No. 672,246. Patented Apr. 16, 1901.

A. G. WATERHOUSE.

FEEDING WATER TO BOILERS.

(Application filed Oct. 16, 1900.)

(No Model.) 4 Sheets—Sheet 1.

Fig. 1.

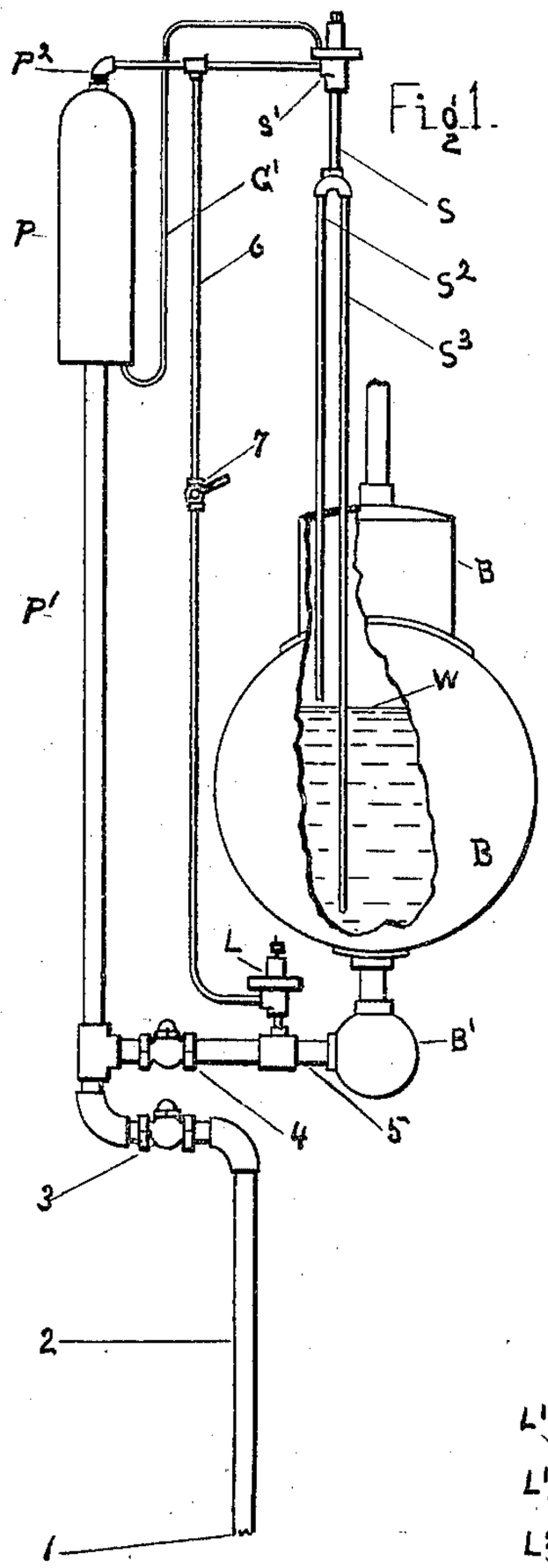
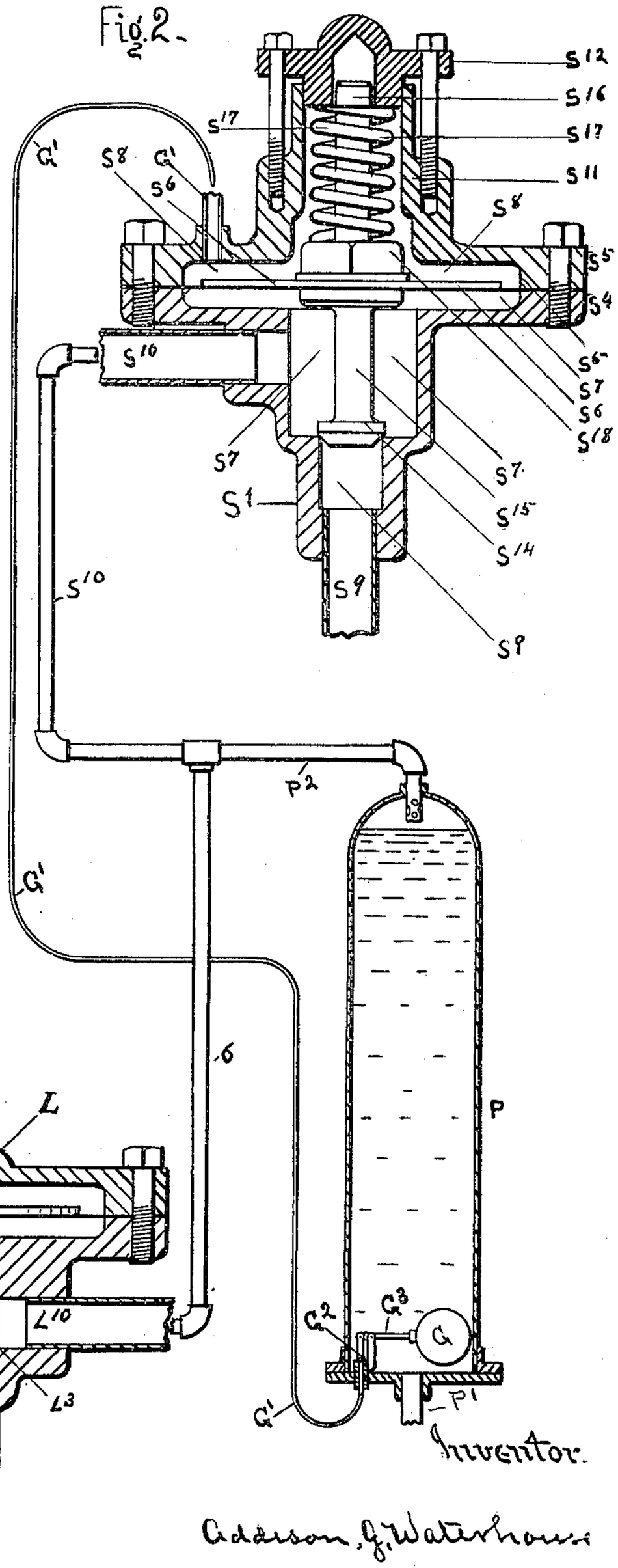


Fig. 2.



Witnesses.
Geo. L. G. Waterhouse.
W. S. Watson

Inventor.
Addison G. Waterhouse

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Fig. 3.

