(No Model.) 2 Sheets—Sheet 1.

W. BURNHAM.

STEAM RADIATOR GOVERNOR.

No. 474,441. Patented May 10, 1892.

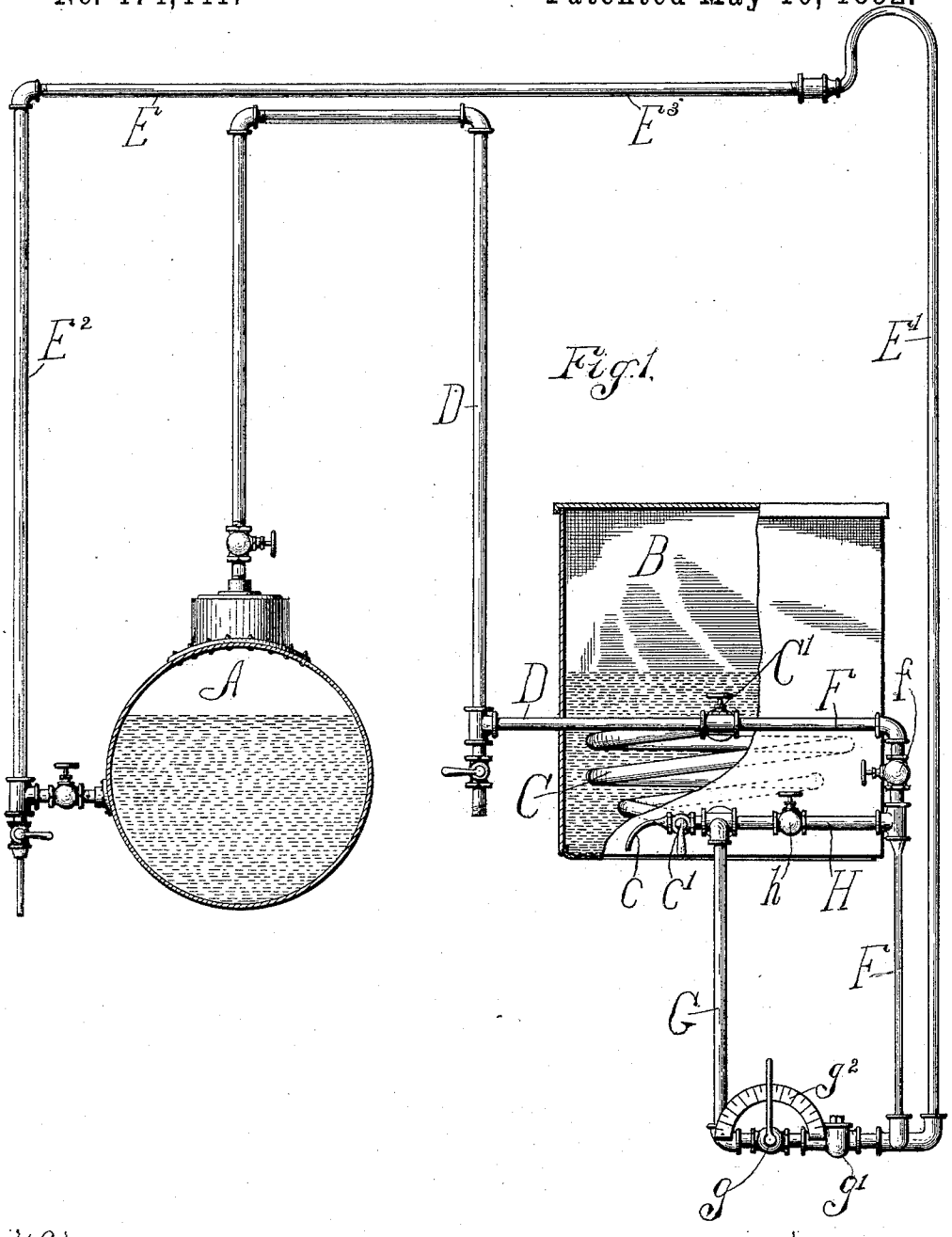


Fig. 1.

Witnesses
H. E. Tomlinson
Louis M. T. Whitehead.

