

J. COLLIS.
STEAM HEATING SYSTEM.
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2 SHEETS—SHEET 1.

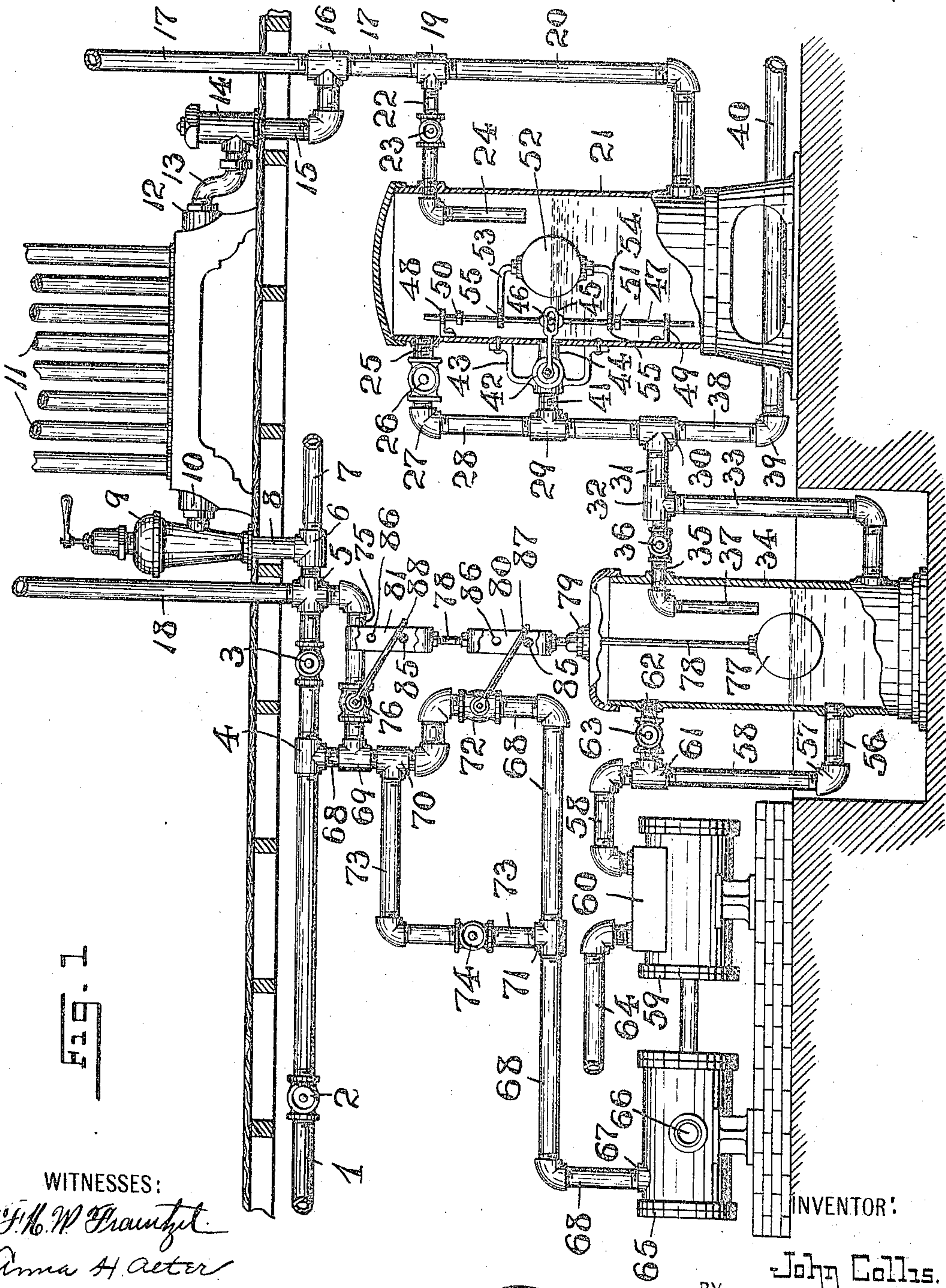


Fig. 1

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2 SHEETS—SHEET 2.



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UNITED STATES PATENT-OFFICE.

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STEAM-HEATING SYSTEM.

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To all whom it may concern:

Be it known that I, JOHN COLLIS, a citizen of the United States, residing at Newark, in the county of Essex and State of New Jersey, have invented certain new and useful Improvements in Steam-Heating Systems, and do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to characters of reference marked thereon, which form a part of this specification.

My present invention relates, generally, to steam-heating systems for buildings, and, the invention relates, more particularly, to a novel steam-heating system in which the air is first removed from the apparatus, so as to produce a suitable vacuum, and steam is then admitted into the apparatus at or below atmospheric pressure, all with a view of providing a simply arranged circulating system of pipes and heaters, through which the heat-producing medium is circulated in substantially the manner and for the purposes hereinafter more particularly set forth.

My present invention, therefore, has for its principal object to provide a novel steam-heating system comprising a circulating system of pipes and heaters or radiators located at different points in said pipes, through which a heating medium, such as exhaust steam or live steam is to be conducted, the system of pipes being provided at a point below or at the bottom of the return riser or risers with an automatically operating air and water-reservoir and condenser, to be used in connection with a normally slowly working pump or the like for first exhausting the air from the pipe-system, so as to produce a vacuum, and receiving the water of condensation in said reservoir, the latter being provided with mechanism or devices for automatically controlling the supply of the return water to the vacuum producer, such as a pump or other similarly operating mechanism, so that the source or means for producing the vacuum is automatically controlled by the water of condensation.

My invention has for its further object to provide an automatically operating air and water reservoir and condenser located at the end or bottom of the riser, the parts

and connections with the pipes of the system being such that the escape of any vapor back to the vacuum-producing source, such as a pump or other suitable mechanism, is clearly prevented, the air-connections at the bottom of the return riser or risers and at the vacuum-producing source being sealed, as will hereinafter more fully appear.

The invention has for its further object to provide in connection with my novel steam-heating system, a novel means for the controlling of another valve by the mechanism which is operated by the water of condensation, for admitting live steam into the system, in case that the supply of exhaust steam is insufficient for the purposes of my present invention.

