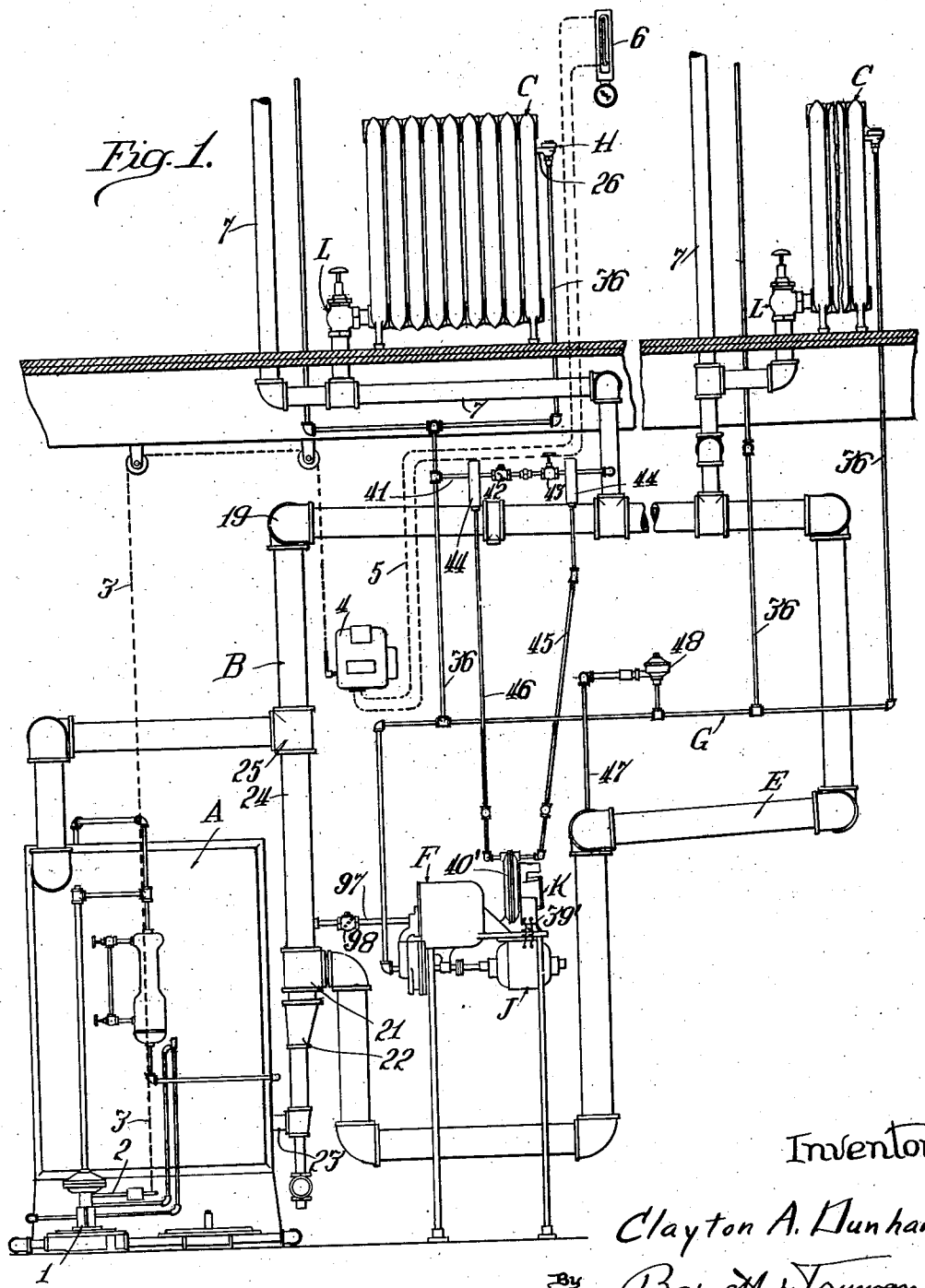
April 23, 1935. C. A. DUNHAM 1,999,040

HEATING SYSTEM

Filed Jan. 14, 1928 4 Sheets-Sheet 1

Fig. 1.



