No. 840,833. PATENTED JAN. 8, 1907.

J. FEHRENBATCH.

STEAM CONTROLLER.

APPLICATION FILED FEB. 16, 1906.

2 SHEETS—SHEET 1.

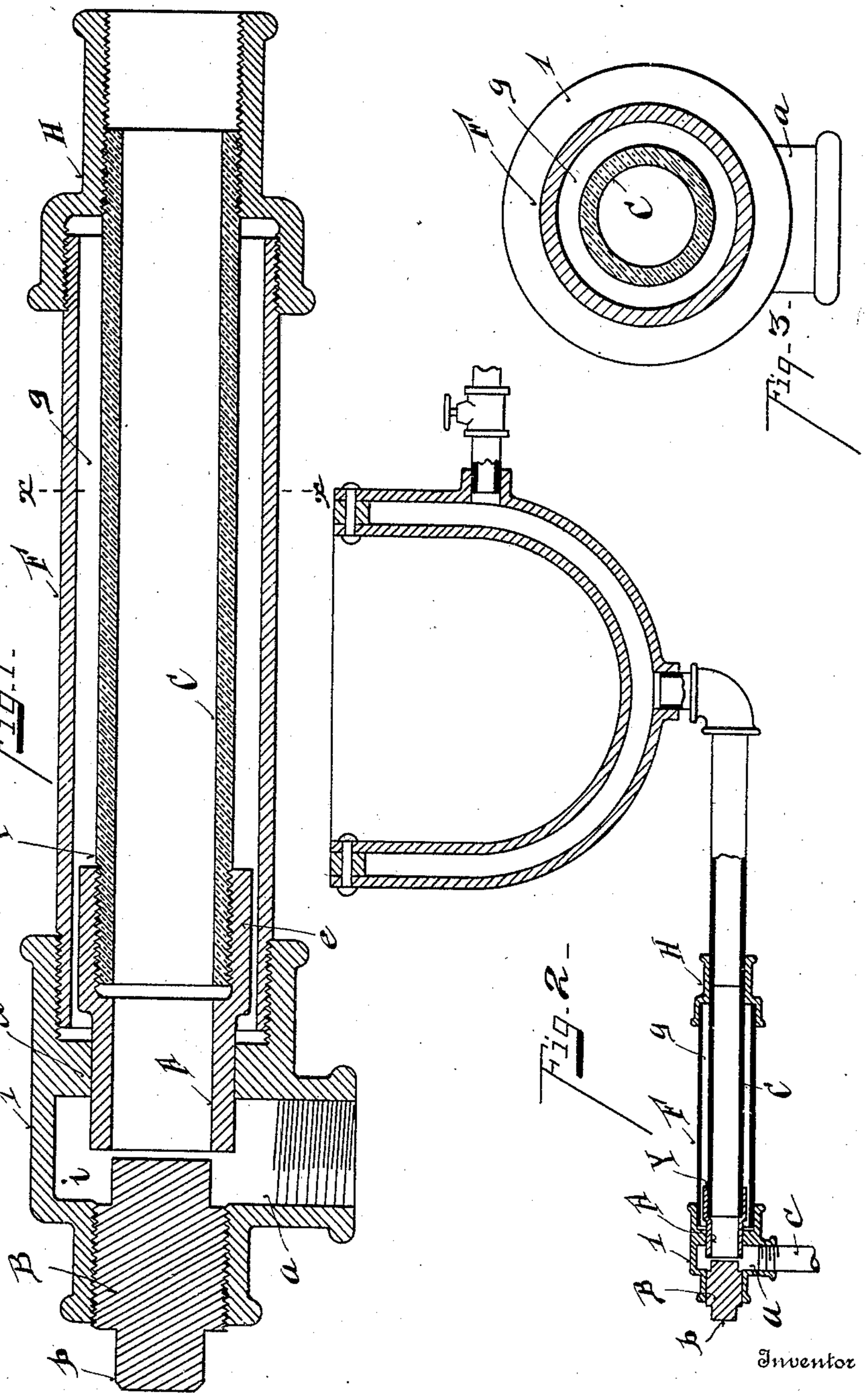

Fig. 1.

Fig. 3.

Fig. 2.