A further object of the invention is to so arrange the parts which control the supply of the live steam, that the live steam may be used periodically only, and the operation of the parts also being such that the flow of live steam will be only enough to supply the heaters or radiators without any waste; that is, the supply of live steam being automatically shut off.

Other objects of this invention will be clearly understood from the following detailed description of this invention; and are finally to provide a vacuum steam heating system comprising various apparatus and instrumentalities all arranged to provide a simple, durable and inexpensive construction, and one which operates automatically and is most efficient in its operation.

The invention is clearly illustrated in the accompanying drawings, in which:—

Figure 1 is a diagrammatical representation of a heating system or apparatus embodying the principles of this invention, said view showing in connection with the system portions of one heater or radiator, and portions of the supply-riser and return pipe or riser, and an arrangement of air and water-receivers and condensers, shown in vertical section, suitably located in the system of piping forming part of said heating apparatus. Fig. 2 is a vertical section of my novel form of radiator-valve; Fig. 3 is an elevation of a valve-lever actuating element or device; and Fig. 4 is a transverse section of the same, said section being taken on line 4—4 in said Fig. 3. Fig. 5 is a sectional representation of an automatic drainage valve and air dispelling device located between the outlet of a radiator and a return-

pipe; and Fig. 6 is a cross-section of the same, said section being represented as taken in a vertical plane at right angles to the plane of the section of the drawing in said Fig. 5.

Similar characters of reference are employed in all of the above described views, to indicate corresponding parts.

Referring now to the several figures of the drawings, the reference-character 1 indicates a main steam-pipe, leading from the main source or steam-generator, such as a steam-boiler, from which live steam can be conducted into and through said pipe. In the present instance, the said pipe 1 has located therein, at any suitable and convenient positions, a pair of closing and manually operated valves 2 and 3, the said pipe being provided between said valves with a T-fitting 4, and at a point beyond said valve 3 with suitable fittings 5 and 6, the fitting 6 having connected therewith a pipe 7 for conveying exhaust steam from any suitable point to said fitting 6. Connected with said fitting 6 is a pipe 8 which is connected with a radiator-valve 9, preferably of the construction shown in the drawings and hereinafter more particularly described. Suitably connected with said radiator-valve, by means of a connection, as 10, is a radiator or heater 11 of any known construction. Attached to the outlet 12 of said radiator is a connection 13, preferably made as shown, and with which is connected an automatically operating drainage-valve 14, preferably of the construction shown in the drawings and subsequently more fully described. Leading from said drainage-valve is a suitable pipe-connection which is connected by means of a T-fitting 16 with a return-riser or pipe 17, leading from any other number of radiators or heaters, not here shown, with which the heating system is provided.

The reference-character 18 indicates a supply-pipe or riser which is connected with the previously mentioned T-fitting 5 and leads to such other radiators or heaters with which the heating system is provided for conveying steam to such radiators. Connected with the lowest end-portion of the return-riser or pipe 17 is a T-fitting 19, from which extends a pipe 20, which is suitably connected with the lower portion of a suitable receiver, tank or condenser, as 21. A pipe 22, of a smaller cross-sectional area than the pipes 17 and 20, extends from the T-fitting 19 and passes into the upper portion of the receiver or tank 21, said pipe 22 having a hand operated regulating-valve 23 located therein, and terminating within said receiver or tank 21 in a downwardly extending pipe-end 24. Leading from another part of the upper portion of said receiver or tank 21 is a pipe 25 in which there is a hand operated regulating-valve 26, said pipe be-

ing connected by means of a fitting 27 with a pipe 28 which is provided with a pair of T-fittings 29 and 30. Connected with and leading from the T-fitting 30 is a pipe 31 which is connected with another T-fitting 32 to which is secured a pipe 33 which leads into the lower portion of another receiver, tank or condenser, as 34. Another pipe 35 of smaller cross-sectional area than the pipes 31 and 28, and in which there is a valve 36, leads from the T-fitting 32 and extends into the upper portion of the receiver or tank 34, said pipe 35 terminating within said receiver or tank 34 in a downwardly extending pipe-end 37.

Suitably connected with the T-fitting 30 is a pipe 38 and fitting 39 to which is secured a pipe 40 leading from one or more other receivers, tanks or condensers, similar to the receiver or tank 21, and suitably connected, in the manner just stated, below other return-risers or pipes of other radiators in the heating system, as will be clearly understood.

Suitably connected with and extending from the T-fitting 29 is a pipe 41 which extends into the receiver or tank 21 at a desirable point between the lower inlet and upper outlet of said receiver or tank, substantially as illustrated. Located in said pipe is a valve 42, connected with a bracket 43 secured to the tank 21, said valve 42 having suitably connected with its valve-stem an actuating lever or arm 44. This lever or arm is provided upon its end-portion with a link-shaped part or member 45 into which extends a pin or projection 46 formed upon the side of a rod 47 which is movably disposed in suitable guides 48 and 49, and is provided with suitable stops 50 and 51, which may be adjustably arranged upon said rod and are adapted to limit the movements of said rod in either direction. Riding upon the surface of the water of condensation in said tank or receiver 21 is a float 52, from the opposite portions of which extend suitably shaped rods or arms, as 53 and 54, respectively provided at their free ends with suitably formed eyes or embracing portions 55 which embrace and are independently movable upon said rod 47, so as to be brought in engagement with said stops 50 and 51, as the water rises or falls, to move the rod 47 in either direction, as the case may be, and by means of the lever or arm 44, which is moved accordingly, opening or closing said valve 42, as will be clearly evident.

