No. 635,042.

Patented Oct. 17, 1899.

H. L. GOODWIN.

AIR HEATING SYSTEM.

(Application filed Dec. 16, 1898.)

(No Model.)

3 Sheets—Sheet 1.

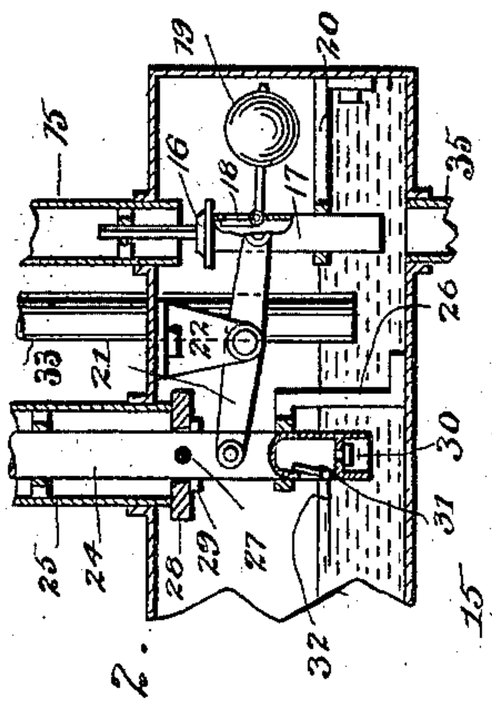

Fig. 2.

Fig. 1.

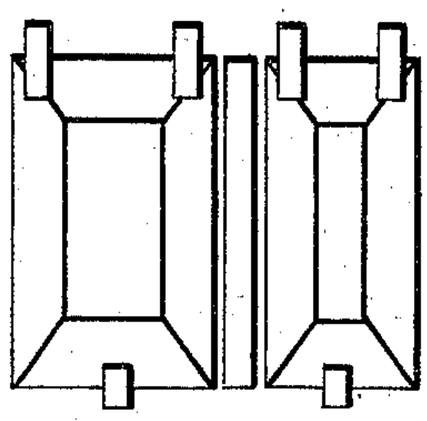

Fig. 4.

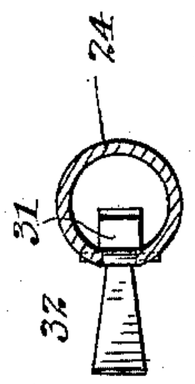

Fig. 3.

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(No Model.) 3 Sheets—Sheet 2.

Fig. 4.

