No. 882,300. PATENTED MAR. 17, 1908.

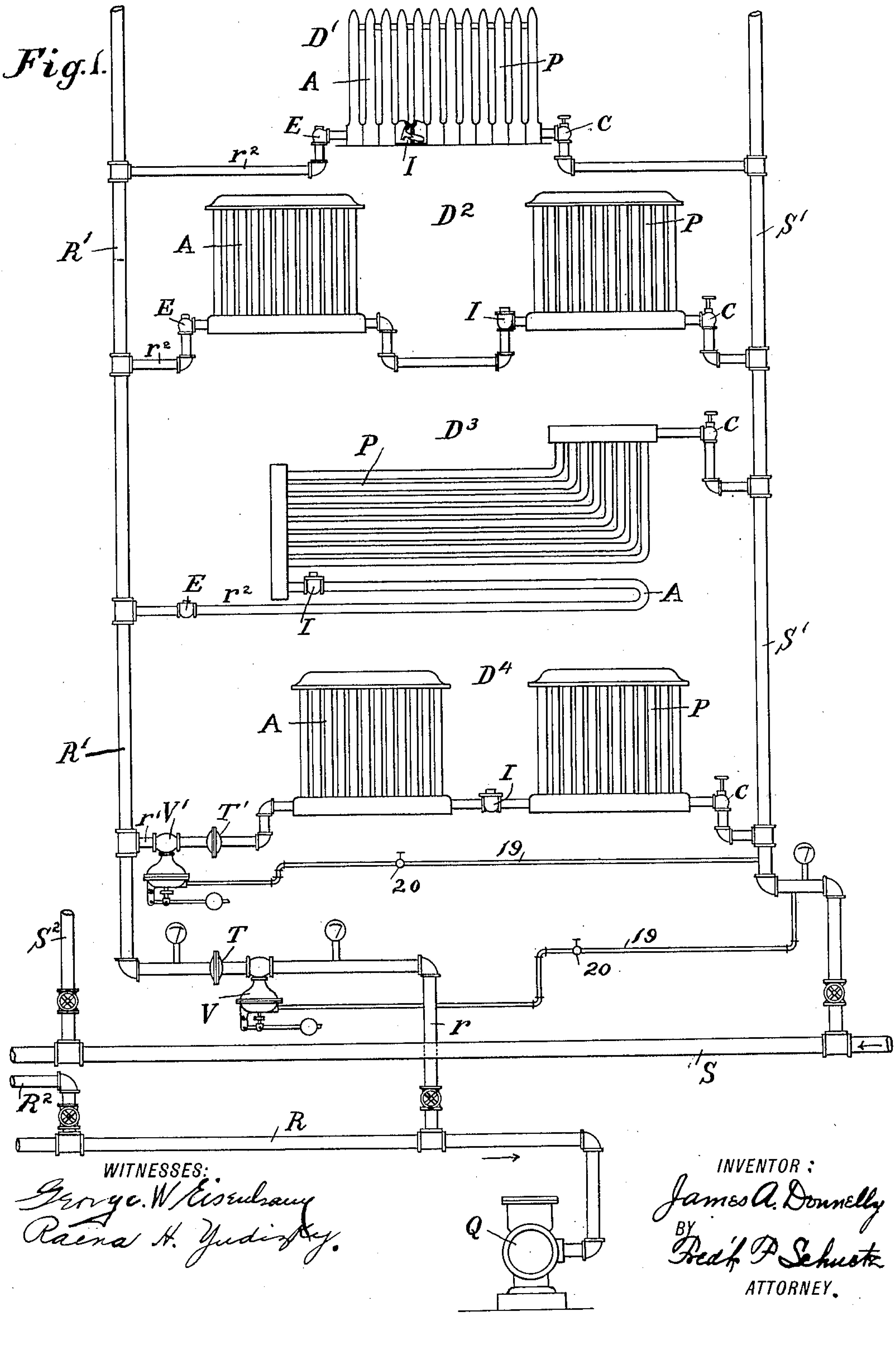
J. A. DONNELLY.

STEAM HEATING SYSTEM.

APPLICATION FILED OCT. 21, 1904.

2 SHEETS—SHEET 1.

Fig. 1.



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2 SHEETS—SHEET 2.

