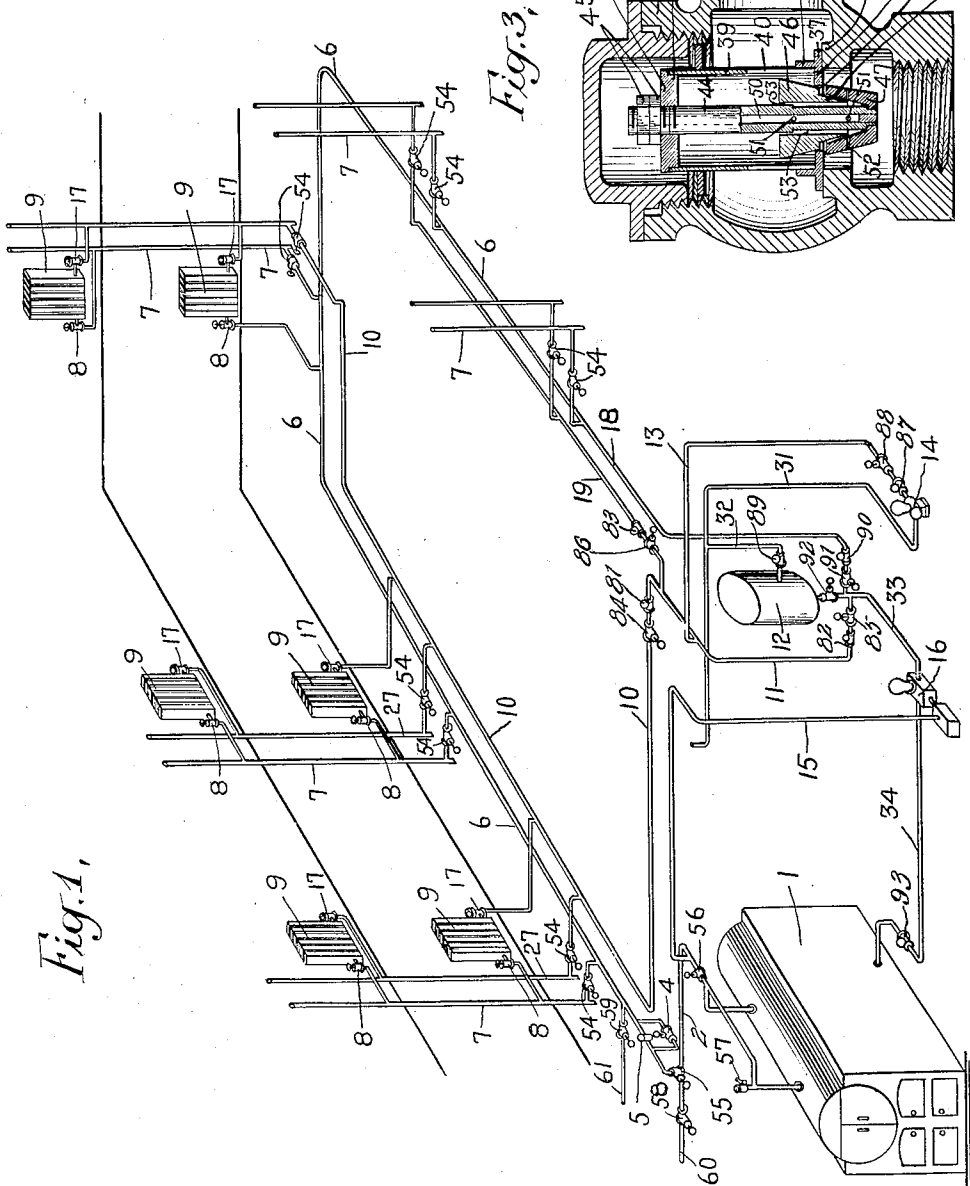


1,237,253.

Patented Aug. 14, 1917.

