(No Model.)

F. TUDOR.

STEAM HEATING APPARATUS.

No. 318,401. Patented May 19, 1885.

Old System

Fig. 1.

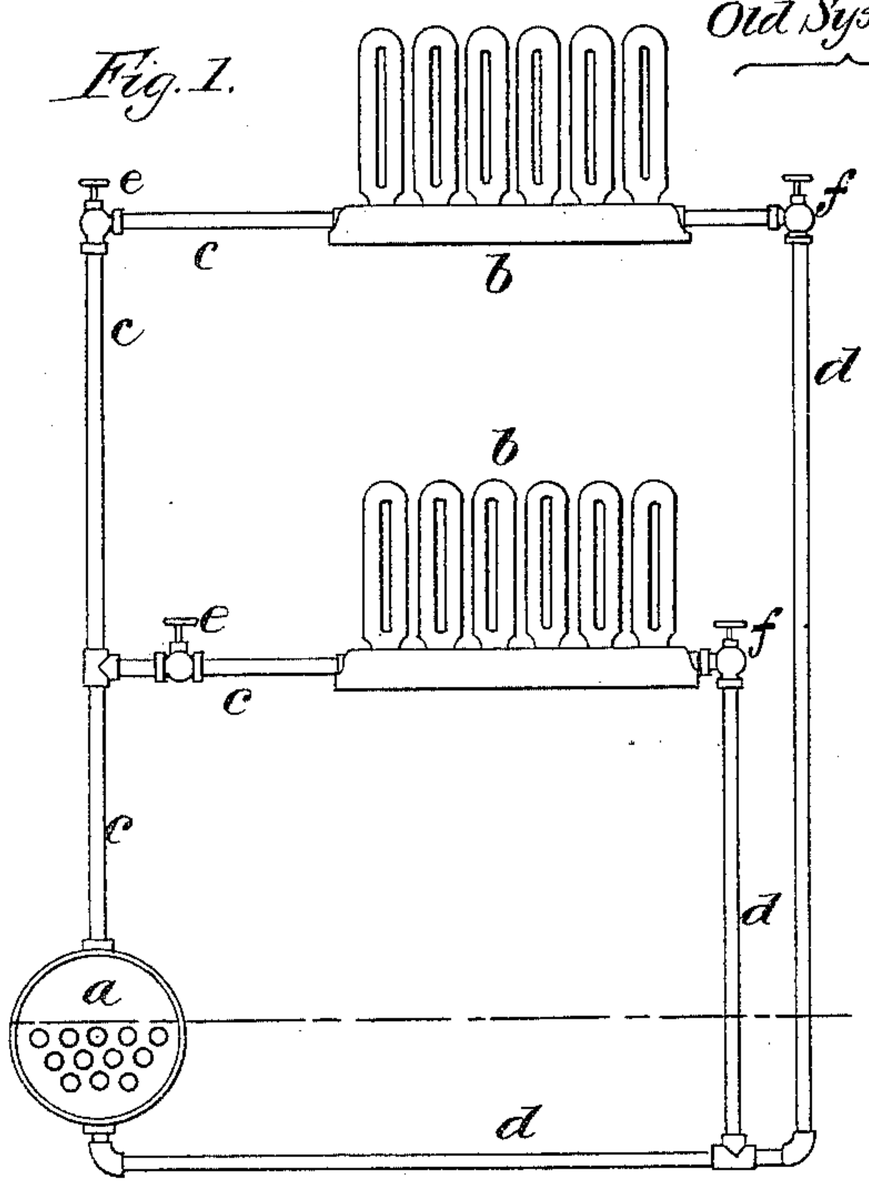
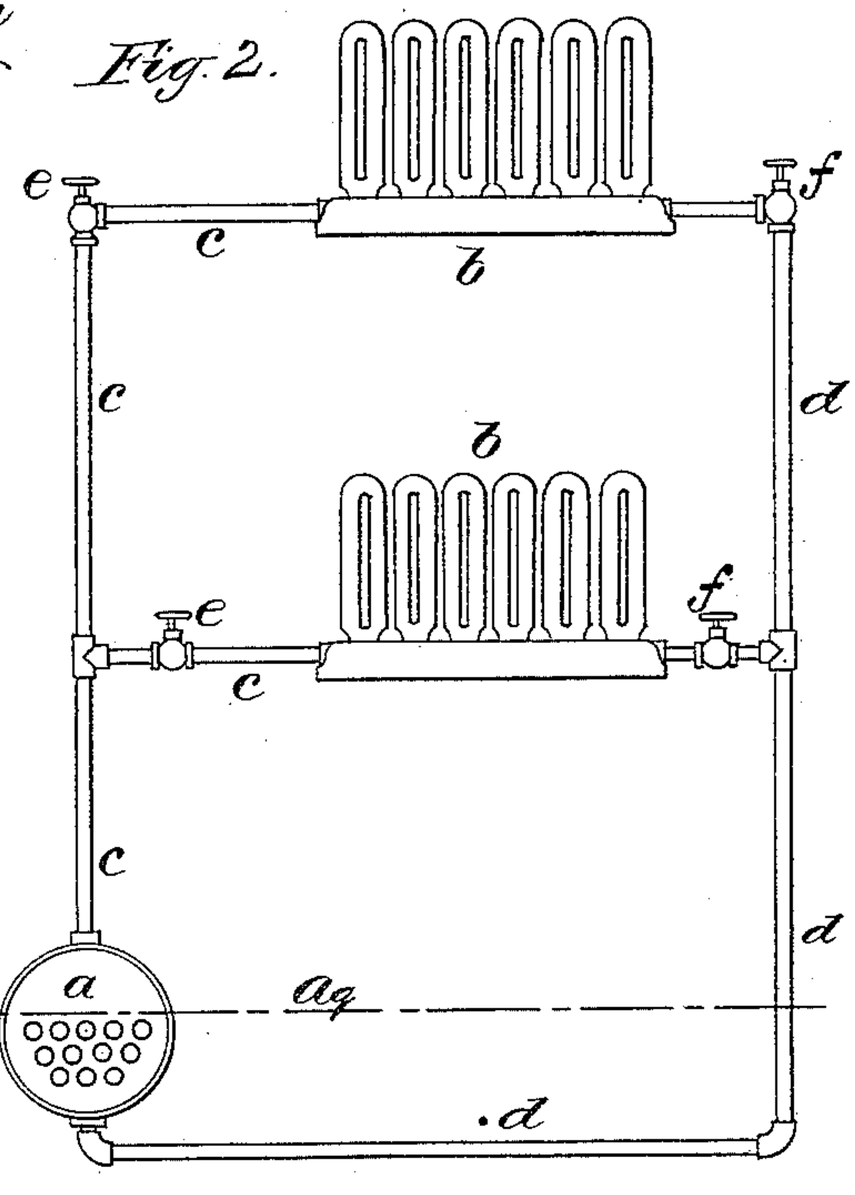