Inventor

Clayton A. Dunham

By Barnett & Truman

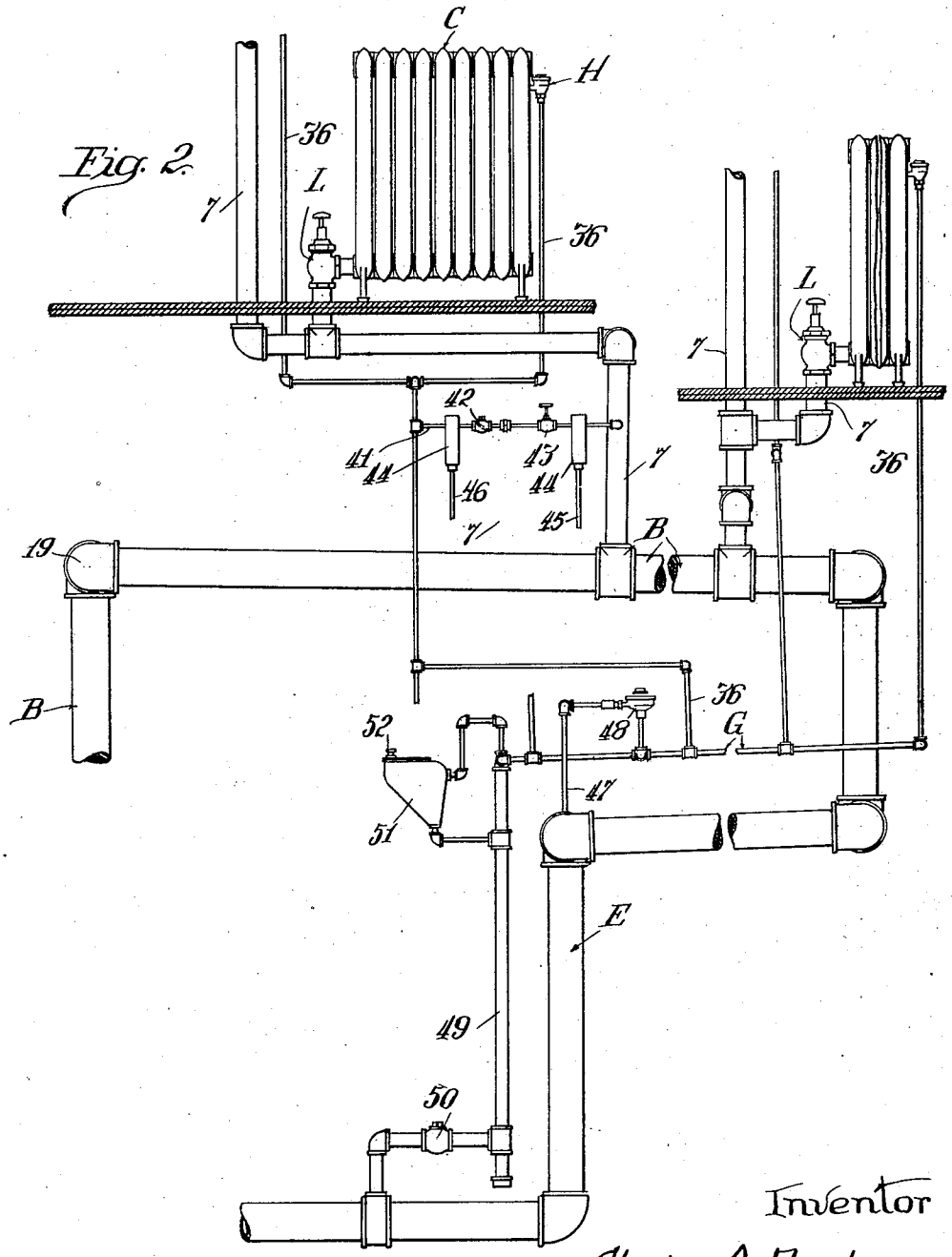
Attorneys.

April 23, 1935. C. A. DUNHAM 1,999,040

HEATING SYSTEM

Filed Jan. 14, 1928 4 Sheets-Sheet 2

Fig. 2.



Inventor

Clayton A. Dunham

By Barnett & Truman

Attorneys.

April 23, 1935. C. A. DUNHAM 1,999,040

HEATING SYSTEM

Filed Jan. 14, 1928 4 Sheets-Sheet 3

Fig. 4.