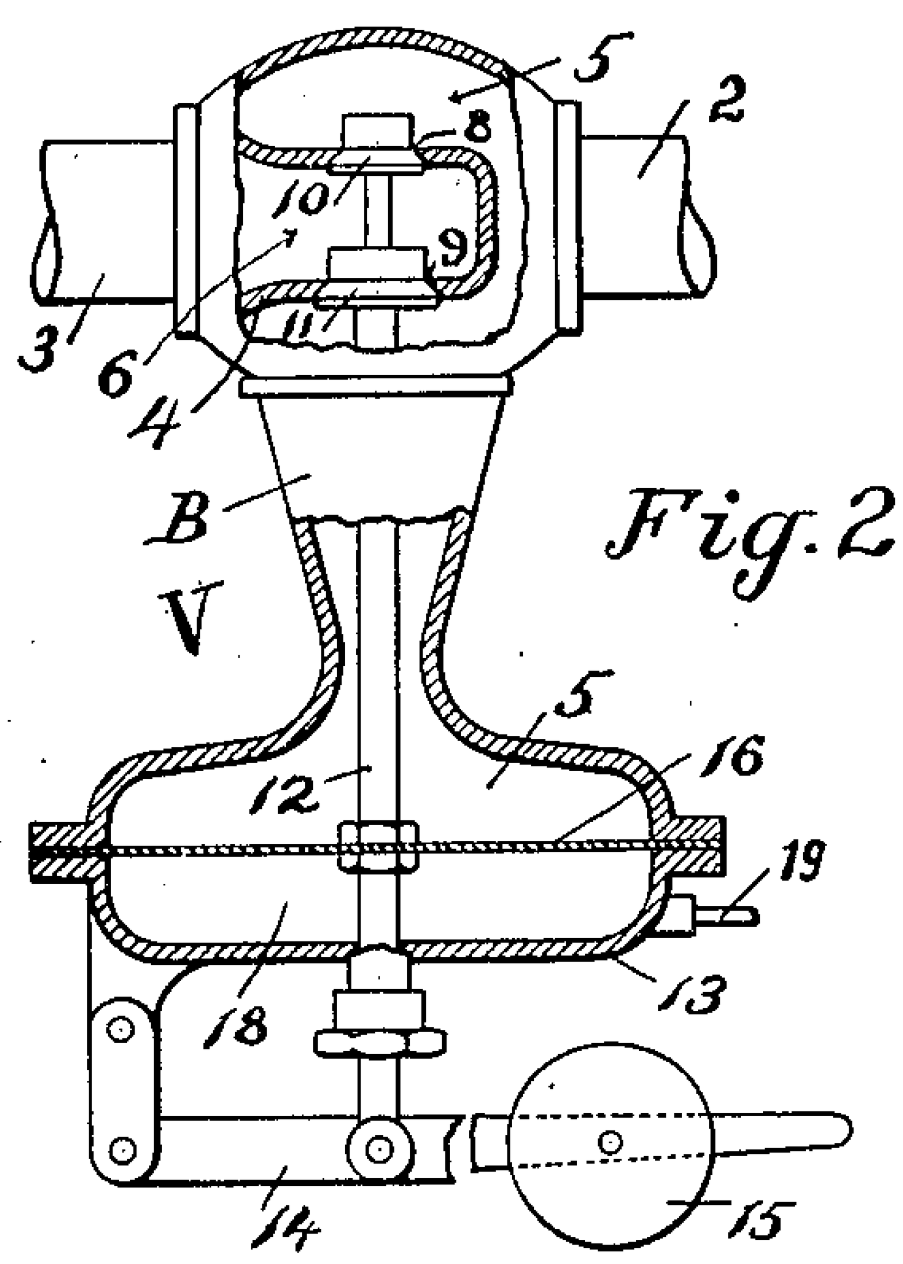
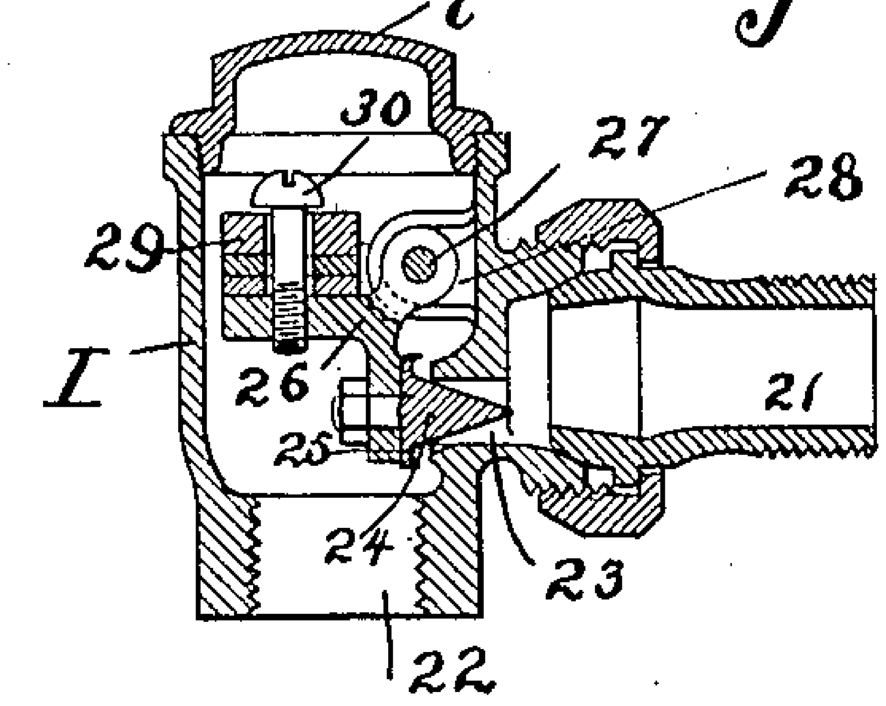


Fig. 2.

Fig. 3.



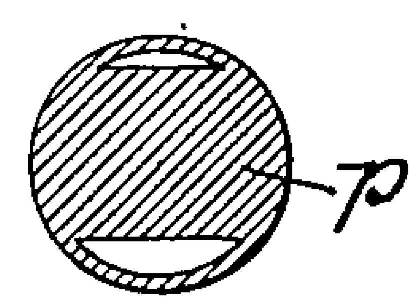


Fig. 8.