Fig. 2.



New System.

Fig. 3.

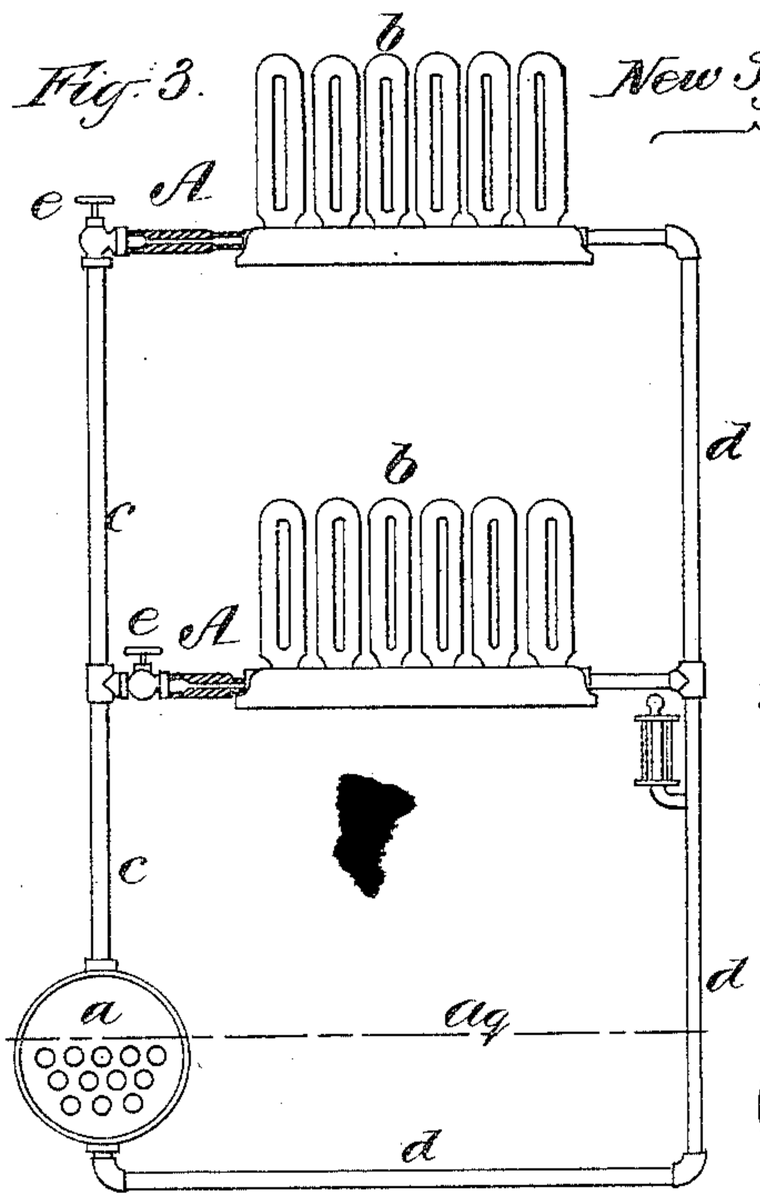