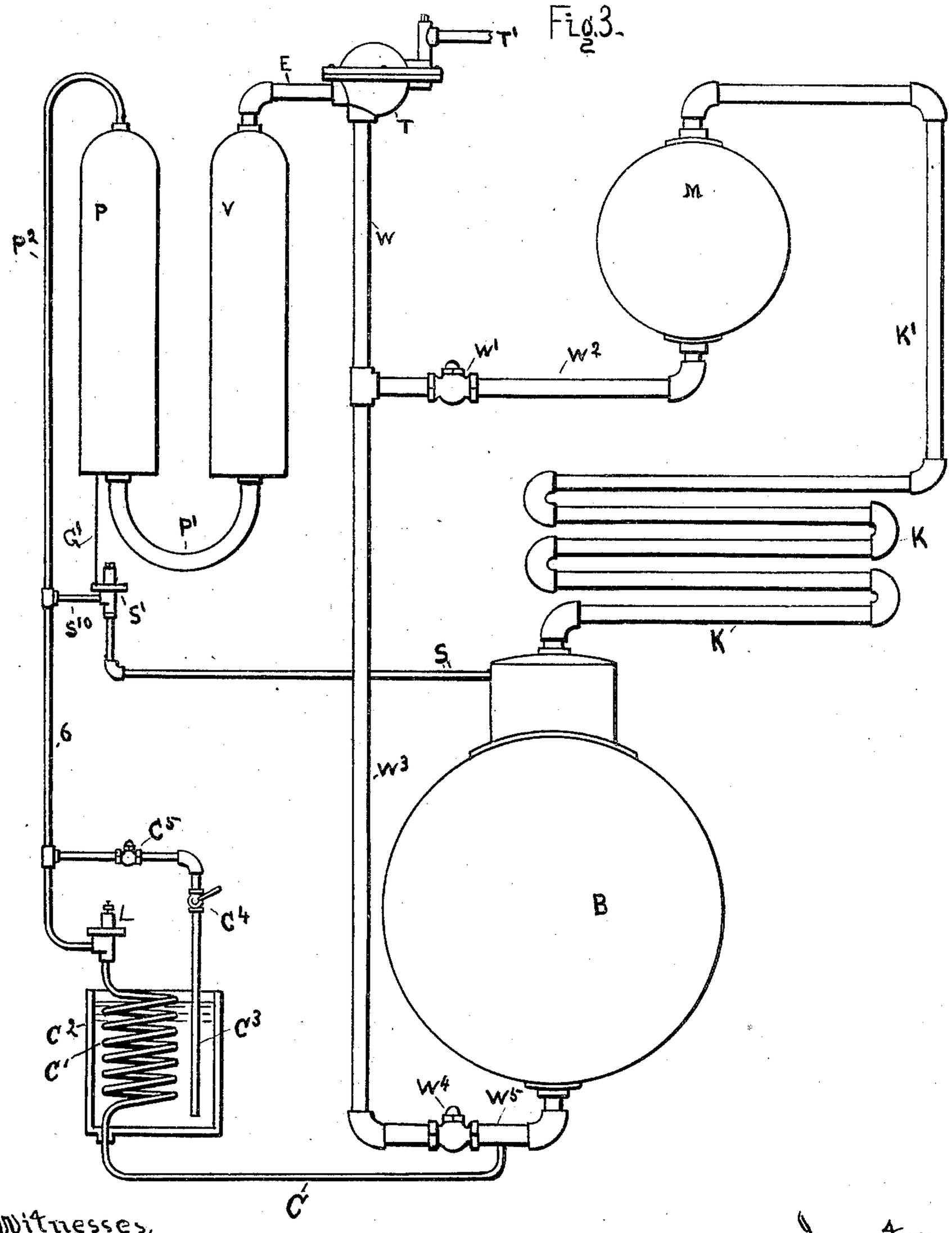

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Fig. 4.

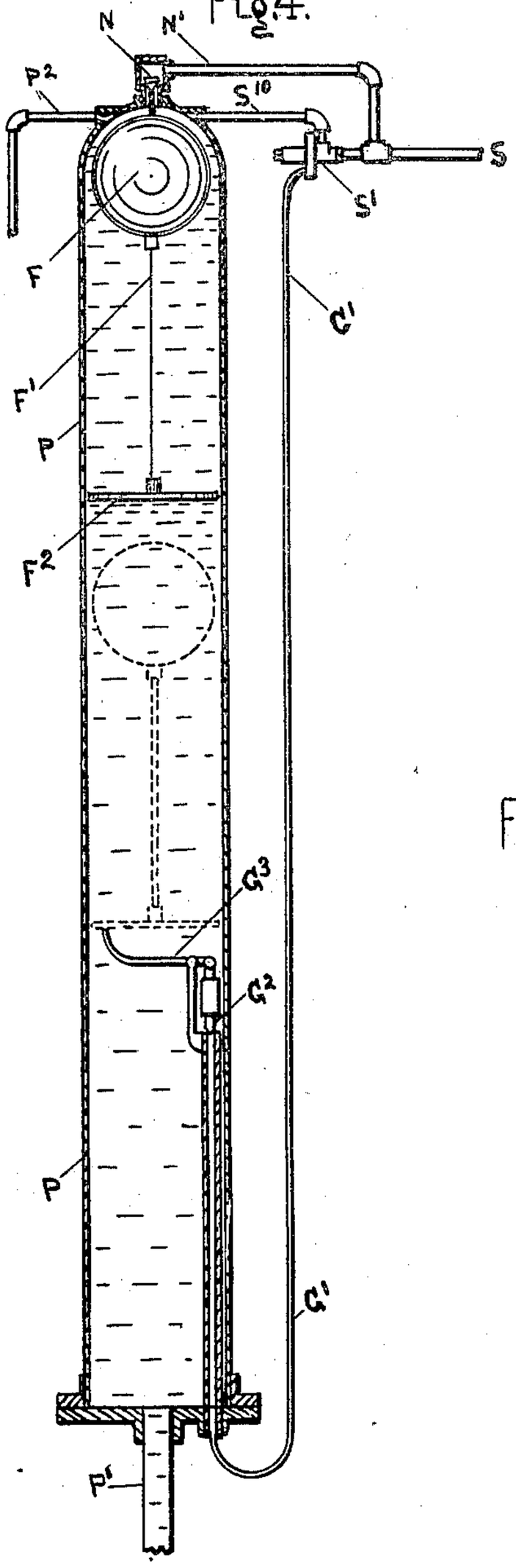


Fig. 6.

