(No Model.) 2 Sheets—Sheet 1.

W. P. SKIFFINGTON.

HEATING SYSTEM.

No. 556,562. Patented Mar. 17, 1896.

Fig. 1,

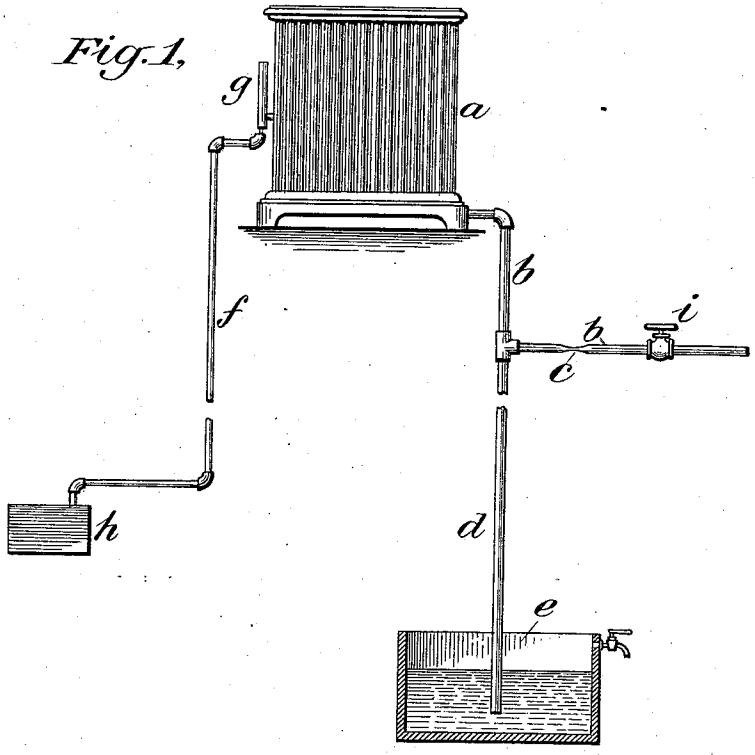
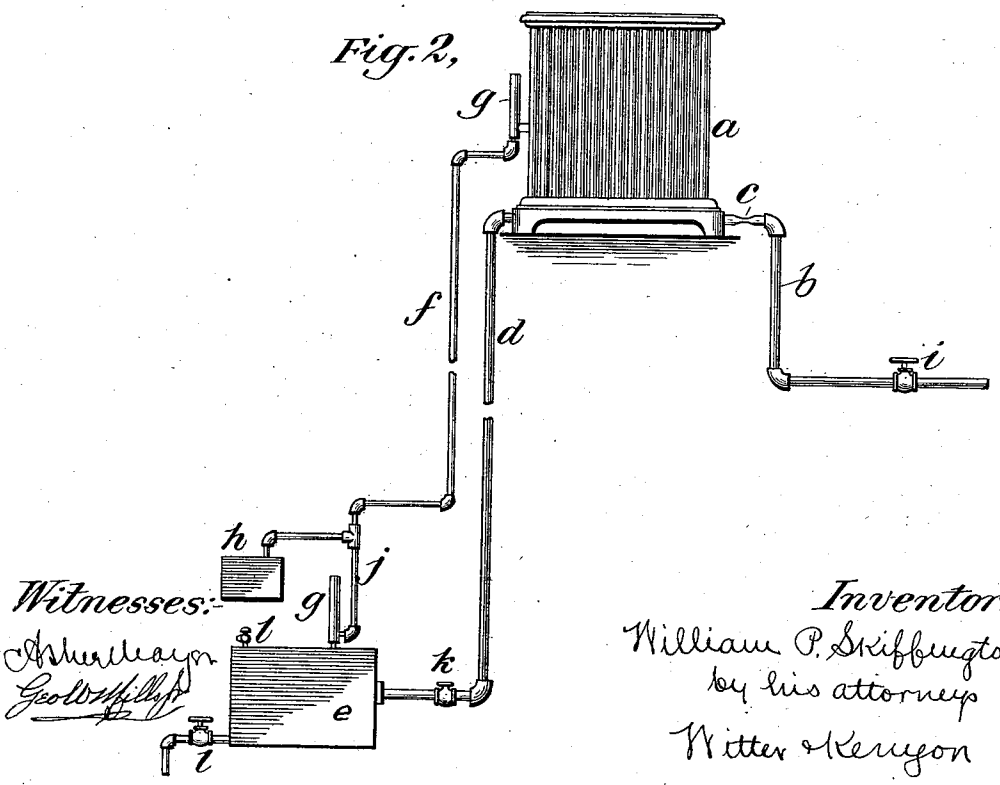