Leading from the tank, receiver or condenser 34 is a pipe 56, said pipe extending from the interior of the tank or receiver at a point above the point of inlet between the pipe 33 and the said tank or receiver, the said pipe 56 being also connected by means of a fitting, as 57, with a pipe 58 leading to and

communicating with the suction-chamber 60 of a suitable pump, as 59. In the said pipe 58 is a T-fitting 61, a pipe-connection 62, in which there is a hand operated regulating-valve 63, being located between said fitting 62 and the upper interior of the said receiver or tank 34. Extending from the suction-chamber of said pump is the usual outlet or discharge-pipe 64. The reference-character 65 indicates the steam-cylinder of the pump, and 66 is the exhaust which is connected therewith. Intermediately disposed between the T-fitting 4 in the main pipe or line 1 and the inlet 67 of said steam-cylinder 65 is a steam-conveying pipe 68, in which pipe are located several T-fittings 69, 70 and 71, and a valve 72; a pipe 73 in which there is a valve 74 being connected with the T-fittings 70 and 71, so as to provide a by-pass for the purposes to be presently more fully stated. Extending from the fitting 5 is another pipe-connection 75 which communicates with the T-fitting 69 in the pipe 68 and is provided with a valve 76. Movably arranged within said receiver or tank 34, so as to ride upon the surface of the water of condensation in said receiver or tank, is a float 77, said float being provided with a vertical stem or rod 78 which extends through and is slidably arranged in a guide 79 in the top of the said tank or receiver. Suitably connected with the said stem or rod 78 are a pair of valve-lever actuating members or elements 80 and 81, preferably of the construction shown in Figs. 3 and 4 of the drawings, and consisting of link-shaped devices, the sides 82 and 83 of which may be provided with holes or perforations 86 for the insertion of an engaging pin, bolt or stud 85, and one of the sides, as 82, being preferably formed with an open portion 84 for the arrangement between the sides of the member or element 80 of a valve-spindle operating arm or lever 87, adapted to be detachably connected with the valve 72; or, for the arrangement between the sides of the other member or element 81 of a valve-spindle operating arm or lever 88, adapted to be detachably connected with the valve 76.

Referring now to Fig. 2 of the drawings, it will be seen that the radiator-valve 9, previously mentioned comprises a suitably formed main hollow or chambered body 89 provided with a suitable inlet 90 and an outlet 91. Rotatably disposed upon a seat 92 within said body is a valve-body or element 93, which has a perforated top 94, but is open at the bottom, as at 95, so as to form a chamber 96. The purpose of this perforated top 94 is to permit sufficient fluid, as steam, to pass upon the other side of said top, that the valve-body or element 93 will be balanced. In its side 97 the said valve-body or element 93 is made with an opening 98,

adapted to be moved over the opening of the outlet 91, so as to provide a direct passageway for the heating medium entering at 90 into the chamber 96 and through the opening 98 and outlet 91 to the radiator, as will be clearly evident; but the parts being arranged so that said opening 98 is moved away from the outlet 91, so as to close the passageway for the steam to the radiator. Upon the upper closed top 94 of the said valve-body or element 93 is an upwardly extending projection or lug 99 upon which is arranged a socket-like end-portion 101 of an operating stem 100 which is provided at its upper end-portion with a suitably disposed operating handle 102. The upper portion of the said main hollow or chambered body 89 is formed with a screw-threaded part 103 upon which is screwed a suitably formed closing cap or bonnet 104. This cap or bonnet 104 is made with a suitable screw-threaded neck or open part, as 105, through which the valve-stem 100 extends, as shown, and upon the upper portion of the said bonnet or cap 104 is a chambered member or bonnet 106 which is provided with an internally screw-threaded portion 107, so as to be adapted to be screwed upon the screw-threaded portion of the closing cap or bonnet 104. Upon its upper portion the said member or bonnet 106 is made with a tubular part 108, through which the valve-stem extends and is rotatively arranged therein as shown. Suitably arranged within the chambered part of the closing cap or bonnet 106, resting directly upon a closing end-portion 109, forming a valve-seat, is a packing gasket 110, or a metal disk may be used, said disk resting upon said portion 109 which in that case is ground to provide a ground joint. The operating stem or spindle 100 is provided with a flange 111, resting directly upon said gasket or packing disk 110, a spring 112, which is arranged within the chamber 113 and which encircles the said spindle 100, in the manner shown, being used for pressing the annular flange 111 down upon the said packing disk 110 for retaining it in its operative position, as will be clearly evident. If desired another packing disk 114 may also be arranged, in the manner shown in said Fig. 2 of the drawings, and held in the said position, as shown, by means of an annular off-set 115 of the closing cap or bonnet 104, when the latter is screwed down upon the hollow or chambered body 89. In this manner I have provided a packless and quick-opening radiator valve, which at no time requires any packing and insures against the leakage of steam around the stem of the valve. The valve is quick-opening, about one-quarter of a turn opening and closing the outlet 91, and I have produced a simply constructed radiator-valve which is admirably adapted for use in

vacuum steam heating systems, because there can be no leakage as with the ordinary packed radiator valves, which no matter how carefully they are packed about the valve-stem, will with constant use wear away, and very often after a few operations a sufficient leak will develop around the packed stem of the valve to make it impossible to hold the vacuum on that particular radiator.

Referring now more particularly to Figs. 5 and 6 of the drawings in which I have shown a construction of drainage or discharge valve, the same consists, essentially, of a tubular body or member, as 14, which is open at both ends, as at 116 and 117, the end 117 being suitable for attachment to the pipe 15; and, the upper end-portion of the said tubular member being provided with an external screw-thread 118, upon which is screwed a closing cap 119 preferably provided with an annular projection 120 for screwing the cap in place. Extending from the one side of the said tubular member 14 is an externally screw-threaded tubular portion or element 121, which is adapted to be connected with the pipe 13 leading from the radiator 11, and forms a suitable inlet into the interior of the said tubular body 14, as will be clearly understood. An angular valve-seat 122 may be provided, and arranged upon the said valve-seat, so as to close the same by means of its own weight, is a suitable valve-disk or plate 123, the said disk or plate being provided with suitably formed ears or lugs 124, for arranging said ears or lugs over a pin or pintle 125 for operatively connecting the said valve-disk or plate to a perforated ear or lug 126, so that the valve disk or plate 123 will be secured in its operative position in a hinge-like manner. The said disk or plate 123 may be provided with a yoke-shaped member 127 with which is connected a stem. This stem 128 has pivotally connected therewith an upwardly extending rod 129 which has arranged thereon and has suitably secured thereto a counterbalancing disk 130 of substantially the same or of a slightly larger area than that of the valve-disk or plate 123, said disk 130 being suitably fitted in the annular portion 131 of the tubular member 14, and being capable of a free slidable movement therein. The said valve-disk or plate 123 is provided with a small orifice or hole 132 which is covered by a small valve-disk or plate 133, normally held in its closed position by a spring 134, said parts being arranged substantially in the manner shown in said Fig. 5 of the drawings.