Inventor:
Walter Burnham
By Dayton, Poole & Brown.
His Attorneys

(No Model.) 2 Sheets—Sheet 2.

W. BURNHAM.

STEAM RADIATOR GOVERNOR.

No. 474,441. Patented May 10, 1892.

Fig. 2.

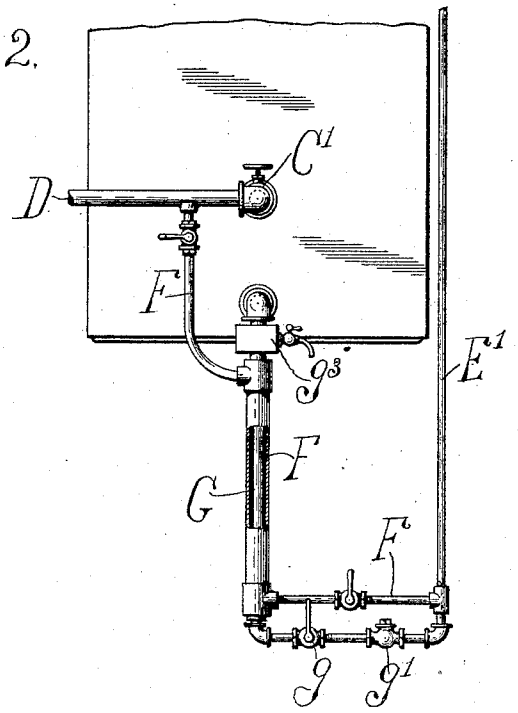
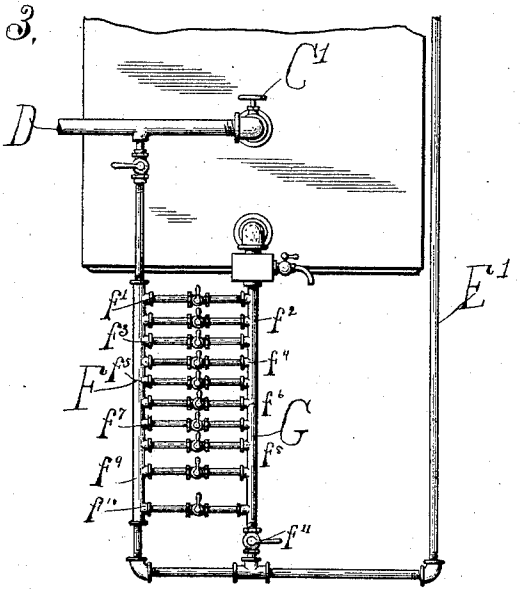


Fig. 3.



Witnesses.
C. E. Tomlinson.
Louis W. F. Whitehead.

Inventor.
Walter Burnham.
By Dayton, Poole & Brown
His Attorneys.

UNITED STATES PATENT OFFICE.

WALTER BURNHAM, OF CHICAGO, ILLINOIS.

STEAM-RADIATOR GOVERNOR.

SPECIFICATION forming part of Letters Patent No. 474,441, dated May 10, 1892.

Application filed January 12, 1892. Serial No. 417,889. (No model.)

To all whom it may concern:

Be it known that I, WALTER BURNHAM, of Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Steam-Radiator Governors; and I do hereby declare that the following is a full, clear, and exact description thereof, reference being had to the accompanying drawings, and to the letters of reference marked thereon, which form a part of this specification.

This invention relates to improvements in apparatus for heating by steam, and more especially to means by which the quantity of steam admitted to a heating-coil or other similar heating device may be controlled in proportion to the expenditure of heat by radiation or conduction from the pipe or passage containing the steam used for heating, so as to prevent undue condensation and consequent reduction of pressure in the steam-generator when the apparatus is working under conditions producing exceptionally rapid condensation of steam—as, for instance, when the entire body of water to be heated by the steam-coil is cold.