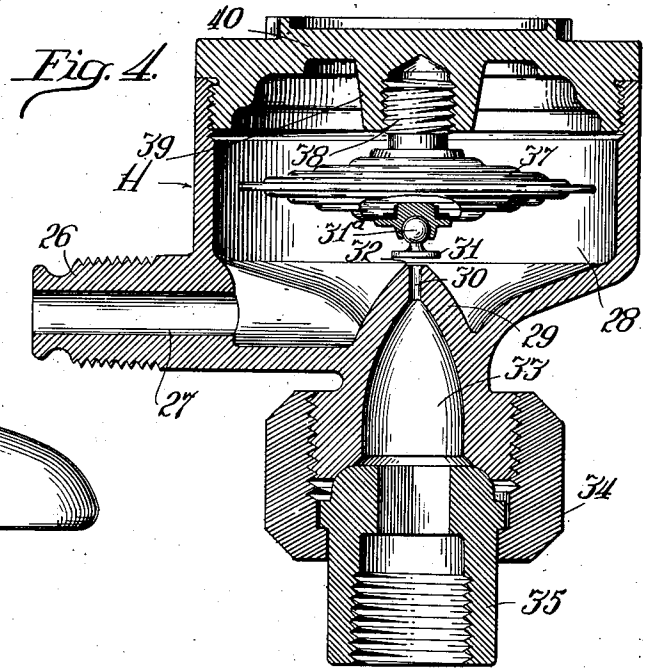
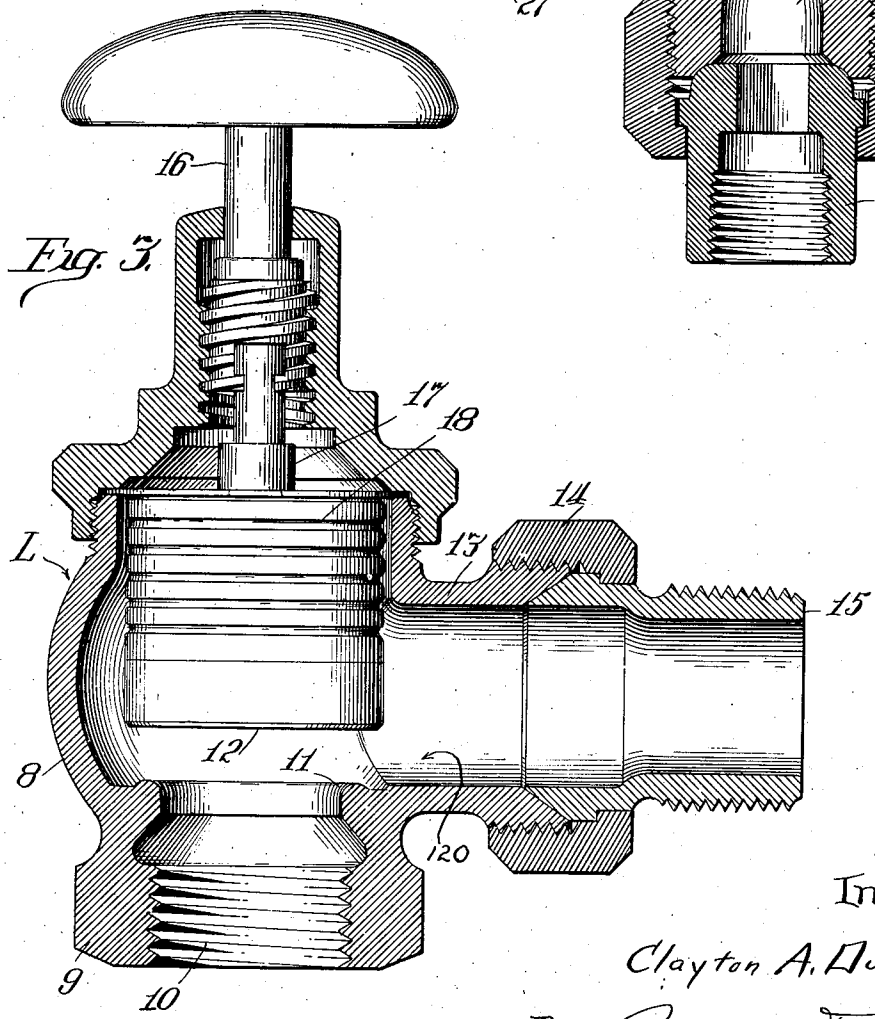


Fig. 3.



