air-discharge pipe communicating
40 with the receptacle near the predetermined low level for liquid therein, an air-inlet connected with said pipe, a valve to permit the admission of air through said inlet and prevent its discharge therefrom, a passage connected with said pipe for the discharge of air
45 therefrom, a normally closed valve to control said passage, and means to open said valve upon the liquid in the receptacle passing below said air-discharge pipe to permit the escape of air through the latter from the surface
50 of the liquid, substantially as described.

13. An apparatus of the character described comprising a receptacle provided with liquid induction and eduction means, means for admitting steam thereto and shutting it off therefrom, an air-discharge pipe communicating
55 with the receptacle near the predetermined low level for liquid therein, an air-inlet connected with said pipe, a valve to permit the admission of air through said inlet and prevent its discharge therefrom, a passage connected with said pipe for the discharge of air therefrom, a normally closed valve to control said passage, means to open said valve upon
60 the liquid in the receptacle passing below said

air-discharge pipe to permit the escape of air through the latter from the surface of the liquid, and a check-valve to prevent the return flow of air past said normally closed valve and to permit the discharge of air from the
70 passage, substantially as described.

14. An apparatus of the character described comprising a receptacle provided with liquid induction and eduction means, means for admitting steam thereto and shutting it off therefrom, an air-discharge pipe communicating
75 with the receptacle near the predetermined low level for liquid therein, an air-inlet connected with said pipe, a valve to permit the admission of air through said inlet and prevent its discharge therefrom, a passage connected with said pipe for the discharge of air therefrom, a normally closed valve to control said passage, means to open said valve upon
80 the liquid in the receptacle passing below said air-discharge pipe to permit the escape of air through the latter from the surface of the liquid, a check-valve to prevent the return flow of air past said normally closed valve and to permit the discharge of air from the passage, a pipe connecting said passage with the means for letting on and shutting off the steam on the side of the passage beyond said valve, and means to permit the escape of air from said pipe after it has operated the steam-controlling means, substantially as described.
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15. An apparatus of the character described comprising a receptacle provided with liquid induction and eduction means, means for admitting steam thereto and shutting it off therefrom, an air-discharge pipe communicating
100 with the receptacle near the predetermined low level for liquid therein, an air-inlet connected with said pipe, a valve to permit the admission of air through said inlet and prevent its discharge therefrom, a passage connected with said pipe for the discharge of air therefrom, a normally closed valve to control said passage, means to open said valve upon
105 the liquid in the receptacle passing below said air-discharge pipe to permit the escape of air through the latter from the surface of the liquid, a check-valve to prevent the return flow of air past said normally closed valve and to permit the discharge of air from the passage, a pipe connecting said passage with the means for letting on and shutting off steam on the side of the passage beyond said valve, means to permit the escape of air from said pipe after it has operated the steam-controlling means, and means for controlling the passage of air from said pipe, substantially as described.
110 115 120

16. An apparatus of the character described comprising a receptacle provided with liquid induction and eduction means, means for admitting steam thereto and shutting it off therefrom, an air-discharge pipe communicating
125 with the receptacle near the predetermined low level for liquid therein, a valve to control
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the discharge of air through said pipe, a tube entering said receptacle near the air-discharge pipe and containing material adapted to expand upon changes of temperature, and means
5 for causing such expanded material to open said valve to permit the sudden discharge of air from said receptacle, substantially as described.

17. An apparatus of the character described
10 comprising a receptacle provided with liquid induction and eduction means, means for admitting steam thereto and shutting it off therefrom, an air-discharge pipe communicating with the receptacle near the predetermined
15 low level for liquid therein, a valve to control the discharge of air through said pipe, a tube entering said receptacle near the air-discharge pipe, a chamber connected with said tube and having a flexible diaphragm, and
20 means to be operated by the movement of said diaphragm to open said valve, said tube and chamber containing material adapted to expand or to have its pressure increased upon changes of temperature to thereby cause said
25 diaphragm to operate said valve to permit the sudden discharge of air from the receptacle, substantially as described.

18. An apparatus of the character described comprising a receptacle provided with liquid
30 induction and eduction means, means for admitting steam thereto and shutting it off therefrom, an air-discharge pipe communicating with the receptacle near the predetermined low level for liquid therein, a valve to control
35 the discharge of air through said pipe, a tube entering said receptacle near the air-discharge pipe, a chamber connected with said tube and having a flexible diaphragm, and a plunger guided to be operated by said diaphragm and
40 to operate said valve, said tube and chamber containing material adapted to expand to cause the diaphragm to operate said valve, substantially as described.

19. An apparatus of the character described
45 comprising a receptacle provided with liquid induction and eduction means, means for admitting steam thereto and shutting it off therefrom, a pipe leading into said receptacle to admit air thereto and discharge air therefrom,
50 said pipe being perforated at its portion within the receptacle to permit air to pass in both directions therethrough, and means for controlling the discharge of air from said pipe, substantially as described.

55 20. An apparatus of the character described comprising a receptacle provided with liquid induction and eduction means, means for ad-

mitting steam thereto and shutting it off therefrom, a pipe leading into said receptacle to admit air thereto and discharge air therefrom, 60
a valve to control the discharge of air from said pipe, a pipe entering said receptacle and surrounded therein by the air-admission pipe, material within the second-named pipe adapted to expand to create a pressure upon an in- 65
crease of temperature, and means for causing said material to operate said valve upon such increase of temperature, substantially as described.

21. The combination of a receptacle pro- 70
vided with liquid induction and eduction means, means for controlling the supply of steam thereto, means for admitting liquid for condensation thereto, means for admitting air to the receptacle independent of the admission 75
of liquid thereto, a valve to control the discharge of air from the surface of the liquid, and a thermostat connected with the receptacle and having a movable member to be operated by the varying temperatures to which it is 80
subjected by the rise and fall of liquid in said receptacle, the movable member of said thermostat being connected with said valve to open the latter upon the thermostat being sub- 85
jected to temperature above the temperature of the main body of the liquid in the receptacle, substantially as described.

22. The combination of a receptacle provided with liquid induction and eduction means, means for controlling the supply of 90
steam thereto, means for admitting liquid for condensation thereto, means for admitting air to the receptacle independent of the admission of liquid thereto, a valve to control the discharge of air from the surface of the liquid, 95
and a thermostat connected with the receptacle and having a movable member to be operated by the varying temperatures to which it is subjected by the rise and fall of liquid in said receptacle, the movable member of said 100
thermostat being connected with said valve to open the latter upon the thermostat being subjected to temperature above the temperature of the main body of the liquid in the receptacle, and means for causing the air discharged 105
by said valve from said receptacle to operate the steam-controlling means to shut off the steam from the receptacle, substantially as described.

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