April 11, 1944. J. E. LA ROCQUE ET AL 2,346,590

INNER-TUBE RADIATION WITH MODULATING TRAP

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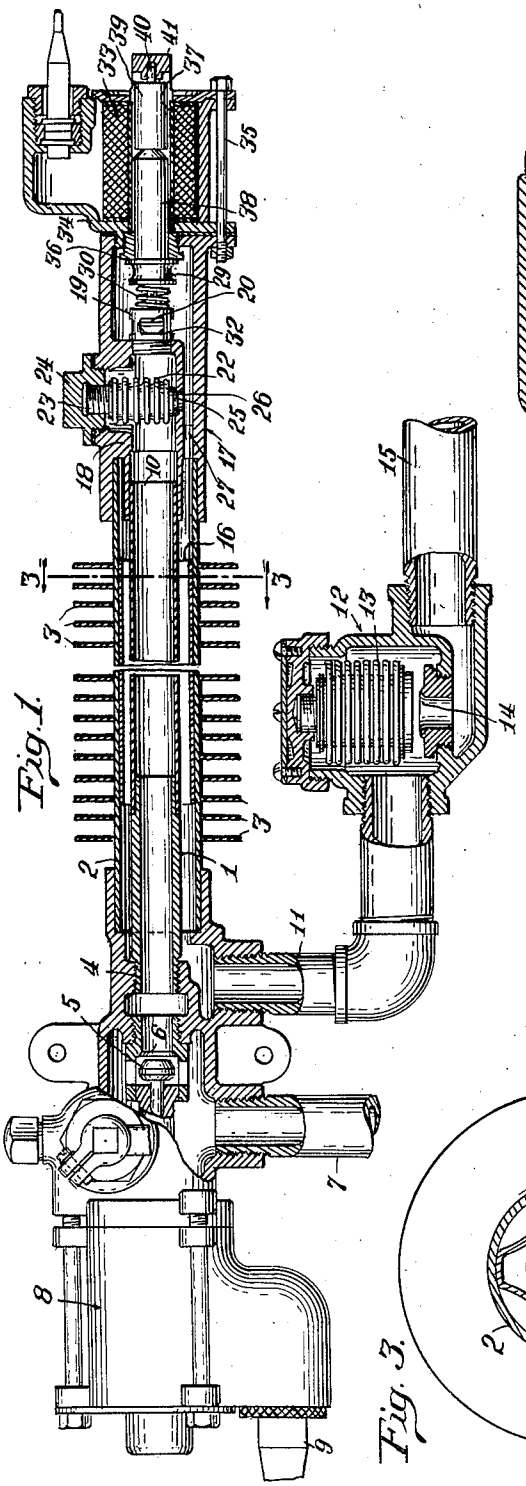


Fig. 1.

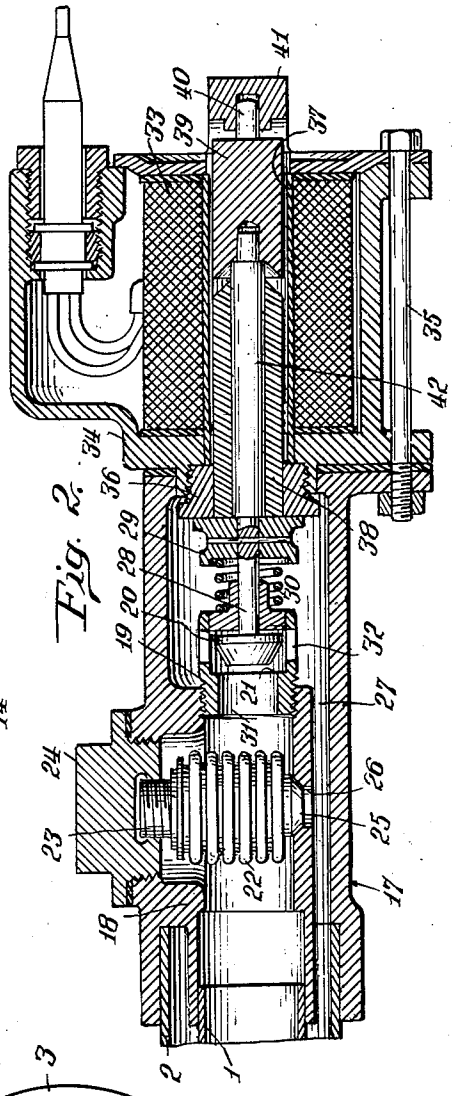


Fig. 2.