Inventor

Clayton A. Dunham

By Barnett & Truman

Attorneys

April 23, 1935. C. A. DUNHAM 1,999,040

HEATING SYSTEM

Filed Jan. 14, 1928 4 Sheets-Sheet 4

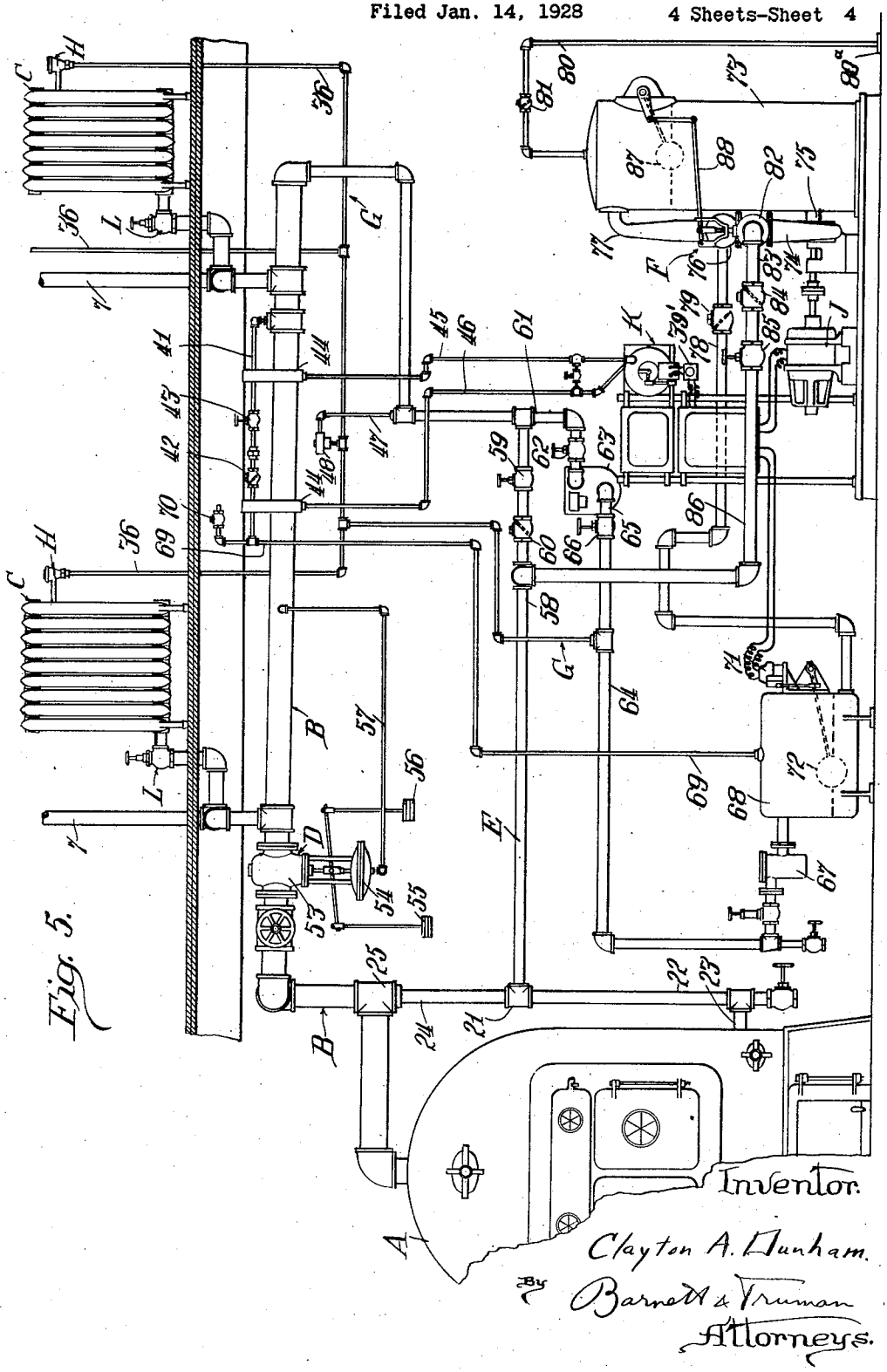


Fig. 5.

Inventor.
Clayton A. Dunham.
By Barnett & Truman
Attorneys.

Patented Apr. 23, 1935 1,999,040

UNITED STATES PATENT OFFICE

1,999,040

HEATING SYSTEM

Clayton A. Dunham, Glencoe, Ill., assignor to C. A. Dunham Company, Marshalltown, Iowa, a corporation of Iowa

Application January 14, 1928, Serial No. 246,713

3 Claims. (Cl. 237—9)

This invention relates to a steam heating system, and more particularly to a heating system in which sub-atmospheric pressures are maintained in the radiators, and also usually in the steam generator, means being provided for regulating the sub-atmospheric pressure of the steam within the radiators in order to vary the heat radiated in acordance with the requirements of prevailing temperature conditions, and for regulating the rate of steam generation in those installations where the buildings have their own boiler plants. This application relates to certain modifications and improvements to the heating system disclosed in my Patent No. 1,644,114, granted October 4, 1927. In said prior patent is disclosed a heating system using sub-atmospheric steam, the system disclosed in said patent being of the so-called two-pipe type, that is the steam is supplied to the radiators through one pipe, and the air and condensate withdrawn through a separate return pipe. The present application relates to the adaptation of this invention to the so-called one-pipe type of heating system, that is the steam is supplied to the radiator and the liquid condensate withdrawn through a single pipe connected with the lower portion of the radiator, although a second smaller pipe is connected with the upper portion of the radiator for withdrawing air or other gases.

In general, the apparatus used constitutes a closed system, including a steam generator from which steam is supplied to radiators which are normally in open communication with the steam supply main. This steam supply main loops back to the generator, and is so inclined that liquid condensate from the radiators will gravitate back to the boiler or steam generator. Suitable control means is provided, such as a fire control system for the generator, or a reducing valve is used between the generator and radiators, whereby the sub-atmospheric pressure of the steam delivered to the radiators is adjustably controlled. Where a reducing valve or thermostatically operated valve is used to control the supply, means should be provided to return the condensate to the boiler if the pressure difference between the boiler, the radiators and the supply piping to them is such that the condensate cannot return by gravity. Each radiator is provided with an air outlet pipe near its top, in which is a thermostatically operated steam-trap to prevent the escape of steam but permit air to be withdrawn from the radiator. These air pipes lead to suitable vacuum producing means, which is automatically controlled so as to maintain a substantially constant difference in pressure between the steam supply pipe and the air-return pipes, regardless of the absolute pressure maintained in the supply main and radiators. This automatically controlled vacuum-producing means cooperates with the pressure control means at the generator, to maintain substantially constant the desired sub-atmospheric pressure of the steam within the radiators.

The principal object of this invention is to provide a steam heating system operating as briefly outlined hereinabove, and as explained more in detail in the specifications which follow.

Other objects and advantages of this invention will be more apparent from the following detailed description of certain approved forms of apparatus designed for carrying out the principles of this invention.

In the accompanying drawings:

Fig. 1 is an elevation indicating somewhat diagrammatically the principal elements of one form of heating system operating according to this invention.

Fig. 2 illustrates a modification of the return pipe system shown in Fig. 1.

Fig. 3 is a vertical section through one of the radiator inlet valves.

Fig. 4 is a vertical section through one of the thermostatic air-line valves.

Fig. 5 is a diagrammatic elevation, similar to Fig. 1, showing a system embodying a reducing valve, and pumping means for returning condensate to the boiler.

Many of the devices and mechanisms used in this system are well known in this art, may be constructed in a variety of forms, and are here indicated rather diagrammatically.