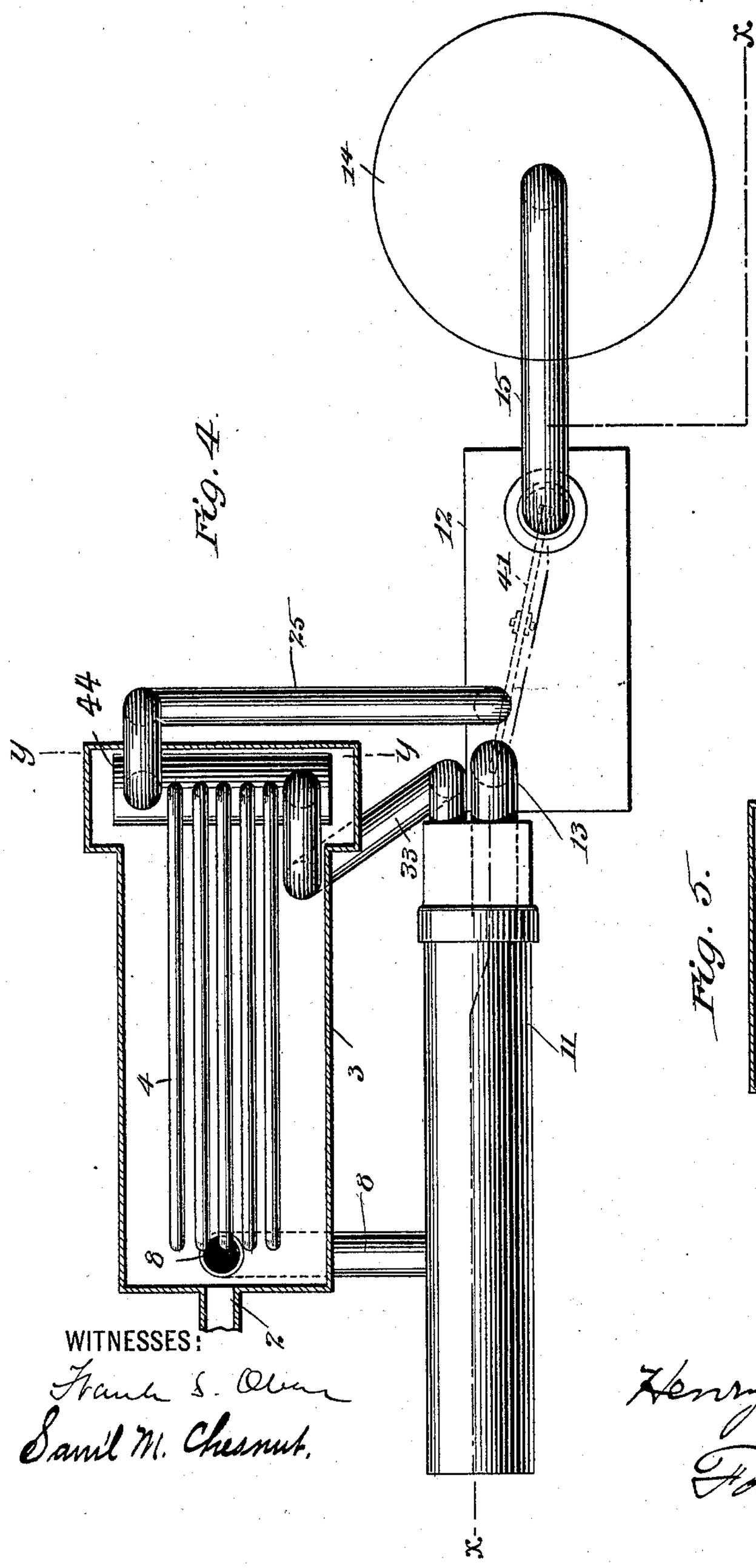
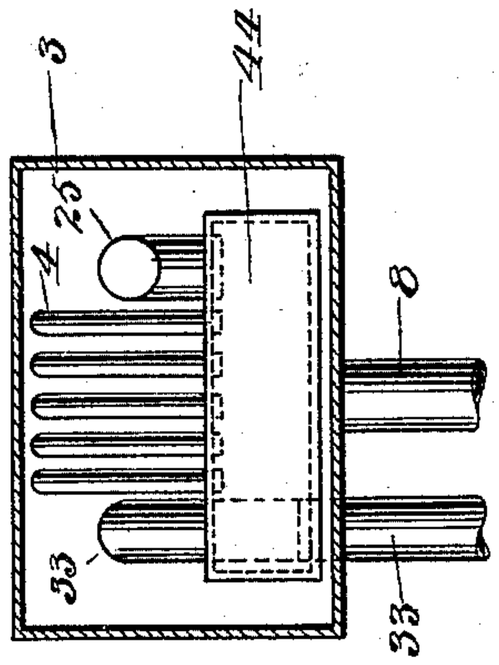


Fig. 5.