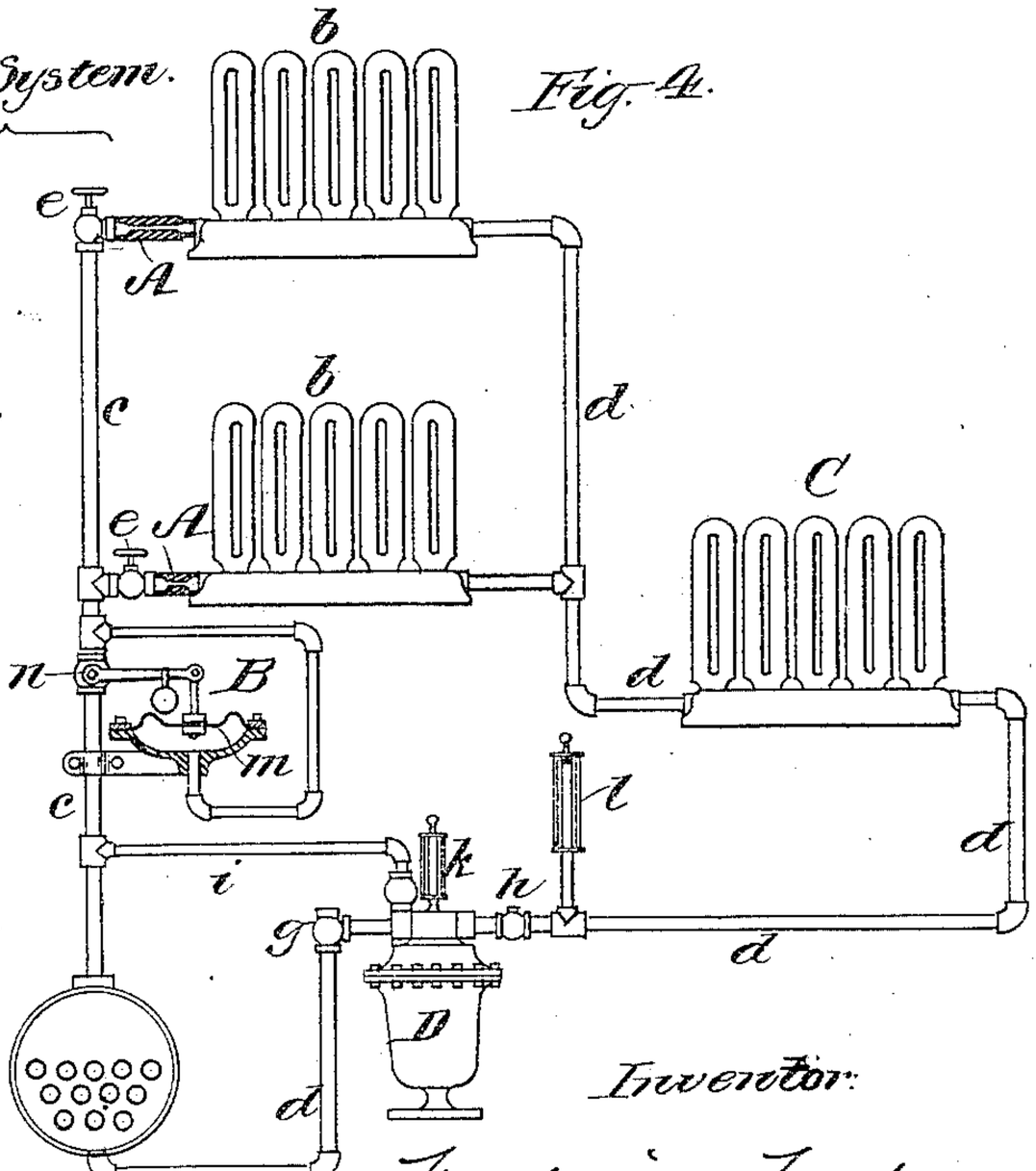
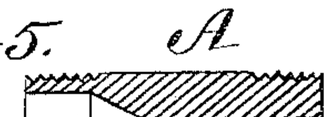