Referring first to Fig. 1, at A is indicated the steam generator which furnishes steam through the supply main B to the radiators C. The supply main B has a continuation E which is looped back to the generator. It will be noted that the upper run of the supply pipe B inclines slightly downwardly toward the return pipe E so that the condensate which drains into the main B may gravitate back to the boiler or generator. A vacuum producing mechanism indicated generally at F is connected through the system of air exhaust piping G with the upper portion of each of the radiators C. Between each radiator and the air-exhaust pipe leading therefrom is positioned a thermostatically operated steam trap H (shown in detail in Fig. 4), which permits the withdrawal of air from the radiator, but automatically closes to prevent the flow of any sub-

stantial quantity of steam therefrom. The air pump or vacuum producing mechanism F is driven by a motor J which is started and stopped by the pressure controlled switch mechanism K. This latter combination of devices operates automatically to maintain a substantially fixed difference in pressure between the return air piping G and the interior of radiators C.

Suitable inlet valves L (for example of the type shown in Fig. 3) are used to cut the respective radiators into or out of service by governing the flow of steam thereto from the steam supply pipe B.

In the system here shown by way of example, which is best adapted for small installations such as home heating systems, the generator or boiler A is heated by an automatic gas heater indicated generally at 1, the control lever 2 on this heater being connected by chain 3 with a motor 4, electrically connected through wires 5 with a thermostat 6, located in the apartment whose temperature is to be regulated. The steam pressure in the system is partially governed by this control of the heat applied to the boiler A, whereby the rate of steam generation is regulated.

Steam flows from the generator A through the supply main B and the branch pipes or risers 7 to the several radiators C. Each radiator C is connected with one of the risers 7 through an inlet or supply valve L, one of which is shown in section in Fig. 3. This valve may be of any suitable type, which, when open, will permit a free flow of steam into the radiator as well as a flow of liquid condensate out of the radiator into the riser 7. In the example shown, the valve casing 8 is formed with a downwardly extending inlet connection 9 adapted to be threaded to the upper end of riser 7. At the upper end of the inlet passage 10 is the annular valve seat 11, adapted to be engaged by the movable valve member 12 in order to cut off the flow of steam through the valve. The horizontally extending outlet passage 120 is formed in the extension 13, which is connected with the radiator inlet by means of threaded collar 14 and adapter 15. The hand-operated screw 16 engages the valve stem 17 to move the valve 12 toward or from the valve seat 11, in the usual manner. The flexible metallic diaphragm 18 connected at its lower end with valve plate 12 and at its upper end with the valve casing, serves to prevent the escape of steam through the upper part of the valve casing and eliminates the necessity for packing about the valve operating mechanism. The essential characteristic of the valve used at L is that, when the valve is open, a free flow of steam from the supply main B to the radiators C is permitted, while at the same time the liquid condensate which forms in the radiator may drain out through the valve and riser 7 into the supply main B.

It will be noted that the highest point 19 of the supply main B is positioned above the point where the first riser 7 drains into main B, and that the substantially horizontal portion of the supply main inclines downwardly from the point 19 toward the return pipe connection E, so that all liquid condensate delivered into the main B from the radiators will drain into the return main E and thence flow back to the boiler A. The return main E connects at 21 with a vertical pipe 22 opening at its lower end 23 into the boiler A, an upper extension 24 of this pipe connecting at 25 with the supply main B so that boiler pressure will be imposed upon this water column to facilitate the gravitation of the condensate back into the boiler. In this form of the invention, substantially boiler pressure will prevail in all parts of the supply and return mains B and E.

In the upper portion of each radiator an air outlet is provided in which is secured the nipple 26 of the thermostatic air valve H, best shown in Fig. 4. Air flows from the radiator through passage 27 into the valve chamber 28, from the bottom portion of which chamber rises the conical dome 29 provided with the outlet passage 30. A movable valve plate 31 is adapted to seat against the valve seat 32 at the upper end of passage 30 to cut off the flow of steam from chamber 28 through passage 30 into the outlet passage 33. Outlet 33 is connected by means of threaded annular collar 34 and the adjustable adapter 35 with the upper end of the exhaust air riser 36. A fluid-filled thermostatic disk 37 is adjustably suspended by means of the threaded stud 38 from a downwardly projecting portion 39 of the cover plate 40 of the valve casing. The valve plate 31 is adjustably supported by means of the ball and socket connection 31a from the lower side of the thermostatic disk. In the absence of steam, the thermostatic disk 37 will contract and lift the valve plate 31 from the valve seat 32, and air may be drawn out from the radiator through passage 27, valve chamber 28, outlet passages 30 and 33, into the air exhaust pipe 36. When the radiator has been purged of all air, the steam will flow from the radiator through passage 27 and fill the valve chamber 28 and the thermostatic disk 37 will immediately become heated and expand so as to move the valve plate 31 against the valve seat 32 and cut off the flow of steam through outlet passage 30. The valve will remain closed as long as the chamber 28 is filled with steam, but when this steam has condensed and air has again accumulated in the valve chamber 28 the disk 37 will contract and permit this air to be exhausted through pipe 36. By locating the outlet passage 30 in the summit of the dome 29, all condensate that accumulates within the valve chamber 28 will drain back into the radiator instead of passing out through the air outlet 33.