2 SHEETS—SHEET 1.



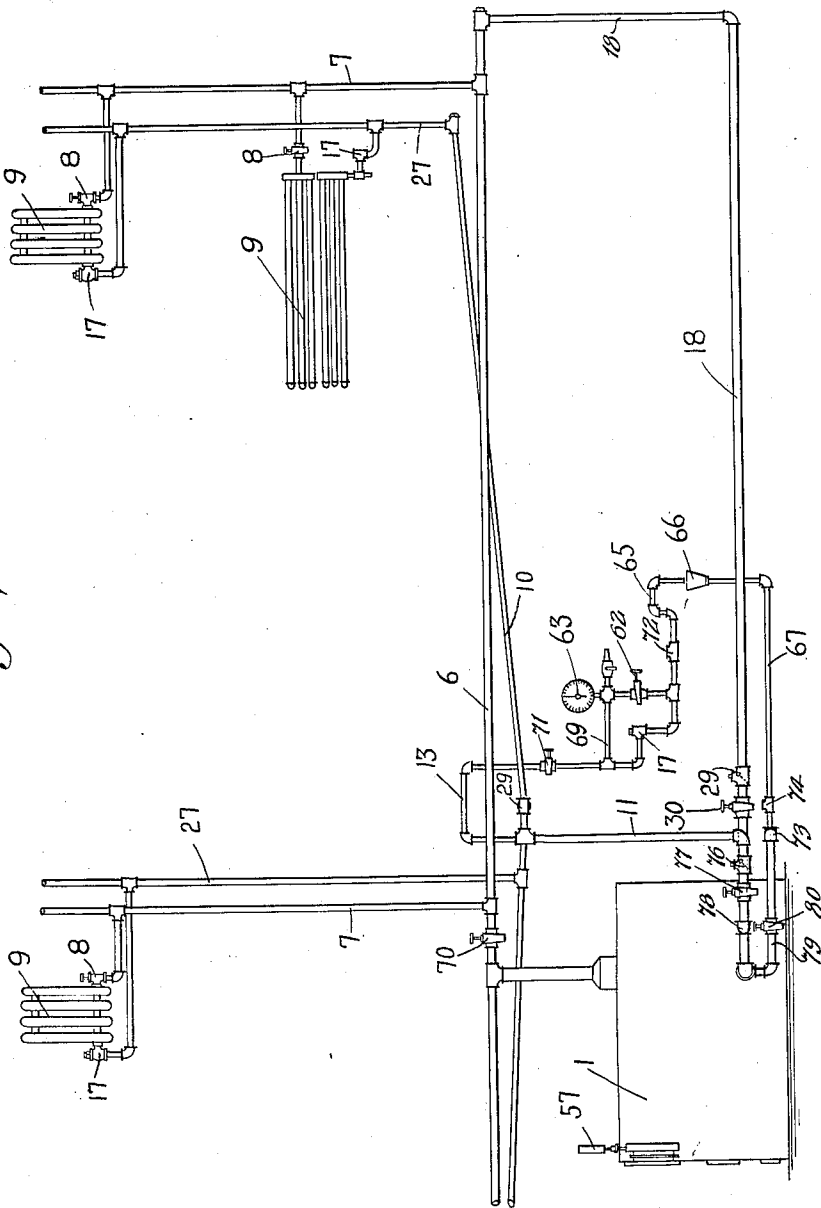
WITNESSES
Newton B. Rogers
John O. Campbell

INVENTOR,
Andrew G. Paul
 BY
Kenyon & Kenyon
 his ATTORNEYS.

1,237,253.

Patented Aug. 14, 1917.
2 SHEETS—SHEET 2.

Fig. 2.



WITNESSES
Newton C. Burgess
John O. Gump

INVENTOR,
Andrew G. Paul
BY
Kenyon & Kenyon,
his ATTORNEYS.

UNITED STATES PATENT OFFICE.

ANDREW G. PAUL, OF BOSTON, MASSACHUSETTS.

HEATING SYSTEM.

1,237,253.

Specification of Letters Patent.

Patented Aug. 14, 1917.

Application filed October 9, 1913. Serial No. 794,218.

To all whom it may concern:

Be it known that I, ANDREW G. PAUL, a citizen of the United States, and a resident of the city of Boston, county of Suffolk, and State of Massachusetts, have invented new and useful Improvements in Heating Systems, of which the following is a specification.

My invention relates to heating systems of the closed type and in which steam or some other vehicle is caused to flow to heat-distributing means such as radiators or heaters, through a suitable system of pipes, and to give off a portion of its heat as a result of which the heating vehicle is condensed in the radiators or heaters.

The object of my invention is to improve the movement of the heating vehicle in the system so that one radiator will not short circuit another radiator and also its circulation in the radiators or heaters and to remove from their interior walls all the non-heating gases which may collect there and which tend to prevent an efficient transmission of the heat of the heating vehicle to the radiator.