Fig. 4.



Witnesses:
Henry F. Parker
Jno. E. Lavin

Fig. 5.



Inventor:
Frederic Tudor
by
Chas. M. Higgins
Attorney

N. PETERS. Photo-Lithographer, Washington, D. C.

UNITED STATES PATENT OFFICE.

FREDERIC TUDOR, OF BOSTON, MASSACHUSETTS.

STEAM-HEATING APPARATUS.

SPECIFICATION forming part of Letters Patent No. 318,401, dated May 19, 1885.

Application filed January 18, 1884. (No model.)

To all whom it may concern:

Be it known that I, FREDERIC TUDOR, of Boston, in the county of Suffolk and State of Massachusetts, have invented certain new and useful Improvements in Steam-Heating Apparatus, of which the following is a specification.

My invention relates to the ordinary system of steam-heating for buildings, where the steam is distributed from a central source or boiler through pipes to a series of radiators throughout the building, and the condensation from which is usually returned through separate pipes to the boiler. In this system, as usually constructed for high pressure, there is no means whereby the amount of steam and consequent amount of heat can be regulated to or reduced at each radiator, and hence whenever the radiators are put in action they must always be put in full maximum action, or supplied with the full maximum or more than the full maximum amount of steam, the valves on both steam and return pipes being opened fully.