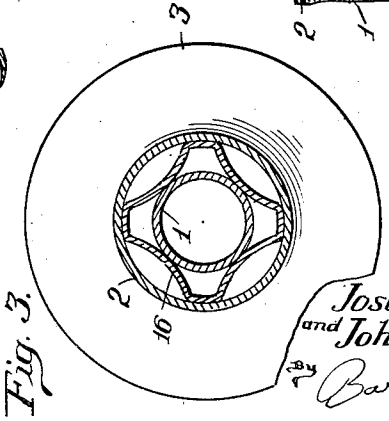


Fig. 3.

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Fig. 4.

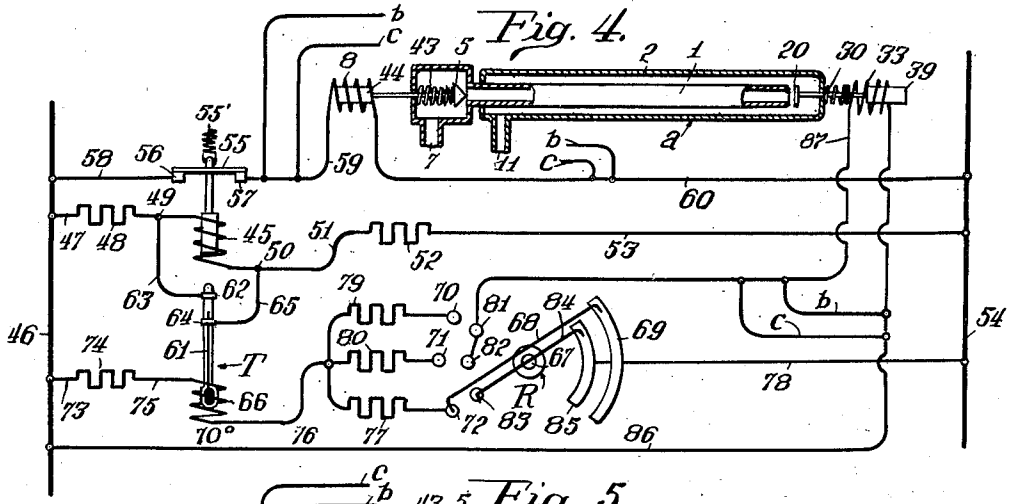


Fig. 5.

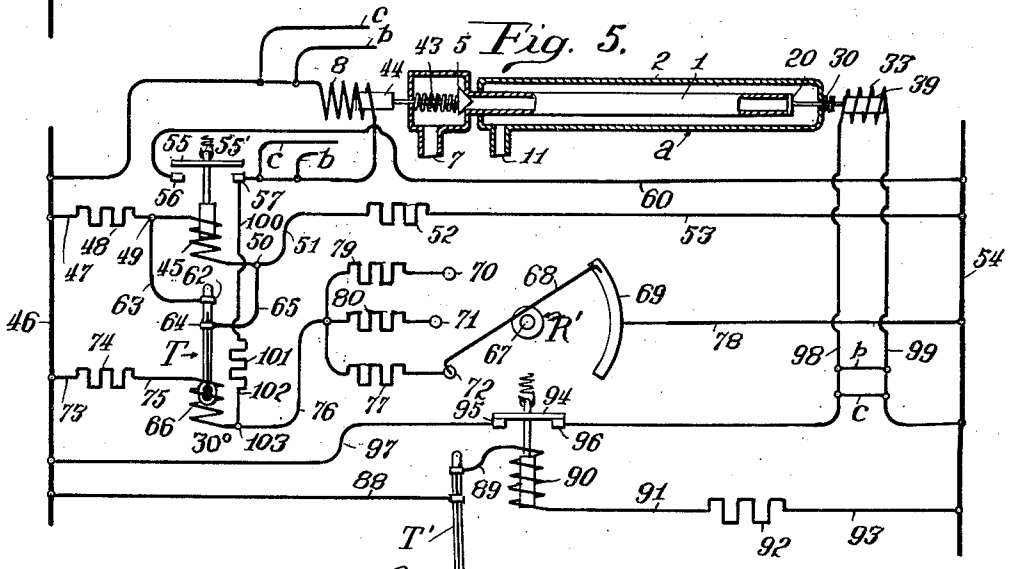
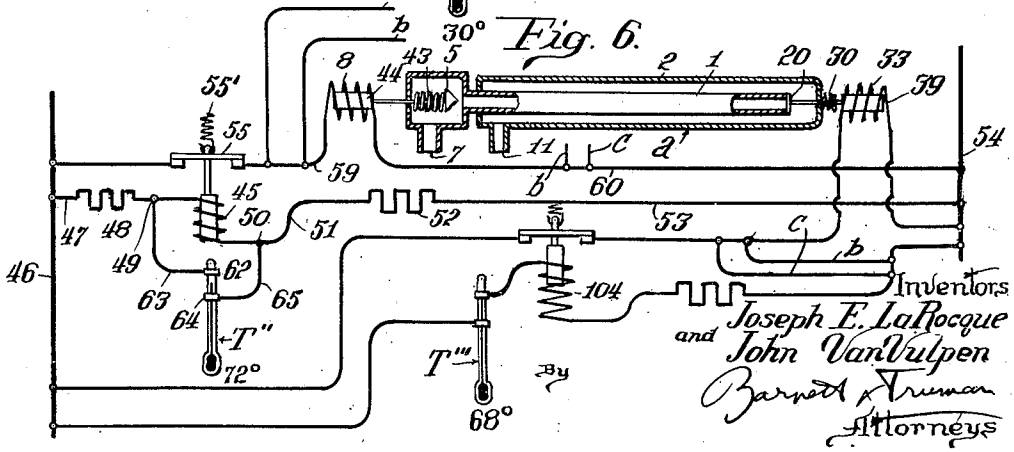