Another object of my invention is to remove the water of condensation as well as the air and other non-heating gases that may collect in the heating devices in an efficient, reliable and economical manner.

In some systems heretofore used it has been customary to remove the air and water of condensation from the radiator into the return passage through separate openings in the discharge side of the radiators either by producing a vacuum in the return passage or by forcing the air out of the radiators by means of pressure on the supply side and then removing the air and water together from the return passage.

In the systems heretofore employed if the supply of steam is not ample to furnish all the radiators on the system with a full supply and one radiator on the system is put in such condition that it condenses the steam supplied to it rapidly, it will draw more steam than should be supplied to it, and as a result the other radiators on the system will be robbed of their necessary amount of steam, or short circuited, and consequently they will not be sufficiently heated.

According to the present invention, I have provided a closed system in which the supply may be at or below atmospheric pressure, the air and water of condensation may

be continuously discharged into the return pipe while steam will be prevented from entering therein, and in which the contents of the return pipe are permitted to flow into the radiators under certain conditions explained hereinafter.

My invention consists in the combination with a radiator or heater and the other necessary parts of a heating system, of a return or discharge pipe in which there is placed an automatic valve near the discharge end of each radiator which valve is adapted to slowly but continuously remove air and other non-heating gases and water, as it is formed, from the radiator without substantial waste of the heating vehicle and which valve allows the contents of the return pipe to flow into the radiators when the pressure in the return pipe exceeds that in the radiators, and means are also provided at the lower end of the return or discharge pipe by which the air and other non-heating gases may be removed from the return pipe separately from the water of condensation, which water may return to the boiler or source of supply by means of its own weight, or it may be pumped into the boiler, if desired. The separate handling of air and water effects considerable saving in power for this purpose and it also effects a saving in cost of installation and operation.

My invention consists also in the method hereinafter explained and claimed.

The means employed in this system will be described in connection with the drawings which form a part of this specification and in which—

Figure 1 is a system having a supply and a return passage having an exhaustor on the end thereof;

Fig. 2 shows a two-pipe gravity system; and

Fig. 3 represents a valve which I prefer to use on the discharge side of the heating devices.

In all the figures corresponding parts have been similarly numbered.

In Fig. 1 is shown a source of heat such as a boiler 1 which is adapted to furnish steam for the heating devices 9 on the system. The heating devices are connected with the source through a common supply pipe 6. Each heating device is supplied by a branch 7 connected with the pipe 6 which is connected to the source through the pressure reducing valve 5 and the pipe 2. Ar-

ranged around the reducing valve 5, as a by-pass, is a pipe containing an ordinary hand-operated valve 4. There is placed a valve 55 in the supply pipe 6 whereby it may be opened and closed. There is a pipe 60 which may carry high pressure steam to any desired means and a valve 58 is placed in this pipe whereby it may be controlled. The pipe 61 is adapted to deliver low pressure steam into the pipe 6 so that the heating system may be operated on exhaust steam from an engine. In this case the valve 55 would be closed or the supply may be partly through 61 and partly through the reducing valve 5. A valve 56 is provided to cut off boiler steam to the entire system. The usual safety valve 57 is placed on the boiler. In the branches 7 leading to the heating devices are placed hand-operated valves 8 to control the supply of steam to the heating devices or radiators 9. Valves 54 are placed in the branches 7 and 27 so that they may be closed if desired. The discharge sides of the radiators are connected through the valve 17, which is of the type shown in Fig. 3, with the branch 27 leading to a common return pipe 10. The return pipe 10 is connected with the return tank 12 through the pipe 11. The pipe 19 connects with the return 11 whereby the water of condensation from certain parts of the system is conducted to the tank 12. In the pipes 10, 11 and 19 are arranged check valves 81, 82 and 83, respectively. Near each of these check valves are arranged gate valves 84, 85 and 86, respectively. All of these check valves, both in the pipes 10 and 19, which connect therewith, open in a direction toward the return tank 12. At a point on the pipe 11 is connected a branch 13. This connection is made at the top of the pipe 11 so that air may be drawn off through the pipe 13 as hereinafter explained. The pipe 13 is connected with the suction side of the pump 14. A check valve 87 and a gate valve 88 are provided near the pump, the check valve opening in the direction of the pump. A pipe 31 connects the discharge side of the pump with a vent or other suitable place. To the underside of the pipe 31 is connected a pipe 32 which leads into the return tank 12. This pipe is adapted to take any water that may be deposited from the discharged air and return it to the tank 12 and is provided with a check valve 89. A pipe 18 is employed as a drip for the supply pipe 6. This pipe is connected with the return tank 12 in the same manner as the pipe 11 but separate therefrom. By the use of a drip of this kind the water condensed in the supply pipe runs back to the tank 12, and does not flow back in the supply pipe against the steam. It has a check valve 90 and a gate valve 91. A gate valve 92 is in the common pipe con-

