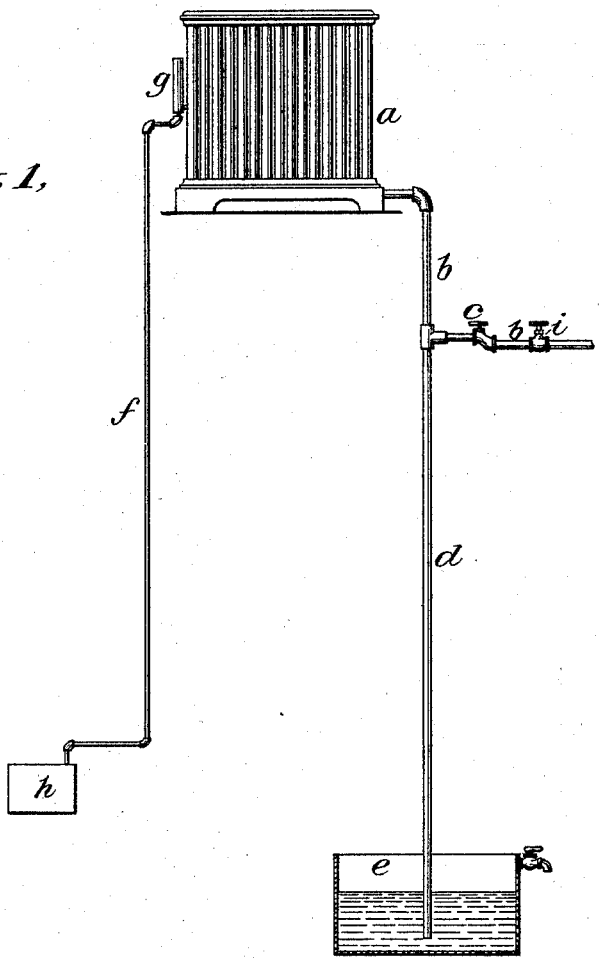
(No Model.) 4 Sheets—Sheet 1.

W. P. SKIFFINGTON.

HEATING SYSTEM.

No. 526,754. Patented Oct. 2, 1894.

Fig. 1,



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(No Model.)

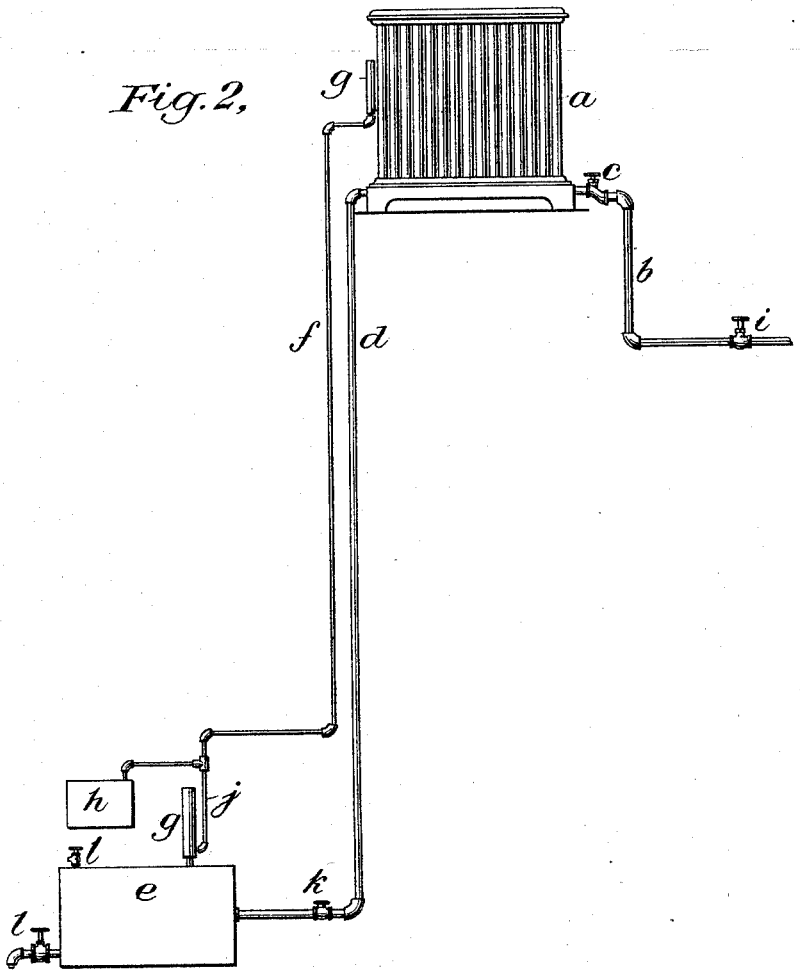
4 Sheets—Sheet 2.