Now, the object of my invention is to enable the steam to be reduced or regulated at each radiator as may be required for the desired amount of heat from an extreme minimum to an extreme maximum, according to the wish of the occupant or the state of the weather, and also to dispense with the necessity of valves between the radiators and return-pipe, and yet prevent any pressure in the return-pipe and any accumulation or regurgitation of water therein, and also prevent the supply of more than a true maximum amount of steam to the radiator when in full action—that is, an amount beyond its capacity for full condensation.

To these ends the chief feature of my invention may be stated to consist in a supply orifice or nozzle between the steam-pipe and the radiator having a definite relation with the condensing capacity or surface of the radiator and with the normal steam-pressure—that is, so proportioned as to be capable of admitting only the maximum amount of steam which the radiator can condense; hence when the steam-valve on the radiator is opened fully only the true maximum amount of steam can be admitted to the radiator, and all this will be rapidly condensed therein without forming any pressure in the radiator or return-pipe, and the full heating effect will be obtained, whereas by closing the valve partially the amount of steam admitted will be reduced corresponding to the amount of closure, and the desired regulation of heat thus obtained without admitting any pressure to the return-pipe, which in the present system is impracticable. At the same time the use of cut-off valves between radiator and return-pipe is obviated.

My invention therefore consists, mainly, in the feature above outlined, and in certain details in combination therewith, as hereinafter fully set forth.

In setting forth my invention I shall describe and illustrate it in contrast with the old or ordinary system now in use.

Referring, therefore, to the drawings, Figures 1 and 2 represent diagrammatic elevations of the old system, one figure showing a slightly different arrangement of piping from the other. Fig. 3 is a diagram or elevation of my improved system adapted for very low pressure, and Fig. 4 is an elevation or diagram of my improved system adapted for high pressure. Fig. 5 is an enlarged sectional view of one of the graduated or proportioned supply-nozzles used in my system.

Referring to Figs. 1 and 2, *a* indicates the boiler or source of steam, and *b* the radiators. *c* is the steam-pipe proceeding from the boiler and connecting with one side of each radiator, and *d d* are the return-pipes proceeding from the opposite side of the radiators and extending down to connect with the base of the boiler.

e e are the steam-throttling valves between the steam-pipe and radiators, and *f f* similar valves between the radiators and return-pipes.

Fig. 1 represents the arrangement usually employed for low pressure, an independent return-pipe extending down directly from each radiator to the main return-pipe in the cellar, which goes to the base of the boiler, whereas Fig. 2 represents the arrangement generally used for high pressure, each radiator opening into a common return-pipe. Either of these arrangements, however, may be used for low or high pressure, and referring to these arrangements, as shown in Figs. 1 and 2, it will be readily seen that when steam

is formed in the boiler *a*, and the valves *e f* opened, the steam will be admitted to and condensed in the radiators *b b*, and the water of condensation will be returned from thence to the boiler, and hence heat will be given out at the radiators, the quantity depending on the pressure of steam and the superficial extent and exposure of the radiators. It will be noted, however, referring to Fig. 2, that in order to have the apparatus act properly as described both valves *e f* must be fully or equally opened to obtain the full and free admission of the steam to the radiators and returns, so that the pressure in the radiators and returns shall be nearly equal to the pressure in the steam-pipe; hence the radiator must always be run with a full head of steam, for it will be readily seen that if the steam-valves are partially closed with the view to reduce the quantity of steam and consequently the amount of heat emitted from the radiators the pressure will then become reduced in the radiators and return-pipes, and the full or confined pressure now acting upon the water in the boiler will force the water back through the return-pipes and into the radiators, where it will accumulate so as to deprive the boiler of its proper quantity of water and expose the radiator to danger from frost, as well as cause noisy shocks when this water again comes in contact with the steam; hence it is obvious that in the system described a pressure must always be maintained in the radiators and return-pipes, and that the heat cannot be regulated by regulating the steam-valves, but these valves must either be turned fully on or fully off in order to raise or lower the heat, and no intermediate reduction or uniform low rate of heat can be maintained.