The several exhaust pipes or risers 36 all lead into the common exhaust main G, which leads down to the air pump or vacuum producing mechanism indicated generally at F. Many different forms of exhausting mechanism could be used, the one here shown by way of example being described in detail and claimed in the copending application of Crosthwait, Serial No. 209,775, filed August 1, 1927. Suffice to state that an impeller driven by the electric motor J serves to circulate water from and back to a separating chamber in such a manner that a continuous series of charges or slugs of air are withdrawn from the pipe G and discharged into this chamber. The supply of water with which the pumping mechanism is originally primed is not exhausted but is used over and over again. This water supply will be gradually augmented by vapors condensed from the air which passes through the pumping system, and any excess of this liquid which accumulates is discharged through the pipe 97 provided with one-way check valve 98 into the condensate return pipe E. While the type of pump just briefly described is preferred, any suitable type of exhausting mechanism which may be driven from an electric motor such as J, may be used.

Motor J is under the control of the mechanism

indicated generally at K. Mechanism K preferably comprises an electric switch 39' which is operated by a differential pressure controller 40', these devices being preferably of the type described and claimed in the co-pending application of McMurrin, Serial No. 174,994, filed March 12, 1927. Briefly described, the controller 40' is of the well known type in which a central diaphragm separates a high pressure chamber from a lower pressure chamber. The diaphragm is actuated in one direction by a spring and in the other direction by the difference in pressure between the two chambers. Movements of the diaphragm serve to open or close the switch 39' and thus stop or start the motor J. An equalizing pipe 41 is provided between selected points in the supply and return sides of the system. As here shown this pipe connects one of the steam risers 7 with one of the exhaust pipes 36, through a one-way check valve 42 and a normally open cut-off valve 43. The check-valve will remain closed unless the pressure in the supply pipe falls below the pressure in the return pipes, in which case the valve will open and permit the pressures to equalize. A pair of surge chambers 44 are provided in equalizing pipe 41, one in the high pressure and one in the low pressure end of this pipe, and these chambers are respectively connected by pipes 45 and 46 with the high and low pressure chambers of controller 40'. By suitably adjusting the differential control mechanism K, the air evacuating mechanism F will be started into operation whenever the pressure differential between supply pipe B and air exhaust pipe G falls below a certain minimum, and the pumping mechanism will be stopped when this pressure differential has again been established.

In order to vent any air that may accumulate in the return main E, into the air exhaust pipe G, a pipe connection 47 is provided which leads through a thermostatic trap 48, which may be similar to one of the traps H already described, and discharges into the air return pipe G. In an obvious manner, any air which may accumulate in pipe E will be drawn off through pipe 47 and trap 48 into the air exhaust pipe G, but as soon as steam commences to flow through this pipe the trap 48 will be closed.

In the modification shown in Fig. 2, a drip pipe 49 leads from an intermediate portion of the air exhaust pipe G and discharges through a one-way check valve 50 into the condensate return pipe E. An air eliminator 51 of any approved form, provided with an air vent valve 52, is connected with the drip pipe 49 above the normal water level therein so as to vent air or other gases from this line whenever the exhausting mechanism is not in operation and the air pressure within the system has risen to normal atmospheric pressure. Otherwise this modification operates in the same manner as the preferred form shown in Fig. 1.

In the modification shown in Fig. 5, a reducing valve D is provided whereby any desired sub-atmospheric pressure may be maintained in the portion of the supply main B beyond the valve D, and in the radiators, even though a higher pressure is created in the generator or boiler A. In this system, a pumping means is also provided for positively returning accumulated condensate to the boiler when the boiler pressure is so much higher than the return line pressure that a gravity return becomes impractical. In this form of the apparatus, many of the parts are the same as already described in connection with Figs. 1 and 2, and these features will be indicated by the same reference characters and not further described, except as to the details in which they differ from the first described installation. The reducing valve D is of a well-known type in which a normally closed valve within the casing 53 is controlled by diaphragm 54, and the balancing weights 55 and 56. The diaphragm 54 is subject on one side to atmospheric pressure and on the other side to the reduced pressure in supply main B (low pressure side) by means of the pipe 57 connected at one end to the housing of the diaphragm and at the other end to the supply main at a point sufficiently remote from the valve to be uninfluenced by pressure disturbances in the vicinity of the valve. The weights 55 and 56 are so adjusted that when the pressure in the low pressure side of supply main B falls below a desired minimum, the valve in casing 53 will open to admit an additional quantity of steam from the high pressure side of the main. As soon as the pressure in the low pressure side of the main has risen to the desired point, the valve will automatically close, and remain closed until more steam is required to maintain the necessary minimum pressure. By properly adjusting the weights 55 and 56, any desired sub-atmospheric pressure may be maintained in the low pressure side of supply main B, and hence in the radiators C. Instead of the manually adjusted reducing valve just briefly described, an automatic temperature-controlled valve may be substituted of the type shown and described in my Patent 1,644,114, hereinabove referred to.