necting the pipes 11 and 18 with tank 12. The return tank 12 is connected by a suitable pipe 33 with the pump 16, and the pump is suitably connected with the boiler 1 by the pipe 34 so that the water in the return tank may be pumped into the boiler as desired. A check valve 93 is placed in the pipe 34 leading from the pump to the boiler and opening toward the boiler. The pump is operated by steam from the boiler through the pipe 15.

The valve illustrated in Fig. 3 is of the type shown in an application filed by me on the 19th day of June, 1913, Serial No. 774,541. This valve, shown partly in section, comprises a casing 35 having a seat 36 of the usual form. There is a member 37, hereafter called an adapter, arranged to rest on the seat 36, said adapter having a seat 38, hereinafter called a secondary seat. By adapter I mean a member which will permit the use of a given valve with a seat of any size. Mounted on the adapter is a screen 39 which is preferably a section of tube having slots 40 cut in one end thereof. The metal between the slots has a spring action to hold the screen in place on the adapter by pressing against an annular projection 41 on the adapter 37. Mounted on the screen 39 is a collar 42 which may have an annular projection or shoulder 43 on its under side similar to that on the adapter. The projection 43 fits snugly inside the upper end of the screen 39 and thereby makes a rigid structure composed of the adapter 37, screen 39 and the collar 42. Mounted in the collar 42 is a stem 44 having a screw-threaded top with locknuts 45 by which the position of a valve member 46 with relation to a cup 47, which is rigidly mounted on the lower end of the stem 44, may be regulated and maintained. The stem 44 is of such length that it extends below the secondary seat 38 of the adapter 37. The cup 47, therefore, which is mounted on the lower end of the stem is also below the seat 38 when in position. The valve member 46 rests on the secondary seat 38 of the adapter and its normal seated position is thereby determined. The stem 44 passes through a valve member 46 which is slidably mounted thereon. In the valve member is an opening bored approximately one-one-hundredth of an inch larger in diameter than the stem for reasons to be discussed hereinafter. The valve member is preferably, but not necessarily, conical in shape and a portion thereof is cut away, forming a shoulder 48 on the lower part thereof. The portion 49 projecting below the shoulder is adapted to fit snugly into the cup-shaped member 47 which is carried on the lower end of the stem, the cup member being cut away in its upper interior portion so as to receive the lower portion of the valve member and so form a pressure area

between them. Normally the nuts 45 are so adjusted that there is a little space between the portion 49 and the upper part of the cup 47 when the valve member 46 is seated. The stem 44 is provided with a longitudinal passage 50 extending entirely through the stem except for a short distance near the lower end thereof; and it is also provided with openings 51 leading from the passage to the exterior of the stem. The holes 51 may be of any number desired but when employed they are preferably of small diameter. One, or one set of the openings, is provided a short distance below the top of the valve member 46 when in its seated position, and another, or another set is provided at a point opposite the lower end of the projection 49 on the lower portion of the valve member 46 when in its normal seated position so that when the valve member is seated these openings 51 at the lower end of the stem will be partly closed or controlled by the projection 49 on the valve member which controls the openings 52 in the cup member 47. The passages 51 are in open communication with the longitudinal passage 50. The stem is reduced in diameter from a point just below the top of the valve member when seated to the lower end of the stem. The cup member mounted on the end of the stem is provided with passages 52 leading from the outer surface into the lower portion of the cavity therein. The passages 52 may be so positioned that the projection 49 on the valve member 46 will approximately cover them when the member is in its normal seated position. The position of the valve member relatively to the passages 52 in the cup and stem may be adjusted by the nuts 45 on the upper end of the stem. It is understood that a passage 53 of increased cross-section between the valve member and the stem may be obtained in other ways, than that shown, with satisfactory results, the object being to get an increased passage at this point and thereby a decreased resistance to flow. The passage 50 through the stem is capillary in character so that steam will be prevented from passing therethrough in any substantial amount.