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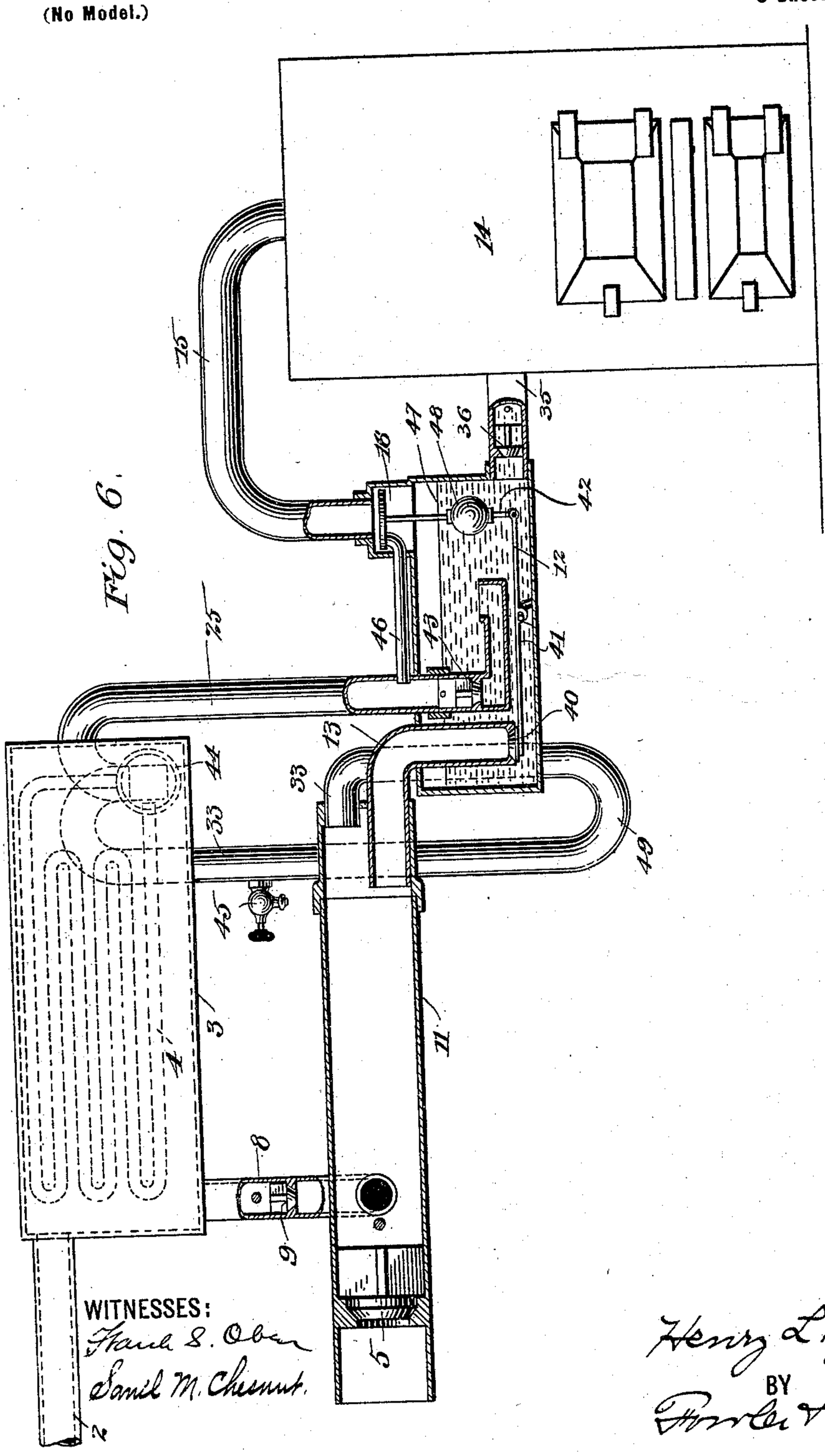
(Application filed Dec. 16, 1898.)

(No Model.)

3 Sheets—Sheet 3.

Fig. 6.



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UNITED STATES PATENT OFFICE.

HENRY L. GOODWIN, OF NEW YORK, N. Y.

AIR-HEATING SYSTEM.

SPECIFICATION forming part of Letters Patent No. 635,042, dated October 17, 1899.

Application filed December 16, 1898. Serial No. 699,430. (No model.)

To all whom it may concern:

Be it known that I, HENRY L. GOODWIN, a citizen of the United States, residing at New York city, borough of Manhattan, county and State of New York, have invented certain new and useful Improvements in Air-Heating Systems, of which the following is such a full, clear, and exact description as will enable any one skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, forming part of this specification.

My invention relates to a system for heating by means of hot air; and the principal objects of the invention are to provide an efficient and economical means for forcing or pumping the fresh air through the heating apparatus and thence into the main from which the hot air is taken for heating purposes.

To these ends my invention consists in the various novel and peculiar arrangements and combinations of the different parts of the apparatus, all as hereinafter fully described and then pointed out in the claims.

I have illustrated types of my invention in the accompanying drawings, wherein—

Figure 1 shows an embodiment of one form of my invention, with the greater portion thereof shown in vertical longitudinal section. Fig. 2 is a detached view of the valve mechanisms of the steam-supply pipe and the pipe supplying the steam-radiator, the position of the valves being the reverse from that shown in Fig. 1. Fig. 3 is an enlarged view of a horizontal section of the lower portion of the tubular valve. Fig. 4 is a plan view of another form of my apparatus. Fig. 5 is a sectional view, the plane of which section is indicated by line *y y*, Fig. 4. Fig. 6 is a sectional view of the apparatus shown in Fig. 4, the various planes of which section are indicated by lines *x x* in Fig. 4.

Referring to the drawings, in which like numbers of reference indicate like parts throughout, 2 is the hot-air-supply main, from which the hot air is taken or distributed for heating purposes. This main 2 leads from the heating-chamber 3, in which the fresh air as it is introduced therein is heated by its passage over the steam coils or radiator 4.

5 is the fresh-air supply, which opens into the water or pumping chamber 6 and which is supplied with a valve 7 to prevent the air from passing from the water-chamber back through the intake 5 during the pumping action.

8 is a pipe which connects the water-chamber 6 with the heating-chamber 3, and this communicating pipe is provided with a downwardly-closing valve 9 and also with a float-valve 10, which closes said communicating pipe after the pumping action and serves to prevent the water escaping from the water-chamber into the heating-chamber.