Witnesses

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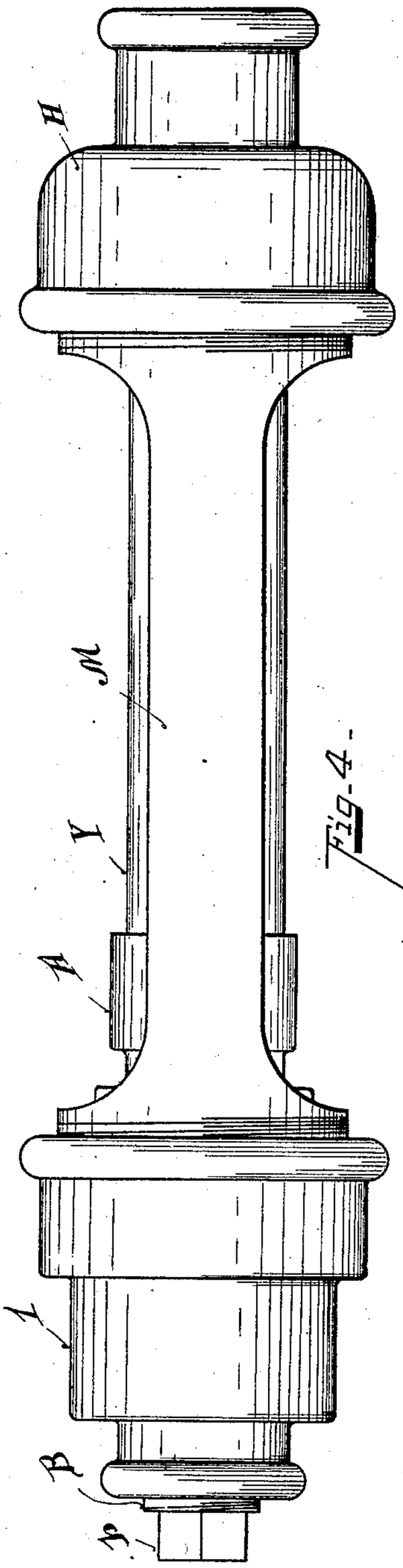

Fig. 4.

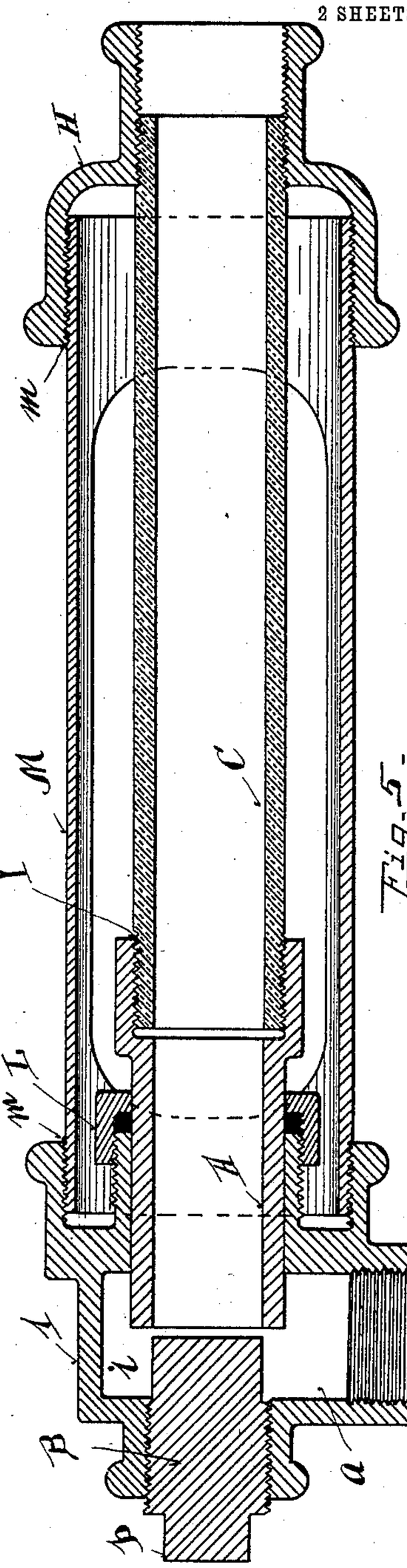

Fig. 5.

Witnesses

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STEAM-CONTROLLER.

No. 840,833. Specification of Letters Patent. Patented Jan. 8, 1907.

Application filed February 16, 1906. Serial No. 301,443.