The object of my invention may be more readily understood by a consideration of the fact that under the circumstances last referred to condensation of steam in a coil surrounded by cold water which is to be heated may be so rapid as to use a large proportion of the steam produced by the generator, while under ordinary conditions—that is to say, when keeping up to a certain temperature a tank of water which is fed with cold water at a rate sufficient to compensate for vaporization only—the quantity of steam used will constitute only a small fraction of the steam produced in the generator. It follows that where steam from a single generator is used for a variety of purposes great inconvenience will be caused under the circumstances stated by the reduction of pressure produced by the condensation in the heating-coil of the larger part of the steam coming from the generator.

An apparatus embodying my invention is intended and adapted to govern or control the quantity of steam supplied to the heating-coil, so that substantially the same amount of steam will be used at all times and the consumption of an exceptional quantity, which would under ordinary circumstances produce a greater condensation, will be prevented.

In the accompanying drawings, Figure 1 is a view in elevation, with parts in section, of an apparatus embodying my invention. Figs. 2 and 3 are detail views showing modified forms of some of the parts.

As shown in the said drawings, A is a steam-generator; B, a tank containing water to be heated; C, a steam-coil located in the lower part of said tank; D, a steam-supply pipe leading from the steam-generator to the upper end of the coil. E is a steam-loop or return-pipe constructed in the manner set forth in a prior patent, No. 394,859, granted to William Irving December 18, 1888, and adapted for returning water of condensation from the steam-coil into the generator by the direct action of steam and without the agency of any pump or similar mechanical device, said steam-loop comprising a riser E′, a drop-leg E^2 and a horizontal E^3 connecting the riser with the drop-leg. Said drop-leg enters the boiler at a point below the water-level therein, and is adapted to contain a pressure-balancing liquid column, above which is located a space subject to low pressure, toward which steam flows through the riser and into which water is carried or swept upwardly in the form of short pistons filling the bore of the riser, waves on the sides of the riser or of globules suspended in the steam by steam which passes upwardly through the riser to the upper part of the loop, as fully set forth in said Irving patent.

F is a pipe forming a continuation or branch of the pipe D and leading downward to and connected at its lower end with the riser E′.

G is a pipe connected with the lower end of the coil C and leading downward to and connected with the lower end of the riser E′. Said pipe G is provided with a regulating-valve *g* and a check-valve *g′*, which valves are herein shown as located in a lower horizontal part of said pipe G.

H is a pipe connecting the lower end of the steam-coil with the pipe F. The pipe H is provided with a valve *h* and the pipe F with

a valve *f*, located between the upper end of the coil C and the junction of the pipe H therewith.

c is a discharge-pipe at the lower end of the coil C, the same being controlled by a valve *c'*.

C' is a valve controlling the passage of steam into the upper end of the coil C.

The operation of the parts constructed as above described is as follows: Supposing the coil to be cold, the valve C' is opened and the valve *c'* slightly opened and all air thereby blown out of the coil. The blow-off valve *c'* is then closed and the valves *f*, *g*, and *h* opened, so as to place the return system in operation; or, in other words, to effect the return to the boiler through the loop E of water of condensation accumulating in the pipes D and F, the coil C, and pipes G and H, back to and into the generator in the manner contemplated in the said Irving patent. If now the valves *g* and *h* are closed, water of condensation will fill the pipe G and the coil and the pressure in the return system will then be greater than the steam-pressure acting through the coil upon the upper end of the pipe G. The water column in said pipe G will, however, act upon the valve *g* with a pressure which when added to that of the steam upon the upper end of said water column will be greater than the steam-pressure in the return system. It follows that if the valves *g* be opened, water will flow from the coil through the pipe G and valve *g* into the riser E', and will be returned to the boiler by the action of steam passing through the steam-pipe F and carrying said water in separated or detached masses upward through the riser. As water is drawn from the coil the coil will be filled with steam, and it follows that by opening the valve *g* to a desired extent water may be allowed to escape from the coil just as fast as it will accumulate therein by condensation when the apparatus is working under normal conditions—that is to say, assuming that all of the steam made in the generator is employed for heating water in the tank. Then the valve *g* may be turned to allow the escape of water of condensation from the coil at the same rate that it is condensed therein, and this can be determined by gradually opening the said valve *g* until the boiler-pressure begins to fall, when the maximum amount of water which the boiler can evaporate and still hold a desired steam-pressure will be determined. In other words, assuming the boiler will evaporate two gallons of water per minute and the valve *g* is set so that only two gallons of water per minute can pass through it, then the water evaporated will be condensed in and escape from the coil as fast as it is produced and all the steam made will be employed in heating the water. Furthermore, any increase in the quantity of water allowed to escape from the coil will result in a lowering of the boiler-pressure, because the balance between evaporation and condensation will then be destroyed and more steam will be condensed in the coil than is produced in the boiler. By so controlling the exit of water of condensation from the coil therefore the amount of condensation in the coil may be governed or controlled without reference to the temperature of the water, it being obvious that if the water is so cold as to produce more water of condensation than can escape through the valve then the coil will be filled with water up to a point where the steam-space is so reduced as to give a condensing-surface sufficient only for condensing that quantity of water which will pass through the regulating-valve. It follows that as the heat of the tank-water increases condensation in a given steam-space of the coil will be diminished; but as a definite quantity of water is drawn off through the regulating-valve, if the steam-space in the coil is so small as to produce water in quantity less than is drawn off, the steam-space will be increased and will continue to increase until the amount of condensation is just equal to the quantity of water discharged, when evaporation and condensation will again be in equilibrium. When the tank-water is very hot, the coil will be entirely filled with steam, in which case the valve *f* may be closed and the valve H opened, when the coil will be thrown into direct circuit with the return system, and water of condensation, as fast as formed, will pass into the riser of the return or steam loop and will be carried back to the boiler.