In order to move the body of water in the water-chamber and cause it to act like a piston to drive the contained air through the air-heating chamber 3 and at the same time admitting the steam to the radiator, I provide the following mechanism. (Shown in Figs. 1 to 3, inclusive.) The water-chamber is divided into two compartments 11 and 12, which communicate at the lower parts by passage-way 13, and these compartments I term, respectively, the "first" and "second" compartments. The induction-pipe 5 and the eduction-pipe 8 are both in communication with the upper part of the first compartment 11 of the water-chamber. The second compartment 12 is connected to an ordinary steam-boiler 14 by means of steam-supply pipe 15, having an upwardly-closing valve 16, controlling its communication with the water-chamber. From the valve 16 depends a tubular air-compressing chamber 17, which is open at the bottom and closed at all other points except at one side near the top, where there is an opening which is covered by the outwardly-closing valve 18, having float 19 connected therewith. The air-compressing chamber 17 moves vertically in a suitable guide 20, and to one side of it is pivoted the end of lever 21, which is fulcrumed at its center on the fixed bracket 22, and has its other end pivoted at 23 to the tubular valve 24, the upper end of which projects well within the enlarged end of the supply-pipe 25 of the steam-radiator 4, while the lower end thereof projects down to near the bottom of the compartment 12, where its lower end works in a suitable guide 26. This tubular valve 24 is open at both ends and is provided with a lateral valve-opening 27 near its center, which is covered and uncovered by the annular

valve 28, which is carried loosely by said tubular valve. Upon the exterior of the valve 24 just below the opening 27 is a fixed stop 29, upon which the annular valve 28 rests loosely, and when the tubular valve is raised the annular valve is carried up by the stop thereon and is seated against the lower end of the radiator supply-pipe 25, which enters the second compartment of the water-chamber. At the same time the annular valve 28 covers and closes the lateral valve-opening 27 of the tubular valve, as will be understood from Fig. 2. At the lower end of the tubular valve 24 is a downwardly-opening valve 30, while just above the lower end thereof is an inwardly-opening valve 31, having a wing 32, which projects out into the surrounding water to be acted upon by the movement of the water, as hereinafter described. (See the enlarged view, Fig. 3.)

The return-pipe 33 of the steam-radiator 4 extends into the second compartment 12 of the water-chamber and down to near the bottom thereof, and is provided at its lower end with an upwardly-closing valve 34. This second compartment is also connected to the steam apparatus by means of a return-pipe 35, having therein a check-valve 36 for preventing a backflow of water from the apparatus into the compartment, at the same time permitting the water under certain conditions to pass from said compartment into the steam apparatus. This second compartment is also provided with an air-vent 37, which is connected therewith at a point slightly above the lowest point to which the water descends, so that under certain conditions the air above the water in the second compartment may find an exit for a brief period through the vent 37, the upper end of which extends above the highest point reached by the water. Within the air-vent 37 is arranged a float-valve 38, which keeps the vent closed as long as the water in the second compartment stands above the lower opening of the vent.