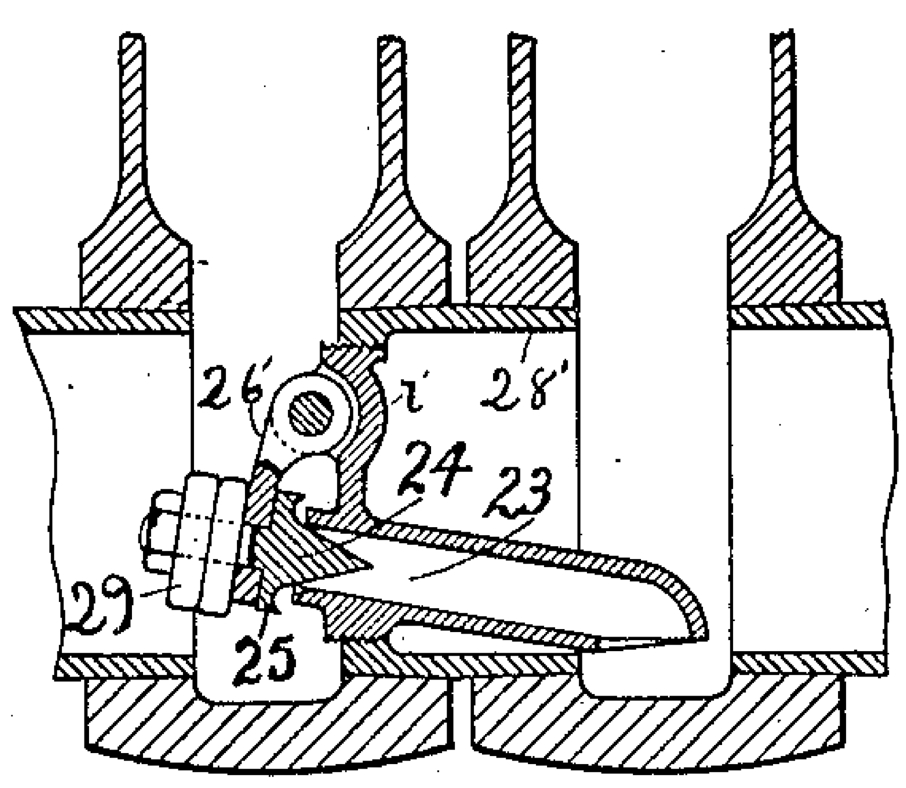


Fig. 4.

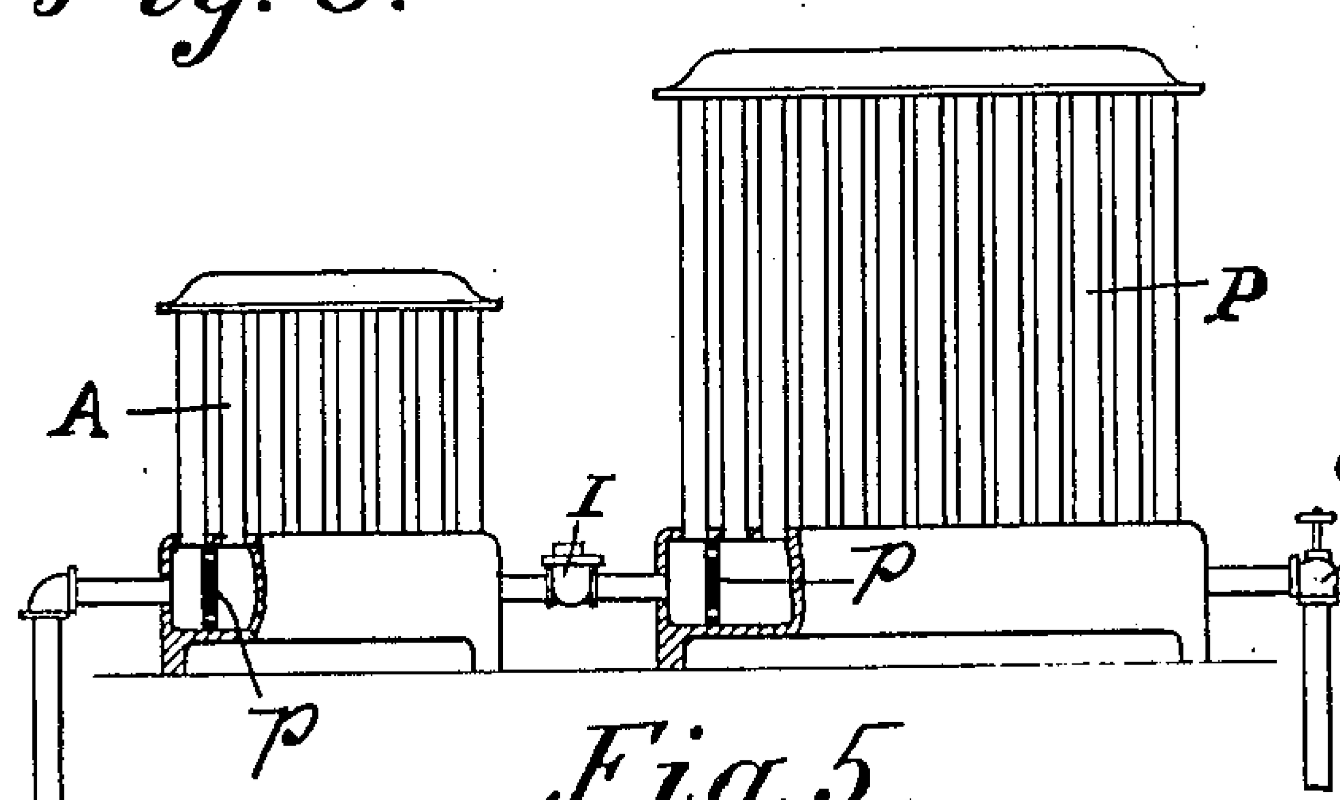


Fig. 5.