W. P. SKIFFINGTON.

HEATING SYSTEM.

No. 526,754. Patented Oct. 2, 1894.

Fig. 2.



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(No Model.) 4 Sheets—Sheet 3.

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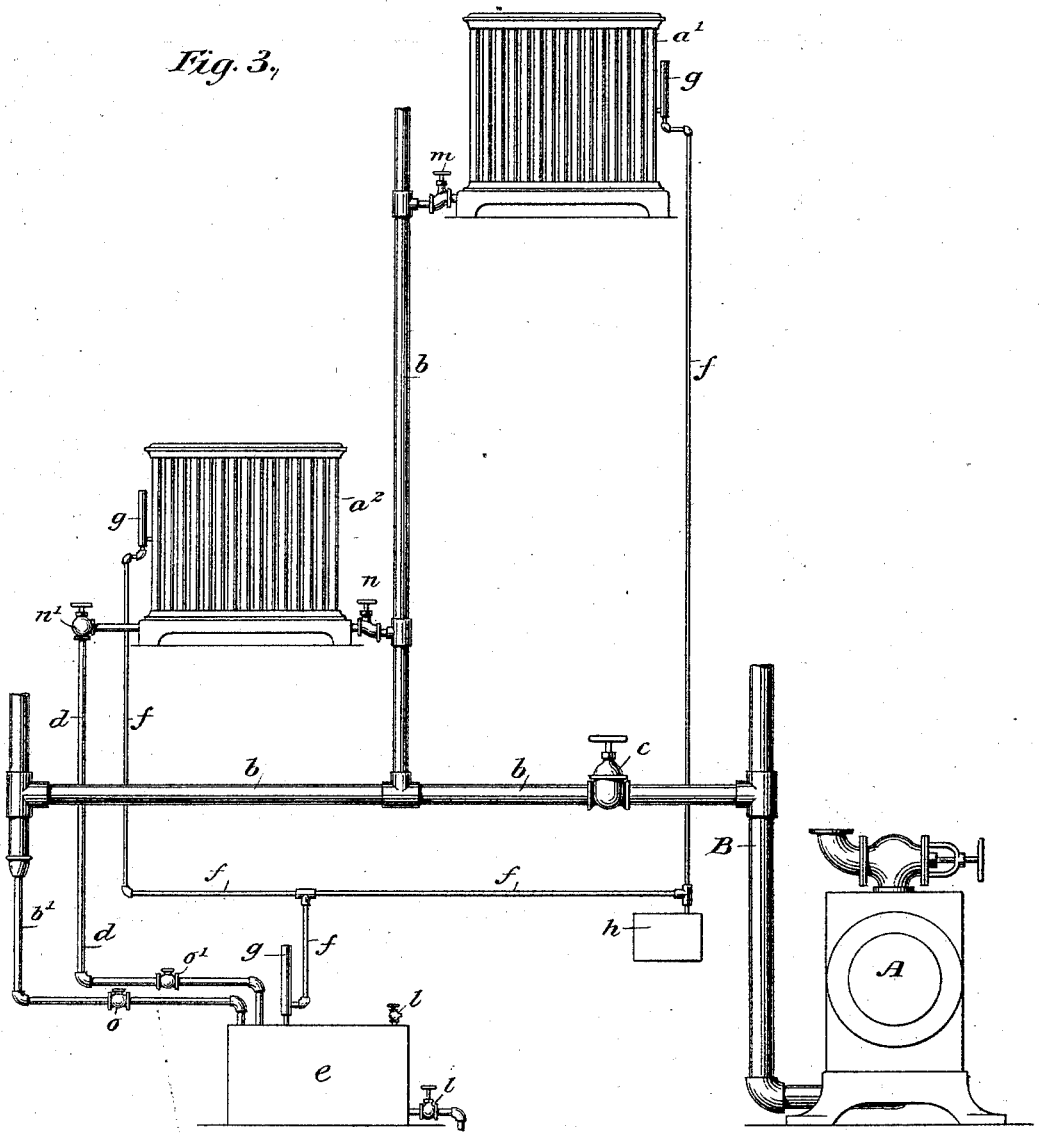
HEATING SYSTEM.

No. 526,754. Patented Oct. 2, 1894.

Fig. 3.



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(No Model.) 4 Sheets—Sheet 4.