The valve member and the seat are purposely formed in such way that the surfaces of the two are not in continuous contact, but contact at certain points or places in their surfaces, and in between these points in the line of contact are formed capillary ducts. This construction can be secured by making the lower surface of the member or the upper surface of the seat, or both of them, somewhat roughened, or with irregularities, in the process of manufacture, which will prevent continuous contact, and leave capillary passages in between; or the under surface of the member, or the upper surface of the seat, or both of them, may be provided

with fine grooves or passages which will produce capillary ducts when the member is seated. These capillary passages may be formed in any well-known manner such as by cutting, stamping or filing. There will then be a large number of openings of very small cross-section, or in other words capillary passages, between the valve member and its seat, and leading from the inlet to the outlet passage of the valve when it is seated. They exist between the valve member and its seat along their line of contact and are consequently very short.

The operation of the device shown in Fig. 3 is as follows:—When air comes to the valve the air will escape through the capillary passages between the secondary seat 38 of the adapter 37 and the valve member 46, through the passage 53 between the member 46 and the stem 44, and also through the longitudinal passage 50 in the stem and the passages 52 in the cup. The air can flow directly downward through the passage 53 to the cup and then out through the passages 52 in the cup; or the air can flow through the longitudinal passage 50 and out through the passage 51 into the cup member and escape through the passages 52. When water comes to the valve the water will be drawn into the capillary passages between the valve and the secondary seat of the adapter and as there is then a difference of pressure between the upper and lower sides of the valve 46, this water may be forced through these passages in small amount in the beginning. As soon as the water is given a flow or movement through these passages between the seat and the member, the body of water to be discharged is transformed from a static into a flowing body which has the effect of lifting the valve member away from the seat 38 and thereby increasing the communication between the two sides of the valve. This has the effect of reducing the difference in pressure between the inlet and outlet of the valve as a result of which the principal force necessary thereafter to hold the valve open is that required in suspending the member 46. This lifting effect of the water upon the member transforms the capillary passages into passages of larger cross-section, which in turn permit of an increased lifting effect and thereby cause the valve to be raised to a point sufficient to allow the water to be discharged. The lifting effect on the valve member is accelerated by the action of the current of air flowing down through the passage 53 between the stem and the valve member, and also by that flowing through the longitudinal passage 50 by reason of the fact that this air escaping into the space between the cup member and the lower portion of the valve member tends to equalize the pressure in that space with the pressure in the interior of the valve and thereby decrease the

differential pressure on the two sides of the valve member. This causes the action of the water flowing through the capillary passages to be more effective, and to lift the valve member more readily. As soon as the water has been discharged from the valve the lifting effect will cease and the weight of the valve member will cause it to seat. When the valve is seated the difference of pressure on each side of the valve which is then increased will hold it firmly seated.

When the valve is thus seated the passage from the inlet to the outlet side of the valve is again made capillary in character. When the steam reaches the valve, therefore, it will find only capillary passages and as the characteristics of steam are radically different from those of water or air it is found, as a matter of fact, that the steam will not flow in any substantial amount through these capillary passages. It is my present belief that as the steam tends to pass through the capillary passages any amount, however small, which might gain entrance, will condense and as there is not sufficient water at this time to cause the lifting effect above described, the passages remain capillary in character and effectively prevent the passage of steam. It is found in practice that water constantly drips from the valve and it is my belief that this drip is caused by the condensing of steam near the valve and as steam occupies many times the space its water of condensation does it follows that the arrangement by which the water is continuously discharged through the valve causes a continuous and sluggish movement of the contents of the radiator toward the return pipe. This is beneficial because it allows an efficient removal of the non-heating gases and an efficient circulation of the heating vehicle in the radiator. The steam cannot pass through the passage 53 because no substantial quantity of steam can flow through the capillary passage between the top of the valve member and the stem. Should any steam escape into the longitudinal passage 50 and tend to flow through the lower passages 52, it will be prevented from escaping by the fact that the passage 50 is capillary and also by the fact that the projection 49 on the valve substantially or nearly closes the passages 52. The position of the cup with relation to the valve member when the latter is in seated position can be changed and adjusted by screwing the nuts 45 up or down on the stem, and thereby lifting or lowering the stem and cup relatively to the other parts. When the stem is lowered the space between the lower end of the projection 49 and the wall of the cup is increased and the lower passages 52 are not shut off to the same extent by the projection 49 when the valve member is seated. In this condition a flow of air through the

longitudinal passage 50 and the passages 52 will be more rapid and the pressure within the cup below the projection 49 will therefore be greater and the valve will lift more readily than if these passages were not provided.