Fig. 2,



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by his attorneys

Witter & Kenyon

(No Model.) 2 Sheets—Sheet 2.

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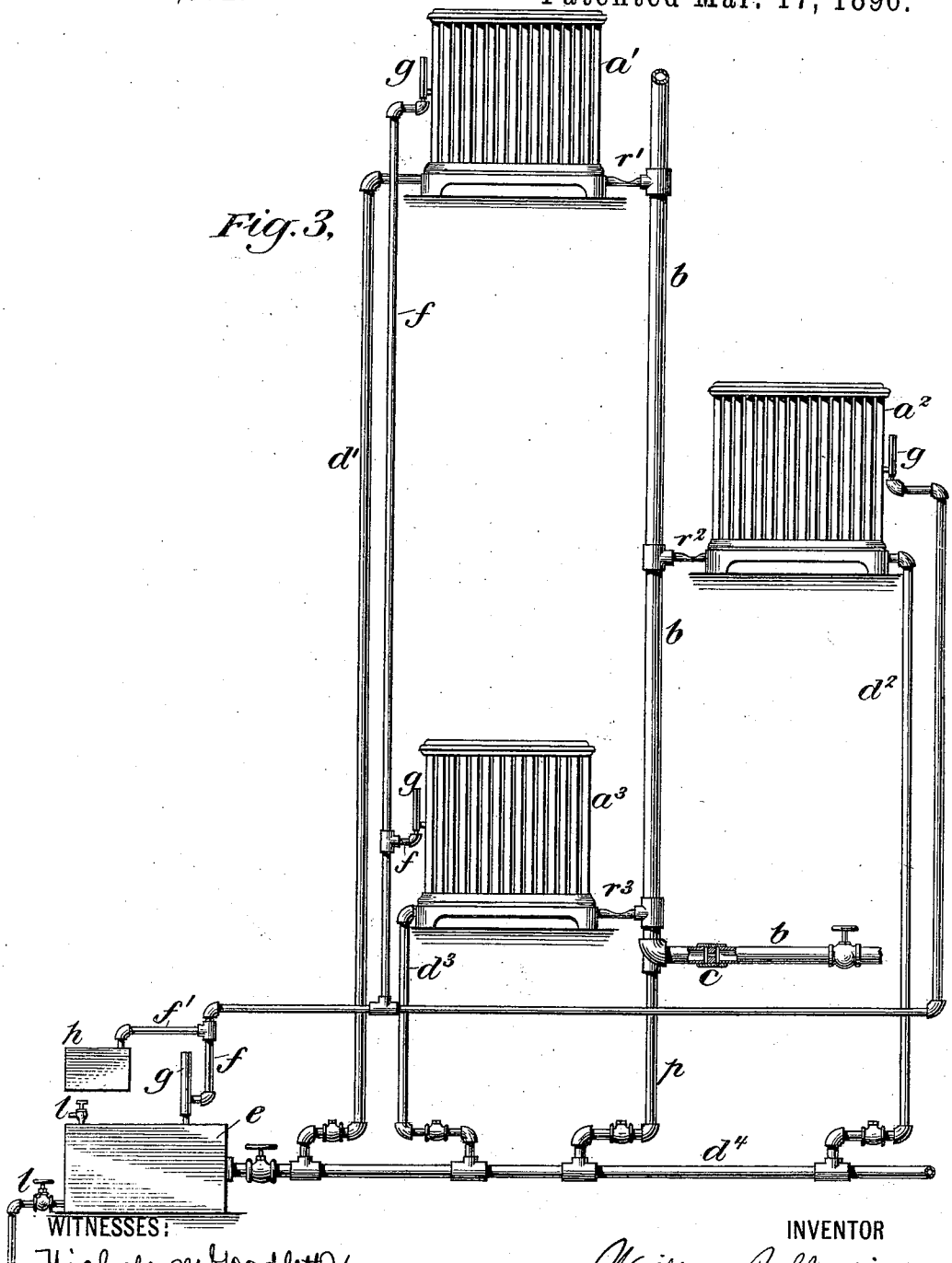
Fig. 3.