In the operation of the apparatus described in reference to Figs. 1 to 3, inclusive, the water-chamber is filled something more than half full of water and the live steam upon reaching a certain pressure in the boiler opens the valve 16 of the supply-pipe 15, which action causes the tubular valve 24 to close, likewise the annular valve 28, carried thereby, so that all communication is cut off between the space above the water in the second compartment and the supply-pipe 25 of the radiator, as will be understood from Fig. 2. The steam thus entering the second compartment gradually depresses the water therein, thereby raising the water in the first compartment 11 and driving the air therefrom through the heating-chamber 3 and thence to the hot-air supply 2. The depression of the water in the compartment 12 carries down with it the wing 32 of the valve 31, keeping this valve closed until the water has about uncovered it, and this permits the air above the water to open the valve 31 and momentarily enter the tubular part 24 by reason of the pressure therein being less than that in the said compartment. The air thus entering through the valve 31 so increases the pressure within that it allows said tubular valve to gravitate down and for the moment leaving the annular valve 28 closed, whereby the lateral opening 27 of the tubular part is uncovered and admits the steam into the tubular part and thence into the pipe 25. After a small quantity of steam has thus passed through the lateral opening 27 of the tubular part 24 the annular valve is no longer held up by the difference in pressure and drops down, and thus gives to the steam a free passage from the compartment 12 into the radiator supply-pipe 25, so that the radiator is charged with sufficient steam to heat the air brought in contact with it in the heating-chamber 3. The valve 30 in the lower end of the tubular part 24 opens downwardly, so as to readily release any water accumulating in the lower end of the tubular part 24. At the same time it prevents the water in compartment 12 from being forced into the part 24 when such water is being depressed by the steam, as indicated in Fig. 2. The passage of the steam from the compartment 12 into the radiator, as well as the condensation of the steam, produces a partial vacuum above the water in the compartment 12, and this causes the body of water in the first compartment 11 to flow back and be returned into the compartment 12 by atmospheric pressure in compartment 11, causing the second compartment to fill. As the water begins to rise in compartment 12, the air is compressed within the air-chamber 17, the valve 18 of which is at such time closed, and the continued compression of the air within such chamber lends material assistance to the closing of the valve 16 of the steam-pipe 15. When the valve 16 is thus closed, the water will have reached the float 19, and thereby opened the valve. The opening of this valve 18 permits the compressed air to escape from the air-chamber 17, and thus taking away the support afforded by the compressed air permits the valve 16 to be readily opened by the pressure of steam in the supply-pipe 15. In order to prevent too great an accumulation of air above the water in the compartment 12, I provide such compartment with an air-vent 37, which opens therein at a point just above the lowest level reached by the water and extends upwardly to a point above the highest level attained by the water. This vent is provided with a float-valve 38, which keeps the vent closed as long as the water stands above the opening of the vent in the compartment. When too large a quantity of air has accumulated above the water, such air finds an exit through the vent 37 as soon as the water in the compartment is carried down below the vent-opening. The outer end of the vent 37 is provided with an ordinary automatic thermal valve 50, like that used on ordinary steam-

radiators, and this valve remains open until contact is made with it by steam, the heat of which at once closes the valve and prevents further escape of the steam. In this form of the apparatus the water of condensation from the radiator passes through the return-pipe 33 down into the compartment 12, and this increased quantity of water in the water-chamber is compensated for by an equal amount of water being forced back into the boiler through the return-pipe 35 at the time when the opening of the steam-valve 16 reduces pressure in the boiler sufficiently to permit such return flow.

Referring now to the form of apparatus shown in Figs. 4, 5, and 6, the first compartment 11 of the water-chamber is placed above the second compartment 12, and they are connected by pipe 13, which projects down to a point near the bottom of the second compartment and has its lower end provided with a downwardly-opening valve 40, which valve is connected by a pivoted lever 41 to the stem 42 of the valve 16, which controls the opening of the steam-supply pipe 15 coming from the boiler 14. The valve-stem 42 carries a float 48, which aids in closing the valve 16. This second compartment is connected with the boiler 14 by pipe 35, having a check-valve 36 therein. The supply-pipe 25 of the steam-radiator 4, which is located in the heating-chamber 3, projects within the second compartment 12 to near the bottom thereof, where it has an L-shaped end for containing water and is provided with a downwardly-closing valve 43 to check a backflow through the pipe. The quantity of water held by the lower bent end of the pipe 25 offers enough resistance to the steam to prevent it from prematurely passing into said pipe. The return-pipe 33 of the steam-radiator is made in the form of a siphon, with the short leg connected with a water-drum 44 at the lower end of the steam-radiator 4, while the long leg of this pipe is extended down below the second compartment 11 and is brought up again and introduced into the end thereof, the lower bent end of this long leg forming a U-trap 49 to hold water therein for the purpose of preventing the steam passing from the radiator to the water-compartment 11 into which the water is introduced to pump the air thence into the heater 3 through the connecting-pipe 8, having a check-valve 9 therein. The long leg of this siphon 33 is provided with an air-vent 45, which may be of the ordinary type used in steam-radiators for the purpose of letting out the contained air when the apparatus is started in operation. The space above the water in the second compartment 12 under certain conditions is placed in communication with the radiator supply-pipe 25 through means of a pipe connection 46, which connects with the side of the pipe 25 and projects into the upper part of the compartment 12 in such position that the end therein may be opened or closed by the under side of the valve 16 of the steam-supply pipe 15. When the backflow of water from the first compartment into the second through the connection 13 forces open the valve 40 of such connection, the valve 16 closes the supply 15, at the same time opening the passage-way 46, so that the pressure in the space above the water in compartment 12 and the pressure within the pipe 25 are equalized.