As in the first described form of the apparatus, the supply main B continues into the return main or drip-pipe E which loops back to the boiler so that under some conditions the condensate that is returned to main B from the radiators may gravitate through return main E to the boiler. The lower section 58 of drip-pipe E is provided with a cut-off valve 59 and a one-way check valve 60, opening toward the boiler, so that water cannot be forced back into the return system by the higher pressure existing in the boiler. On the low-pressure side of check valve 60, a drain pipe 61 forming a branch of the return main E leads through cut-off valve 62 to the steam trap 63. The lower portion 64 of the air exhaust main G is of increased capacity so as to also handle liquid condensate, and communicates through a branch 65 and cut-off valve 66 with the steam-trap 63. Under normal operating conditions, with a high pressure in the boiler, and cut-off valve 62 open, the check-valve 60 will remain closed and condensate will not gravitate directly to the boiler but will drain through branch 61 and steam trap 63 into the lower branch 64 of exhaust main G, along with the exhausted air. The trap 63 will automatically close when steam attempts to pass through it (in much the same manner as the traps H already described) so as to prevent the low pressure in return main G from being raised to the higher pressure existing in supply main B and return main E.

The air and condensate pass through pipe 64 and suction strainer 67 into the accumulator tank 68. A low-pressure air pipe 69 extends upwardly from the accumulator tank and is provided adjacent its end with an outwardly opening check-valve 70, whereby air may be vented through this pipe whenever the pressure in the return lines rises above atmospheric pressure. The low-pressure end of equalizing pipe 41 is connected into pipe 69, and the differential pressure controller

K is connected with the equalizing pipe in the manner already described in connection with Fig. 1. The controller K actuates the switch 39' for stopping and starting the pump-operating motor J, and this motor is also under the control of a second switch 71, actuated by the float 72 in the accumulator tank, so that the pumping mechanism will be started whenever a predetermined quantity of liquid accumulates in tank 68, regardless of the relative pressures existing in the mains.

The suction producing mechanism F, in the form here shown, comprises a tank 73 partially filled with water, from the lower portion of which a pump 74 driven by motor J withdraws water through pipe 75 and forces this water upwardly through a jet exhauster 76 and pipe 77 back into tank 73. This hurling water circuit produces a suction in the casing of jet exhauster 76, which draws up water and air from the accumulator tank 68 through pipe 78, these materials being carried along with the water of the hurling circuit and discharged into the tank 73. The one-way checkvalve 79 in pipe 78 prevents the return of these materials to the accumulator tank. The gases discharged into tank 73 are vented to the atmosphere through pipe 80 provided with the checkvalve 81. As here shown pipe 80 discharges into a sewer connection at 80a. A second outlet from water pump 74 leads through valve 82, pipe 83, check-valve 84, cut-off valve 85 and pipe 86 to the portion 58 of return main or drip-pipe E on the high pressure side of check-valve 60. A float 87 in the tank 73 opens the valve 82 by means of link connections 88, when the liquid accumulating in tank 73 reaches a certain height, thus permitting the pump 74 to force water from tank 73 into the boiler A.

As is well known, steam will be generated at atmospheric pressure at 212° Fahrenheit. Under higher pressures, steam will be generated at higher temperatures, and conversely, under a vacuum steam will be generated at lower temperatures, the temperature of the steam depending upon the degree of vacuum existing in the system. This principle is utilized in this heating system so that by varying the sub-atmospheric pressure in the supply main B and in the radiators C, the temperature of the steam delivered thereto is correspondingly varied so that steam at comparatively low temperatures may be maintained in the radiators when prevailing weather conditions necessitate only a mild radiation of heat from the radiators. Obviously, steam may be generated more economically at lower temperatures, and it is more efficient and economical to maintain a constant supply of steam at a comparatively low temperature than an intermittent supply of steam at a higher temperature. While the degree of vacuum existing in the system may be varied from atmospheric pressure or slightly above, to as low as perhaps twenty-four inches of vacuum in order to obtain the desired heating effect from the radiators, it is also desirable that a substantially constant and relatively small difference in pressure be maintained between the supply mains and the air exhaust system in order to make sure that the radiators are properly filled with steam at the desired sub-atmospheric pressure at all times. Accordingly, the vacuum producing system is adjusted to maintain this substantially fixed pressure differential between the steam supply mains and the exhaust pipes, and this exhausting mechanism will also function as hereinafter explained, in cooperation with the boiler control devices or the reducing valve, to maintain the desired degree of vacuum throughout the radiation system.

When starting the operation of either form of this system, heat is applied to the boiler A and the pumping mechanism F is started to create a suction in the exhaust main G. At this time the system will be empty of steam, and the thermostatic traps H will be open, so that this suction will extend throughout the system including the generator A, wherein the pressure is so lowered that the steam is rapidly generated and drawn into the supply main and thence into the radiators C. When steam attempts to pass through the traps H, these traps will close and remain closed until such time as the steam within the valve chambers 28 has condensed and air has again accumulated therein. The exhausting mechanism F will continue to operate until the sub-atmospheric pressure in air exhaust pipe G (which is now cut off from the supply side of the system by the closed traps H) has been lowered to the point that the necessary pressure differential has been attained, whereupon the control mechanism K will operate to stop the motor J. As steam condenses in the radiators C, the pressure in the radiators and supply main B and generator A will be lowered below the desired sub-atmospheric pressure for which the system is adjusted, thus causing the more rapid generation of steam in the boiler A in the apparatus shown in Fig. 1, or causing steam to pass the reducing valve D of Fig. 5, which will again fill the radiators at the desired sub-atmospheric pressure. The liquid resulting from the condensed steam within the radiators C will drain out through the risers 7 into the supply main B and then drain through return pipe E back to the generator, or in the Fig. 5 form of the apparatus this condensate will normally drain into tank 68. Whenever any air has accumulated in one or more of the radiators, the corresponding traps H will open and this air will be drawn out through the exhaust system, the controller K acting to start the pumping system whenever necessary to maintain the desired pressure differential between the exhaust pipes and the interior of the radiators.