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UNITED STATES PATENT OFFICE.

WILLIAM P. SKIFFINGTON, OF NEW YORK, N. Y., ASSIGNOR TO THE PAUL STEAM SYSTEM COMPANY, OF MAINE.

HEATING SYSTEM.

SPECIFICATION forming part of Letters Patent No. 556,562, dated March 17, 1896.

Original application filed August 11, 1891, Serial No. 402,384. Divided and this application filed September 28, 1894. Serial No. 524,344. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM P. SKIFFINGTON, a citizen of the United States, residing in New York city, in the county and State of New York, have invented a new and useful Improvement in Heating Systems, of which the following is a full, clear, and exact specification, reference being had to the accompanying drawings, which form a part hereof.

This invention relates to apparatus for use in heating systems wherein steam or other suitable heating agent is circulated for the purpose of conveying and imparting heat to the places desired; and it consists in an improved construction and arrangement of the different parts of such apparatus.

The object of my invention is to control the admission and the circulation of the heating agent to and in a heating system so as to regulate the temperature of the heating agent and circulate it at such temperature as may be desired.

By means of my improvement steam can be circulated at a temperature as low as 120° Fahrenheit or at any temperature above that point.

This case is a division of my application filed August 11, 1891, Serial No. 402,384.

My improved apparatus consists in the combination, with a heating system made up of radiators or heaters and connecting-pipes, of means for measuring the quantity of the heating agent supplied to the system through the supply-pipe consisting of a restricted opening of fixed dimensions located in the supply-pipe and of an air-pipe connected with the system in addition to the supply and return pipe and provided with an exhauster for drawing air from the system through the said air-pipe and of a sealed return or escape pipe for the water of condensation.

It will be obvious that my improved apparatus may be embodied in a heating system in which only one radiator or heater is employed.

My invention is fully shown in the accompanying drawings, in which—

Figure 1 shows one form of my improved apparatus, the apparatus shown in this figure containing but a single radiator or heater and being connected on the plan of a single-pipe system—that is to say, having but one pipe for the admission of the heating agent and the return of the water of condensation. Fig. 2 shows a second form or embodiment of my improved apparatus. This apparatus contains but a single radiator or heater, but is constructed on the plan of a double-pipe system—that is to say, with a supply-pipe for the admission of the heating agent and a separate return-pipe for the escape of the water of condensation. It is obvious that as many heaters or radiators might be employed in this system as might be desirable. Fig. 3 shows a further embodiment of my invention.

Similar letters of reference refer to similar parts in the different figures.

I will first describe the different forms of apparatus shown in the various figures and will then explain in what way or by what method the heating agent is admitted, circulated and controlled in and by means of the said apparatus.