In the operation of the apparatus shown in Figs. 4, 5, and 6, the second compartment 12 of the water-chamber being filled about three-quarters full, the valve 16 opens when the pressure of steam in the supply 15 becomes sufficiently great to force down the valve, and this admits the steam above the body of water 47, at the same time closing the connection 46 with the radiator-supply. The air confined above the water interposes itself as a layer between the water and the live steam, thereby preventing rapid condensation of the steam, which would occur if the steam were brought directly in contact with the water. The pressure of the steam above the water depresses the same and forces it through the supply-pipe 25 into the drum 44 of the steam-radiator, the pipe 25 being carried up above the drum to the same height as the bend in the siphon 33, which is also in communication with the drum. The water is thus raised through the pipe 25, together with a large quantity of steam which finds its way into the radiator. This continues until the drum becomes filled with the accumulated water of condensation from the radiator and the water raised through the pipe 25 and overflows into the siphon 33, the bend 49 of which in the long leg being always filled with water. This serves to siphon the water from the drum 44 into the compartment 11, and the large body of water thus introduced moves through the length of the compartment like a piston and forces the air ahead of it through the pipe 8, thence through the heating-chamber 3 into the hot-air main 2. As the water flows back through the compartment 11 it runs through the connection 13 and opening the valve 40 simultaneously closes the valve 16 of the steam-supply 15 and enters the second compartment. The closing of the valve 16 cuts off the steam from the compartment 12 and this stops the flow of water and steam through the pipe 25 into the radiator, and this condition is maintained until the pressure of the steam in the main 15 becomes sufficiently great to force open the valve 16, whereupon the operation just described is repeated. This repeated pumping action of the water serves to drive the fresh air taken into the compartment 11 through the port 5 out of such compartment through the pipe 8, thence through the heater. This serves to keep up a steady supply of hot air in the main 2, from which it may be taken for purposes of heating. In this form of the apparatus the water of condensation which accumulates in the radiator passes into the water-drum 44 and

remains there until siphoned out by the pipe 33, when, together with the water introduced by the pipe 25, it is passed into the first compartment 11 to effect the pumping action. It then passes into the compartment 12, from where a portion of it eventually gravitates back into the boiler through the return-pipe 35, so that substantially the same quantity of water is maintained in the compartment 12 throughout the operation of the apparatus. When the air introduced in the heating-chamber becomes heated by the radiator, it is expanded, and such expansion tends to force the air from the heater through the hot-air-supply pipe 2.

It will thus be seen that in my improved heating system I utilize the steam to move the body of water with a piston-like action to effect the pumping of the fresh air through the heater and then introduce such steam into the radiator, where upon losing its heat condensation takes place and this in turn assists in actuating the valves of supply-pipe of said radiator.

In both the forms of apparatus in which I have shown embodiments of my invention the air being confined above the water when the live steam is introduced at such point by the steam-supply, such air interposes itself in a layer between the surface of the water and the steam, thereby preventing rapid condensation of the steam.

In each of the forms of my invention which I have herein set forth the several parts thereof are to be so proportioned that the volume of water let into the pumping-chamber 11 is to be sufficiently great to act like an ordinary piston in forcibly driving the air out of such chamber into the heater. In the operation of my improved apparatus I estimate that a boiler-pressure of, say, ten pounds will cause the steam to force open the valve 16 and act upon the water with sufficient pressure to produce the desired pumping action. In the form shown in Figs. 4, 5, and 6 a ten-pound boiler-pressure will readily raise the water through the pipe 25 into the water-drum 44 of the radiator in all cases where the height of the pipe is under, say, twenty feet.

I wish to be understood as not limiting my invention to the specific forms of apparatus herein shown, as various changes may be made in the construction of the same without departing from the spirit of the invention.

Having thus described my invention, what I claim, and desire to secure by Letters Patent, is—

1. An air-heating system comprising the combination of an air-heating chamber provided with an eduction-port and means for heating the air in said chamber, a water-pumping chamber having a valved induction-port for supplying fresh air thereto, a valved connection between said pumping-chamber and said air-heating chamber, a steam-supply pipe connected with said water-pumping chamber, and means for periodically admitting the steam to the water-chamber and causing it to move the body of water therein for pumping the air from the water-chamber into and through the heating-chamber, substantially as and for the purpose set forth.

2. An air-heating system comprising the combination of an air-heating chamber provided with an eduction-port, a water-pumping chamber having a valved induction-port for supplying fresh air thereto, a valved connection between said pumping-chamber and said air-heating chamber, a valved steam-supply pipe connected with said water-chamber, a steam-radiator for heating the air in said heating-chamber and having its supply and return pipes each valved and connected with said water-chamber, means for periodically actuating the valve of said steam-supply pipe to admit steam to the water-chamber for moving the water therein to pump the air therefrom into the heater and then admitting said steam to the radiator, and means for automatically taking a quantity of water from the water-chamber to compensate for the water of condensation added thereto by the radiator, substantially as and for the purpose set forth.