It will be noted that the use of a check-valve in the return-pipe between boiler and radiators will not obviate the difficulty, as the water would soon accumulate from condensation above the check-valve and produce the same effect. The difficulty, however, can of course be obviated in a great measure by limiting the apparatus to low pressure, so that the column of water in the lower part of the return-pipe below the first radiator will balance the steam-pressure in the steam-pipe, and form a seal between the boiler and return side of the radiators; but the use of low pressure is not practicable in apparatus adapted for extensive heating, and it is the use of high pressure for extensive heating which my invention more particularly contemplates, although it is also adapted to low pressure, as will now appear.

The particular difficulty above stated can of course be obviated by the use of an ordinary steam-trap between the boiler and return-pipe, as is frequently used; but while this would prevent the backing up of the water in the returns and radiators it would not enable one radiator to act independently of the other, so that one could give out a low heat under a low supply of steam, and the other a high heat under a full supply of steam; for it will be obvious that if the valves on one radiator were only partly opened to let in a limited supply of steam with a view to obtaining a reduced heat, while the valves on another radiator were opened wide to obtain the full heat, the high pressure of steam in the latter radiator would of course flow out through the returns and into the former radiator until the pressure was equal, or nearly so, in both. It is therefore the independent regulation of the heat in the individual radiators from one extreme to the other which I aim to accomplish, and which chiefly distinguishes my invention, as will be now made apparent.

Referring, therefore, to Figs. 3 and 4, it will be seen that corresponding parts referred to in Figs. 1 and 2 are lettered similarly, and from this it will be noted that no throttle-valves are used between the radiators *b b* and the return-pipe *d*, which pipe is common to all the radiators. The steam-pipe *c*, however, instead of connecting with the radiators through an opening of indefinite and ample size, as heretofore, connects thereto through a special nozzle, nipple, or throat, A, of restricted or definite size, having a definite relation or proportion to the capacity or surface of the radiator—that is, the area of the orifice of the steam-supply throat A is so proportioned to the area or heating-surface of the radiator at a certain pressure of steam as to admit only the quantity of steam at that pressure which the radiator can fully condense under normal conditions, without allowing any appreciable pressure to accumulate in radiators or returns. This proportion of the orifice to the radiator is of course determined by experiment at first, for each case and each radiator of a certain area may always afterward be supplied with the orifice of proper size therefor, suited to its surface and to the pressure to be used in it, as will be readily understood. I thus find that the supply-orifice may be made very small, and while it is not necessary to here specify the proper sizes of orifices for radiators of every size and for various pressures, I would give the following general rule of proportion, which I have found practical—that is, a circular hole one-fourth inch diameter will pass enough steam at two pounds' pressure to heat a radiator containing about one hundred and twenty-five square feet.

The restricted supply throats or nozzles A may be formed, as shown in Fig. 5, in the shape of an ordinary nipple or fitting threaded externally at each end and bored with an orifice of definite proportioned size, as described, and these may be employed to connect the steam-pipe with the radiators, as shown in Figs. 3 and 4. The restricted throats may, however, be used between radiator and steam-pipe in any other suitable way, the object, as before described, being to produce a restricted opening having a definite relation to the size of the radiator, or pipes and radiators supplied by it, and its distance from the source