Referring to Fig. 1, *a* is a radiator or heater which is constructed in any ordinary or usual manner.

b is the supply-pipe, which is connected with any suitable source from which the steam or other heating agent is to be supplied to the system. This supply-pipe is provided with a measuring device, consisting of a restricted opening *c* of fixed dimensions. This restricted opening is set so as to keep the heating agent in the radiator at such a pressure as will produce or secure the desired temperature therein. The opening thus controls and measures the heating agent admitted to the radiator, permitting only such a quantity to flow into the radiator as will keep the temperature up to the desired degree and preventing any greater supply, the effect of which would be to raise the temperature above that limit. This restricted opening on the supply-pipe can be made in other forms. As shown in the drawings, it is made by reducing the diameter or size of the pipe.

d is an extension of the supply-pipe, running down to the tank *e*, in which the water of condensation is collected. This tank *e*, as shown, is open to the atmosphere, but the pipe *d* extends down nearly to the bottom of the tank *e*, so that the lower end of the pipe

d can be sealed by the water of condensation which escapes into the tank *e*.

f is an air-pipe independent of the supply-pipe *b* and connected at one end with the heater *a* and at the other end with an exhauster *h*. The exhauster may be of any ordinary construction adapted to the work to be performed, the varieties of exhauster which I prefer to use being a steam-jet exhauster when steam above the pressure of the atmosphere can be conveniently obtained to supply it, or a water-jet exhauster supplied by water under pressure. In the construction shown in the drawings the pipe *f* is connected with the heater at a suitable place above the point where the water of condensation collects.

g is an automatic valve placed upon the air-pipe *f* for preventing the steam or other heating agent from being drawn through the pipe *f* after air has been exhausted from the heater. This valve may be constructed in such a way that it closes when the heating agent is brought into contact with it, but opens when any quantity of air collects near it and thus reduces the temperature of that part of the heater.

i is an ordinary valve placed in the supply-pipe *b* to enable the supply of the heating agent to be entirely cut off when desired.

I will now explain the way in which the apparatus just described and shown in Fig. 1 is designed to be used and the method of circulating and controlling the heating agent by means of it.

I will suppose that the heating agent employed is to be steam. The steam is taken from any source of supply and may be under any degree of pressure, either above atmospheric pressure or just equal to atmospheric pressure or below atmospheric pressure. The valve *i* is opened so as to permit the steam to pass through the supply-pipe *b* and through the restricted opening *c* in that pipe. The exhauster *h* is put into operation preferably at or about the same time, and air is exhausted from the radiator *a* and the supply-pipe *b* and its extension *d* through the air-pipe *f*. Before the operation is begun the lower end of the pipe *d* is sealed in the tank *e* by placing water in the tank *e* to a height sufficient to seal the lower end of the pipe *d* or by using an ordinary check-valve. By reason of the exhausting of air from the radiator and its pipes the steam is very quickly introduced into the radiator *a*, and the radiator is in this way brought into almost immediate operation in heating the surrounding atmosphere. As soon as the steam reaches the automatic valve *g*, which is supposed to be a thermostatic valve, as above explained, that valve is closed by the action of the heat contained in the steam upon the valve. The system is now full of steam. This steam will be under a pressure less than the pressure upon the steam in the source of supply, by reason of the fact that the steam has had to pass through the restricted opening *c* of the supply-pipe and into a space—to wit, the pipes of the heater—from which air has been exhausted. As the radiator gives off its heat the steam in the radiator will be condensed, tending in this way to reduce the pressure in the radiator. As a result of this condensation and consequent reduction of pressure, more steam will flow into the radiator through the restricted opening *c* in the supply-pipe, and in this way the supply of steam in the radiator will be maintained; but by reason of the measuring device or restricted opening in the supply-pipe the steam in the radiator will be kept under a lower pressure than the steam in the source of supply, and will therefore be expanded into greater volume, and a less weight of steam will fill the radiator and will accomplish the work of heating the same. As the steam is condensed in the radiator the water of condensation flows back through the vertical part of the supply-pipe *b* and its extension *d* down into the tank *e*, where it is collected.