Having in the foregoing description set forth in a general way, one arrangement of devices and instrumentalities for producing a vacuum steam-heating system embodying the principles of my present invention, I will now briefly set forth the method of its

operation. In practical use and assuming that it is desired to use steam at or below atmospheric pressure, the valve 74 is set so that it is only partially open, the valve 72 being closed and the valve-operating arm or lever 87 being connected with the projecting end of the valve-spindle and its end-portion being inserted between the sides of the device 80, in the manner shown. It will be well to mention here, that the other valve-operating arm or lever 88, however, is detached from the projecting end of the spindle of the valve 76, because it is not desirable to actuate the said valve 76, at this time.

When exhaust steam is used for heating purposes, the valve 3 in the pipe 1, is closed and valve 2 is opened. The live steam enters through pipe 1 into the pipe 73, and through the partially open valve 74 in said pipe 73, passing into the steam-cylinder 65 of the pump 59, and being exhausted at 66.

Owing to the partially open condition of the valve 74 a slow movement of the pump is produced with the result that the air is drawn by suction from the radiator 11 into the pipe-connection 13 and the orifice 132 in the disk or plate 123 of the discharge or drainage valve 14, suitably lifting the small valve-disk or plate 133, the several regulating valves 23, 26, 36 and 63 being set so as to regulate the area of the passages in the pipes 22, 25, 31 and 62 in which the regulating valves are placed. The air is thereupon sucked through the pipes 15, 17, 22 and 24 into the receiver or tank 21, and from said receiver or tank 21, through the pipes 25, 28, 31, 35 and 37 into the receiver or tank 34. From within this receiver or tank 34 air is sucked into and through the pipe 62 and part of the pipe 58 into the suction-chamber 60 of the pump 59, being finally expelled through the discharge pipe 64. At the same time, the small orifice 132 is such that a smaller vacuum is produced in the radiator than in the vertical return-risers, the area of the disk 130 being practically the same as that of the valve-disk or plate 123 so that any action of the disk or plate 123 swinging open is counteracted by the counterbalancing disk 130. The arrangement of the cap 119 upon the upper portion of the valve-casing 14 is such that it does not fit tight, whereby some air is permitted to enter the valve-casing above the counterbalancing disk 130, and thus aids in causing said disk to counteract the opening movement of the valve-disk or plate 123. The same results take place in all other radiators upon the riser 17, or those arranged in the line of piping of which the pipes 40 and 38 are part. The radiator-valve 9 having also been opened, exhaust steam enters from the pipe 7 through the pipe-connections 8 and 10 into the radiator 11, for heating purposes. A vacuum having thus been produced, the

valves 23, 26 and 63 are now closed so that the water of condensation and any vapor that may come from the radiator will be caused to flow directly into the bottom of the closed water-receiver and condenser, the vapor or steam as soon as it comes in contact with the cold body of water, always in the tank, being immediately condensed into water.

Any ordinary amount of water of condensation resulting in the radiator or radiators 11, flows through the orifice 132, from the pipe-connection 13, and thence through the pipes 15, 17 and 20 into the bottom of the receiver or tank 21, located at the bottom of the return-riser. The rising water in each receiver or tank 21 finally floats the float 52, so as to cause the same to move upward, at the same time, sealing the inlet to pipe 24. The upward movement of the float 52, brings the arm 53 against the stop 50, whereby the rod or stem 47 is also moved in an upward direction, so that the valve-operating arm or lever 44 is operated so as to open the valve 42. The water then flows from said receiver or tank 21, into and through the pipes 41, 28, 31, and 33, into the bottom of the main receiver or tank 34, where the water of condensation is collected. In like manner, all other water of condensation coming through the pipe 40, passes through the pipes 38, 31 and 33 into the bottom of the tank or receiver 34. As the water in said tank or receiver 34 rises, it lifts the float 77, and produces an upward movement of the stem or rod 78, and the device 80 connected with said stem or rod, the water at the same time sealing the inlet end of the pipe 37. The upward movement of the said device 80, by means of the pin, stud, or the like, 85, being brought in lifting engagement with the end of the valve-operating arm or lever 87, moves the latter and opens wide the valve 72. A full supply of live steam, from the pipe 1, is thereby permitted to enter the steam-chamber or cylinder of the pump, through the pipe 68, so as to cause the rapid working of the latter. The result will be that the excessive collection of the water of condensation in the tanks or receivers 34 and 21, will be pumped therefrom, and will be exhausted at the pump through the outlet pipe 64, as will be clearly understood. The lowering levels of the different bodies of water in the receivers or tanks 34 and 21, produce a lowered condition of the floats, so that the valve 72 is again closed and the valve 42 is also closed, thus bringing the entire system once more down to its normal condition, for the repetition of the various steps in the method or process hereinabove described.

In case of a large supply of water of condensation in the radiator, at such time after the valve 9 has been kept closed, or that may

have collected in the pipe connections between the radiator and the drainage valve 14, when the pump is rapidly set in operation, the increased supply of water lifts the said disk or valve or plate 123 to such a degree, that the water of condensation is suddenly removed, in the same manner as above described. In case the exhaust from the steam-engine or other source of supply is insufficient to properly heat the radiators, it may be desired to periodically admit live steam into the radiators. To do this the valve-operating lever or arm 88 is now connected with the end of the valve-spindle of the valve 76, the end-portion of the lever or arm 88 being arranged between the sides of the device 81, so as to rest upon the pin or stud 85 of said device. The upward movement of the rod or stem 78, also moves said device 81 in an upward direction, so that the valve 76 is opened, whereby live steam from the pipes 1 and 68 enters the pipe 75 and then passes into the riser 18 and through the pipes 8 and 10 and the valve 9 into the radiators, in addition to the supply of exhaust steam, as will be clearly understood. The lowering of the water-level in the receiver or tank 34 again produces the closed condition of the valve 76, so that only exhaust steam is admitted to the radiators. The arm or lever 88 can thereupon be again disconnected, or left in its connected relation, so that the valve 76 will be intermittently opened and closed, so that live steam will be periodically admitted into the radiators, if found desirable. By also opening the valve 3 live steam can be directly admitted into the risers and radiators from the main steam-pipe 1, in the case that it is necessary to make repairs to the other parts of the system, or otherwise.