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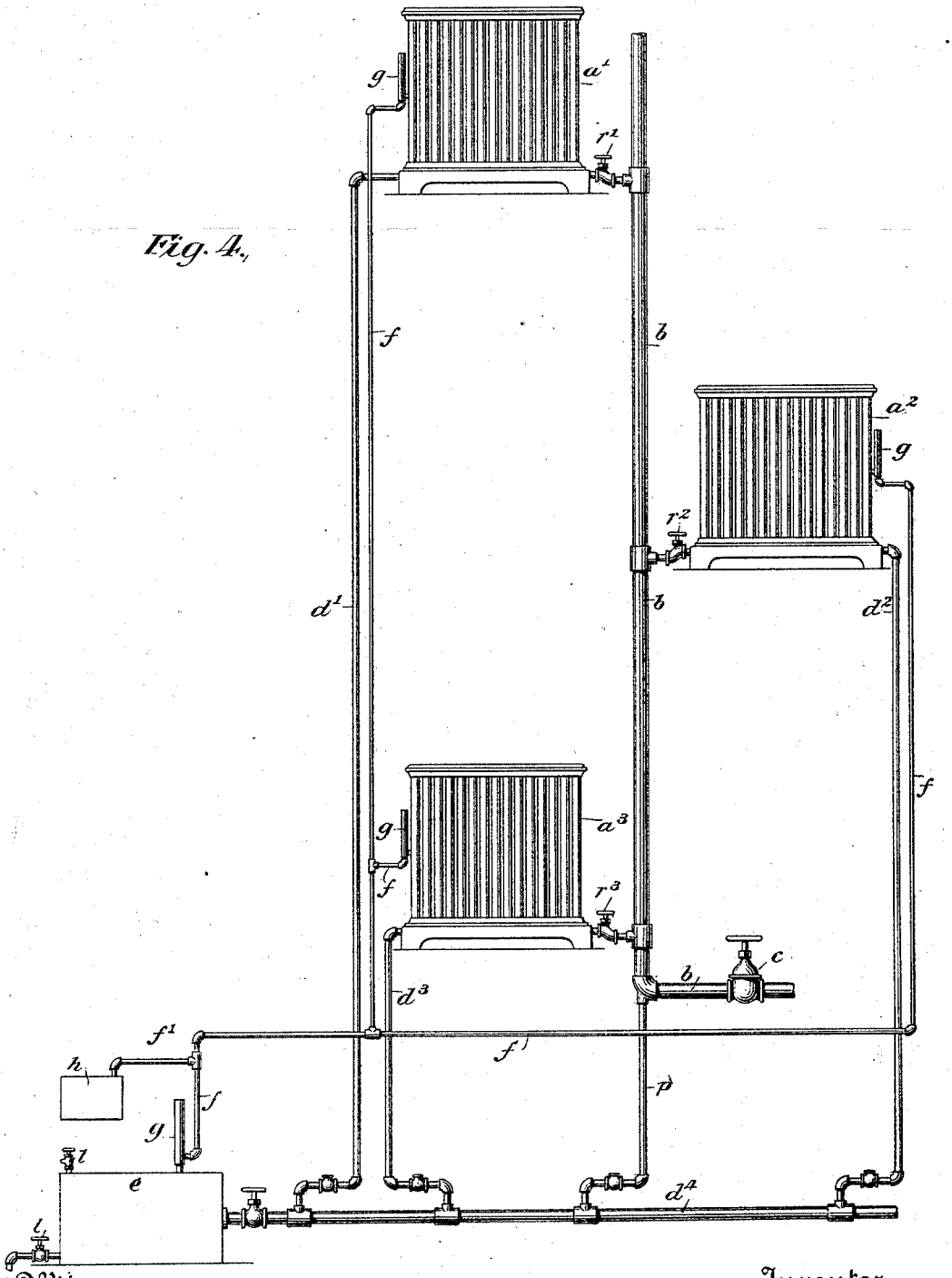
HEATING SYSTEM.

No. 526,754. Patented Oct. 2, 1894.

Fig. 4.



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UNITED STATES PATENT OFFICE.

WILLIAM P. SKIFFINGTON, OF NEW YORK, N. Y., ASSIGNOR OF THREE-FOURTHS TO ANDREW G. PAUL, OF BOSTON, MASSACHUSETTS.

HEATING SYSTEM.

SPECIFICATION forming part of Letters Patent No. 526,754, dated October 2, 1894.

Application filed August 11, 1891. Serial No. 402,384. (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.