The operation above described is made possible by the fact that the escape-pipe or return-pipe for the water of condensation is sealed at its lower end. The effect of sealing this pipe is to prevent the pressure of the steam in the system from being in any way affected or modified by any pressure which might otherwise be admitted into the system through the return-pipe.

In a heating system it is generally known beforehand what pressure the steam will be under in the boiler or other source of supply from which the steam is taken. This being known and the extent of surface in the heating system which has to be heated being also known the measuring device—that is, the restricted opening *c*—can be made of such fixed dimensions as, under the conditions named, to permit the entrance of only such an amount of steam as will keep the steam which is in the system at any desired pressure.

In using my improved apparatus in the manner already explained I keep the system substantially exhausted of air. This is accomplished by the operation of the exhauster *h* whenever air collects in the radiator or system. The air-pipe *f* is additional to the supply and return pipe, so that air is drawn out from the system through a separate pipe or passage from that through which the water of condensation escapes and so that the water of condensation cannot pass out through the air-pipe.

Referring to Fig. 2, *a* is a radiator which is made in a suitable manner. *b* is the supply-pipe. *c* is the restricted opening in the same. *d* is the return-pipe for the escape of the water of condensation. *e* is the tank for the collection of the water of condensation. This tank in the apparatus shown in Fig. 2 is a closed tank, thus operating to seal the return-pipe *d*. *f* is an air-pipe independent of the supply and return pipe and connected at one

end with the radiator *a* and at the other end with an exhauster *h*. *j* is a branch of the air-pipe running to the top of the tank *e*, by means of which air can be exhausted from that tank. The pipe *f* is provided at the end where it is connected with the radiator and at the point of its connection with the tank *e* with automatic valves *g* for preventing the exhaustion of steam from the apparatus after air has been drawn out. *i* is an ordinary valve in the supply-pipe. *k* is a check-valve in the return-pipe which permits the water of condensation to escape into the tank *e*, but closes to prevent the entrance of air or water in the opposite direction into the return-pipe *d*. The tank *e* is provided with valves *l l*, one at the top of the tank for admitting the air when water is to be drawn off from the tank and one at the bottom for permitting the escape of such water from the tank *e*. Any other suitable means can be employed for withdrawing the water of condensation.

My improved apparatus shown in Fig. 2 is designed to be used in substantially the same manner as the apparatus shown in Fig. 1, except that the water of condensation in the apparatus shown in Fig. 2 escapes through the separate return-pipe *d* instead of passing back through the supply-pipe, and also that air is exhausted through the air-pipe not only from the radiator and its connecting-pipes, but also from the tank *e*.

Where a plurality of radiators are connected up in the system a restricted opening could be located in the main supply-pipe to measure the quantity of steam to be supplied to the system and thus regulate the pressure therein, and a restricted opening could also be located in the individual supply-pipe of each radiator to regulate its individual pressure. Such a construction is shown in Fig. 3, in which a' a^2 a^3 are radiators. *b* is the supply-pipe. *c* is a restricted opening in the supply-pipe. d' d^2 d^3 are the return-pipes, provided with check-valves near their lower ends. d^4 is a common return-main. *e* is a tank to receive the water of condensation. *f* is the air-pipe. f' is the connection between it and the exhauster *h*. *g g g g* are automatic valves. *l l* are valves on the return-tank for admitting air and allowing the water of condensation to escape, and r' r^2 r^3 are restricted passages or openings in the separate branches of the supply-pipe connecting with the separate radiators. By this arrangement different pressures and temperatures can be maintained in the different radiators.

Heretofore, so far as I am aware, nearly all heating systems in which steam or other similar heating agents have been used have been operated in such a manner that the pressure which existed in the supply-pipe has been maintained throughout in the heaters or radiators as nearly as possible. This has been necessary because the only means of removing air that collected from time to time in the heaters or radiators was by forcing that air out into the atmosphere through a suitable cock or valve by means of the superior pressure in the heaters or radiators.