Fig. 6.



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UNITED STATES PATENT OFFICE

2,346,590

INNER-TUBE RADIATION WITH MODULATING TRAP

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Application February 14, 1942, Serial No. 430,956

12 Claims. (Cl. 257—2)

This invention relates to improvements in a steam heating system, and more particularly to improvements in a radiator for use in this system and means for controlling the same. The radiator is of the "inner-tube type" and comprises an outer tube provided with a plurality of spaced radiating ribs or fins adapted to increase the radiating or heat-transmitting surface, and an inner tube into which steam is admitted at one end in a controlled manner. The opposite end of this inner tube is normally open, while the corresponding end of the outer tube extends beyond the innertube and is closed. The steam and condensate escaping from this end of the inner tube or pipe will flow back through the outer pipe between the inner and outer pipes, and the condensate will be discharged from an opening in this outer pipe adjacent the admission end of the inner pipe. Normally the far end of a radiator of this type, that is the end remote from the inlet and discharge openings will be the hotter end. In order to equalize the temperature throughout the length of the radiator several expedients have been resorted to, one of which is to provide a direct metallic contact extending throughout the length of the radiator between the inner and outer pipes. Examples of this are shown in the copending application of Lehane and Van Vulpen, Serial No. 430,955, filed February 14, 1942, and one form of such a radiator is shown herein as a part of the present invention.

According to this present invention a steam-trap is provided at the outlet end of the inner pipe so as to prevent the normal escape of steam from this pipe although permitting accumulated condensate to flow from this pipe into the outer pipe. The fluids returning through the outer pipe will thus be confined to condensate and non-condensable gases. However, there is another opening at the discharge end of the inner pipe which is normally open but which is closed by electrically operated means at such times as the full capacity of the radiator is not desired. When this valve is closed and steam is confined to the inner pipe, the heat from the steam must flow by conduction through the inner pipe and intervening means to the outer pipe and thence be radiated from the fins on the outer pipe. When the discharge valve at the outlet end of the inner pipe is closed, only condensate can flow through and past the trap. However, when the valve is opened, steam will flow into the outer pipe and back through the space between the two pipes thus considerably increasing the amount of steam condensed and hence increasing the steam output of the radiator. In this way the maximum heat output of the radiator is provided. Alternative means, as hereinafter disclosed, may be provided for not only regulating the admission of steam to the inner pipe but also regulating the position of the discharge valve at the opposite end of the inner pipe so as to determine the heat output in accordance with requirements.