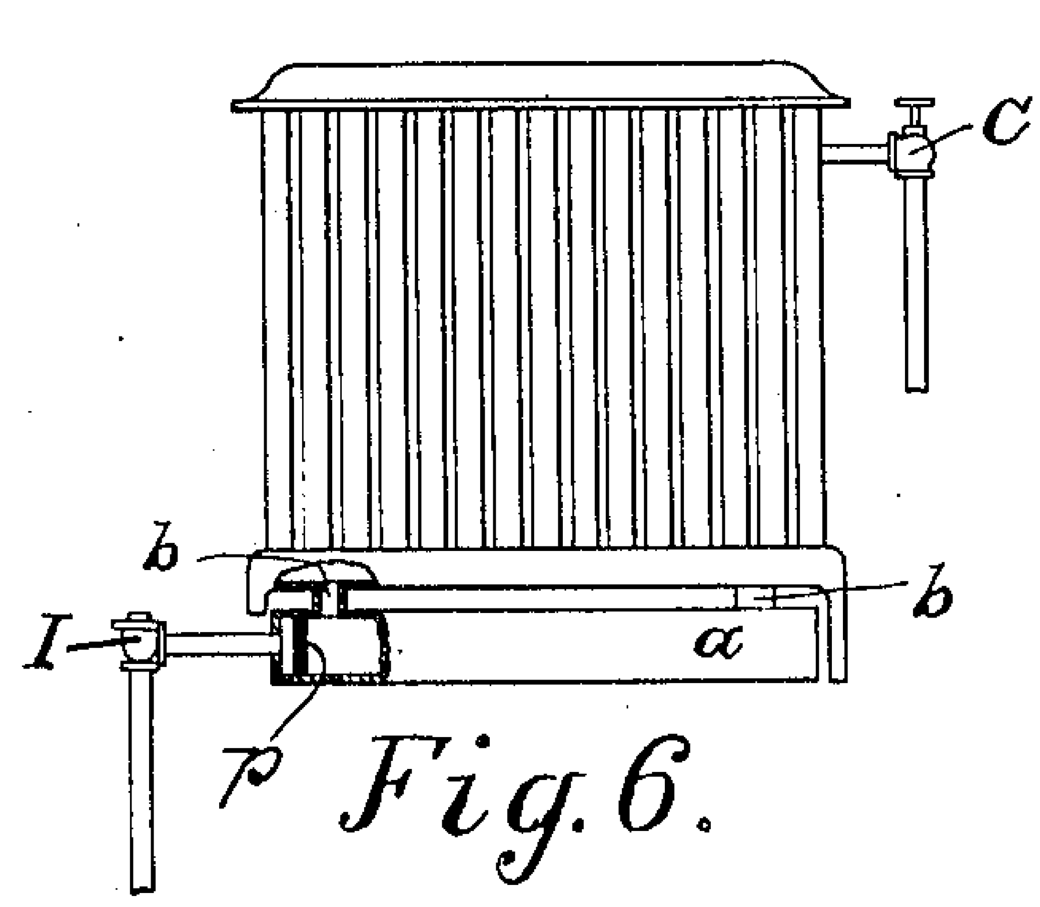


Fig. 6.