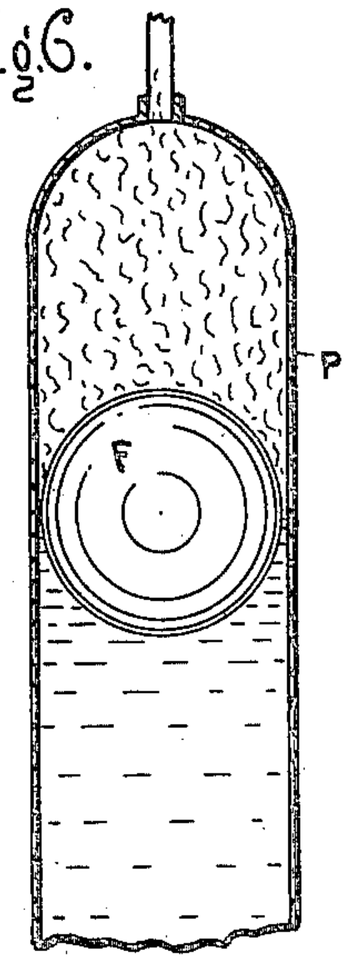


Fig. 5.

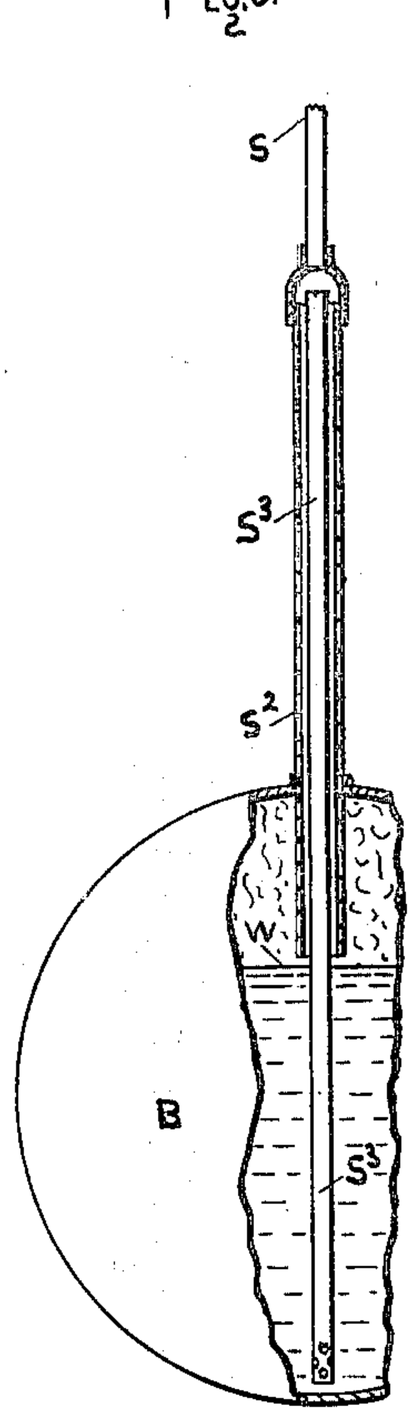
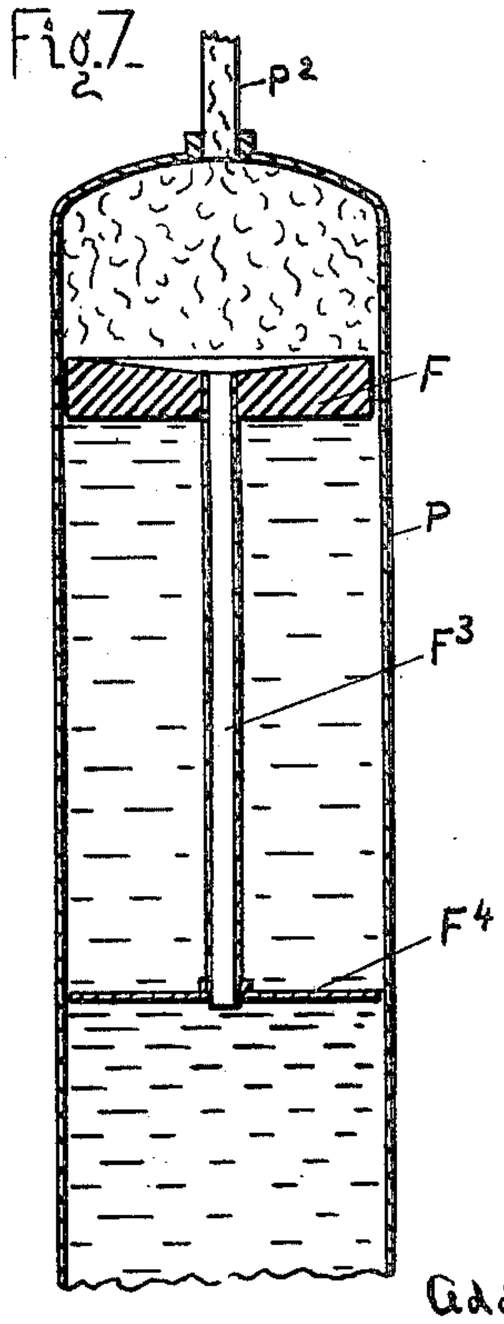


Fig. 7.



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Geo. L. G. Waterhouse.
W. L. Watson

Inventor.
Addison G. Waterhouse.

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(No Model.) 4 Sheets—Sheet 4.