The principal object of this invention is to provide an improved radiator and control means therefor as briefly described hereinabove and disclosed more in detail in the specifications which follow.

Another object is to provide improved means for controlling the flow of steam from the inner pipe to the outer pipe of a radiator of the general type herein disclosed.

Another object is to provide a radiator of this improved type in combination with means for maintaining a continuous metallic contact between the inner and outer pipes to provide for uniform heat distribution throughout the length of the radiator.

Another object is to provide improved means for selectively and cooperatingly controlling the valves at the two ends of the inner steam-pipe.

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

In the accompanying drawings:

Fig. 1 is a longitudinal vertical section, partially broken away, through an improved radiator and certain associated parts.

Fig. 2 is a longitudinal vertical section, on a larger scale, through the right hand end portion of Fig. 1.

Fig. 3 is a transverse section, on a larger scale, taken substantially on the line 3—3 of Fig. 1.

Fig. 4 is a wiring diagram, showing the improved radiator diagrammatically and indicating one form of cooperative control for the valves.

Fig. 5 is a diagrammatic view, similar to Fig. 4, but showing the steam-discharge valve controlled in accordance with out-door temperature changes.

Fig. 6 is another view, similar to Figs. 4 and 5, but showing both the inlet and discharge steam-valves controlled in accordance with inside temperature changes.

Referring first to Figs. 1, 2 and 3, the improved radiator comprises an inner steam tube 1 and an outer radiating tube 2 provided on its exterior with a plurality of spaced fins 3 for increasing

the radiating or heat-transmitting surface in a well known manner. Steam is admitted at one end 4 of the inner pipe and the steam flow is controlled by a valve 5 adapted to heat against the valve-seat 6 and thus cut off the flow of steam from the inlet pipe 7. The valve 5 may be of any preferred type and actuated either manually or electrically. In the present example this valve is of the electrically-operated type, and may be of the type shown in the patent to Parks and Peterson, No. 2,310,745, granted Feb. 9, 1943. The solenoid-operating means is enclosed in the casing 8 and supplied with electric power through the plug indicated at 9.

Steam would normally flow (except for the improvements hereinafter described) from the open end 10 of inner pipe 1 into the outer pipe 2, through which such steam and condensate would flow back toward the valve structure and then out through the discharge pipe 11 which is provided with a steam-trap indicated generally at 12. If steam should reach the thermostatic bellows 13, this bellows would expand so as to close against the outlet port 14 and prevent the escape of fluids. This will prevent the escape of steam, but if sufficient condensate accumulates, the trap will open so as to permit this condensate and non-condensable gases to flow out through the discharge pipe 15.

Means may be provided to equalize the transmission of steam from the inner steam pipe 1 to the outer radiating pipe 2 at all positions throughout the length of the radiator. In the present example a metallic spacer 16, contacting alternately with the inner and outer pipes 1 and 2, extends substantially throughout the length of these pipes. Heat is thus transmitted from the inner pipe to the outer pipe by direct metallic contact. This is one of the examples shown in the copending application of Lehane and Van Vulpen, hereinabove referred to.

The outer end of the outer pipe 2 is mounted in and secured to the fitting 17 in which is formed the housing 18 into which extends the corresponding end of inner steam pipe 1. A cage or fitting 19 is threaded into the outer end of housing 18, this cage containing the movable valve member 20 adapted to engage the valve seat 21 within the cage and thus completely close this outlet to the housing 18. Within the housing 18 is mounted the bellows member 22 of a steam-trap having an upper threaded extension 23 carried by the screw-plug 24 mounted in the upper portion of the housing. The bellows 22 contains a volatile fluid so as to expand when heated by steam, in which case the valve member 25 at the lower end of the bellows will engage within and close the port 26 in the bottom of housing 18. When there is no steam in this end of the inner pipe, or when condensate or non-condensable gases collect in this end of the pipe, the bellows 22 will contract and permit the flow to escape into the outer chamber 27 which forms an extension of the outer pipe 2. Such fluids will then flow back (to the left) through the outer pipe and escape through discharge pipes 11 and 15.

It will now be seen that the steam trap 22 (as long as the valve 20 is closed) will confine substantially all steam to the inner pipe 1, but will open when necessary to permit condensate to be discharged.