From the foregoing description of my present invention it will be seen that I have devised a simply constructed and efficiently operating steam-heating system or apparatus in which the vacuum-producing source is automatically controlled by the water of condensation, so as to maintain a vacuum in the radiators and keep them free from the water of condensation, the general arrangement and construction of the parts being such that all the noises due to hammering are fully overcome.

I claim:—

1. A heating system comprising a radiator, a main pipe leading to and connected with said radiator, and a pump, said pump having a steam and a suction chamber, a return-riser leading from said radiator, a valve in said main pipe for admitting live steam to the radiator, said valve being normally closed, a pipe connected with and leading from said main pipe to the steam-chamber of the pump, an automatically controlled valve in said last-mentioned pipe,

pipe-connections between the suction chamber of the pump and the return-riser for producing a vacuum in the radiator, and instrumentalities located between said pipe-connections and provided with means operated from the water of condensation for periodically opening and closing the valve in said main pipe, and automatically controlling the valve in the pipe leading from said main pipe to the steam-chamber of the pump.

2. A heating system comprising a radiator, a main pipe leading to and connected with said radiator, and a pump, said pump having a steam and a suction chamber, a return-riser leading from said radiator, a valve in said main pipe for admitting live steam to the radiator, said valve being normally closed, a pipe connected with and leading from said main pipe to the steam-chamber of the pump, an automatically controlled valve in said last-mentioned pipe, pipe-connections between the suction chamber of the pump and the return-riser for producing a vacuum in the radiator, and an air and water receiver and condenser located between said pipe-connections, and means connected to said air and water-receiver and condenser and operated from the water of condensation in said receiver and condenser for periodically opening and closing the valve in said main pipe, and automatically controlling the valve in the pipe leading from said main pipe to the steam-chamber of the pump.

3. A heating system comprising a radiator, a main pipe leading to and connected with said radiator, a return-riser extending from said radiator, and a pump, said pump having a steam chamber and a suction chamber, a pipe between said main pipe and the steam-chamber of the pump, a valve in said pipe, said valve being only partially open so as to admit a limited quantity of steam to the steam-chamber of the pump for slowly operating the same, a by-pass pipe connected with said pipe on opposite sides of said partially closed valve, a normally closed valve in said by-pass pipe, pipe connections between the suction chamber of the pump and the return-riser for producing a vacuum in the radiator, and instrumentalities located between said pipe-connections for automatically controlling the said valve in said by-pass pipe and the operation of the pump by means of the water of condensation.

4. A heating system comprising a radiator, a main pipe leading to and connected with said radiator, a return-riser extending from said radiator and a pump, said pump having a steam chamber and a suction chamber, a pipe between said main pipe, and the steam-chamber of the pump, a valve in said pipe, said valve being only partially open so as to admit a limited quantity of steam

to the steam-chamber of the pump for slowly operating the same, a by-pass pipe connected with said pipe on opposite sides of said partially closed valve, a normally closed valve in said by-pass pipe, pipe connections between the suction chamber of the pump and the return-riser for producing a vacuum in the radiator, and instrumentalities located between said pipe-connections for automatically controlling the said valve in said by-pass pipe and the operation of the pump by means of the water of condensation, and also being adapted to act as a sealing means for preventing the escape of any vapor from the return-riser.

5. A heating system comprising a radiator, a main pipe leading to and connected with said radiator, a return-riser extending from said radiator, and a pump, said pump having a steam chamber and a suction chamber, a pipe between said main pipe and the steam-chamber of the pump, a valve in said pipe, said valve being only partially open so as to admit a limited quantity of steam to the steam-chamber of the pump for slowly operating the same, a by-pass pipe connected with said pipe on opposite sides of said partially closed valve, a normally closed valve in said by-pass pipe, a closed tank for receiving water of condensation, said tank being in communication with the discharge end of the return riser and the suction chamber of the pump, a float floating upon the surface of the water of condensation in said tank, and means connected with and operated from said float for opening and closing the normally closed valve in said by-pass pipe, all arranged to exhaust the air from the radiator and withdraw the excess water of condensation from the tank.

6. A heating system comprising a radiator, a main pipe leading to and connected with said radiator, a return-riser extending from said radiator, and a pump, said pump having a steam chamber and a suction chamber, a pipe between said main pipe and the steam-chamber of the pump, a valve in said pipe, said valve being only partially open so as to admit a limited quantity of steam to the steam-chamber of the pump for slowly operating the same, a by-pass pipe connected with said pipe on opposite sides of said partially closed valve, a normally closed valve in said by-pass pipe, a closed tank for receiving water of condensation, said tank being in communication with the discharge end of the return riser and the suction chamber of the pump, a float floating upon the surface of the water of condensation in said tank, and means connected with and operated from said float for opening and closing the normally closed valve in said by-pass pipe, all arranged to exhaust the air from the radiator and withdraw the excess water of condensation from the tank,

and also being adapted to act as a sealing means for preventing the escape of any vapor from the return riser.

7. In a heating system, a radiator and return-riser, means for supplying a heating medium to said radiator, a return-valve located between said radiator and said riser, said return-valve being constructed to operate automatically and allow the passage of air as well as small quantities of water from the radiator, and also opening wide for the passage of increased quantities of water of condensation from the radiator, a pump comprising a steam chamber and a suction chamber, a pipe leading from the main pipe to said pump, a valve in said pipe, said valve being only partially open so as to admit a limited quantity of steam to the steam-chamber of the pump for slowly operating the same, a by-pass pipe connected with said pipe on opposite sides of said partially closed valve, a normally closed valve in said by-pass pipe, a closed tank for receiving water of condensation, a pipe connection between the return-riser and said tank, a pipe connecting said tank with the suction chamber of the pump, a float floating upon the surface of the water of condensation in said tank, and means connected with and operated from said float for opening and closing the normally closed valve in said by-pass pipe, all arranged to exhaust the air from the radiator and withdraw the excess water of condensation from the tank.