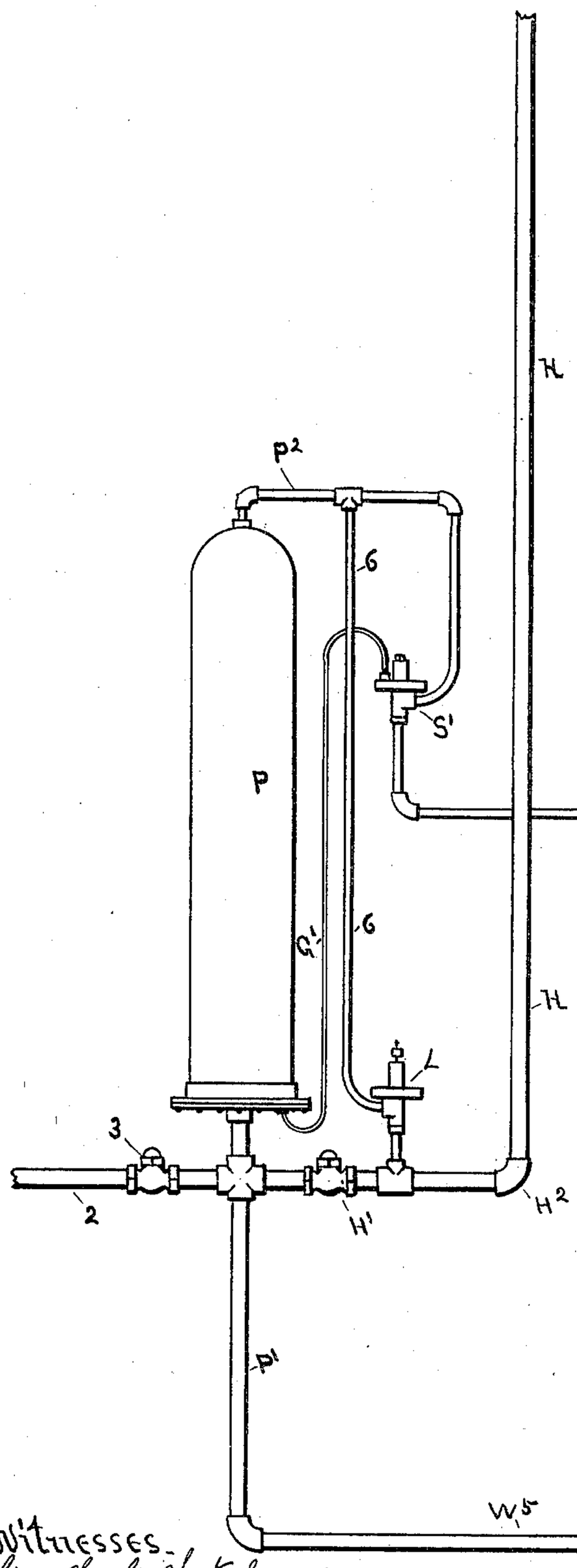
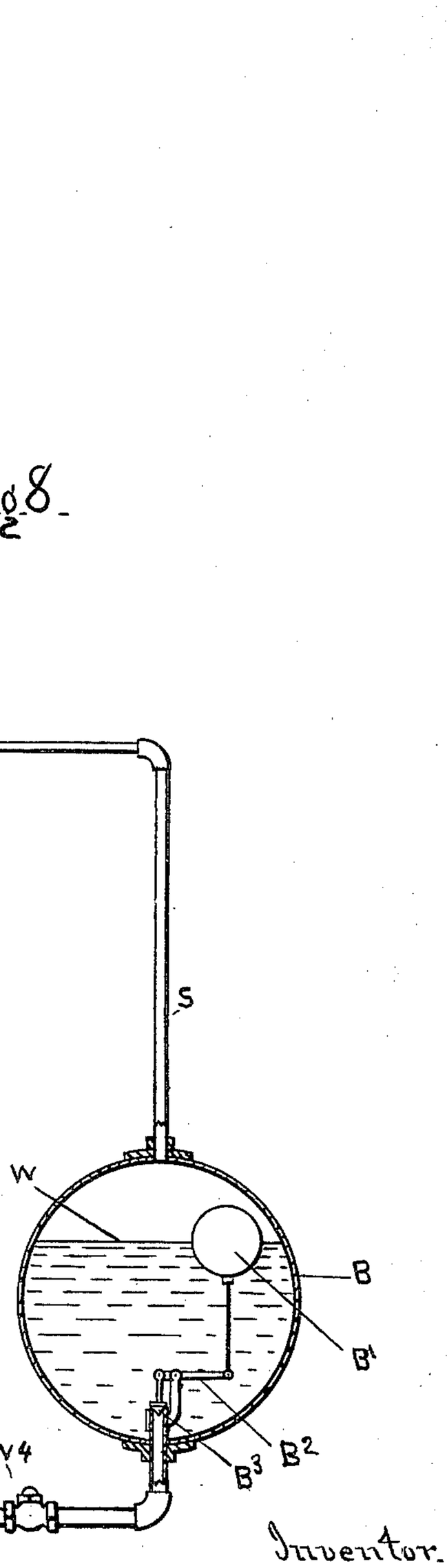


Fig. 2.



Witnesses.
Geo. L. G. Waterhouse.
W. S. Walton

Inventor.
Addison G. Waterhouse.

UNITED STATES PATENT OFFICE.

ADDISON G. WATERHOUSE, OF SPRINGFIELD, PENNSYLVANIA.

FEEDING WATER TO BOILERS.

SPECIFICATION forming part of Letters Patent No. 672,246, dated April 16, 1901.

Application filed October 16, 1900. Serial No. 33,217. (No model.)

To all whom it may concern:

Be it known that I, ADDISON G. WATERHOUSE, a citizen of the United States, residing in the township of Springfield, county of Delaware, State of Pennsylvania, have invented new and useful Improvements in Apparatus for Feeding Water into Steam-Boilers, of which the following is a specification.

The object of my invention is to perform the work economically of feeding water into steam-boilers by means which will employ steam from the boiler to act directly upon the surface of the water to be forced into the boiler, thereby returning all of the heat which is employed in the form of steam back to the boiler with the water fed into it; also, to do away with the use of steam-pumps and avoid the loss due to friction, wear, and leakage common to both pumps and engines and the loss of steam common to the use of steam-engines employed for working pumps.

My invention consists of means for carrying out the work of automatically feeding water into a steam-boiler by employing the difference between the specific gravity of a column of water and a column of steam when both are in communication with and under the same pressure as the steam in the boiler for causing the water to flow into the boiler by gravitation and be displaced by steam and by condensing the steam produce a partial vacuum by which more water will be drawn into the apparatus and confined, so that it in turn will be acted upon by the steam and forced into the boiler by means which will be repeated automatically.

My invention also embraces means for maintaining a constant water-level in a steam-boiler by making the different operations dependent upon such water-level being maintained below a fixed point or level, such as described in my former application, Serial No. 27,232, filed August 17, 1900, in such a way as to carry out my invention, as fully set forth by reference to the accompanying drawings, in which—

Figure 1 shows diagrammatically all parts of a complete apparatus. Fig. 2 shows parts of an apparatus in section. Fig. 3 shows an apparatus for feeding water from a steam-condenser back into a steam-boiler. Figs. 4, 5, 6, and 7 are modified details shown in section. Fig. 8 shows an apparatus for feeding a steam-boiler combined with a steam and vacuum pump.

Fig. 1 shows an apparatus consisting of a steam-boiler B, from which steam is supplied and into which water is forced, so that the level of such water in the boiler will be maintained constantly at a point represented by the water-line W. The apparatus connected to the boiler for performing this work automatically consists of the pumping-tank P, placed above the level of the water in the boiler B and adapted for being filled with water from a source of supply 1, coming through the lifting-pipe 2, check-valve 3, and pipe P′ by means of a vacuum formed in the tank P, which water then in P is then placed under the same pressure as the steam in the boiler B by admitting steam from the boiler through pipes S^2 and S and the automatic steam-valve S′ and pipe P^2 into the tank P and upon the surface of the water therein. This will place the water in tank P under the same pressure as water in the boiler B, and while under this pressure and being at a higher level than the water in the boiler it will flow by gravitation from the higher to the lower level by passing back through the pipe P′, which leads from the bottom of the tank P, then through the check-valve 4, opening toward the boiler, then through pipe 5 into the drum B′, and into the boiler B. As soon as the water has left the tank P the steam leading to it is shut off. This is immediately followed by condensation, which slightly lowers the steam-pressure in tank P below the pressure in the boiler B. This difference of pressure, even when very slight, would cause a limited amount of the water in the drum B′ before it had passed into the boiler and become heated to flow back through the pipe 5, valve L, tube 6, and part of the steam-pipe P^2 into the top of the tank P, thereby completely condensing the steam in P and forming a vacuum therein, which would draw a fresh supply of water from 1 through pipe 2, check-valve 3, and pipe P′ and refill the tank P, when it would again be ready for another operation.