of steam. I prefer to embody the restricted throat within the throttle or regulating valve itself, and I have designed for this purpose a special form of valve, which, however, need not be described here, but which I have made the subject of a separate application, filed March 1, 1884, Serial No. 122,664. It will therefore be seen that as my system uses no throttle-valves between the return-pipe and radiators, hence the return-pipe requires to be entirely free, or almost free, from steam-pressure when the steam-valves *e e* are closed. In the low-pressure apparatus shown in Fig. 3 this is accomplished by the column of water in the return-pipe below the radiator, which will always equal or overbalance the steam-pressure, as usual in low-pressure apparatus. In the high-pressure apparatus shown in Fig. 4, however, the return water discharges into a trap, D, on the return-pipe, through which it is returned to the boiler, the trap illustrated being what is known as the "Albany" trap, which I prefer to employ; but any other suitable trap may be employed. This trap is arranged on the return-pipe near the boiler in the manner usual in high-pressure steam-heating apparatuses, as illustrated, and check-valves *g h* are arranged on the return-pipe on each side of the trap and open toward the boiler in the well-known manner, and thereby prevent the backing up of any water in the return-pipe. A small pipe, *i*, supplies a vent of steam from the steam-pipe to the trap when the trap acts to discharge its accumulation into the boiler in the well-known manner. The trap is fitted with an air-valve, as shown at *k*, and the return-pipe is fitted with a similar air-valve, as shown at *l*, which allow air to escape in advance of the steam, but close automatically by thermal expansion as soon as the steam arrives at and heats the valve, as well known by steam-engineers. I prefer to employ a pressure-regulator, as shown at B, to reduce and regulate the pressure between the boiler and the pipes which supply the radiators, and thus maintain a uniform pressure in the supply-pipe. This regulator works in the ordinary manner of pressure-regulators, as well shown in Fig. 4, and therefore needs no detailed description. It will therefore be now understood that when a steam-heating circuit such as Fig. 3 or Fig. 4 is provided with the restricted supply-throats A, as described, and means employed, as set forth, for preventing the rise of water in the return-pipe, when the steam-valves *e e* are opened fully all the steam will be admitted to the radiators which they can condense, and no more, and hence the full or maximum heating effect will be obtained. If, however, it is now required to obtain a reduced heat in any particular radiator, it is only necessary to partially close the valve thereof, and the amount of steam admitted thereto will be reduced correspondingly; and hence the heat may be maintained regularly at any desired rate from maximum to minimum, according to the degree which the valve is opened or closed, which is a novel and very important advantage in steam-heating. It will be further seen that as the radiator can at the most receive only the amount of steam which it can fully or nearly fully condense, hence little or no pressure will exist in the radiator or return-pipe during the emission of heat, and hence the condensation will flow into the returns with certainty, and a positive circulation will be insured, as the pressure will always be greater in the supply-pipe than in the radiators or returns, the pressure being thus always greatly preponderating in the direction of the flow of the water toward the boiler, as is always desirable and necessary in steam-heating apparatuses for certain circulation and effective action.

As it will not always be possible in extensive apparatuses to so proportion the restricted throats A as to prevent the passage through them of a quantity of steam greater than the radiators can condense, I prefer to provide the apparatus in Fig. 4 with what may be termed a "condenser," C, to condense any slight overplus of steam, and thus keep the returns free from any objectionable amount of steam-pressure. This condenser, as shown, is located, of course, upon the return-pipe, and may be employed as a heater for heating air or water, and when the apparatus is in action it will be seen that no pressure can exist in the return-pipe until this condenser is fully heated. It will be also noted that the rise of pressure in the supply-pipe beyond the normal point for which the restricted throats and their radiators are adjusted is prevented by the pressure-regulator B, and hence no excess can enter the radiators and return-pipes from that cause, for when the pressure rises abnormally in the boiler the diaphragm *m* will act to close the steam-valve *n*, so as to admit less steam to the supply-pipe, and thus maintain practically the same pressure therein.

Having now fully set forth my invention, the advantages which it possesses may be here briefly recapitulated: First, a more equal distribution of steam to the several radiators, and especially at the lowest pressure, when very little heat is desired; second, the control of the supply of steam at any radiator or set of pipes and radiators fed by one valve without retaining water in the radiator or interfering with the circulation in other radiators; third, a difference of pressure in the supply and return pipes, whereby the circulation is rendered more positive, condense-water is more surely kept where it belongs, and noise and water-hammering in the pipes prevented; fourth, the expulsion of air from the radiators into the return-pipes, whence it may be allowed to escape at the air-valves *k* or *l*, thus dispensing with the necessity of an air-valve on each radiator, with their complication of drip-pipes to drain the air-valves, as is customary; fifth, dispensing with the necessity of throttle-valves between radiators and returns.