At times it is desirable to permit steam to flow back through the outer pipe 2 and thus increase the heating capacity of the pipe, as has been done in previous radiators of this type, and for this reason means is provided for opening and holding open the discharge valve 20. The valve 20 is carried at the inner end of a stem 28 slidable in the outer end of cage 19, and a spring 30 compressed between the outer end of the cage and a collar 29 mounted on the outer end of stem 28 serves to normally move the valve 20 to its open position. Fluids can then pass through the openings 31 and 32 in the cage and thence flow back through the outer tube 2.

A solenoid coil 33 is mounted in a housing 34 secured to the outer end of housing 17 by the bolts 35. A screw-plug 36 in the outer end of housing 17 holds in place the guide tube 37 within the solenoid and a guide 38 within the inner portion of the solenoid. A core 39 is slidable within tube 37 and has a stem 40 at its outer end slidable within an opening in the cap 41 mounted in the outer end of tube 37. A stem 42 projecting from the inner end of core 39 is slidably guided through the guide plug 38 and when the solenoid is energized and core 39 is drawn in or toward the left, the stem 42 will push in the valve stem 28 and force valve 20 to its seat 21.

When the inner tube or pipe 1 is thus closed, the steam trap 22 will be effective to prevent the escape of steam while permitting condensate and non-condensable gases to escape through the lower opening 26. When the solenoid 33 is de-energized, and valve 20 is opened by the spring 30, the steam trap 22 will be substantially ineffective and steam, as well as other fluids can flow from the inner pipe into and back through the outer pipe in the usual manner.

It will now be seen that the input of steam is controlled at all times by the valve 5. If the solenoid 33 is energized, the outer valve 20 will be held closed by solenoid 33. In that event the steam will be confined to the inner pipe 1, although condensate and non-condensable gases can escape through steam trap 22. If the full capacity of the radiator is desired, that is the maximum input of steam is to be utilized, the valve 20 is permitted to be opened by the spring 30. In all cases a uniform distribution of heat from the radiator is provided throughout its length by the metallic spacer 16 or other equivalent means.

Different manners in which the electrically controlled valves at the two ends of the radiator are controlled cooperatively are disclosed in Figs. 4, 5 and 6, by way of example. In each of these figures the radiator is shown diagrammatically. The valve 5 is shown as moved to closed position by the spring 43 and withdrawn to open position by the solenoid 8 drawing in the core 44. As already described, the closure valve 20 at the opposite end of the inner steam pipe 1 is normally opened by the spring 30, but is closed by the solenoid 33. In each of Figs. 4, 5 and 6 only a single radiator is indicated by way of example at *a*, but it is to be understood that a plurality of such radiators can be simultaneously controlled, as indicated at *b* and *c*, these other radiators being simply connected in parallel as indicated by the partial circuits shown.

Referring first to Fig. 4, the relay 45 will normally be energized through the following circuit: From main 46 through wire 47, resistor 48, terminal 49, relay coil 45, terminal 50, wire 51, resistor 52, and wire 53 to the negative main 54. When this circuit is completed and the relay 45 is energized, the contact 55 will be drawn down against the pair of fixed contacts 56 and 57 so as to complete the following circuit: From main 46,

through wire 58, relay contacts 56, 55 and 57, wire 59, solenoid coil 8, and wire 60 to the main 54. This will move the valve 5 to open position, as indicated in the drawings, thus admitting steam to the inner pipe 1.

Assuming that the mercury column thermostat indicated generally at T is adapted to function at 70°, the mercury column 61 will at that temperature engage the upper contact 62, thus completing a shunt circuit around the relay 45 as follows: From terminal 49, through wire 63, thermostat contact 62, mercury column 61, contact 64 and wire 65 to the other terminal 50. The relay 45 will thus be de-energized, and spring 55' will lift the contact 55 out of engagement with contacts 56 and 57, thus breaking the energizing circuit for solenoid 8 and permitting the valve 5 to close under the influence of spring 43. The valve will again be opened when the temperature at the thermostat T falls below 70°.