I am also aware that it has been proposed heretofore to attach an exhausting device to the end of the return-pipe of such a system and to, by means of such an exhauster, draw the steam or other heating agent continuously through the heating system; but in this latter case the pressure in the heaters or radiators was substantially the same as in the source of supply, and, moreover, the steam or other heating agent was constantly wasted by being drawn out through the return-pipe of the system.

By means of my improved apparatus the pressure in the radiators or heaters can be reduced very much below that which exists in the source of supply, and the heating agent can be circulated at a pressure below the atmosphere and yet be made to do its work of heating substantially as efficiently as it would at a high pressure. This results in great economy as well as in the more accurate regulation of the heating capacity or temperature of the radiators. This will appear from the following consideration: If an ordinary radiator be filled with steam at a pressure of, say, thirty pounds to the square inch, it will contain steam of a much higher tension, or, to put it in another way, steam containing a much larger number of heat-units than is necessary to do the work which such a heater is designed to do. A large part of the contents of the heater will therefore be useless and will not be available in the work of heating the room or other place where the radiator is put. If the pressure were reduced in such radiator to a point below the atmosphere, the heating agent within the radiator would be very much expanded, but it would still contain a sufficient body of heat or a sufficient number of heat-units to do the required work, and, generally speaking, it is true that this radiator containing a heating agent at less pressure than atmospheric pressure would heat the room as effectively as a radiator containing the same heating agent under a pressure of thirty pounds. In the latter case the radiator-pipes might feel hotter to the hand, but they would not be more effective in heating air, which is a substance that is not heated by radiation but by contact. This fact is accounted for by the large quantity of latent heat which is contained in the heating agent and which enables the heating agent at a pressure below the atmosphere to heat the air of a room practically as effectively as the same heating agent would do if under a pressure of thirty pounds.

In my improved apparatus the pressure of the heating agent can be regulated simply with reference to the degree of temperature desired in the system or radiator and without regard to any other consideration, such as the removal of air. The heating agent can be circulated as efficiently below atmosphere

as above. The circulation is produced by the condensation of the heating agent in the system. As condensation takes place, more of the heating agent is supplied to the system through the measuring device in the supply-pipe. This measuring device measures and thus restricts the quantity of heating agent admitted, allowing just a sufficient quantity to flow into the system to keep the pressure or temperature therein up to the desired point. As the system is kept substantially free of air and other obstructing gases, and as nothing can enter the system except through the measuring device, the quantity of heating agent fed to the system can be accurately controlled and thereby the pressure and temperature accurately regulated. Different temperatures may be maintained in different heaters or radiators all fed from the same source of supply. These improved results are rendered possible by the fact that air which is in the heating system at the start or which collects therein during the operation is removed by means of the air-pipe and the exhauster at its end and is not dependent for its removal upon pressure within the system.

In my improved apparatus I am also enabled to regulate more accurately and between wider limits the amount of heat which is supplied by the radiator. Thus while, as above explained, a radiator having its heating agent under a pressure somewhat less than atmospheric pressure would heat the air in a room as efficiently as the same radiator having the same heating agent under a pressure of thirty pounds, still by reducing sufficiently the pressure upon the heating agent in the radiator the heating agent may be so expanded and the number of heat-units contained in it may be so reduced as to supply less heat to the air of the room. In this way the temperature of the room may be reduced, whereas in the old system, if the radiator were used at all, the amount of heat given off by it could only be changed within very narrow limits, and this mainly by varying the pressure of the heating agent in the source of supply.

It will therefore be apparent that my improved apparatus secures marked advantages, in that the pressure within the radiators can be reduced to any reasonable point desired and the temperature thus accurately regulated, and in that a given temperature can be produced by the use of a minimum quantity of the heating agent.

What I claim as new, and desire to secure by Letters Patent, is—

1. The combination with a steam-heating system which is provided with an air-exhauster and with the usual supply-pipe for steam, of a measuring device comprising a restricted opening of fixed dimensions situated in the said supply-pipe, substantially as before set forth.