My improved apparatus in its broadest form 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, and of an air pipe connected with the system in addition to the supply and return pipe and provided 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. Fig. 3 shows a third form or embodiment of my improved apparatus. This apparatus as shown contains two radiators or heaters, one of which is connected on the plan of a single pipe system and the other of which is connected on the plan of a double pipe system. Of course as many radiators might be used in such a system as were desired. Fig. 4 shows a fourth form or embodiment of my improved apparatus. This apparatus is shown as containing three radiators or heaters, all of them connected upon the plan of the double pipe system and each radiator having in its own particular supply pipe a measuring device consisting of a reducing valve which is supplemental to the measuring device in the main supply pipe, which is also a reducing valve. It is obvious that as many heaters or radiators might be employed in this system as were desirable.

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 reducing valve *c*, that is to say, a valve which will operate to keep the pressure in the pipes at one side of it at a certain point no matter how the pressure may vary above that point in the pipes on the other or supply side of the valve. This reducing valve is set or regulated so as to keep the heating agent in the radiator at such a pressure as will produce or secure the desired tempera-

ture therein. The valve 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. The construction of such a reducing valve is well known and it is therefore not necessary to describe it herein. The measuring device on the supply pipe can be made in other forms. It may consist of a restricted or contracted opening in the pipe itself, made, for example, by reducing the diameter or size of the pipe. In the preferred form or species of my invention I use the reducing valve. *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 the 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 reducing valve *c* in that pipe. The exhauster *h* is put into operation preferably at or about the same time and the 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 the 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 we will suppose 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 reducing valve *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 reducing valve *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 reducing valve 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 smaller amount 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, whether it be a reducing valve, or a restricted opening in the pipe, or some other form of measuring device, can be so made or regulated, or made of such a size 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. A reducing valve is the best form of measuring device as it can be so set or regulated as to keep the pressure and therefore the temperature in the system at the desired point irrespective of what the pressure may be on the supply side.

As already stated, in place of the reducing valve *c* shown in Fig. 1, a restricted opening in the pipe could be used, which would also operate in the manner already explained to keep the steam in the system at any desired pressure.

It is necessary in using my improved apparatus in the manner already explained, to 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 by which means such air is drawn out or exhausted. The air pipe *f* is additional to the supply and return pipe so that the 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 the radiator which is made in any suitable manner. *b* is the supply pipe. *c* is a measuring device consisting of a reducing valve 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 the 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 the 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 the air is exhausted through the air pipe not only from the radiator and its connecting pipes, but also from the tank *e*. In place of the reducing valve *c* in the supply pipe, a restricted opening in the pipe itself or some other form of measuring device may be used as already explained in connection with Fig. 1.

Referring to Fig. 3, A represents a steam engine from which passes an exhaust pipe B, through which the exhaust steam from the engine escapes. The supply pipe *b* of the heating system is connected with the exhaust pipe B of the engine. *c* is a measuring device, being what is technically known as a reducing valve placed in the supply pipe *b*. This reducing valve is so constructed as to maintain on the heating system side of it any desired pressure irrespective of any variation in the pressure of the steam that may take place in the exhaust pipe B, it being understood of course that the pressure on the heating system side of the reducing valve cannot be greater than the pressure of the steam in the exhaust pipe B. a' and a^2 are radiators or heaters of any suitable construction. The radiator a' is connected upon the single pipe plan, that is to say, the steam is supplied to the radiator a' through the supply pipe *b* and the water of condensation is returned from this radiator a' through the same pipe *b*, passing from that pipe down through the pipe b' and on into the tank *e*. *m* is a valve of any ordinary construction placed in the short branch of the supply pipe *b* which leads directly to the radiator a'. a^2 is a radiator connected upon the double pipe plan, that is to say, the steam is supplied to the radiator through the supply pipe *b* and the water of condensation passes out from the radiator through the return pipe *d* and down into the tank *e*, where the water of condensation is collected. *n* is a valve of any ordinary construction placed in the short branch of the supply pipe *b* which leads to the radiator a^2, and n' is a valve of ordinary construction placed in the return pipe *d* which leads from the radiator a^2. *f* is an air pipe independent of the supply and return pipe, having branches connecting with each of the two radiators and also with the top of the tank *e* and connected at its other end with the exhauster *h*. This air pipe is provided with an automatic valve *g* where it is connected with the two radiators and the tank, for preventing the exhausting of steam through the said air pipe from the radiators or the tank. The pipe b' is provided with a check valve *o*, which permits of the passage of the water of condensation from the pipe b' into the tank *e*, but which prevents the passage in the contrary direction of the water of condensation. The pipe *d* is also provided with a similar check valve o', which operates in the same manner. The tank *e* is provided with two valves *l l*, one at the top of the tank to admit air to the same when the water of condensation is to be drawn off and one at the bottom of the tank to per-

mit the escape of the water of condensation. Any other suitable means may be employed for this purpose.