In the system shown in Fig. 1, the boiler-heating apparatus must be so adjusted that the rate of steam generation will just compensate for the condensation in the radiators and supply main B, so that the sub-atmospheric pressure in the system will not build up above the desired maximum. This may be accomplished by a manual control of the heat applied to the boiler, or may be controlled automatically by mechanism such as the thermostat 6 and motor 4 shown in Fig. 1. When a reducing valve is used such as shown at D in Fig. 5, the pressure in the generator A may be permitted to build up higher than the pressure desired within the radiators. Sometimes it is desired to use higher pressure steam from generator A for other purposes, or it is desirable to use exhaust steam or steam from a central heating plant, in which cases the reducing valve D is desirable. In such systems, the reducing valve D will remain open when the system is started until the desired sub-atmospheric pressure (for which the valve D is set) is attained within the supply main B beyond the valve D, and in the radiators C, after which the valve D will automatically close and only open at intervals to admit additional steam to the heating system when the pressure falls below the desired minimum. The pressure in the generator A may

build up above this point without affecting the established sub-atmospheric pressure of the steam within the radiating system. In such an event, the liquid condensate from the return pipe E will be drawn into tank **73** and forced at intervals into the boiler by pump **74**, all as previously described.

The form of apparatus shown in Fig. 5 may be operated substantially the same as the form shown in Fig. 1, by closing the cut-off valve **62**, opening the valve **59**, and controlling the fires under boiler A so as to generate the steam at low-pressure. In such case the condensate will gravitate directly to the boiler through pipe **58**, and the pumping mechanism F will function merely to exhaust air from the system as in the first described form of the apparatus.

The object sought to be attained by this system is the substantially constant emission of heat from the radiators at a rate just sufficient to replace the heat loss from the building. This is accomplished not by turning the radiators on or off at intervals, but by changing the temperature of the steam maintained in the radiators and this in turn is accomplished by varying the sub-atmospheric pressure of this steam. This pressure variation is accomplished by adjustment of the reducing valve D, or by control of the fires under the boiler, all as hereinabove described.

I claim:

1. In a steam heating apparatus, a generator, a supply pipe, a plurality of radiators, branch pipes placing the supply pipe in normally constant communication with the lower portion of each radiator whereby steam is supplied to each radiator and liquid condensate drains out into the supply pipe, a reducing valve in the supply pipe between the generator and the radiators an exhaust main having branch pipes leading respectively to the upper portion of each radiator, a thermostatic trap between each radiator and the exhaust pipe to prevent the escape of steam from the radiator, the supply main terminating in a drip-pipe leading back to the generator, a check-valve in the drip-pipe, a branch pipe leading from the low-pressure side of the check valve in the drip-pipe to the exhaust main, a steam trap in this branch pipe, and an exhausting mechanism connected with the exhaust main and comprising means for venting the air and for forcing the liquid condensate back into the high-pressure portion of the drip-pipe and thence into the generator.

2. In a steam heating apparatus, a generator, a supply pipe, a plurality of radiators, branch pipes placing the supply pipe in normally constant communication with the lower portion of each radiator whereby steam is supplied to each radiator and condensate drains out into the supply pipe, a reducing valve in the supply pipe between the generator and the radiators, an exhaust main having branch pipes leading respectively to the upper portion of each radiator, a thermostatic trap between each radiator and the exhaust pipe to prevent the escape of steam from the radiator, a drain pipe for liquid connecting the supply pipe with the exhaust main, a steam trap in the drain pipe, a pipe connecting the drain pipe with the generator, a one-way valve in this latter pipe opening only toward the generator, an exhausting mechanism connected with the exhaust main and comprising means for venting the air and returning liquid condensate to the generator, a motor for driving the exhausting mechanism, a switch mechanism controlling the motor, and a pressure-operated controller in communication with the supply and exhaust pipes for operating the switch so as to maintain a predetermined pressure differential between the supply and exhaust mains.

3. In a steam heating apparatus, a generator, a supply pipe, a plurality of radiators, branch pipes placing the supply pipe in normally constant communication with the lower portion of each radiator whereby steam is supplied to each radiator and condensate drains out into the supply pipe, a reducing valve in the supply pipe between the generator and the radiators, an exhaust main having branch pipes leading respectively to the upper portion of each radiator, a thermostatic trap between each radiator and the exhaust pipe to prevent the escape of steam from the radiator, a drain pipe for liquid connecting the supply pipe with the exhaust main, a steam trap in the drain pipe, a pipe connecting the drain pipe with the generator, a one-way valve in this latter pipe opening only toward the generator, and an exhausting mechanism connected with the exhaust main and comprising means for venting the air and for forcing liquid condensate back into the generator.

CLAYTON A. DUNHAM.