To perform the above work automatically, certain operations are to be successively per-

formed, which are in the following order: To start with, the tank P is assumed to be filled with water. Means are then employed which are made dependent upon the tank P being filled with water for causing the steam to be let on from the boiler B to the surface of the water in P. Then means are employed resulting from or dependent upon the water being all or partly forced from the tank P for causing the steam from the boiler B to be shut off. Then the fall of the pressure in P which follows the shutting off of the steam allows condensing-water under pressure at or near that of the steam in the boiler to enter the tank P and condense the steam, thereby forming a vacuum therein, which vacuum is employed for refilling the tank P with water from the source of supply, and again employing means resulting from or dependent upon the tank P being filled with water for letting on steam, so that these operations will be automatically repeated. Various means and forms of apparatus, together with details thereof, are shown for carrying out these different operations involved in this work which I reserve as subjects for other applications for Letters Patent, including the valves and forms of construction employed for performing the different kinds of work described, as described and claimed in my said former application, Serial No. 27,232.

The work of letting on and shutting off the steam is performed by the automatic steam-valve S′. (Shown in Fig. 2.) This valve S′ is shown in an enlarged section and consists of two shells S^4 and S^5, bolted together, with a flexible diaphragm S^6 placed between them, so as to form two separate recesses S^7 and S^8 each side of the diaphragm S^6. The recess S^7 has an inlet steam-passage S^9 and an outlet-passage S^{10}. The other recess S^8 has a projecting hollow hub S^{11}, which is closed by the gland S^{12}, so as to form S^8 into a closed recess having a tube G′ leading to it, so that if steam or water should enter the recess through this tube G′ under pressure it would bulge the diaphragm S^6 outward or toward the recess S^7. Extending through the diaphragm S^6 is a valve-stem S^{15}, which is provided with a valve S^{14} in the recess S^7, which closes the steam-inlet S^9, and this stem also forms the guide S^{16} in the recess S^8 and is secured to the diaphragm S^6 by the nut S^{18}. Surrounding the guide S^{16} is a pressure-spring S^{17}, which is backed by the gland S^{12} and presses upon the nut S^{18} and diaphragm S^6, so as to force the valve S^{14} hard upon its seat and prevent steam from entering the inlet S^9 against any steam-pressure which may be produced in the pipe leading to the inlet S^9. The action of this valve is as follows: The steam is normally prevented from entering by the pressure of the spring S^{17}, owing to the steam in S^9 exerting a pressure upon such a small surface as that offered by the valve S^{14}; but if a back pressure should be exerted through the outlet S^{10} in the recess S^7 upon the greater surface offered by the flexible diaphragm S^6 it would overcome the pressure of the spring S^{17} and by bulging the diaphragm toward the spring raise the valve S^{14} and admit steam through S^9 into the recess S^7 and out through the outlet S^{10}, and if the steam passing out at S^{10} had to perform any work by passing out under pressure it would exert a corresponding back pressure upon the diaphragm S^6 and keep the valve S^{14} open. If at this stage an opposing pressure should be offered upon the opposite side of the diaphragm S^6 by steam or water entering the tube G′ into the recess S^8, it would by the aid of the spring S^{17} overcome the back pressure in the recess S^7 and bulge the diaphragm S^6 toward the recess S^7 and close the valve S^{14}. This would shut off the steam and cause the back pressure of the steam passing out through S^{10} to die out, so that if the pressure produced in recess S^8 through tube G′ was then removed the pressure offered by the spring S^{17} would keep the valve S^{14} closed. This valve S′ is used to let on and shut off the steam by means which will accord with the rise and fall of the water in the pumping-tank P, (shown in reduced size,) which work is done as follows: When the tank P is nearly refilled with water through pipe P′ by means of a vacuum, as stated, the condensing-water, which continues to flow in a limited quantity under pressure through the valve L and tube 6 into the top of the tank P, soon forms a pressure therein, and this pressure is communicated through the pipe P^2 and outlet S^{10} into the recess S^7 of the valve S′, which pressure acting upon its diaphragm S^6 lets on steam, as described, and the back pressure of this steam, produced by acting upon the water in P, keeps the valve open until the steam forces the water in P down to the level, which would cause the float G to fall, and thereby, acting through its pivoted lever G^3, would open the small valve G^2 and allow either water or steam to pass through tube G′ into the valve-recess S^8 at a pressure equal to the pressure in tank P, and this pressure, together with that of the spring S^{17}, would close the valve S^{14}, as stated, which would be followed by a fall of pressure and finally by a dying out of the back pressure in the valve-recess S^7, which would enable the spring S^{17} to keep the valve S^{14} closed after the opposing pressure exerted through tube G′ died away. So by the means stated, which are dependent upon the tank P being filled by or emptied of water, the steam would be let on when the tank P was filled with water and shut off after the water was forced from it.

Fig. 2 also shows an enlarged sectional view of an automatic condensing-valve L, composed of two shells L′ and L^2, screwed together, having a flexible diaphragm L^5 placed between them. The lower shell has a closed recess L^3 with an inlet L^9, through which condensing-water enters from any source of supply from which water can be secured at sufficient pres-

sure. This inlet L^9 is provided with a check-valve L^6, which will at all times prevent the return of water and by which the admission of water is regulated. The diaphragm is arranged so that when it is bulged upward the check-valve L^6, which is guided by its shank L^7, has a long lift, so that it will admit of the free passage of water; but when the diaphragm L^5 is bulged down it limits the lift of the check-valve L^6 by pressing on the top of the stem L^7, so that very little water can pass through. The movement of this diaphragm L^5 is limited by having a bolt L^{11} secured to its center by means of the bolt-head L^{12} on one side and the nut L^{13} on the other. This bolt L^{11} extends out through the top of the shell L^2 and has set-nuts L^{14}, which by striking on the top of the shell L^2 will limit the downward bulge of the diaphragm L^5 and also limit the amount of water which can flow through the valve, as stated. There is a comparatively light spring L^{15} placed around the bolt L^{11} and arranged so that it will bulge the diaphragm L^5 downward and with a force sufficient to partly check the flow of water through the valve when there is no other cause opposing the flow of such water out through its outlet L^{10}. In action the working of this valve is as follows: When the condensing-water begins to pass through it and enters the top of the tank P, it enters against a pressure of steam therein, and this pressure produces a back pressure in the valve under the diaphragm L^5, which bulges it up against the spring L^{15} and allows a long lift to the check-valve L^6 and a free passage to the water. When the pressure in the tank P lowers by part of the steam it contains being condensed, the back pressure lowers and the spring L^{15} begins to act and limits the flow of water to that just sufficient for completing condensation and producing a vacuum in P, and when such vacuum is produced then a negative pressure or suction is imparted from the tank P to the valve L, which causes atmospheric pressure to act upon the upper surface of the diaphragm L^5, which, with the aid of the spring L^{15}, will bulge the diaphragm downward as far as the set-nuts L^{14} will allow it to move. These nuts can be adjusted so that the movement of the check-valve L^6, and consequently the flow of water through the valve, will be limited to that which is just sufficient to maintain the vacuum in the tank P and cause it to refill by drawing water from its source of supply through the pipe P′.