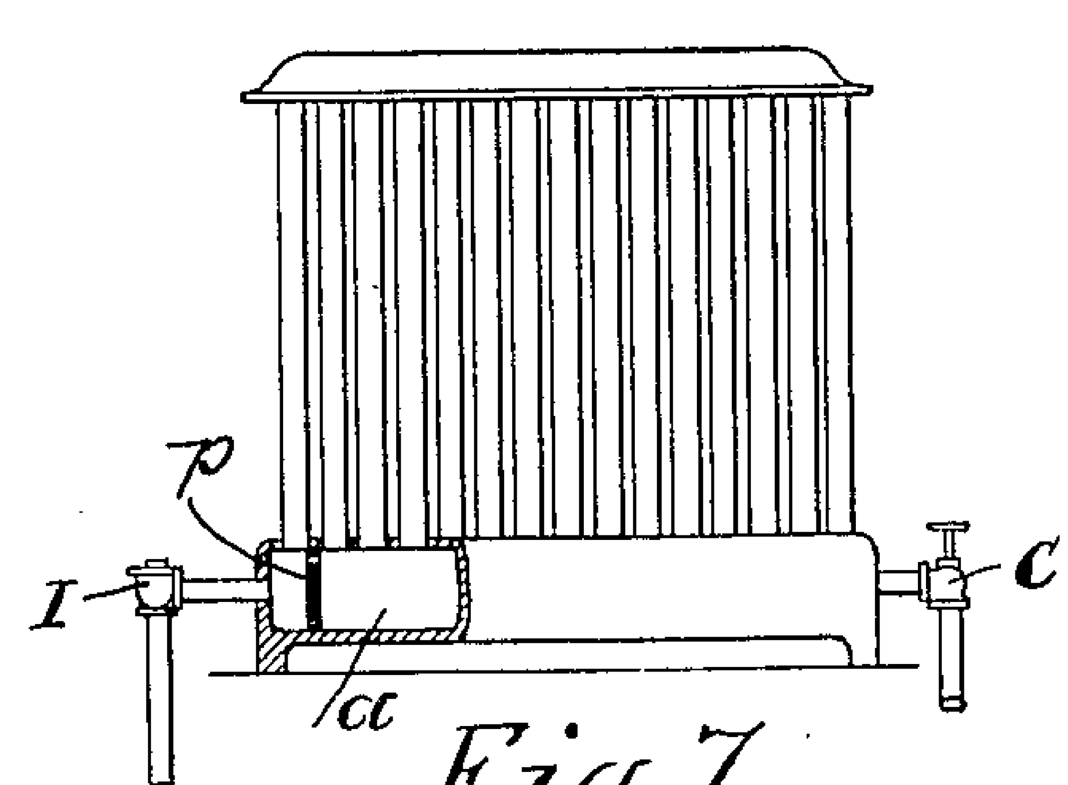


Fig. 7.

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JAMES A. DONNELLY, OF NEW YORK, N. Y.

STEAM-HEATING SYSTEM.

No. 882,300. Specification of Letters Patent. Patented March 17, 1908.

Application filed October 21, 1904. Serial No. 229,410.

To all whom it may concern:

Be it known that I, JAMES A. DONNELLY, a citizen of the United States of America, and residing at borough of Brooklyn, city of New York, county of Kings, and State of New York, have invented certain new and useful Improvements in Steam-Heating Systems, of which the following is a specification.

My invention relates to a system of steam heating, and particularly to a system utilizing the exhaust steam from a steam engine or from other steam apparatus, where it is necessary to maintain a vacuum in the return. It is so designed as to reduce the steam in the return to a minimum, thereby maintaining a substantially uniform vacuum therein and also enabling the size of the vacuum pump to be materially reduced. The system further is so designed as to be readily controlled by the person in charge and capable of adjustment to varying conditions of weather.

My invention will best be understood when described in connection with the accompanying drawings in which:—

Figure 1 is a diagrammatic view illustrating my steam heating system. Fig. 2 is a sectional view of the pressure regulating valve employed. Fig. 3 is a sectional view of an automatic impulse valve which may be used at the outlet of the primary radiating device. Fig. 4 is a sectional view illustrating the application of the automatic impulse valve shown in Fig. 3 to a combined primary and auxiliary radiating device. Figs. 5, 6 and 7 are various forms of radiating devices. Fig. 8 is a detail sectional view of the partition used in the base of the radiator shown in Figs. 5, 6 and 7.

Similar letters and numerals of reference designate corresponding parts throughout the several views.

Referring now to Figs. 1, S designates the steam main of the system, which main is connected to the exhaust from an engine or other steam apparatus, rejecting steam at a low absolute pressure. From the steam main S, branches lead to the various sections of the heating system, and the condensed water and air are discharged into a return main R, connected to a pump Q, through the branch returns R^1, R^2, etc. Fig. 1 shows but two steam branches S^1, and S^2, two return branches R^1, R^2, and but one section of the heating system. Into each branch return pipe R^1, etc., is inserted a pressure regulating valve V in such a position as to be readily accessible to the engineer in charge. The function of this valve is to maintain a constant predetermined difference of pressure between the supply S^1 and the return R^1, and also to act as mechanical means for the removal of air. The valve V is shown in detail in Fig. 2.

The letter B designates the body or casing of the valve V including the separate cap 13 which closes the lower end. A flexible diaphragm 16 is inseterd between the cap 13 and the upper part of the body dividing the space in the valve body into an upper low pressure chamber 5 and a lower high pressure chamber 18. A hollow U-shaped partition 4 projects into the globular part of the valve body B and forms a discharge chamber 6 with an outlet 3, while the chamber 5 extending from the diaphragm into the globular part of the valve body B has an inlet 2 to be connected to the fluid, the pressure of which is to be regulated.

In the partition 4 are formed two passages or openings 8 and 9 arranged in a vertical line and controlled respectively by valve-pieces 10 and 11 mounted upon a common valve-rod 12. The lower end of this valve-rod passes through the cap 13, which is the bottom of the valve body or casing, and is connected with a lever 14 having thereon an adjustable weight 15 which exerts a downward pull on the valve-rod. The chamber 18, formed by the cap and diaphragm is connected by a small branch pipe 19 with the high pressure conduit S^1 and constitutes the high pressure chamber. A suitable valve 20 may be placed in the branch pipe 19.

Under normal working conditions, the valves 10 and 11 are always more or less open, due to the action of the weighted lever and the pressure on the upper face of the diaphragm 16, and it will now be readily understood, that as the pressure in the pipe or conduit R^1 or in the chamber 5 varies, the change of pressure on the diaphragm 16 will either increase or decrease the area of the openings at the valves 10 and 11, thus permitting more or less escape of fluid from the pipe or conduit, under the influence of a vacuum pump. The same is true for variations of the pressure in the pipe or conduit S^1.