In order that the system may function at different selected temperatures, that is to provide "low," "medium" or "high" temperatures, a manually adjusted rheostat R is provided in connection with a heating coil 66 adapted to add a selected amount of heat to the atmospheric temperature within the space affecting the thermostat T. The rheostat R comprises an arm centrally pivoted at 67 and carrying a conductor 68 which is in continuous engagement at one end with the arcuate contact 69 and engages at the other end with any one of a series of contacts 70, 71 or 72. Assuming that the rheostat is in the "high" position now shown, a circuit will flow from main 46 through wire 73, resistor 74, wire 75, heater 66, wire 76, resistor 77, terminal 72, conductor 68, arcuate contact 69, and wire 78 through the main 54. The heat thus added to thermostat T will cause said thermostat to function at a "high" temperature, for example 76°. If the thermostat arm is moved in a clockwise direction to the "low" temperature position, the heating circuit will flow through the resistor 79 and contact 70 to the rheostat arm, thus adding less heat to the thermostat which will now function at a temperature of (for example) 70°. In the "medium" position the circuit will flow through the resistor 80 and contact 71 and will cause a temperature of (for example) 72° to be maintained by the thermostat T.

There are three other contacts 81, 82 and 83 adapted to be engaged by one end of a second conductor 84 on the rheostat arm, the other end of which conductor engages the arcuate contact 85 also connected through wire 78 with the negative main 54. When the rheostat is in the "high" position, as shown, no additional circuit will be completed since the conductor 84 is in engagement with the contact 83. However, if the rheostat is moved to either the "low" or "medium" positions a circuit will be completed from the positive main 46 through wire 86, solenoid coil 33, wire 87, and either of the contacts 81 or 82 to the conductor 84, arcuate contact 85 and wire 78 to the negative main 54. With the solenoid 33 thus energized, the core 39 will be drawn in and valve 20 will be closed (against the resistance of spring 30) so as to confine the steam to the inner pipe 1. However, with the rheostat in the "high" position now shown, the solenoid 33 will be de-energized and the valve 20 will be moved to open position by the spring 30. Consequently with the rheostat turned to "high" the valve 20 will be open and steam can flow into the outer pipe 2 as well as the inner pipe 1 and the radiator will be operating at full capacity.

Referring now to the alternative construction shown in Fig. 5, a thermostat T' is positioned so as to be responsive to temperature changes outside of the building. As long as this outside temperature is above 30° (for example) a controlling circuit will flow as follows: from the positive main 46 through wire 88, the mercury column of thermostat T', wire 89, relay coil 90, wire 91, resistor 92 and wire 93 to the negative main 54. As long as the tempreature remains above 30°, the relay contact 94 will be pulled down against fixed contacts 95 and 96, thus completing the following circuit: from positive main 46 through wire 97, relay contacts 95, 94 and 96, wire 98, solenoid coil 33, and wire 99 to the negative main 54. Thus at all temperatures above 30° the valve 20 will be closed and the steam will be confined to the inner pipe 1.

If the outside temperature should fall below 30°, both of these circuits will be broken and the solenoid 33 de-energized so that spring 30 will open the valve 20 and permit the steam to flow into the outer pipe 2, thus increasing the capacity of the radiator.

The rheostat R' is the same as rheostat R shown in Fig. 4 with the exception that the contacts for controlling the valve 20 are omitted, but the same control as already described for thermostat T to provide low, medium or high temperatures is provided. It is possible with any of these forms of control to provide means for causing the thermostat T to "cycle" or admit steam in individual bursts or impulses to the radiator instead of providing a steady but restricted flow of steam thereto. For this purpose a wire 100 leads from the fixed contact 57 to resistor 101 and thence through 102 to the terminal 103. Consequently when the temperature of thermostat T is below that required to de-energize the relay 45 and contact 55 is drawn down so as to complete a circuit through solenoid 8 and open the valve 5, another circuit will be at once completed as follows: from positive main 46 through wire 73, resistor 74, wire 75, heating coil 66 to terminal 103, thence through wire 102, resistor 101 and wire 100 to relay contact 57, and thence through relay contacts 55 and 56, and wire 60 to the negative main 54. As a consequence additional heat will be at once applied to the thermostat T so as to de-energize the relay 45 and again cause the valve 5 to be closed. It follows that steam will be applied to the steam pipe 1 of the radiator in successive momentary bursts instead of in the form of a restricted steady stream. It will be understood that this form of "cycling" control could also be used in either of the other control systems shown in Figs. 4 or 6.