It follows from the above that by the use of the apparatus described the water in the tank may be kept at any temperature desired and the full or any desired boiler-pressure retained in the coil and return system. Such regulation may be easily effected by manipulation of the valve *g*, the lever of which is shown as arranged to pass over a divided segment g^2, by which the extent of its movement may be easily seen and controlled. It is obvious, for instance, that the lower the temperature which it is desired to retain in the tank the less steam will be used and the less condensation will take place. The valve *g* will therefore be set to allow the escape of a less quantity of water from the coil when a lower temperature in the tank is desired, cutting off the escape of water of condensation obviously resulting in the coil becoming partially filled and a consequent reduction of the steam-space and of the amount of steam condensed. Similarly, to secure a higher temperature of water in the tank, the valve *g* is opened to allow the escape of a greater quantity of water from the coil in a given time, and a greater part of the coil will then be filled with steam, the amount of heat lost in condensation or conduction will be greater and the quantity of water condensed will be proportionally greater. Finally, when the desired temperature is so great as to require that all of the coil should be filled with steam to accomplish the heating of the water, then the valve *h* may be opened, as before de-

scribed, and the coil brought into direct contact with the return-system. The apparatus described therefore constitutes a means of regulating perfectly the temperature of the water in the tank.

Such apparatus also affords a means of automatically regulating the quantity of steam used, so as to prevent lowering of the pressure in the boiler, because, as before stated, if condensation in the coil increases so as to produce more water of condensation than can escape through the regulating-valve *g*, then the steam-space of the coil will be diminished by the filling of the coil with water, and the amount of steam used thereby decreased until condensation is so small as to call for the normal consumption of steam only.

In the apparatus described regulation may be accomplished otherwise than by the use of the valve *g*, as above set forth—as, for instance, let it be assumed that the evaporating-capacity of the boiler is two gallons, and that said valve *g* is set to allow the escape of three gallons per minute when the valve C′ is open and the coil subject to the full steam-pressure. If said valve C′ is then closed so as to shut off three-fourths of the steam-passage, the little steam passing through it cannot maintain a high pressure of steam, because the steam-pressure in the coil added to the water-pressure in the descending-pipe G does not equal at the check-valve *g′* the pressure in the return system. Under these conditions, therefore, said check-valve remains closed and no water will pass from the coil, but it will remain in the coil, so as to reduce the steam-space thereof until the small quantity of steam passing through the valve C′ will keep up the boiler-pressure therein, when the increased pressure thereby produced on the water column in pipe G will enable the water to flow out through the check-valve to the return system. It follows, therefore, that regulation may be effected either by the use of the valve C′ or the valve *g*, or by both valves.