When the pressure in the pipe or conduit R^1 falls, the decreased area of the openings at the passages 8 and 9 will check the discharge from the valve, thereby increasing the pressure at the inlet to the valve and maintaining the desired difference of pressure between the steam supply S^1 and the return R^1.

When the pressure in the pipe or conduit R^1 rises, the pressure on the upper side of the diaphragm 16 forces the same downwardly and increases the area of the passages 8 and 9. This causes an increased suction in the pipe or conduit R^1, and the fluid is rapidly drawn out, thus diminishing the pressure in the pipe, and reëstablishing the desired difference of pressure. The degree of difference of pressure to be maintained is controlled by the position of the weight 15 on the lever 14 and may be varied as conditions require. When the steam is supplied constantly at atmospheric pressure, the high pressure chamber 18 may be opened to the atmosphere.

In practice I place in the return pipe R^1 near the valve V a strainer T to remove the dirt invariably present. This strainer is so constructed as to be readily removed for cleaning.

Between the steam supply S^1 and the return R^1 are placed the various radiating devices D^1, D^2, D^3 and D^4 receiving steam through an ordinary inlet valve C. These radiating devices are so constructed as to form two independent radiating surfaces, a primary radiator P and an auxiliary radiator A connected by means for restricting the flow, such as a contracted passage, thermostatic valve or automatic impulse valve, the latter shown in Figs. 3 and 4. The outlet from the auxiliary radiating surface A is connected to the branch return R^1 by the pipe r^2 into which may be inserted a check valve E to prevent heating from the return. The pressure regulating valve V^1 may be inserted into this pipe r^2 as shown at D^4, affording another means of control for that particular radiating device.

In practice I prefer to use the automatic impulse valve in the connection between the primary and auxiliary radiating surfaces. This valve is located on the outlet side of the primary radiating device and has a yielding, weighted valve piece 24 provided with an impact surface 25 beyond the seat of the passage-way 23. It is caused to move away from its seat by the accumulated head of water of condensation and the impact of the issuing jet of water, thus gradually opening the passage-way until the water of condensation is substantially discharged, when it returns to its normal position in which it presents a minimum opening. The passage of steam through this valve is thus reduced to a minimum and a very regular and positive action is obtained. The valve as shown in Fig. 3 comprises a valve body or casing I provided with a removable top i, and having an inlet 21 and an outlet 22. A valve passage-way 23 is controlled by a valve piece 24, preferably made conical in form and having an enlarged base 25 located beyond the passage-way 23 and formed into a suitable impact surface. The said valve-piece is connected to one arm of a bell-crank lever 26 pivoted at 27, to a projection 28 of the valve casing. The other arm of the lever 26 is weighted to the desired amount by weights 29 held in position by the screw 30. In practice these weights are so adjusted that a minimum restricted opening is left for the passage of air and of water of condensation under normal conditions. When, however, there is an accumulation of water of condensation to a sufficient height to form a jet of water, the impact of the latter upon the impact surface 25 of the valve-piece causes the latter to move away from the passage-way 23 and increases the area of opening, thus increasing the jet and furthering the outward movement until it is thrown wide open. When the water is substantially discharged, the valve piece gradually closes under the action of the weights 29 until it resumes its normal position.

Should the opening through the valve become closed by dirt, the pressure due to the head of the accumulating water will move the valve piece in opposition to the weights and cause the dirt and water to be blown out. This type of valve is designed to be used in connection with the previously described pressure regulating valve.

The radiating devices placed between the supply and the return may be of various forms and combinations as shown in Fig. 1. D^1 illustrates the auxiliary and primary radiating devices combined in one, an automatic impulse valve, substantially similar to that shown in Fig. 3 being placed in the base connection 28′ between the two parts as shown in Fig. 4. The valve passage way 23 is in this case formed in a piece i' screwed into the base connection 28′, and to which piece the lever 26′ is pivoted carrying the valve-piece 24 and weighted with the weights 29. D^2 illustrates primary and auxiliary radiators separate and distinct. D^3 the same, the radiating devices being in coil form. D^4 illustrates the form shown in D^2, Fig. 1, the check valve E in the outlet pipe r^2 being replaced by the pressure regulating valve V^1. A strainer T^1 is placed ahead of this valve as in the case of the valve V.

In order to further prevent the return pipe from being filled with steam, the radiating devices may be so designed as to hold back and cool the water of condensation causing it to accumulate in the base of the radiators or in a chamber placed beneath the radiators. By this means the water is cooled a definite amount, depending upon the surface exposed. Various forms of these radiators are illustrated in Figs. 5, 6 and 7. Fig. 6 shows a radiator having a chamber a beneath it and connected at each end by a passage b. Near the outlet end of this chamber a partition p of the form shown in Fig. 8 is placed, the said partition p forming a trap for the water used, but allowing the air to pass out.

If the valve I, placed at the outlet of the primary radiator, be a thermostatic valve and situated on a level somewhat above the bottom of the chamber in the base of the radiator D, Figs. 5, 6 and 7, the air as well as the water may be cooled a definite amount. The valve is set to open to the water and the air at the desired temperature. As the warm water cannot reach the valve directly because of the partition p, it is cooled before reaching the thermostatic valve, having been retained in the cooling chamber a sufficient time.

Fig. 7 shows the two chambers shown in Fig. 6 combined into one, and Fig. 5 the modification applied to both primary and auxiliary radiating devices.