My improved apparatus is designed to be used in substantially the same manner as the apparatus shown in Fig. 2. By means of the reducing valve *c* the pressure of the steam in the supply pipe *b* can be kept at any desired point not greater than the pressure in the exhaust pipe B, irrespective of the pressure of the steam in the exhaust pipe B. As the steam condenses in the radiators more steam is supplied to the radiators through the supply pipe *b*, a sufficient quantity of the steam being admitted through the reducing valve to keep the pressure of the steam in the supply pipe *b* at the desired point. As the return pipe *d* is in each case sealed so that no pressure can get into the system through such return pipe, the pressure of the steam in the radiators and adjoining pipes may be accurately regulated. By means of the air pipe the air can be drawn off not only at the beginning of the operation but also whenever it collects in the radiators.

Referring to Fig. 4, a' a^2 and a^3 are radiators or heaters made of any suitable construction. *b* is the supply pipe for the admission of steam. *c* is a measuring device consisting of a reducing valve placed in the supply pipe, constructed in such a way that the pressure on the heating system side of it can be kept at any desired point not greater than the pressure in the source of supply irrespective of the variations of the pressure of the steam upon the other side of it in the source of supply. The radiators shown in this figure are all constructed in accordance with the double pipe system, that is to say, the steam is admitted to each radiator through the branch of the supply pipe *b*, and the water of condensation is permitted to escape from each radiator through a separate return pipe. d' is the return pipe for the water of condensation leading from the radiator a' to the tank *e*, or to a common pipe which connects the return pipes from the different radiators and which itself runs into the tank *e*. d^2 is the return pipe for the water of condensation leading from the radiator a^2 and connecting with the common pipe d^4 that extends into the tank *e*. d^3 is the return pipe that leads from the radiator a^3 into the common pipe d^4 that runs into the tank *e*. Each of the return pipes d', d^2 d^3 is provided with a check valve near its lower end, just above where it connects with the pipe d^4. These check valves serve to permit of the escape of the water of condensation through the return pipe d^4, but to prevent the return in the contrary direction of any steam or air into such return pipes. *f* is the air pipe which is provided with several branches leading to each radiator and one branch leading to the top of the tank *e*. The air pipe is connected at one end to the exhauster *h*. This air pipe is also provided with automatic valves *g* at the points where it is connected with the radiators and with the tank for the purpose of preventing the exhaustion of steam from the radiators and the tank into the air pipe, as already explained in connection with Fig. 1. *p* is a pipe running from the lower end of the supply pipe *b* down to the common pipe d^4 for permitting the escape of such water of condensation as may flow down the supply pipe *b*. This pipe *p* is also provided at its lower end with a check valve for the purpose already described. The tank *e* is provided with two valves *l l*, one at the top of the tank to admit the air when it is desired to draw off the water of condensation and one at the bottom of said tank to permit the escape of the water of condensation. Any other suitable means may be employed for this purpose. r', r^2 and r^3 are measuring devices consisting of reducing valves placed in the short branches of the supply pipe *b*, which lead to the radiators a', a^2, and a^3 respectively. These valves r', r^2 and r^3 are reducing valves similar in character to the valve *c* and tend to supplement the action of the valve *c*. They also enable the three radiators to be operated under different pressures, that is to say, the valve r' may be so regulated as to keep the steam in the radiator a' under a pressure of say five pounds. The valve r^2 may be so regulated as to keep the steam in the radiator a^2 under a pressure of ten pound at the same time. The valve l^3 may be so regulated as to keep the steam in the radiator a^3 under a pressure of fifteen pounds at the same time. In this way the three radiators may be operated under different pressures, the result of which would be that the three radiators would tend to heat the rooms in which they are placed, respectively, to different degrees.

My improved apparatus shown in Fig. 4 is designed to be used in substantially the same manner as already explained in connection with the other figures, with the exception that in addition to regulating the pressure of the steam in the system by means of the reducing valve *c*, the pressure in each radiator can be separately regulated below that point by its own reducing valve.

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 the 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 lattter 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 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 the 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 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.

In the present application it is my purpose to claim my invention broadly and generically and also to claim in combination the specific form of measuring device which I consider the best, namely, the reducing valve. I have reserved the specific claims for the combinations including my other form of measuring device for a separate application.

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 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 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 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 reducing valve, an air pipe in addition to the supply and return pipe connecting in said system, an exhauster for drawing the 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, a reducing valve in each branch pipe 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 the 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 reducing valve and branch pipes connecting the main supply pipe with the several radiators or heaters, a reducing valve in each branch pipe 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 the 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 reducing valve, 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 exhauster 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 reducing valve 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 reducing valve, 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 reducing valve, 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.

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