To all whom it may concern:

Be it known that I, JOHN FEHRENBATCH, a citizen of the United States, residing at Cincinnati, in the county of Hamilton and State of Ohio, have invented certain new and useful Improvements in Steam-Controllers, of which the following is a specification.

The objects of my invention are as follows:

First. To provide a device which will automatically control the amount of steam to be used in a steam-heating appliance by using it as an inlet-controller or as an outlet-controller or by using one as an outlet-controller and one as an inlet-controller at the same time.

Second. To provide a device that will serve as an automatic steam-trap, as well as a controller, when used as the outlet-discharge of a steam-chamber.

Third. To provide a device which when attached to the outlet of a steam appliance can be readily regulated, first, so that only condensation will be discharged; second, so that steam and condensation will be discharged, and, third, so that no condensation will be accumulated and that only steam will be discharged.

Fourth. To provide a device which will control the quantity of steam admitted to or discharged from a steam-heating appliance and that when used at the inlet and outlet of such steam-heating appliance can be adjusted so as to produce any degree of heat due to the steam at any desired pressure below the initial or boiler pressure.

By these means the device is adapted to be applied to a large range of steam-heating appliances to economically use the steam at widely-varying temperatures by simple adjustments to meet the desired condition.

The features of the invention are more fully set forth in the description of the accompany drawings, forming a part of this specification, in which—

Figure 1 is a central longitudinal section of my combined controller and steam-trap. Fig. 2 is a vertical section of a steam-heating vessel with a controller of reduced size attached to the discharge-pipe. Fig. 3 is a section on line *x x*, Fig. 1. Fig. 4 is a longitudinal elevation of a modification of Fig. 1. Fig. 5 is a longitudinal sectional view of Fig. 4.

The device as a controller is constructed as follows: 1 represents a fitting. B represents an adjustable piston screw-threaded into the fitting *l* and having a projecting end *b*, which is preferably square-sided to receive a wrench for making adjustments. *a* represents the elbow portion of the fitting, screw-threaded to receive the pipe *c*, as shown in Fig. 2, which pipe when attached to the device when used as an outlet-controller will be the discharge-pipe for steam and condensation and when the device is used as an inlet-controller it will be the inlet-pipe for the live steam. *d* represents an annular bearing-support of the free end of the expansion-tube Y, which is preferably made in two sections A and C; but the expansion-tube Y may be made of one section of pipe. The preferred form, however, is to make the expansion-tube in two sections, so that section A, which is screw-threaded to the free end of section C, may be termed a "hollow" movable cylinder and section C may be termed the "expansion-tube" proper. The hollow movable cylinder A and the adjustable piston B may be made of any suitable metal, but preferably of cast-steel hardened or of wrought-iron case-hardened for reasons hereinafter stated. When the expansion-tube Y is made in two sections, it is preferably constructed as follows: Section A of the expansion-tube Y, being a hollow movable cylinder, is provided with a fitting *e*, into which is fitted the free end of section C of the expansion-tube Y. The opposite end of said expansion-tube is screw-threaded into the fitting H. Said fitting is provided with an additional fitting, into which is screw-threaded the pipe F, the opposite end of said pipe being screw-threaded into the fitting 1. *g* represents a jacket-space between the pipe F and the expansion-tube. *i* represents an annulus in the fitting 1.

It will be observed that the hollow movable cylinder A and the adjustable piston B project into the annulus *i* on the same axial plane, and, as shown in the drawings, there is a small space between them constituting the discharge or admission orifice, depending upon whether the device be employed at the inlet or the outlet of a steam appliance. If employed at the outlet, it will be the discharge-orifice, and if employed at the inlet it will be the inlet-orifice. Adjustable piston B is made to fit closely into the bore of the hollow cylinder A, being axially in line radially with each other. The adjustable piston B may be set so as to just fit into the bore of the movable hollow cylinder A and practically form a steam-tight joint, or the adjust-

ment may be so made that the longitudinal expansion of the tube Y will cause the movable hollow cylinder A to be moved over the inner end of the adjustable piston B, and thereby close the orifice and prevent the discharge of condensation or steam.