It is of course to be understood that I do not limit myself to the particular form of valves or radiating devices employed, as my invention consists essentially in the combination of a primary and auxiliary radiator with means for establishing a controllable difference of pressure between the supply to and the return from said combination of primary and auxiliary radiators.

In all vacuum systems, it is essential to maintain the absolute pressure of the steam in the primary radiating devices as near as possible to that of the steam supply, and to provide means for the removal of the air from the radiating devices. It is also essential to keep steam out of the return as much as possible, so as to have the vacuum pump to remove only air and condensed water. With such a condition the drop of vacuum in the return pipe is avoided and a substantially uniform vacuum maintained throughout the return.

The vacuum systems installed up to the present time do not give entire satisfaction as proper regard has not been given to keeping out the steam from the return and to placing all of the radiating devices under practically the same and uniform conditions. These systems use automatic valves which pass the water of condensation from atmospheric pressure and a temperature of 212 degrees F. into a pressure in many plants as low as five pounds absolute and 160 degrees F. Water under these conditions will give off almost 5% of its weight into steam, and this steam will have a volume nearly three times as large as steam at atmospheric pressure. One and a half pounds of steam under these conditions will occupy about 110 cubic feet. It will thus readily be seen that if for every thirty pounds of water passed under these conditions through an automatic valve, almost 110 cubic feet of steam are generated at a temperature of 160 degrees F., a device of this character delivering water only, under these conditions, is an impossibility.

For a rather large plant using the old system, a return pressure of five pounds absolute may be assumed as a fair standard. With the supply at atmospheric pressure at the beginning of the line and the return at the pump at five pounds absolute, a difference of ten pounds exist between the two sides of the automatic valves in the radiators located near that place. As the distance from the beginning of the line increases, the pressure in the steam supply falls very slowly so that at the farthest end of the system, it may be from fourteen to thirteen pounds absolute. In the return, however, the pressure increases very rapidly from the pump to the farthest end so that there will be a pressure of from thirteen to twelve pounds absolute at the farthest end. The necessity of creating and maintaining this difference of pressure of one pound at the most remote point of the system compels the use of the before assumed five pounds absolute pressure at the pump. There is therefore a gradually decreasing difference of pressure in going from the pump to the most remote point of the system and no two valves work under the same conditions.

The increase of pressure in the return-line from the pump to the most remote point depends upon the length of the run, the number of units, and whether a considerable number of units are near the beginning of the run and so subject to the high difference of pressure. This extremely large increase in pressure in the return main is caused by the quantity of steam brought back through the return main being more than the capacity of the pipe, and makes necessary the use of either a large amount of jet water, or the use of a very large vacuum pump, or sometimes both.

To cut down the quantity of steam passing into the return, I reduce the steam leakage through the ports of the automatic valves from that due to a ten pound difference of pressure to that due to a difference of pressure of one-quarter pound or less. This is made possible by the employment of the previously described pressure regulating valve which is placed in the return and maintains therein a pressure at a constant predetermined amount below that in the supply.

As shown in Fig. 1 these pressure regulating valves are placed in the branch return pipes from the radiating devices and control the flow of fluid by checking or releasing the pressure on the inlet side of the valve, as the difference of pressure is respectively increased or decreased. The regulation is not affected by varying pressure in the return beyond the valve and depends only on the pressures in the supply pipe and the return to the valve.

I also obtain the advantages of a surface condensing system, in still further reducing the steam entering the return by placing therein immediately beyond the primary radiating devices auxiliary radiating surfaces of sufficient capacity to condense the steam passing through the automatic valves of the primary radiating devices, the steam formed by the water from the primary radiating devices entering a chamber of lower pressure, and to cool the water thus condensed and the air a definite amount.

The initial condition of lower pressure in the auxiliary radiating devices is obtained by causing the air to flow through the pressure regulating valve into the lower pressure of the main return at first faster than it can enter through the leakage port of the automatic valve thereby causing the pressure to drop the desired amount. The pressure regulating valve then partly closes the passage through itself. Thereafter the flow of air through the regulating valve will depend upon the rate of condensation, the difference in pressure being kept constant. If the rate of condensation in the auxiliary radiating device becomes so rapid as to reduce the pressure in it, the pressure regulating valve closes against the passage of air and holds the air back until the pressure rises to reestablish the desired difference. To secure a different heating effect, it is only necessary to increase or decrease the difference of pressure in order to increase or decrease the amount of heat radiated. If the difference be increased, steam will have to be condensed more rapidly in the auxiliary radiator, thus lowering the pressure therein and assisting in maintaining the desired difference.

It will thus be seen that by varying the difference in pressure between the supply and the return by means of the pressure regulating valve, a corresponding variation in the condensation is effected and a consequent variation in the amount of heat radiated. The pressure regulating valve is usually placed so as to be readily accessible to the engineer in charge and it thus becomes a simple matter to vary the heating effect of the radiating devices. In plants of considerable magnitude the system is divided into a number of sections, each section having its own pressure regulating valve, said valve being placed directly under the control of the engineer in charge. Even should this valve be closed against the passage of air, it will still remove the water of condensation, as the static head of the water gathering upon the diaphragm causes it to act as a steam trap. An automatic valve may be placed in the base of a radiator as shown in Fig. 4, thus combining the primary and auxiliary radiator into one. A light check valve may also be placed on the outlet of the auxiliary radiator to prevent heating from the return. A further control of the radiating combination is made possible by varying the amount of steam supplied through the inlet valve to the primary radiator.