In Fig. 2 I have shown a construction in which the lower part of the pipe F is enlarged and the pipe G located within the same. In this construction the steam in F transmits its heat to the water in pipe G, which is of about the same temperature when it enters said pipe G as the water in the tank. By this construction, therefore, I utilize the steam which is constantly passing through the pipe F during the operation of the return system for heating the water of condensation before the latter passes into the return system and is carried back to the generator. In small pipes the water, when carried along with the steam or air, may move in pistons filling the bore of the pipe. In such case the air or steam will pass the regulating-valve *g* very rapidly; but the piston of water following it at a high speed will be instantly stopped when it reaches said valve *g*, thereby producing a shock or "water-hammer." To prevent this result, I have greatly enlarged the pipe G at its upper end, so as to form a chamber g^3 in which the water may pass around the air or steam instead of passing along with it, thereby securing a solid body of water at the valve *g*.

The difference in pressure between the steam within the coil and that in the return system determines the extent of steam area in the coils necessary to keep up a certain pressure, it being obvious that the height of the water column in the pipe G must be such as to balance the pressures in the coil and return systems, so that the greater the differences in pressures the higher will be the said column. The height of the water column in pipe G is therefore one of the factors by which the extent of the steam-space in the coil is determined.

Fig. 3 shows a construction in which regulation is effected by changing or shifting vertically the position of the lower end of the water column in the pipe G. In this instance the pipes F and G are connected by horizontal passages f' f^2 f^3, &c., at different heights. When the water is cold and a discharge of a small quantity only of the water of condensation from the coil is desired, the highest passage f' is opened and all others left closed. When the tank-water becomes hotter, one of the lower cross-pipes is opened and the upper one is closed. If the valves in all of the cross-pipes are closed and the valve f^{11} is also closed, water will fill the said pipe G and the coil, and none can escape. If, however, one of the lower valves is opened, water will pass through one of the cross-pipes and will act against the steam-pressure in the return system with a pressure due to the steam-pressure in the coil added to the weight of the column of water in the pipe G and coil above the cross-pipe, through which water is escaping. When one of the lowermost valves is open this water column will fill only a small part of the coil, and thus give a large steam-space therein, while if one of the uppermost valves is open the water column will nearly fill the coil, and a relatively small steam-space will be afforded in said coil. It follows, therefore, that by opening one of the other of the cross-pipes the steam area of the coil may be controlled so as to increase or decrease the quantity of steam condensed in the coil, and to thereby regulate the quantity of steam used.

The apparatus shown in Fig. 3 has the disadvantage of not being automatic or of requiring hand-manipulation of the valves to secure proper results, and this form is herein shown solely for the purpose of more fully illustrating the principles involved in the regulating devices, and is not recommended for practical use.

I claim as my invention—

1. The combination, with a steam-generator, a heating-coil, and a steam-loop for returning to the generator the water condensed

in the coil, said coil containing a water column acting against the back-pressure in the loop, of means for controlling the escape of water from the lower end of the water column to the loop, substantially as described.

2. The combination, with a steam-generator, a steam-heating coil, and a steam-loop to return the water of condensation from the coil to the generator, of a depending pipe connected with the lower end of the coil to afford a water column adapted to overcome the difference in pressure between the coil and the steam-loop, substantially as described.

3. The combination, with a steam-generator, a heating-coil, and a steam-loop, of a depending pipe connected with the lower and discharging end of the coil and with the loop, said pipe to afford a water column of sufficient height to overcome an excess of pressure in the loop over that in the coil, and means for controlling the exit of water from said pipe into the loop, substantially as described.

4. The combination, with a steam-generator, a heating-coil, and a steam-loop for returning the water condensed in the coil to the generator, of a depending pipe connected with the lower and discharging end of the said coil and delivering into the loop, and a valve for controlling the flow of liquid from said pipe to the said loop, substantially as described.

In testimony that I claim the foregoing as my invention I affix my signature in presence of two witnesses.

WALTER BURNHAM.

Witnesses:
H. H. NEWMAN,
S. F. CHAMBERLAIN.