In practice the movable hollow cylinder A is operated by expansion and contraction longitudinally of the expansion-tube Y. This expansion and contraction is caused by variations in the temperatures of steam or condensation, which may be circulated through the controller in either direction. The contraction and expansion of the tube Y is greater than that of the pipe F, because the steam or condensation comes in direct and immediate contact with the tube Y and not with the pipe F, and the tube Y being separated from the pipe F by the jacket-space *g* the extremes between the maximum and minimum temperatures of the tube Y will be much greater than the extremes between the maximum and minimum temperatures of the pipe F. Hence the difference in the expansion and contraction of the tube Y and pipe F, even if the two were made of the same kind of metal and have the same coefficient of expansion, would be sufficient for efficient operation of the device, provided that both the tube and pipe were made of sufficient length or the hollow movable cylinder A and the adjustable piston B of sufficient diameter; but with the pipe F made of iron and section C of the expansion-tube Y made of brass the difference in the expansion and contraction of the pipe and tube would be greater during the operation of the device than it would be if both tube and pipe were made of the same kind of metal.

The movable hollow cylinder A is made to fit closely in its bearing of the fitting 1 and yet permit it to work freely to and from the piston B, the inner end of the adjustable piston B being made to fit closely in the bore of the movable hollow cylinder A, so that when the tube Y expands longitudinally in the direction of the piston B the passage-way or orifice between the ends of the cylinder and piston is contracted and when the tube Y contracts the passage-way or orifice between the ends of the cylinder and piston is enlarged. The area of said passage-way or orifice between the movable hollow cylinder A and the adjustable piston B may be regulated by adjusting piston B to or from the movable hollow cylinder A to suit the conditions under which the device may be operated—that is, it may be adjusted so as to provide for the discharge of a greater or lesser amount of condensation, as may be found necessary, and prevent any undue accumulation of condensation in the steam-chamber to which the device may be attached, and when so regulated the device will be perfectly automatic in its operation and will need no further adjustment so long as the conditions under which it is being operated remain without any extreme variations.

The device may be operated by the admission of steam or condensation either from the direction of the fitting 1 or from the fitting H; but when used at the outlet of a steam-chamber I prefer to use it as shown in Fig. 2.

The device may be used as a reducer of pressure in a steam-heating appliance, so as to produce any desired temperature in such steam-heating appliance above the temperature of the atmosphere and not exceeding the temperature due to the initial or boiler pressure. To accomplish that result, it will be necessary to attach a regulating device to the inlet-pipe and a regulating device at the outlet of a steam-heating appliance. Now if the adjustable pistons B and the inside diameter of the movable hollow cylinders A and the inside diameter of sections C of the expansion-tube Y be of the same dimensions and the adjustable piston B in each regulating device be screwed back from the hollow cylinder A far enough to produce an area of opening in each device equal to the area of cross-section of the bore of the movable cylinder A and section C of the expansion-tube Y the full, or very nearly full, initial or boiler pressure will be produced in the chamber of the steam-heating appliance. This would be true if the inlet and outlet passage-ways of the steam-chamber were wide open and both be of the same size, if ordinary valves were used. Taking, for example, ordinary steam cooking-kettles used in hotels, public and other institutions, where the heating-surface of that part of the kettle which is covered by water or other fluid has about ten square feet and the space between the outer and inner shell be not over two inches, and, if, for example, a four-inch pipe having a four-inch opening leading into the steam-chamber and attached thereto and a four-inch pipe leading from a four-inch discharge-opening of said chamber and attached thereto, the initial or boiler pressure would be produced in said chamber; but there would be a tremendous waste of steam. Under such conditions the inlet-valve might be closed sufficiently with the outlet-valve and pipe wide open to reduce the pressure in the steam-chamber to any required pressure, and consequently any desired degree of temperature; but there would still be a large waste of steam on account of the large outlet. However, it has been ascertained by actual experiments that any desired pressure from zero to boiler pressure, and consequently any desired temperature above the temperature of the atmosphere, but not exceeding the temperature due the initial or boiler pressure, can be produced with an area of opening of three one-hundredths (.03) of an inch

in the outlet passage-way by regulating the inlet passage-way accordingly, so that if a temperature due to steam having a pressure of fifty pounds per square inch be required and the boiler or initial pressure of the steam being one hundred pounds per square inch the inlet passage-way would require an area of opening a trifle over one-half of that contained in the outlet passage-way; but with a regulating device attached to the inlet passage-way and one at the outlet passage-way adjusted to discharge only condensation the appliance will use the least possible amount of steam necessary to do the work required and will be automatically controlled and regulated under ordinary conditions.

The movable hollow cylinder A and the adjustable piston B, as has been stated, may be made of any suitable metal, but preferably of cast-steel, and the inner ends tempered to the desired hardness, first, for durability, and, second, to enable the edges to shear away any hard substance which may lodge on and tend to clog the passage-way between the movable cylinder A and the adjustable piston B, which object cannot be accomplished by the use of flat or beveled seated valves.