I am of course aware that heretofore in

steam-heating practice there has always been some attempted proportion of the supply-pipes to the radiators; but in all such cases the pipe or valve is generally so proportioned as to admit a large excess of steam over what the radiator can condense, and not the restricted or limited quantity proportioned to its condensing-power under normal conditions, as in my improvement, where the supply-throat is so proportioned to the radiator as to admit only the quantity of steam which it can condense under normal conditions; hence in my system no appreciable pressure will exist in the radiator during its heating action, while a considerable pressure will exist in the old system, whose proportion of parts does not aim to limit the supply of steam to the normal condensing-power of the radiator, but only to prevent an unnecessary excess of pressure in the radiator.

What I claim as my invention is—

1. A steam-heating apparatus constructed with restricted supply-throats between supply-pipes and radiators, having a definite relation or proportion to the condensing-surface of the radiator, so as to admit practically only the amount of steam which the radiator can condense, substantially as and for the purpose set forth.

2. A steam-heating apparatus consisting of a boiler or source of steam, one or more radiators, a supply-pipe extending from the steam-space of the boiler and connecting with each radiator, and provided with throttling-valves at each radiator and with restricted supply-throats so proportioned to the radiator as to admit only the quantity of steam which it can condense under normal conditions, and a return-pipe without throttling-valves extending from each radiator to the water-space of the boiler, arranged and operating substantially as and for the purpose set forth.

3. An improved steam-heating apparatus formed by the combination, with a steam-boiler and a series of radiators, of a return-pipe extending from the water-space of the boiler and connecting to all the radiators in common at points above the water-line, and a steam-supply pipe extending from the steam-space of the boiler to the radiators, with restricted supply-throats between the radiators and the supply-pipe so proportioned to the radiators as to admit only the quantity of steam which it can condense under normal conditions, substantially as herein shown and described.

4. A steam-heating apparatus consisting of a boiler or source of steam and one or more radiators, a supply-pipe extending from the steam-space of the boiler to each radiator and provided with throttling-valves and with restricted supply-throats so proportioned to the radiator as to admit only the quantity of steam which it can condense under normal conditions, with a return-pipe extending from the radiators to the water-space of the boiler and provided with an air-valve common to the system, substantially as herein shown and described.

5. A steam-heating apparatus substantially such as set forth, having restricted supply-throats A, so proportioned to the radiators as to admit only the quantity of steam which they can condense under normal conditions, between supply-pipe and radiators, and a condenser, C, upon the return-pipe, substantially as and for the purpose set forth.

6. A steam-heating apparatus substantially such as set forth, having a pressure-regulator, such as B, between the boiler and radiators and supply-throats between the supply-pipe and radiators, with a return-pipe so proportioned to the radiators as to admit only the quantity of steam which they can condense under normal conditions, opening freely from each radiator and finally discharging into the boiler, and provided with means to prevent the backing up of water therein, substantially as herein set forth.

7. A steam-heating apparatus substantially as shown in Fig. 4, consisting of a boiler, *a*, supply-pipe *c*, with valves *e*, and restricted throats A, so proportioned to the radiators as to admit only the quantity of steam which they can condense under normal conditions, radiators *b b*, return-pipe *d*, condenser C, and trap D, arranged and operating substantially as herein shown and described.

8. A steam-heating apparatus substantially such as shown in Fig. 4, consisting of a boiler, *a*, supply-pipe *c*, pressure-regulator B, valves *e*, restricted throats A, so proportioned to the radiators as to admit only the quantity of steam which they can condense under normal conditions, radiators *b b*, return-pipe *d*, condenser C, and trap D, arranged and operating substantially as and for the purpose set forth.

FREDERIC TUDOR.

Witnesses:
JNO. E. GAVIN,
CHAS. M. HIGGINS.