What I claim as new and desire to secure by Letters Patent is:—

1. In a steam heating system, the combination of a steam supply pipe, a return for the air and for the water of condensation, a primary radiating device communicating with the steam supply pipe, an auxiliary radiating device communicating with the outlet of the primary radiating device and with the return, and means within said communication between the primary and auxiliary radiating devices for restricting the flow of fluid, and means beyond said means within the communication acting to automatically control the pressure existing on the inlet side of said means and to control the flow through said return.

2. In a steam heating system, the combination of a steam supply pipe, a return for the air and for the water of condensation, a primary radiating device communicating with the steam supply pipe, an auxiliary radiating device communicating with the outlet of the primary radiating device and with the return, and means within said communication between the primary and auxiliary radiating devices for restricting the flow of fluid, and means beyond said radiating devices located in the return, and acting to automatically control the pressure in the inlet side of said means and to control the flow through said return.

3. In a steam heating system, the combination of a steam supply pipe, a return for the air and for the water of condensation, a primary radiating device communicating with the steam supply pipe, an auxiliary radiating device communicating with the outlet of the primary radiating device and with the return, means within said communication between the primary and auxiliary devices for restricting the flow of fluid, and means for automatically establishing a predetermined substantially constant difference of pressure between the supply and the return.

4. In a steam heating system, the combination of a steam supply pipe, a return for the air and for the water of condensation, a primary radiating device communicating with the steam supply pipe, an auxiliary radiating device communicating with the outlet of the primary radiating device and with the return, means within said communication between the primary and auxiliary radiating devices for restricting the flow of fluid, and means for automatically controlling the difference of pressure between the supply and the return.

5. In a steam heating system, the combination of a steam supply pipe, a return for the air and for the water of condensation, a primary radiating device communicating with the steam supply pipe, an auxiliary radiating device communicating with the outlet of the primary radiating device and with the return, means within said communication between the primary and auxiliary radiating devices for restricting the flow of fluid, means beyond the auxiliary radiating device for automatically restricting the flow of fluid, and means for controlling the difference of pressure between the supply and the return.

6. In a steam heating system, the combination of a steam supply pipe, a return for the air and for the water of condensation, a primary radiating device communicating with the steam supply pipe, an auxiliary radiating device communicating with the outlet of the primary radiating device and with the return, means within said communication adapted to restrict the flow therethrough to yield to an increasing difference of pressure, and means for automatically controlling the difference of pressure between the supply and the return.

7. In a steam heating system, the combination of a steam supply pipe, a return for the air and for the water of condensation, a primary radiating device communicating with the steam supply pipe, an auxiliary radiating device communicating with the outlet of the primary radiating device and with the return, an automatic valve in said communication between the primary and auxiliary radiating device, and a pressure regulating valve for automatically controlling the difference of pressure between the supply and the return.

8. In a steam heating system, the combination of a steam supply pipe, a return for the air and for the water of condensation, a primary radiating device communicating with the steam supply pipe, an inlet valve to the primary radiating device, an auxiliary radiating device communicating with the outlet of the primary radiating device and with the return, an automatic valve at outlet of said primary radiating device, and a pressure regulating valve in the return from said auxiliary radiator for automatically controlling the difference of pressure between the supply and the return.

9. In a steam heating system, the combination of a steam supply pipe, a return for the air and for the water of condensation, a primary radiating device communicating with the steam supply pipe, an auxiliary radiating device communicating with the outlet of the primary radiating device and with the return, an automatic valve in said communication between the primary and auxiliary radiating device, provided with a yielding valve piece having a conical projection fitting the valve passage way, and means for automatically controlling the difference of pressure between the supply and the return.

10. In a steam heating system, the combination of a steam supply pipe, a return for the air and for the water of condensation, a primary radiating device communicating with the steam supply pipe, an auxiliary radiating device communicating with the outlet of the primary radiating device and with the return, an automatic valve in said communication between the primary and auxiliary radiating device, provided with a yielding valve piece having a conical projection fitting the valve passage way, and a pressure regulating valve in the return from said auxiliary radiator for automatically controlling the difference of pressure between the supply and the return.

11. In a steam heating system, the combination of a steam supply pipe, a return for the air and for the water of condensation, a primary radiating device communicating with the steam supply pipe and provided with a chamber for cooling the water of condensation, an auxiliary radiating device communicating with the outlet of the said primary radiating device and with the return, means within said communication between the primary and auxiliary radiating devices for restricting the flow of fluid, and means for automatically controlling the difference of pressure between the supply and the return.

12. In a steam heating system, the combination of a steam supply pipe, a return for the air and for the water of condensation, a primary radiating device communcating with the steam supply pipe and provided with a chamber for cooling the water of condensation, an auxiliary radiating device communicating with the outlet of the primary radiating device and with the return and provided with a chamber for cooling the water of condensation, means within said communication between primary and auxiliary radiating devices for restricting the flow of fluid, and means for automatically controlling the difference of pressure between the supply and the return.

In testimony whereof, I have signed my name to this specification in the presence of two subscribing witnesses, this 20th day of October 1902.

JAMES A. DONNELLY.

Witnesses:

George W. Eisenhause,

William T. Donnelly.