2. The combination with a steam-heating system which is provided with an air-pipe, in addition to the supply and return pipe or pipes, and with an exhauster for drawing air from the system through the said air-pipe and with the usual supply-pipe, of a measuring device comprising a restricted opening of fixed dimensions situated in the said supply-pipe, substantially as before set forth.

3. The combination with a steam-heating system which is provided with an air-pipe, in addition to the supply and return pipes, and with an exhauster for drawing air from the system through the said air-pipe, and with the usual supply-pipe, of a measuring device comprising a restricted opening of fixed dimensions situated in the said supply-pipe, and a sealed escape-pipe for the water of condensation, substantially as before set forth.

4. In combination with a heating system, a supply-pipe provided with a restricted opening of fixed dimensions, an air-pipe in addition to the supply and return pipes connecting in said system, an exhauster for drawing air from the system through the said air-pipe, and a sealed escape-pipe for the water of condensation, substantially as shown and described.

5. In combination with a heating system containing a number of radiators or heaters, a main supply-pipe, branch pipes connecting the main supply-pipe with the several radiators or heaters, each branch pipe provided with a restricted opening of fixed dimensions for separately controlling each radiator or heater, an air-pipe in addition to the supply and return pipes connecting with each of the said radiators or heaters, an exhauster for drawing air from the said radiators or heaters through the said air-pipe, and sealed escape-pipes for the water of condensation, substantially as before set forth.

6. In combination with a heating system containing a number of radiators or heaters, a main supply-pipe provided with a restricted opening of fixed dimensions and branch pipes connecting the main supply-pipe with the several radiators or heaters, each branch pipe provided with a restricted opening of fixed dimensions for separately controlling each radiator or heater, an air-pipe in addition to the supply and return pipes connecting with each of the said radiators or heaters, an exhauster for drawing air from the said radiators or heaters through the said air-pipe, and sealed escape-pipes for the water of condensation, substantially as shown and described.

7. In combination with a heating system containing a number of radiators or heaters, a supply-pipe provided with a restricted opening of fixed dimensions, the supply-pipe being connected by branches with each of the radiators or heaters, an air-pipe in addition to the supply and return pipes connected by suitable branches with each of the said radiators or heaters and provided at each radiator or heater with an automatic valve for preventing the escape of the heating agent, an ex-

hauster for drawing air from the system through the said air-pipe, and sealed escape-pipes for the water of condensation, substantially as shown and described.

8. In combination with a heating system containing a number of radiators or heaters, a supply-pipe provided with a restricted opening of fixed dimensions and connected with the said radiators or heaters, an air-pipe in addition to the supply and return pipes connected by suitable branches with each of the radiators or heaters and also connected with the tank for collecting the water of condensation, each of the branches of the air-pipe being provided with an automatic valve near each radiator or heater and near the said tank, an exhauster for drawing air from said radiators or heaters and the said tank through the said air-pipe, sealed escape-pipes for permitting the passage of the water of condensation to the said tank, a check-valve in each of the said escape or return pipes, substantially as shown and described.

9. In combination with a heating system, a supply-pipe provided with a restricted opening of fixed dimensions, an air-pipe in addition to the supply and return pipes connected with the heater or radiator at a suitable place above the point where the water of condensation collects, an exhauster for drawing air from the system through the said air-pipe, and a sealed escape-pipe for the water of condensation, substantially as shown and described.

10. In combination with a heating system, a supply-pipe provided with a restricted opening of fixed dimensions, a sealed tank for the water of condensation, an air-pipe connected with said tank, an exhauster for drawing air from the system through the said air-pipe, and a sealed escape-pipe for the water of condensation, substantially as shown and described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

WILLIAM P. SKIFFINGTON.

Witnesses:

NICHOLAS M. GOODLETT, Jr.

ASHER MAYER.