By adjusting the position of the cup, therefore, the valve can be made to lift more readily, and I believe that, under these conditions, it rises higher and gives a wider opening. The valve is so arranged that the air passes out through capillary passages but when the water comes these passages are increased to allow water to flow as above described. The valve member is also mounted so that it will be lifted or opened when the pressure in the return pipe to which it is connected is greater than that of the radiator so that a ready flow of the contents of the return pipe into the radiators is permitted. By this arrangement constant communication between the radiators and the return exists in both directions while the steam is confined to the radiators.

By using an adapter which provides a secondary seat for the valve, a valve device like that shown in Fig. 3 can be made in a certain size and used with various sizes of casing by using an adapter of the proper diameter. The purpose of the screen 39 is to prevent dirt, or other foreign substance, from flowing into the interior of the valve from the outer chamber of the valve casing. When the parts are assembled, as shown in Fig. 3, they can be adjusted and tested and are then ready to be placed in the main casing 35 in a heating system or other place. This assures a proper adjustment of the parts so that the future operation of the valve is more satisfactory than if it had to be adjusted in the main casing in which it is applied. Other advantages of this structure will be apparent. It must be understood, however, that the valve can be made to operate satisfactorily without this means of adjustment as it can be applied to the main casing direct without an adapter and its secondary seat.

The operation of the system above described is as follows:—

The valves 8 on all the heating devices and the supply valve 55 are opened and the pump 14 is started to draw the air out of the system and fill the heating devices 9 with steam. The valves 17 are so arranged, as described above in connection with Fig. 3, that they will allow the passage of air when a difference of pressure is created on their sides, but will prevent the passage of steam. This air is discharged into the vent by the pump 14. When the air has been sufficiently withdrawn from the system the steam will be evenly circulated through all the heating devices on the system, but will not pass out thereof into the returns 10 and

19. After the steam is in the heating devices it will be condensed and the water of condensation will then continuously flow through the discharge side of the heating devices and through the valve 17 as heretofore described, and will return to the return tank 12 through the pipes 10, 19 and 11 whereby a continuous movement of the contents of the radiator is secured as above described. The return and all other parts of the system are so constructed and arranged that only a very little air can enter the system. Whatever air enters is removed by the pump 14 which operates continuously. The system will continue to operate as above described as long as supplied with steam.

In heating systems heretofore used the circulation at times within the radiators has not been such as to give the best results—that is to say the air contained in the upper looped portions of the sections of the radiator does not escape before the steam has entered and crossed the lower portion of some or all of the sections of the radiator, and consequently they are not properly heated.

From experiments I have concluded that a rapid inflow of steam into a radiator imprisons a certain amount of air close to the inner surface of the radiator and thereby materially decreases the efficiency of the radiator as a heat transmitting medium. This is due to the fact that when the air is caught in this manner it expands and forms a film of heat insulating material between the steam and the inner surface of the radiator and thereby materially reduces the transmission of heat from the steam to the radiator.

It has been the practice in some heating systems heretofore employed to allow the heating vehicle to pass through the radiator into the return passage in an attempt to get proper circulation in the system, but this entails a considerable loss of steam which is condensed in the return. Further it has been found to be the fact, in systems heretofore used, that if the supply is not ample to furnish all the radiators with a full supply of steam at a given pressure, and one radiator becomes, from any cause, a better condenser than another on the system, it will rob the other radiators of their share of steam by rapidly condensing the steam supplied thereto and thereby short-circuit the other radiators.

In the employment of my invention a system is obtained in which the movement of the contents of the radiator is sluggish but continuous, in which the circulation of the steam in the radiator is such as to heat the upper looped portions of the sections as efficiently as any other part of the radiator, and the circulation of the steam in the system is such that a condensing radiator will not short-circuit any other radiator. This