8. In a heating system, a radiator and return-riser, means for supplying a heating medium to said radiator, a return-valve located between said radiator and said riser, said return-valve being constructed to operate automatically and allow the passage of air as well as small quantities of water from the radiator, and also opening wide for the passage of increased quantities of water of condensation from the radiator, a pump comprising a steam chamber and a suction chamber, a pipe leading from the main pipe to said pump, a valve in said pipe, said valve being only partially open so as to admit a limited quantity of steam to the steam-chamber of the pump for slowly operating the same, a by-pass pipe connected with said pipe on opposite sides of said partially closed valve, a normally closed valve in said by-pass pipe, a closed tank for receiving water of condensation, a pipe connection between the return-riser and said tank, a pipe connecting said tank with the suction chamber of the pump, a float floating upon the surface of the water of condensation in said tank, and means connected with and operated from said float for opening and closing the normally closed valve in said by-pass pipe, all arranged to exhaust the air from the radiator and withdraw the excess water of condensation from the tank, and a sealing

means in said system of piping for preventing the escape of any vapor from the return riser, substantially as and for the purposes set forth.

9. In a steam-heating apparatus, a vacuum-producing source, a main pipe with which said vacuum-producing source is connected, a radiator, said radiator being also connected with said main pipe, a closed tank below the radiator for receiving water of condensation, a pipe-connection between the radiator and said tank, and a main closed tank for receiving water of condensation from said first-mentioned tank, a pipe-connection between said tanks, a normally closed valve in said pipe-connection, and a float in said first-mentioned tank, means connected to and operated by said float for automatically opening and closing said valve, a pipe connecting said main tank with the vacuum-producing source, and means in said main tank and connected to said vacuum-producing source, said means being operated by the rise and fall of the water of condensation in said main tank for automatically controlling the vacuum-producing source, all arranged to exhaust the air from said radiator and withdraw the excess-water of condensation from said tanks.

10. In a steam-heating apparatus, a steam-pump, a main pipe with which said vacuum-producing source is connected, a radiator, said radiator being also connected with said main pipe, a closed tank below the radiator for receiving water of condensation, a pipe-connection between the radiator and said tank, and a main closed tank for receiving the water of condensation from said first-mentioned tank, a pipe-connection between said tanks, a normally closed valve in said pipe-connection, and a float in said first-mentioned tank, means connected to and operated by said float for automatically opening and closing said valve, a pipe connecting said main tank with the suction-end of the pump, and means connected to said main tank and operated by the rise and fall of the water of condensation in said main tank for automatically controlling the pump, all arranged to exhaust the air from the radiator and withdraw the excess water of condensation from said tanks.

11. In a heating system, a main pipe, a radiator, a pipe for conveying a heating fluid to the radiator, a pump comprising a steam chamber and a suction-chamber, a pipe leading from said main pipe to said pump for conveying steam to the steam chamber of said pump, a closed tank below the radiator for receiving water of condensation, a pipe-connection between the radiator and said tank, and a main closed tank for receiving the water of condensation from said first-mentioned tank, a pipe-connection between said tanks, a normally closed valve in said

pipe-connection, and a float in said first-mentioned tank, means connected to and operated by said float for automatically opening and closing said valve, a pipe connecting said main tank with the suction-chamber of the pump, and means connected to said main tank and operated by the rise and fall of the water of condensation in said main tank for automatically controlling said pump, all arranged to exhaust the air from the radiator and withdraw the excess water of condensation from said tanks.

12. In a heating system, a main pipe, a radiator, a pipe for conveying a heating fluid to the radiator, a pump comprising a steam chamber and a suction chamber, a pipe leading from said main pipe to said pump, a valve in said pipe, said valve being only partially open so as to admit a limited quantity of steam to the steam chamber of the pump for slowly operating the same, a by-pass pipe connected with said pipe on opposite sides of said partially closed valve, a normally closed valve in said by-pass pipe, a closed tank below the radiator for receiving water of condensation, a pipe-connection between the radiator and said tank, and a main closed tank for receiving the water of condensation from said first-mentioned tank, a pipe-connection between said tanks, a normally closed valve in said pipe-connection, and a float in said first-mentioned tank, means connected to and operated by said float for automatically opening and closing said valve, a pipe connecting said main tank with the suction-chamber of the pump, a float upon the surface of the water of condensation in said main tank, and means connected with and operated from said float for opening and closing the normally closed valve in said by-pass pipe, all arranged to exhaust the air from the radiator and withdraw the excess water of condensation from said tanks.

13. In a steam-heating apparatus, a vacuum-producing source, a main pipe with which said vacuum-producing source is connected, a radiator, and return-riser, a closed tank below the radiator for receiving water of condensation, a pipe-connection between the return-riser and said tank, and a main closed tank for receiving water of condensation from said first-mentioned tank, a pipe-connection between said tanks, a normally closed valve in said pipe-connection, and a float in said first-mentioned tank, means connected to and operated by said float for automatically opening and closing said valve, a pipe connecting said main tank with the vacuum-producing source, and means connected to said main tank and operated by the rise and fall of the water of condensation in said main tank for automatically controlling the vacuum-producing source, all arranged to exhaust the air from

said radiator and withdraw the excess water of condensation from said tanks, and also being adapted to act as a sealing means in the system of piping for preventing the escape of any vapor from the return-riser, when the water in said first-mentioned tank reaches a predetermined height.

14. In a steam-heating apparatus, a steam-pump, a main pipe connected with said pump, a radiator and return riser, a closed tank below the radiator for receiving water of condensation, a pipe-connection between the return-riser and said tank, and a main closed tank for receiving the water of condensation from said first-mentioned tank, a pipe-connection between said tanks, a normally closed valve in said pipe-connection, and a float in said first-mentioned tank, means connected to and operated by said float for automatically opening and closing said valve, a pipe connecting said main tank with the suction-end of the pump, and means connected to said main tank and operated by the rise and fall of the water of condensation in said main tank for automatically controlling the pump, all arranged to exhaust the air from the radiator and withdraw the excess water of condensation from said tanks, and being adapted to act as a sealing means in the system of piping for preventing the escape of any vapor from the return-riser when the water in said first-mentioned tank reaches a predetermined height.

15. In a heating system, a main pipe, a radiator, a pipe for conveying a heating fluid to the radiator, and a return-riser, a pump comprising a steam chamber and a suction-chamber, a pipe leading from said main pipe to said pump for conveying steam to the steam chamber of said pump, a closed tank below the radiator for receiving water of condensation, a pipe-connection between the return-riser and said tank, and a main closed tank for receiving the water of condensation from said first-mentioned tank, a pipe-connection between said tanks, a normally closed valve in said pipe-connection, and a float in said first-mentioned tank, means connected to and operated by said float for automatically opening and closing said valve, a pipe connecting said main tank with the suction-chamber of the pump, and means connected to said main tank and operated by the rise and fall of the water of condensation in said main tank for automatically controlling said pump, all arranged to exhaust the air from the radiator and withdraw the excess water of condensation from said tanks, and also being adapted to act as a sealing means in the system of piping for preventing the escape of any vapor from the return-riser when the water in the first-mentioned tank reaches a predetermined height.