In the modification shown in Fig. 6, a pair of separate thermostats are utilized, one of these T'' functioning at (for example) 72°, whereas the other T''' functions (for example) at 68°. The steam inlet valve 5 will be controlled in the usual manner by the thermostat T''. Whenever the temperature falls slightly below the desired temperature, for example, to 71°, steam will be admitted to the radiator by opening the valve 5 and when the desired temperature of 72° is again reached, this flow of steam will be cut off. During all of this time the 68° thermostat T''' will remain closed (since the temperature does not fall below 68°). Therefore the solenoid 33 will remain energized and valve 20 will be closed so as to confine the steam to the inner pipe 1. However, if

the temperature within the space should fall below 68° the relay coil 104 will be opened so as to cause the energizing circuit for solenoid 33 to be broken, and the valve 20 will be automatically opened by the spring 30. Consequently the radiator will be permitted to operate at its full capacity since steam can now flow past valve 20 into the outer pipe 2.

It will be noted that in all of the different forms of control two different means for controlling the heat output are provided. In the first place the steam input is directly controlled. This steam input may be directly restricted (as by means of a hand valve) but be continuous, or the steam feed may be by spaced bursts so as to cut down the rate of heat supply. In the second place, this steam input may be confined entirely to the inner pipe, or may be permitted to flow inwardly through the inner pipe and thence rearwardly through the outer pipe, thus greatly increasing the effective radiating surface. By simultaneously or successively controlling both of these steps a considerable range of heating capacities is provided. It is also desirable to have the heat distribution uniform throughout the length of the radiator, and this feature will be available no matter whether the closures for the discharge end of the inner pipe are used or not. It should be noted that the condensate flowing back through the outer pipe also serves, in any case, to increase the conduction of heat from the inner steam to the outer pipe and fins.

We claim:

1. In a heating system, a radiator comprising an outer radiating pipe, a plurality of radiating fins on the outer pipe, an inner feed pipe enclosed in the outer pipe, means for regulating the flow of steam into one end of the inner pipe, means for discharging fluids from the corresponding end portion of the outer pipe, the other end of the outer pipe being closed, a steam-trap at the enclosed end of the inner pipe to normally prevent the flow of steam to the outer pipe, an additional outlet to the outer pipe from this end portion of the inner pipe, and electrically operated means for controlling this outlet.

2. In a heating system, a radiator comprising an outer radiating pipe, a plurality of radiating fins on the outer pipe, an inner feed pipe enclosed in the outer pipe, means for regulating the flow of steam into one end of the inner pipe, means for discharging fluids from the corresponding end portion of the outer pipe, the other end of the outer pipe being closed, a steam-trap at the enclosed end of the inner pipe to normally prevent the flow of steam to the outer pipe, an additional outlet to the outer pipe from this end portion of the inner pipe, and means for thermostatically controlling this outlet.

3. In a heating system, a radiator comprising an outer radiating pipe, a plurality of radiating fins on the outer pipe, an inner feed pipe enclosed in the outer pipe, means for regulating the flow of steam into one end of the inner pipe, means for discharging fluids from the corresponding end portion of the outer pipe, the other end of the outer pipe being closed, an outlet to the outer pipe from the enclosed end of the inner pipe, and electrically operated means for controlling this outlet.

4. In a heating system, a radiator comprising an outer radiating pipe, a plurality of radiating fins on the outer pipe, an inner feed pipe enclosed in the outer pipe, means for regulating the flow of steam into one end of the inner pipe, means for discharging fluids from the corresponding end of the outer pipe, the other end of the outer pipe being closed, a steam-trap at the enclosed end of the inner pipe to normally prevent the flow of steam to the outer pipe, an additional outlet to the outer pipe at this enclosed end of the inner pipe, electrically operated means for controlling this outlet and means for causing the heat output to be substantially uniform at any one time through the length of the outer pipe.

5. In a heating system, a radiator comprising an outer radiating pipe, a plurality of radiating fins on the outer pipe, an inner feed pipe enclosed in the outer pipe, means for regulating the flow of steam into one end of the inner pipe, means for discharging fluids from the corresponding end of the outer pipe, the other end of the outer pipe being closed, a steam-trap at the enclosed end of the inner pipe to normally prevent the flow of steam to the outer pipe, an additional outlet to the outer pipe at this enclosed end of the inner pipe, means for thermostatically controlling this outlet and means for causing the heat output to be substantially uniform at any one time throughout the length of the outer pipe.