desirable result is obtained by arranging the means connecting the discharge side of the radiator with the return passage so as to allow the continuous passage of air and water, but prevent the passage of steam into the return pipe, as above described in connection with Fig. 3, and which also permits the passage of the contents of the return pipe into the radiator as well as air and water from the radiator to the return pipe, depending in each case upon the difference of pressure on the sides of the valve. The discharge of air and water through this valve continues regardless of the temperature of the valve. The valve is capillary to flow from the radiators to the return pipe so that the escape of air and water is comparatively slow whereby the interior surface of the radiator is completely "washed" and thereby freed from air or other non-heating gases, as a result of which the heat units contained in the heating vehicle may be efficiently transmitted to and through the metal of the radiator. When the pressure in the return pipe is greater than that in the radiator the valve will open and allow relatively free communication between the return pipe and the radiators whereby the steam is circulated in the system in an efficient and economical manner. If, in my system, therefore, one radiator becomes a better condenser than any other, it will immediately tend to increase the difference of pressure between the supply and the return pipes by drawing upon the return side of every other radiator on the system. This will tend to make a greater difference of pressure between the supply and exhaust sides of the other radiators by lowering the pressure in the return pipe, and as the valves 17 of all the radiators allow the air and water to pass into the return pipe continuously, and also allow the contents of the return to flow into the radiators, regardless of the temperature of the valves, the air and water will be withdrawn from the other radiators and this will cause all of them to circulate evenly and uniformly, because the condensing radiator draws on both the return and the supply pipe and consequently does not take the steam from the other radiators, but on the contrary tends to fill them with steam. This action will continue until the pressure of the supply side of all the radiators is equalized and the pressure of the exhaust side of all the radiators is equalized. As a result of this arrangement the condensing radiator may be partly filled with air or other gas from the return passage and will not be heated to full capacity, if the supply is limited. It will not take all the steam from the other radiators, therefore, but will help them to properly and evenly circulate by locally circulating a part of the contents of the return into itself, there-

by reducing the pressure in the return whereby the air and water are drawn from all the other radiators on the system, and consequently all the radiators on the system will be heated. This same action is caused by a radiator which has been shut off from the supply side of the system and then condenses the steam which it contained at that time, thereby drawing on all the other radiators and circulating the steam in them. I find that the condensing radiator may sometimes have one or more of its loops, on the discharge end, cool but those which are hot are as hot as any of those of the other radiators. The above operation is due in part at least to the sluggish movement of the gaseous contents of the system as regulated by the discharge valve and to the fact that the valves 17 allow continuous communication between the radiators and the return in both directions but prevent the flow of steam into the return pipe. If, however, under the above conditions the volume of steam is sufficient to fill all the radiators at a pressure not lower than that in the return, which pressure in the return is due to the presence of air or regenerated steam from the water of condensation, it will be automatically, properly and evenly distributed among them, as above described.

In Fig. 2 is illustrated a gravity system. This system comprises a boiler supply 1 and a common supply pipe 6. The heating devices 9 are connected with the supply pipe 6 by means of branches 7 through the valves 8. The heating devices 9 are connected with the return passage 10 by means of the valves 17 and the branches 27. The valves 17 are preferably of the type shown in Fig. 3 and above described in connection therewith. Connected with the supply pipe 6 is a drip 18 which leads to the boiler 1 through pipe 68. Connected in this drip 68 is a check valve 29 and a gate valve 30. The gate valve 78 is also in this pipe 68 for the purpose of shutting off connection with the boiler 1 of pipes 68 and 11 for repair purposes or for other reasons. The return pipe 10 is connected with the boiler 1 through a pipe 11 in which are located the check valve 76 and the gate valve 77. This pipe is connected through a check valve 29 and a gate valve 30 with the boiler 1. Connected at a point on top of the return pipe 10 is a pipe 13 having a gate valve 71, a valve 17 of the type shown in Fig. 3, and a check valve 72. Arranged around the valve 17 is a by-pass comprising a pipe 69 and a gate valve 62. Attached to the pipe 69 is a pressure gage 63. The function of the connection 13 and its various parts is to relieve the system of the air by taking it from the return pipe 10. The air is discharged to the atmosphere by pressure on the supply side. If, for any reason, this passage 13 becomes flooded with

water or contains water from any cause, it will empty into a device, such as a funnel 66, which will conduct the water to the sewer connection 73. The pipe 79 connects the boiler 1 with the sewer connection 73. In this pipe is the gate valve 80 by which the boiler 1 may be drained or blown off. The passage connected with the funnel 66 has a check valve 74. The arrangement of the check valve 72 and the pipe 65 leading to the funnel 66 is such that a water seal will be formed outside the check valve, which opens outward, so as to prevent the entrance of air into the system. The operation of this system is as follows:—