16. In a heating system, a main pipe, a

radiator, a pipe for conveying a heating
 fluid to the radiator, and a return-riser, a
 pump comprising a steam chamber and a
 suction chamber, a pipe leading from said
 5 main pipe to said pump, a valve in said
 pipe, said valve being only partially open so
 as to admit a limited quantity of steam to
 the steam chamber of the pump for slowly
 10 operating the same, a by-pass pipe con-
 nected with said pipe on opposite sides of
 said partially closed valve, a normally closed
 valve in said by-pass pipe, a closed tank
 below the radiator for receiving water of
 15 condensation, a pipe-connection between the
 return-riser and said tank, and a main closed
 tank for receiving the water of condensation
 from said first-mentioned tank, a pipe-con-
 nection between said tanks, a normally
 20 closed valve in said pipe-connection, and
 a float in said first-mentioned tank for auto-
 matically opening and closing said valve, a
 pipe connecting said main tank with the
 suction-chamber of the pump, a float upon
 25 the surface of the water of condensation in
 said main tank, and means connected with
 said float and said valve in the by-pass pipe,
 said means being operated from said float
 for opening and closing the normally closed
 30 valve in said by-pass pipe, all arranged to
 exhaust the air from the radiator and with-
 draw the excess water of condensation from
 said tanks, and adapted to act as a sealing
 means in the system of piping for prevent-
 35 ing the escape of any vapor from the return-
 riser when the water in the first-mentioned
 tank rises to a predetermined height.

17. In a heating system, a radiator and re-
 turn-riser, means for supplying a heating
 medium to said radiator, a return-valve lo-
 40 cated between said radiator and said riser,
 said return-valve being constructed to oper-
 ate automatically and allow the passage of
 air as well as small quantities of water from
 the radiator and also opening wide for the
 45 passage of increased quantities of water of
 condensation from the radiator, a vacuum-
 producing source in said piping, a closed
 tank below said radiator for receiving wa-
 ter of condensation, a pipe-connection be-
 50 tween the return-riser and said tank, and a
 main closed tank for receiving the water of
 condensation from said first-mentioned tank,
 a pipe-connection between said tanks, a nor-
 mally closed valve in said pipe-connection,
 55 and a float in said first-mentioned tank,
 means connected to and operated by said
 float for automatically opening and closing
 said valve, a pipe connecting said main tank
 with the vacuum-producing source, and
 60 means connected to said main tank and op-
 erated by the rise and fall of the water of
 condensation in said main tank for auto-
 matically controlling the vacuum-producing
 source, all arranged to exhaust the air from

said radiator and withdraw the excess water 65
of condensation from said tanks.

18. In a heating system, a radiator and re-
 turn-riser, means for supplying a heating
 medium to said radiator, a return-valve lo-
 cated between said radiator and said riser, 70
 said return-valve being constructed to oper-
 ate automatically and allow the passage of
 air as well as small quantities of water from
 the radiator, and also opening wide for the
 passage of increased quantities of water of 75
 condensation from the radiator, a steam-
 pump, a closed tank below the radiator for
 receiving the water of condensation, a pipe-
 connection between the return-riser and said
 tank, and a main closed tank for receiving 80
 the water of condensation from said first-
 mentioned tank, a pipe-connection between
 said tanks, a normally closed valve in said
 pipe-connection, and a float in said first-
 mentioned tank, means connected to and op- 85
 erated by said float for automatically open-
 ing and closing said valve, a pipe connecting
 said main tank with the suction-end of the
 pump, and means connected to said main
 tank and operated by the rise and fall of the 90
 water of condensation in said tank for auto-
 matically controlling the pump, all arranged
 to exhaust the air from the radiator and
 withdraw the excess water of condensation
 from said tanks. 95

19. In a heating system, a main pipe, a
 radiator and return-riser, a return-valve lo-
 cated between said radiator and said riser,
 said return-valve being constructed to oper-
 100 ate automatically and allow the passage of
 air as well as small quantities of water from
 the radiator, and also opening wide for the
 passage of increased quantities of water of
 condensation from the radiator, a pipe for
 conveying a heating vapor or steam to the 105
 radiator, a pump comprising a steam-cham-
 ber and a suction-chamber, a pipe leading
 from said main pipe to said pump for con-
 veying steam to the steam chamber of said
 pump, a closed tank below said radiator and 110
 riser for receiving the water of condensation,
 a pipe-connection between the return-riser
 and said tank, and a main closed tank for
 receiving the water of condensation from
 said first-mentioned tank, a pipe-connection 115
 between said tanks, a normally closed valve
 in said pipe-connection, and a float in said
 first-mentioned tank, means connected to and
 operated by said float for automatically
 opening and closing said valve, a pipe con- 120
 necting said main tank with the suction-
 chamber of the pump, and means connected
 to said main tank and operated by the rise
 and fall of the water of condensation in said
 main tank for automatically controlling said 125
 pump, all arranged to exhaust the air from
 the radiator and withdraw the excess water
 of condensation from said tanks.

20. In a heating system, a main pipe, a radiator and return riser, a return-valve located between said radiator and said riser, said return-valve being constructed to operate automatically and allow the passage of air as well as small quantities of water from the radiator, and also opening wide for the passage of increased quantities of water of condensation from the radiator, a pipe for conveying a heating vapor or steam to the radiator, a pump comprising a steam-chamber and an exhaust chamber, a pipe leading from the main steam pipe to said pump, a valve in said pipe, said valve being only partially open so as to admit a limited quantity of steam to the steam-chamber of the pump for slowly operating the same, a by-pass pipe connected with said pipe on opposite sides of said partially closed valve, a normally closed valve in said by-pass pipe, a closed tank below the radiator for receiving the water of condensation, a pipe-connection between the return-riser and said tank, and a main closed tank for receiving the water of condensation from said first-mentioned tank, a pipe-connection between said tanks, a normally closed valve in said pipe-connection, and a float in said first-mentioned tank, means connected to and operated by said float for automatically opening and closing said valve, a pipe connecting said main tank with the suction chamber of the pump, a float upon the surface of the water of condensation in said main tank, and means connected with said float for opening and closing the normally closed valve in said by-pass pipe, all arranged to exhaust the air from the radiator and withdraw the excess water of condensation from said tanks.