Fig. 3 shows a modified form of apparatus operated by the same general means as before described and adapted for performing the work of drawing air and water from a steam-condenser, and after first expelling the air it then forces the water back into the boiler, from which it came, in the form of steam. The apparatus includes a steam-boiler B, connected to a steam-condenser M by a series of steam heating-pipes K, or what may represent a steam-engine or any kind of apparatus through which steam passes, and is then condensed in M, or in which steam is condensed, while its water, accompanied by air or gases, passes into M under a partial vacuum and from which they are to be drawn. The apparatus employed for doing this work is chiefly composed of two tanks, one used as a pumping-tank P, into which water is drawn by the condensation of steam and from which it is forced by the pressure of steam, and the other tank V is used as a vacuum-tank, into which the water from the tank P is forced and then withdrawn. The details belonging to this apparatus consist of a steam-pipe S, provided with the automatic steam-valve S′, constructed and used as described. The steam passes from valve S′ through pipe S^{10}, where it joins pipe P^2, which leads to the top of the pumping-tank P. The water-passage through which water is forced into the boiler B leads from the bottom of the pumping-tank P through pipe P′, then up through the vacuum-tank V, and out through pipe E, water-trap T, and then down through pipes W and W^3, check-valve W^4, and pipe W^5 to the boiler B. The air and water are drawn from the condenser M through pipe W^2, check-valve W′, up pipe W, and through the water-trap T and pipe E into the top of the vacuum-tank V. The condensing-water flows from the boiler through pipe C, placed as a shunt around the check-valve W^4, then through a cooling-coil C′, placed in a well C^2, then up through the automatic condensing-valve L, made and used as described, and then up pipes 6 and P^2 into the top of the pumping-tank P. There is also a condensing suction-pipe C^3, which extends from the pipe 6 into the well C^2. This pipe is provided with a check-valve C^5, opening toward pipe 6, and also a restraining-cock for limiting the amount of water which can pass, the object being to cause condensing-water to be drawn directly from the well C^2 by the vacuum in tank P, so as to maintain such vacuum while it is doing its work and by so doing economize in the amount of water drawn back from the boiler by causing the valve L to shut this water off more completely after a vacuum has been started. The operation of this apparatus is as follows: To start with, the tank P is filled with water, by which the valve S′ is caused to let on steam. This forces the water down through pipe P′ and up into the vacuum-tank V, which water while rising in V forces any air which it may contain out through pipe E, water-trap T, and discharge T′, there being a check-valve in connection with this discharge T′, which prevents the return of air. After the water is forced from P into V the valve S′ shuts off the steam, which is then condensed in P, thereby forming a vacuum, which draws the water back from V into P and produces a vacuum in V. This vacuum draws the air and water from the condensing-chamber M by way of pipe

W^2, check-valve W', pipe W, water-trap T, and pipe E into V. As the water again rises in V the air is first forced out through pipe E, trap T, and discharge T'. Then the water which forms in V, which is more than it can hold after receiving the contents of P, is caused to follow the air until it reaches the water-trap T, in which a float is raised by this water, which actuates a valve and closes the opening leading to the discharge T', so the escape of water is shut off until the pressure of steam in P rises to its maximum and places the water in V at the same pressure as that in the boiler B. This pressure in V causes the water, owing to its height above the water in the boiler B, to flow down through pipes W and W^3 and check-valve W^4 into the boiler B, and this flow continues until the water is forced from the tank P, when the steam is shut off and the operation is repeated.

Fig. 4 shows, partly in section, a modified form of pumping-tank P used in certain cases for performing the different operations required. In this form a float F is used, which travels up and down the tank P with the surface of the water and may have connected to it at a distance below, by means of a rod F', a loose-fitting piston F^2, which will confine the water upon which the steam acts between the float F and the piston F^2 while cool water is drawn in and forced out of the lower part of the tank P. When it is not possible to use the pressure produced by the inflowing condensing-water for causing the valve S' to let on steam, then the float F can be used to open a puppet-valve N, which will let on steam through the branch pipe N' into the tank P, and then the back pressure of the steam, through the pipe S^{10} will cause the valve S' to let on steam, which will remain on after the valve N is allowed to close by the float F lowering with the water. The same float F or the piston F^2 attached to it can be used to open the valve G^2 by pressing on the pivoted lever G^3 while at the lower extreme of its movement, as shown by dotted lines, and thereby cause a pressure to be transmitted through the tube G' to the valve S', which will cause the steam to be shut off, as before described.

Fig. 5 shows a modified detail of Fig. 1, which consists of a steam-pipe leading upward from a steam-boiler B. In Fig. 1 this device is shown in the form of two parallel pipes S^2 and S^3. The one S^2 leads from a point just above the water-level W, while pipe S^3 leads below that level, both joining in and continued by the steam-pipe S. In this Fig. 5 pipe S^2 is represented by the outer pipe S^2 and the other by the inner pipe S^3, the object of this device being to cause the apparatus to force water into the boiler whenever the water-line W falls below the lower end of pipe S^2 and to stop such action when it rises to or is above this level W. The action is produced as follows: When the level of the water W is below the end of pipe S^2, steam can pass up into it, and what water there is in pipes S^2 and S^3 will be immediately siphoned down through pipe S^3, so there will be a clear passage for steam through pipe S^2 to pipe S, which will cause the apparatus to work, as stated, by balancing a column of steam in these pipes against a column of water in the apparatus; but as soon as the water-line W rises in the boiler to or above the end of pipe S^2 water will pass up this pipe, which will stop the action of the apparatus by causing the weight of the water in the steam-pipes to balance the water in the apparatus and prevent the action due to gravitation, so that no water will be forced into the boiler until the water-level W again falls below the end of the pipe S^2, so that steam can again enter and cause the water to be siphoned out and be replaced by steam, which will again start the apparatus into action.