Another advantage of my invention over devices operated with valves moving against seats is that in case of extreme expansion or improper adjustment of the device the bore of the movable hollow cylinder A will slip over the adjustable piston B, thus cutting off the circulation of the steam or condensation without breaking or damaging the device.

The device may, as has also been stated, be operated by the admission of steam or condensation from either end; but the preferred manner of operating the device when employed at the outlet passage-way of a steam-chamber is by the admission of the steam or condensation from the end of the fitting H, as shown in Fig. 2, for the following reasons: If the steam or condensation be admitted to the orifice between the movable hollow cylinder A and the inner end of the adjustable piston B from the direction of the pipe-opening *c* in the fitting 1, the full or very nearly full pressure contained in the steam-chamber of the apparatus to which the device may be attached will be contained in the fitting 1 in the space *i* surrounding the orifice between the movable hollow cylinder A and the adjustable piston B; but immediately after passing through the said orifice into the movable hollow cylinder A the pressure will be reduced to correspond with whatever back pressure may be encountered, which back pressure may not be above atmospheric pressure. Consequently the temperature of the condensation or of the steam will be reduced accordingly, unless a plug or other device having a contracted orifice sufficiently small be inserted in the end of the section C of the expansion-tube Y where it enters the fitting H or in the line of pipe beyond the expansion-tube toward the steam-chamber to which the device may be attached; but if the device be operated by the admission of steam from the end of the fitting H, as shown in Fig. 2, the full or very nearly full pressure contained in the steam-chamber of the apparatus to which the device may be attached will be contained in the expansion-tube Y, and the difference between the temperature of steam and the condensation in the tube Y will be much greater than it would be if admitted to the said tube Y from the fitting 1. Hence the movement of the free end of the tube Y will be correspondingly greater and the device will work more effectively and have greater latitude between the maximum and the minimum amount of condensation to be discharged if the steam and condensation be admitted to the expansion-tube Y from the fitting H than it would if admitted from the cylinder and piston end of the device.

In cases where coils of pipe are employed for heating purposes or for cooking or boiling purposes and the steam is not discharged into the liquid the device may be employed with equally good advantage in the saving of steam and in the preventing of waste.

As a guide for the manufacture and operation of my device it will be sufficient for practical purposes when used as an outlet-controller in connection with any boiling, cooking, or heating apparatus to keep the steam-chamber of any such apparatus free from condensation without waste in steam if section C of the expansion-tube Y be made of brass and the pipe F be made of iron and each have a length of about three feet, and the diameter of cross-section of the bore of the movable hollow cylinder A and the diameter of cross-section of the inner end of the adjustable piston B be not less than seventy-five one-hundredths of an inch and that the diameter of cross-section of the passage-way for steam and condensation from the steam-chamber to which the device may be attached leading to the inner end of the movable hollow cylinder A and the passage-way for steam and condensation leading from the inner end of the hollow cylinder A have a diameter of cross-section of not less than seventy-five one-hundredths of an inch, and when so constructed the device will have sufficient capacity for effectively discharging condensation of from one to one hundred and forty-seven square feet of heating-surface and perform the work automatically when adjusted to suit the required condition. From this basis the size and length of the controller device may be made to apply to the discharging end of any steam-using appliance—such as cooking vessels, steam-radiators, sterilizers, &c.—and it may be used as a

steam-trap simply and will automatically be controlled by the variations of the temperature to discharge all the condensation, or it may be used as a steam-pressure reducer and controller by placing one at the inlet and one at the outlet of the steam-heating appliance. Suppose the device is to act as a steam-trap simply and is to be adjusted to take care of condensation. The device is attached in the position shown in Fig. 2. Steam is admitted into the vessel J by opening a throttling-valve K of the inlet-pipe L. The piston B is adjusted to the mouth of the hollow movable cylinder A, so that practically no steam will pass out of the expansion-tube Y. Now if at any time the amount of condensation should become too great to pass out of the annular orifice between the parts A and B the expansion-tube Y will be cooled by the accumulated condensation and will contract and withdraw the hollow movable cylinder A farther away from the piston B, thereby increasing the area of discharge-orifice and permit the free discharge of the accumulated condensation. The incoming steam, when the condensation has been discharged, will again heat the expansion-tube Y and expand it so that it will move the hollow cylinder A in the direction of the piston B until the escape of steam is cut off. Thus the trap will be automatically controlled by the variations of the temperature to discharge all the condensation, and the steam-heating appliance will be run with a minimum amount of steam always under automatic control. Now if it be desired to raise the temperature in the steam-chamber of the appliance to a greater degree of heat than can be obtained where all the steam is condensed piston B of the inlet-controller can be adjusted so as to provide a larger area of opening for the passage of steam toward the vessel to which it may be attached, and the piston B of the outlet-controller is adjusted so that steam, as well as condensation, will be discharged, wasting some steam in order to get the proper degree of heat, which may be determined by a thermometer attached to the steam-heating appliance. The controllers will thus automatically maintain approximately the desired degree of heat.