21. In a heating system, a radiator and return-riser, means for supplying a heating medium to said radiator, a return-valve located between said radiator and said riser, said return-valve being constructed to operate automatically and allow the passage of air as well as small quantities of water from the radiator, and also opening wide for the passage of increased quantities of water of condensation from the radiator, a vacuum-producing source, a closed tank below said radiator for receiving water of condensation, a pipe-connection between the return-riser and said tank, and a main closed tank for receiving the water of condensation from said first-mentioned tank, a pipe-connection between said tanks, a normally closed valve in said pipe-connection, and a float in said first-mentioned tank, means connected to and operated by said float for automatically opening and closing said valve, a pipe connecting said tank with the vacuum-producing source, and means connected to said main tank and operated by the rise and fall of the water of condensation in said main

tank for automatically controlling the vacuum-producing source, all arranged to exhaust the air from said radiator and withdraw the excess water of condensation from said tanks, and also being adapted to act as a sealing member in the system of piping for preventing the escape of any vapor from the return-riser when the water in the first-mentioned tank is at a predetermined height.

22. In a heating system, a radiator and return-riser, means for supplying a heating medium to said radiator, a return-valve located between said radiator and said riser, said return-valve being constructed to operate automatically and allow the passage of air as well as small quantities of water from the radiator, and also opening wide for the passage of increased quantities of water of condensation from the radiator, a steam-pump, a closed tank below the radiator for receiving the water of condensation, a pipe-connection between the return-riser and said tank, and a main closed tank for receiving the water of condensation from said first-mentioned tank, a pipe-connection between said tanks, a normally closed valve in said pipe-connection, and a float in said first-mentioned tank, means connected to and operated by said float for automatically opening and closing said valve, a pipe connecting said main tank with the suction-end of the pump, and means connected to said main tank and operated by the rise and fall of the water of condensation in said tank for automatically controlling the pump, all arranged to exhaust the air from the radiator and withdraw the excess water of condensation from said tanks, and adapted to act as a sealing member in the system of piping for preventing the escape of any vapor from the riser, when the water in the first-mentioned tank is above a predetermined height.

23. In a heating system, a main pipe, a radiator and return-riser, a return-valve located between said radiator and said riser, said return-valve being constructed to operate automatically and allow the passage of air as well as small quantities of water from the radiator, and also opening wide for the passage of increased quantities of water of condensation from the radiator, a pipe for conveying a heating vapor or steam to the radiator, a pump comprising a steam-chamber and a suction-chamber, a pipe leading from said main pipe to said pump for conveying steam to the steam-chamber of said pump, a closed tank below said radiator, for receiving the water of condensation, a pipe-connection between the return-riser and said tank, and a main closed tank for receiving the water of condensation from said first-mentioned tank, a pipe-connection between said tanks, a normally closed valve in said pipe-connection, and a float in said

first-mentioned tank, means connected to and operated by said float for automatically opening and closing said valve, a pipe connecting said main tank with the suction-chamber of the pump, and means connected to said main tank and operated by the rise and fall of the water of condensation in said main tank for automatically controlling said pump, all arranged to exhaust the air from the radiator and withdraw the excess water of condensation from said tanks, and adapted to act as a sealing member in the system of piping for preventing the escape of any vapor from the riser when the water in the first-mentioned tank is above a predetermined height.

24. In a heating system, a main pipe, a radiator and return-riser, a return-valve located between said radiator and said riser, said return-valve being constructed to operate automatically and allow the passage of air as well as small quantities of water from the radiator, and also opening wide for the passage of increased quantities of water of condensation from the radiator, a pipe for conveying a heating vapor or steam to the radiator, a pump comprising a steam-chamber and an exhaust chamber, a pipe leading from the main steam pipe to said pump, a valve in said pipe, said valve being only partially open so as to admit a limited quantity of steam to the steam-chamber of the pump for slowly operating the same, a by-pass pipe connected with said pipe on opposite sides of said partially closed valve, a normally closed valve in said by-pass pipe, a closed tank below the radiator for receiving the water of condensation, a pipe-connection between the return-riser and said tank, and a main closed tank for receiving the water of condensation from said first-mentioned tank, a pipe-connection between said tanks, a normally closed valve in said pipe-connection, and a float in said first-mentioned tank, means connected to and operated by said float for automatically opening and closing said valve, a pipe-connecting said main tank with the suction chamber of the pump, a float upon the surface of the

water of condensation in said main tank, and means connected with said float for opening and closing the normally closed valve in said by-pass pipe, all arranged to exhaust the air from the radiator and withdraw the excess water of condensation from said tanks, and adapted to act as a sealing member in the system of piping for preventing the escape of any vapor from the riser, when the water in said first-mentioned tank is above a predetermined height.

25. In a heating apparatus, a main heating fluid-conveying pipe, a radiator connected therewith, a return-riser leading from said radiator, an air and water-receiver and condenser connected with said return-riser, a valve in said main pipe for admitting live steam to the radiator, said valve being normally closed, means for intermittently discharging the water and air from the receiver and condenser, and means connected to said air and water-receiver and condenser and operated from the water of condensation in said receiver and condenser for periodically opening and closing said valve and supplying steam to the radiator.

26. In a heating apparatus, a main heating fluid-conveying pipe, a radiator connected therewith, a return-riser leading from said radiator, an air and water-receiver and condenser connected with said return-riser, a valve in main pipe for admitting live steam to the radiator, said valve being normally closed, a float in said receiver and condenser, means for intermittently discharging the water and air from the receiver and condenser, and means connected with and operated from said float for periodically opening and closing said valve and supplying the live steam to the radiator.

In testimony that I claim the invention set forth above I have hereunto set my hand this 25th day of May, 1908.

JOHN COLLIS.

Witnesses:

FREDK. C. FRAENTZEL,
F. H. W. FRAENTZEL.