3. An air-heating system comprising the combination of an air-heating chamber having a hot-air-supply main leading therefrom, a water-chamber provided with a valved induction-port for supplying fresh air thereto, a valved connection between said water-chamber and heating-chamber, a steam-radiator for said heating-chamber and having both its supply and return pipes connected with said water-chamber, a valved steam-supply pipe connected with said water-chamber, and valves controlling said supply and return pipes of the radiator whereby the steam introduced into the said water-chamber by the steam-supply pipe moves the body of water and causes the same to expel the air from said water-chamber into said heating-chamber, said steam then passing into the radiator, substantially as and for the purpose set forth.

4. An air-heating system comprising the combination of an air-heating chamber having a hot-air-supply main leading therefrom, a water-chamber provided with a valved induction-port for supplying fresh air thereto, a valved connection between said water-chamber and heating-chamber, a steam-radiator for said heating-chamber and having both its supply and return pipes connected with said water-chamber, a steam-boiler and a valved steam-supply pipe connecting the same with said water-chamber, and valves controlling said supply and return pipes of the radiator, a return-pipe connecting said water-chamber and said steam-boiler, whereby the steam introduced into the said water-chamber by the steam-supply pipe moves the body of water and causes the same to expel the air from said water-chamber into said heating-chamber, said steam then passing into the radia-

tor, substantially as and for the purpose set forth.

5. An air-heating system comprising the combination of an air-heating chamber having a hot-air-supply main leading therefrom, a water-chamber comprising two communicating compartments, the first one of which is in communication with said air-heating chamber by means of a valved connection and is provided with a valved induction-port for supplying fresh air thereto, a steam-radiator for said heating-chamber and having its supply and return pipes each provided with valves and connected with the second compartment of said water-chamber, a valved steam-supply pipe connected with said second compartment of said water-chamber, whereby the steam introduced in said second compartment by the steam-supply pipe depresses the water therein thereby raising the water in said first compartment to pump the air therefrom through said heating-chamber, said steam then passing into said radiator, substantially as and for the purpose set forth.

6. An air-heating system comprising the combination of an air-heating chamber having a hot-air-supply main leading therefrom, a water-chamber comprising two communicating compartments, the first one of which is in communication with said air-heating chamber by means of a valved connection and is provided with a valved induction-port for supplying fresh air thereto, a steam-radiator for said heating-chamber and having its supply and return pipes each provided with valves and connected with the second compartment of said water-chamber, a steam-boiler and a valved steam-supply pipe connecting said boiler with said second compartment of said water-chamber, whereby the steam introduced in said second compartment by the steam-supply pipe depresses the water therein thereby raising the water in said first compartment to pump the air therefrom through said heating-chamber, said steam then passing into said radiator, substantially as and for the purpose set forth.

7. An air-heating system comprising the combination of an air-heating chamber having a hot-air-supply main leading therefrom, a water-chamber comprising two communicating compartments, the first one of which is in communication with said air-heating chamber by means of a valved connection and is provided with a valved induction-port for supplying fresh air thereto, a steam-radiator for said heating-chamber having its supply and return pipes each provided with valves and connected with the second compartment of said water-chamber, a valved air-vent for said second compartment adapted to remain closed until the water in said compartment falls to a certain level, a valved steam-supply pipe connected with said second compartment of the water-chamber, whereby the steam introduced in said second compartment by the steam-supply pipe depresses the water therein thereby raising the water in said first compartment to pump the air therefrom through said heating-chamber, said steam then passing into said radiator, substantially as and for the purpose set forth.

8. An air-heating system comprising the combination of an air-heating chamber having a hot-air-supply main leading therefrom, a water-chamber provided with a valved connection with said heating-chamber and provided with a valved induction-port, a steam-radiator for said heating-chamber having both its supply and return pipes provided with valves and connected with said water-chamber, a steam-supply pipe connected with said water-chamber and provided with a valve, and connections between the valves of said steam-supply pipe and radiator supply-pipe respectively, whereby as one valve opens the other closes, substantially as and for the purpose set forth.

9. An air-heating system comprising the combination of an air-heating chamber having a hot-air-supply main leading therefrom, a water-chamber comprising two communicating compartments, the first one of which is in communication with said air-heating chamber by means of a valved connection and is provided with a valved induction-port for supplying fresh air thereto, a steam-radiator for said heating-chamber having its supply and return pipes each provided with valves and connected with the second compartment of said water-chamber, and connections between the valve of said steam-supply pipe and said radiator supply-pipe causing one to open while the other closes, the said valve of the steam-supply pipe having connected therewith a vertically-moving air-compressing chamber, whereby the air compressed therein as the water rises in said second compartment actuates the same to close the valve, substantially as and for the purpose set forth.