Fig. 6 shows a float F placed inside of a pumping-tank P, which float can be made flat or of any form or material which will stand the external pressure which it is subjected to and be light enough to float upon the surface of the water as it rises and falls in tank P, one object of this float being to insulate the larger part of the water-surface from the steam, thereby reducing the condensation which would result from such contact.

Fig. 7 shows a modified form of Fig. 6, in which the float F is provided with a tube F^3 for conducting the condensing-water which enters at P^2 down through the hot water which surrounds the float to the cooler water at the lower end of the tank P, the object in this case being to keep the surface water as hot as it is possible to keep it and still be able to form above its surface a sufficient vacuum to draw in and fill tank P with water from the source of supply, which supply may be above or below the apparatus. Therefore the strength of such vacuum would have to correspond with the relative levels of tank P and that of its source of supply. In order to increase the surface heat as much as possible and still avoid the resulting evaporation which heated water would undergo if left on the surface, therefore I employ such means as the insulating-float or any other which will effect the desired result, such as shown in Fig. 7, by extending the tube F^3 downward and fixing a thin light piston-disk F^4 at its lower end, which need not be large enough to cause friction by touching the sides of tank P, but large enough to prevent the hot water above F^4 from circulating and mixing with the cooler water below F^4, and in order to secure a still greater degree of economy by maintaining a higher degree of heat in the top of P than is practical when water is used then I use a body or stratum of non-volatile oil or like material which will float upon the surface of the water in P and still allow the condensing-water from P^2 and the water produced by con-

densation to sink through the oil to the water below. When oil is used, a longer tank is used, as P in Fig. 4, so that as cold water passes in and out at the bottom there will be a large body of warm water remaining in it constantly, so as to cause the oil to keep separated from the transient water by remaining on the surface of the retained water. To better secure the retention of oil within the tank P, the float F, tube F^3, and disk F^4 may be employed, and the space between the disk F^4 and the float F may be partially or entirely filled with oil, which will move up and down with the float and cause F^4 to prevent a circulation and the mixing of the oil and water, while an up-and-down movement is caused by the flowing in and out of water below.

Fig. 8 shows a form of apparatus adapted for feeding water into a boiler B, while at the same time performing other work, such as forcing water up the stand-pipe H. In this form the boiler B has a float B′, which may be placed inside or outside of the boiler, but inclosed so that it will rest upon the surface of the water, (represented by the water-line W of the boiler.) This float B′ is connected to the pivoted lever B^2, which actuates the valve B^3, so as to admit or prevent water from entering the boiler as the line W changes below or above a certain level. The apparatus is constructed the same as shown in Fig. 1, with the exception of the single steam-pipe S and the stand-pipe H, with the condensing-pipe 6 connected thereto. In operation the vacuum is formed in P by condensing-water flowing from the stand-pipe H through the valve L and tube 6 into P at a pressure corresponding to that at which water is raised through stand-pipe H. The steam from the boiler B, passing through the pipe S and valve S′, exerts about the same pressure upon the water in P as in the boiler B, so this water would flow by gravitation into the boiler whenever the valve B^3 was open. Otherwise the water in P would be forced up the stand-pipe H for any purposes desired. If the pressure required for forcing the water up H was less than that required to force it into the boiler B, even then while this work was going on and the valve B^3 was open steam would pass into the tank P faster than water could flow out through the stand-pipe H, so that the pressure in P would equal the boiler-pressure and cause part of the water expelled from tank P to flow into the boiler as often as the valve B^3 opened, so that the water-level in W would be maintained constant by the apparatus while it was doing other work. In this or the other forms of apparatus the tank P can be placed at any desired level above the boiler B. When the work of feeding the boiler is the sole duty of the apparatus, then P need be elevated above the boiler only enough to give the water in P sufficient head to overcome the resistance offered by the valves and pipes; but when used for other work in connection with boiler-feeding, as shown in Fig. 8, then the tank P can be placed as high as the vacuum caused by the condensation of steam will lift water to it, which may be at a sufficient height for use when discharged out of the stand-pipe H at or near the level of tank P. In such a case a very low steam-pressure can be used in the boiler B or that just sufficient to overcome the atmospheric pressure and force steam into P, and any slight steam-pressure above atmosphere could be used to raise the water a corresponding height above P after being lifted up as high as the vacuum in P would raise it. It is also obvious that when water is fed into a boiler by the method described such water can be heated by exhaust-steam, which may be applied to most any part of the apparatus or passages through which the water flows on its way to the boiler.

Referring to Fig. 8, the source of supply 1 may be above or below the boiler B. If above, then a pressure is secured which could be added to the pressure required for forcing water into the boiler, and to this pressure or elevation, due to the level of the source of supply, may be added the height to which the water can be drawn above the supply-level by the vacuum produced in tank P, and to this height or the pressure due to the same can be added the still higher level or pressure to which the water can be forced by the pressure due to the steam from the boiler B. Then we have a pressure in stand-pipe H due to three causes, or at least two of them, which will make the pressure in H greater than that in the boiler, so that water would flow directly back from H into B by reason of the difference between the two pressures. In such a case it is obvious that the pipe P′ can be removed from its direct connection with tank P and be connected to the pipe H, as at the bend H^2, so that while the work of forcing water up pipe H is going on the water will flow at any time that it is permitted to into the boiler B from the pipe H or from the level or pressure to which the water is forced through the pipe H.

The different forms of apparatus shown represent means for practically carrying out my invention when applied to the sole work of feeding water into boilers, as well as performing such work in conjunction with other duties, such as pumping or raising water, and they show means for performing the different actions required for carrying out my invention, which are as follows, to wit: Taking water from a source of supply above or below the level of the boiler or from where it is confined under a pressure above or below that of the atmosphere, drawing it above its source of supply by means of a vacuum formed by the condensation of steam, forcing it to a still higher level or greater pressure by means of the pressure of steam from the boiler, condensing the steam by means of a limited amount of water under a pressure due to its source of supply or the pressure due to its

elevation caused by the vacuum and the pressure of the steam from the boilers or either of them, conserving the heat employed by insulating the surface of the water upon which the steam presses or retaining the heated water in that part of the apparatus where the steam enters by separating it from or preventing it from combining with the cooler transient water or that drawn in and expelled from the apparatus, drawing water and air from a condensing-chamber or from where they are confined under a partial vacuum, separating such air from the water and forcing the water into the boiler by the method described, regulating the action through which the work is done, when such work is for the sole purpose of feeding water in the boiler, by making such action dependent upon a column of steam from the boiler being balanced against a column of water, as described, and making such column of steam dependent upon the level of the water in the boiler being below a fixed point, causing the water to flow into the boiler by the method described through a passage which is opened or closed by means of the rise and fall of the water in the boiler above or below a determined level, and causing each of the described actions to be performed automatically in their respective order and succession.