6. In a heating system, a radiator comprising an outer radiating pipe, a plurality of radiating fins on the outer pipe, an inner feed pipe enclosed in the outer pipe, means for regulating the flow of steam into one end of the inner pipe, means for discharging fluids from the corresponding end of the outer pipe, the other end of the outer pipe being closed, an outlet to the outer pipe at the enclosed end of the inner pipe, electrically operated means for controlling this outlet and means for causing the heat output to be substantially uniform at any one time throughout the length of the outer pipe.

7. In a heating system, a radiator comprising an outer radiating pipe, a plurality of radiating fins on the outer pipe, an inner feed pipe enclosed in the outer pipe, a thermostatically controlled means for regulating the flow of steam into one end of the inner pipe, means for discharging fluids from the corresponding end of the outer pipe, the other end of the outer pipe being closed, a steam trap at the enclosed end of the inner pipe to normally prevent the flow of steam to the outer pipe, an additional outlet to the outer pipe at this enclosed end of the inner pipe, means for thermostatically controlling this outlet and means for causing the heat output to be substantially uniform at any one time throughout the length of the outer pipe.

8. In a heating system, a radiator comprising an outer radiating pipe, a plurality of radiating fins on the outer pipe, an inner feed pipe enclosed in the outer pipe, a thermostatically controlled valve at one end of the inner pipe, means for discharging fluids from the corresponding end portion of the outer pipe, the other end of the outer pipe being closed, an outlet from the inner to the outer pipe at this enclosed end of the inner pipe, an outlet valve for normally closing the outlet, and thermostatic means within the space being heated for opening the inlet valve below a predetermined temperature and opening the outlet valve at a still lower predetermined temperature.

9. In a heating system, a radiator comprising an outer radiating pipe, a plurality of radiating fins on the outer pipe, an inner feed pipe enclosed in the outer pipe, a thermostatically controlled valve at one end of the inner pipe, means for discharging fluids from the corresponding end portion of the outer pipe, the other end of the

outer pipe being closed, a steam-trap at the discharge end of the inner pipe to normally prevent the escape of steam from the inner pipe into the outer pipe, an outlet to the outer pipe at this end of the inner pipe, means for normally closing the outlet, and means for opening this outlet when the temperature outside the space being heated falls below a predetermined minimum.

10. In a heating system, a radiator comprising an outer radiating pipe, a plurality of radiating fins on the outer pipe, an inner feed pipe enclosed in the outer pipe, a thermostatically controlled valve at one end of the inner pipe, means for discharging fluids from the corresponding end portion of the outer pipe, the other end of the outer pipe being closed, a steam-trap at the enclosed discharge end of the inner pipe to normally prevent the escape of steam from the inner pipe into the outer pipe, an outlet to the outer pipe at this end of the inner pipe, a valve for closing this outlet, and thermostatic means within the space being heated for opening the inlet valve below a predetermined temperature and opening the outlet valve at a still lower predetermined temperature.

11. In a heating system, a radiator comprising an outer radiating pipe, a plurality of radiating fins on the outer pipe, an inner feed pipe enclosed in the outer pipe, a thermostatically controlled inlet valve at one end of the inner pipe, means for discharging fluids from the corresponding end of the outer pipe, the other end portion of the outer pipe being closed, an outlet to the outer pipe at the enclosed end of the inner pipe, a valve for closing this outlet, thermostatic means within the space being heated for opening the inlet valve below a predetermined temperature, and opening the outlet of the inner pipe at a still lower predetermined temperature and means for causing the heat output to be substantially uniform throughout the length of the outer pipe at any one time.

12. In a heating system, a radiator comprising an outer radiating pipe, a plurality of radiating fins on the outer pipe, an inner feed pipe enclosed in the outer pipe, a thermostatically controlled inlet valve at one end of the inner pipe, means for discharging fluids from the corresponding end of the outer pipe, the other end portion of the outer pipe being closed, a steam-trap at the discharge end of the inner pipe to normally prevent the escape of steam from the inner pipe, an outlet to the outer pipe at this enclosed end of the inner pipe, a valve for closing this outlet, thermostatic means within the space being heated for opening the inlet valve below a predetermined temperature, and opening the outlet of the inner pipe at a still lower predetermined temperature and means for causing the heat output to be substantially uniform throughout the length of the outer pipe at any one time.

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