10. An air-heating system comprising the combination of an air-heating chamber having a hot-air-supply main leading therefrom, a water-chamber provided with a valved induction-port, a valved connection between said water-chamber and heating-chamber, a steam-radiator for said heating-chamber having its supply-pipe connected with said water-chamber and provided with two valves adapted to close simultaneously but open non-simultaneously, the return-pipe of said radiator being also connected with said water-chamber and provided with a valve, a steam-supply pipe provided with a valve and connected with said water-chamber, and means for actuating reversely the valves of said steam-supply pipe and said radiator supply-pipe, substantially as and for the purpose set forth.

11. An air-heating system comprising the combination of an air-heating chamber having a hot-air-supply main leading therefrom, a water-chamber comprising two communi-

cating compartments, the first one of which is in communication with said air-heating chamber by means of a valved connection and is provided with a valved induction-port for supplying fresh air thereto, a steam-radiator for said heating-chamber having its supply and return pipes each provided with valves and connected with the second compartment of said water-chamber, and connections between the valve of said steam-supply pipe and said radiator supply-pipe causing one to open while the other closes, the said valve of the steam-supply pipe having connected therewith a vertically-moving air-compressing chamber, whereby the air compressed therein as the water rises in said second compartment actuates the same to close the valve, the said air-compressing chamber being provided at its upper end with a float-valve adapted to close and remain closed until said valve of the steam-supply pipe is closed, substantially as and for the purpose set forth.

12. An air-heating system comprising the combination of an air-heating chamber having a hot-air-supply main leading therefrom, a water-chamber provided with a valved induction-port, a valved connection between said water-chamber and said heating-chamber, a steam-supply pipe provided with a valve and connected with said water-chamber, a steam-radiator for said heating-chamber having its return-pipe provided with a valve and connected with said water-chamber, the supply-pipe of said radiator being connected with said water-chamber and provided with valve mechanism comprising an annular valve adapted to close said pipe, a tubular valve loosely extending through said annular valve and provided with a stop acting upon the under side of said annular valve, said tubular valve being provided with a lateral opening covered by the annular valve when resting on the stop, the said tubular valve projecting from a point within said radiator supply-pipe down below the lowest level reached by the water in said water-chamber, means whereby the said valve mechanism of the radiator-supply is closed as the valve of said steam-supply pipe is open, and vice versa, the said annular valve remaining closed until said tubular valve is moved sufficiently far through it to uncover the lateral opening therein, substantially as and for the purpose set forth.

13. An air-heating system comprising the combination of an air-heating chamber having a hot-air-supply main leading therefrom, a water-chamber provided with a valved induction-port, a valved connection between the water-chamber and said heating-chamber, a steam-supply pipe provided with a valve and connected with said water-chamber, a steam-radiator for said heating-chamber having its return-pipe provided with a valve and connected with said water-chamber, the supply-pipe of said radiator being connected with said water-chamber and provided with valve mechanism comprising an annular valve adapted to close said pipe, a tubular valve loosely extending through said annular valve and provided with a stop acting upon the under side of said annular valve, said tubular valve being provided with a lateral opening covered by the annular valve when resting on the stop, the said tubular valve projecting from a point within said radiator supply-pipe down below the lowest level reached by the water in said water-chamber, the said tubular part having near its lower end an outwardly-closing valve provided with a wing projecting outwardly into the body of water, the said wing being acted upon by said water to control the movements of the valve, means whereby the said valve mechanism of the radiator-supply is closed as the valve of said steam-supply pipe is open, and vice versa, the said annular valve remaining closed until said tubular valve is moved sufficiently far through it to uncover the lateral opening therein, substantially as and for the purpose set forth.

14. An air-heating system comprising the combination of a closed water-chamber provided with a valved induction-port for admitting fresh air thereto, a heating-chamber and a valved connection between said water-chamber and heating-chamber, a steam-radiator for said heating-chamber provided with a valved supply-pipe and a valved return-pipe each connected with said water-chamber, and a valved steam-supply pipe connected with the upper part of said water-chamber, the valve of said steam-supply pipe being periodically opened by the pressure of the steam thereon to admit the steam above the water and move the same to pump the air from the water-chamber, whereby the air above the water in said water-chamber serves as a jacket between the water and the steam introduced above the same, substantially as and for the purpose set forth.

In testimony whereof I have hereunto set my hand this 15th day of December, 1898, in presence of the two subscribing witnesses.

HENRY L. GOODWIN.

Witnesses:
WILLIS FOWLER,
SAML. M. CHESNUT.