The valves 8 on the heating devices are opened. The valve 70 on the supply is opened and steam is permitted to enter the common supply main 6. The steam under pressure forces the air out of the supply pipe, the branches 7, the heating devices 9 through the valves 17 into the return. The action of the valve 17 is the same as explained in connection with Figs. 1 and 3. Due to the action of the valves 17, as above explained, the steam does not pass through the valves 17 into the return passage. This means that the return lines will remain filled with air until a sufficient quantity of the steam has been condensed to allow the water of condensation to flow through the valves 17. This water will replace a slight amount of the air in the return which will be exhausted through the passage 13. After the heating devices 9 have become heated and the system is under normal operation, the water of condensation will flow through the valve 17 at substantially the temperature and pressure at which it was condensed. It may be that when the water at this temperature flows into the return passage it will possibly reëvaporate due to the lower pressure in the return. This will tend to increase the pressure in the return which will be immediately relieved by the passage 13 opening to the atmosphere. This relief will be assisted by a rapid condensation of the regenerated steam or vapor due to the lower temperature in the return. As the water of condensation is collected in the return passage it will flow through the passage 11 and by reason of the column will be returned to the boiler 1.

By the provision of the pipe 13 and the valve therein I am permitted to draw off the water and the air of condensation through separate passages, and instead of handling both the air and the water through an exhauster, I am enabled to greatly reduce the amount of power necessary for this purpose by handling the air alone and permitting the water to run to the boiler by its own weight. The distribution of steam and its circulation through the radiators and the system is the same as in Fig. 1.

I intend to be limited in my invention only by the claims appended hereto as many modifications may be employed to secure the spirit of the invention covered thereby.

5 What I claim is:—

1. In a heating system, a source of steam supply, radiators, a supply pipe connecting said radiators with said source and with each other, a sealed return pipe, connections 10 from said radiators to said return pipe and a valve in each said connection adapted to allow the passage of air and water but prevent the outward flow of steam, said valve being also adapted to open and permit the 15 flow of the contents of the return pipe into said radiators.

2. In a heating system, a source of steam supply, radiators, a supply pipe connecting said radiators to said source, a sealed return 20 pipe and a connection between each radiator and the return pipe having an opening which is capillary to flow from said radiators to said return pipe but loses its capillarity to flow from said return pipe to said 25 radiators.

3. In a heating system, a source of steam supply, radiators, a supply pipe connecting said radiators to said source and to each other, a sealed return pipe, connections for 30 said radiators to said return pipe and a valve in each said connection which is capillary to the flow of air and non-heating gases from said radiators, but which opens for flow from said return pipe.

4. In a heating system, a source of steam supply, radiators, a supply pipe connecting said radiators to said source and to each other, a sealed return pipe, connections for 35 said radiators to said return pipe and an automatic valve in each said connection which is capillary to flow from said radiators, but which opens for flow from said return pipe. 40

5. In a heating system, a source of steam supply, radiators, a supply pipe connecting said radiators with said source and with each other, a sealed return pipe connecting

said radiators together, a valve connecting each radiator with said return pipe, said valve being capillary to flow from said radiators and open to flow from said return 50 and means for discharging the contents of said return pipe.

6. In a heating system, a source of steam supply, radiators, a supply pipe, a sealed 55 return pipe, a valve connecting each radiator with said return pipe capillary in the discharge direction but non-capillary in the reverse direction, means for discharging water from said return pipe and means for 60 discharging air from said return pipe.

7. In a heating system a source of steam supply, radiators, a supply pipe connecting said radiators with said source and with each other, a sealed return pipe, a valve connect- 65 ing each radiator with said return pipe, said valve being capillary in the discharge but adapted to open in the reverse direction, means for returning water from said return pipe to said source, means for discharging 70 air from said return pipe and a water seal and check valve in the passage through which the air is discharged.

8. In a heating system, a source of steam supply, radiators, a supply pipe connecting 75 said radiators to said source and to each other, a sealed return pipe, connections for said radiators to said return pipe, and valves in said connections containing a movable valve piece forming, when bearing against 80 its seat, capillary passages for air and non-heating gases and adapted to be lifted away from its seat by an accumulation of water of condensation or by a decrease of pressure in the radiator below that in the return 85 pipe.

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

ANDREW G. PAUL.

Witnesses:

GEORGE S. SQUIBB,

ANDREW G. PAUL, Jr.