What I claim as my invention is—

1. An apparatus for feeding water into a steam-boiler, consisting of a pumping-tank placed above the level of the water in the steam-boiler; a pipe or passage provided with a check-valve leading from a source of supply to the pumping-tank; a pipe or passage provided with a check-valve leading from the pumping-tank to the steam-boiler into which water is to be fed; a steam-pipe leading from the steam-boiler to the top of the pumping-tank, provided with an automatic steam-valve, possessing the elements and connections as described, by means of which steam is let onto and shut off from the pumping-tank to accord with the extreme rise and fall of water in the pumping-tank; and a condensing-water pipe or passage leading from the steam-boiler below its water-line to the top of the pumping-tank and adapted for conducting a limited amount of condensing-water: substantially as and for the purposes set forth.

2. The combination of a steam and vacuum pump with a steam-boiler, consisting of a pumping-tank placed above the level of the water in the boiler, and having a supply pipe or passage, provided with a check-valve, leading from a source of water-supply to the pumping-tank, and a discharge pipe or passage leading from the pumping-tank, provided with a check-valve, and a branch or passage leading to the steam-boiler; a steam-pipe leading from the steam-boiler to the pumping-tank, provided with an automatic steam-valve having the mechanism described for letting on and shutting off steam from the boiler to the tank, to accord with the rise and fall of water in the tank, and a passage extending from the boiler at a point below its water-level, to a point at or near the top of the pumping-tank, adapted for conducting a limited amount of condensing-water: substantially as and for the purposes set forth.

3. In the combination of a steam and vacuum pump and a steam-boiler, consisting of a pumping-tank placed above the level of the water in the boiler, and provided with a supply-passage leading from a source of supply to the pumping-tank, and a discharge-passage leading from the pumping-tank to a point of discharge, including a passage to the boiler, and a steam-pipe leading from the boiler to the tank, provided with an automatic steam-valve, having the elements described for letting on and shutting off the steam to accord with the rise and fall of water in the tank; a condensing-water passage leading from the steam-boiler at a point below its water-level to the pumping-tank at a point at or near its top, through which a limited amount of water can pass from the boiler, and a branch condensing-pipe provided with a check-valve leading from a cold-water supply through which a limited amount of water can be drawn into the pumping-tank: substantially as and for the purposes set forth.

4. An apparatus for feeding water into a steam-boiler, consisting of—a pumping-tank placed above the level of the water in the boiler, and from which water is forced and into which it is drawn by the alternate pressure and condensation of steam therein: a supply-passage leading from a source of supply to the tank through which water can pass only from the source of supply; a discharge-passage leading from the tank and in communication with the steam-boiler, through which water can pass only from the tank; a condensing-water passage through which a limited amount of water, discharged from the tank, can return under pressure, to the tank, thereby causing the condensation of steam in the tank; a steam-pipe leading from the boiler, through an automatic steam-valve to the top of the tank; a tube leading from the tank to a part of the automatic steam-valve and the arrangement of such elements as described for causing the extreme lower movement of the water in the tank, to transmit a pressure from the tank to the steam-valve: substantially as and for the purposes set forth.

5. The combination of a steam and vacuum pump and a steam-boiler, consisting of a pumping-tank placed above the level of the water in the boiler, provided with a suction or supply passage, leading from the bottom of the pumping-tank to the bottom of a vacuum-tank, then from the top of the vacuum-tank, through a passage provided with a check-valve, to a condensing-chamber from which water and air are to be drawn; a discharge-passage leading from the bottom of the pumping-tank to the bottom of the vacuum-tank,

through a passage provided with a water-trap and a check-valve to the steam-boiler, into which the water drawn from the condensing-chamber is fed; a steam-pipe leading from the boiler to the top of the pumping-tank provided with an automatic steam-valve possessing the elements and connections, as described, whereby steam is let on to and shut off from the pumping-tank to synchronize with the rise and fall of water in the pumping-tank and a condensing-water passage leading through passages, wherein the condensing-water is cooled off, and from which a limited amount of water is conducted to the top of the pumping-tank: substantially as and for the purposes set forth.

6. In the combination of a steam-boiler with a steam and vacuum pump, consisting of a pumping-tank placed above the level of the water in the boiler, and provided with a supply-passage leading from a source of supply to the pumping-tank; a discharge-passage leading from the tank to the steam-boiler and a steam-passage leading from the steam-boiler to the pumping-tank provided with means for letting on and shutting off the steam to accord with the rise and fall of water in the pumping-tank—the said steam-passage consisting of two pipes or passages leading from the steam-boiler, one of which starts from a point below the water-level and the other from a point at or near the water-level, the two passages uniting into a single passage at a point above the level of the water in the boiler, and then continuing on to the pumping-tank; substantially as described.

7. In the combination of a steam-boiler with a boiler-feeding apparatus having the arrangement of elements whereby steam from the boiler draws water from a source of supply into the boiler-feeder and forces it therefrom into the steam-boiler, a steam-passage leading from the boiler to the boiler-feeder, consisting of two pipes or passages, one of which leads from the boiler at a point below its water-level, and the other from the boiler at a point at or near the water-level, the two passages uniting into a single passage at a point above the level of the water in the boiler, and continuing on to the boiler-feeder; substantially as set forth.

8. A steam-passage leading from a steam-boiler to a boiler-feeder; consisting of two passages leading from the steam-boiler, one of which leads from a point below the water-level, and the other from a point at or near the water-level, the two passages uniting at a point above the level of the water in the boiler and then continuing on through a single passage to the boiler-feeder; substantially as and for the purpose set forth.

9. In combination with a pumping-tank, from which water is forced and into which it is drawn, by the pressure and condensation of steam, as described; a float placed within the tank, which will rise and fall with the surface of the water therein and open a valve, as the float descends with the surface of the water to the lower extreme of its movement, so that steam or water will pass through a tube or conductor to a steam-valve, whereby the steam is shut off from the tank: substantially as and for the purposes set forth.

10. In the combination of a steam-boiler, with a steam and vacuum pump, as described, whereby the pump can be continually employed for raising water from a source of supply to a place of delivery and periodically employed for feeding water into the steam-boiler; a valve actuated by the rise and fall of the surface of the water in the boiler and adapted for opening and closing the passage leading from the pump to the boiler: substantially as and for the purposes set forth.

11. In the combination of a steam and vacuum pump, with a steam-boiler, as described, wherein the condensing-water employed for condensing the steam in the pumping-tank is drawn from the boiler; a coil or passage placed in cool water or a cooling-well, through which the condensing-water passing hot from the boiler, will be cooled off on its way to the pumping-tank: substantially as described.

ADDISON G. WATERHOUSE.

Witnesses:
GEO. L. G. WATERHOUSE,
W. S. WATSON.