In Figs. 1 and 2 of the preferred form I have shown the jacket-pipe F as a means for connecting the fittings together and avoids the use of a stuffing-box and gland around the cylinder A; but said pipe F is not an indispensable feature, as other supports or attachments may readily be employed.

In Figs. 4 and 5 I have shown one modified form of construction in which a stuffing-box is employed. L represents the gland of the stuffing-box. The fitting *l* is enlarged and the gland screws directly upon the hollow cylinder A. M represents a pipe with sections slotted out, so as to allow a circulation of air, the tube C only being partially jacketed. *m* represents screw-threads on said pipe for engaging into the threads of the fittings at each end. By this construction the fittings are held in position against longitudinal movement, and the contraction and expansion of the tubes Y will regulate the size of the orifice, as above described.

The regulator may be used at both the inlet and the outlet passage-way of a steam-chamber, and when so used any desired steam-pressure, not exceeding the initial or boiler pressure, may be produced in the steam-chamber with the use of the least possible amount of steam. To accomplish this object, both regulators must be attached, with the end H toward the steam-chamber. The condensation or steam from the steam-chamber will be discharged into the outlet-regulator at H, and the live steam will be admitted into the inlet-regulator at *c*, and thence through the orifice into the expansion-tube, and thence into the steam-chamber. When so connected, the adjustable pistons B can be so adjusted that any desired steam-pressure not exceeding the boiler or initial pressure may be produced in the steam-chamber to which they may be attached, and when so adjusted, should the boiler or initial pressure be increased and cause any increase in pressure in the inlet-regulator, and consequently increase temperature, the expansion-tube C will expand proportionally and contract the area of opening between the hollow cylinder A and the adjustable piston B, and thus prevent any material increase in the pressure and temperature in the steam-chamber. Again, when the inlet and the outlet regulators have been adjusted to produce a given steam-pressure in the steam-chamber to which they may be attached and the condensation is being discharged through the outlet-regulator as rapidly as it is being formed and the steam-pressure should be increased in the steam-chamber from any cause, all of the condensation will be blown out and steam will circulate through the expansion-tube C in the outlet-regulator, and because of its temperature being greater than that of condensation which previously filled the tube, the tube will expand, and consequently contract the area of opening between the hollow cylinder A and the adjustable piston B, check the escape of steam, and prevent waste. On the other hand, should the steam-pressure in the steam-chamber to which the regulators may be attached be reduced the operation of the inlet-regulator will be reversed—that is, should the steam-pressure in the steam-chamber to which the regulators may be attached be reduced on account of any reduction in the initial or boiler pressure the temperature of the steam in the inlet-regulator will be reduced proportionately. Consequently the expansion-tube C will contract

and produce an enlargement of the area of opening between the hollow cylinder A and piston B and increase the steam-pressure in the steam-chamber.

The operation of the inlet-regulator is such that as the temperature of steam in the regulator increases with increased pressure the expansion-tube C expands at the same time and contracts the area of opening between the hollow cylinder A and piston B, and as the temperature of steam in the regulator decreases with decreased pressure the expansion-tube C contracts and increases the area of opening between the hollow cylinder A and piston B, so that with increasing steam-pressure the said area of opening decreases and lets in a decreasing amount of steam, and with decreasing steam-pressure the said area of opening increases and lets in an increasing amount of steam. Hence the pressure of steam, and consequently temperature, in the steam-chamber to which the regulators may be attached, are maintained practically uniform at the pressure and temperature for which the regulators may have been adjusted.

It is very important when the device is used to supply steam to an appliance to have at times not only a small area of orifice but to have the same kept clear from obstructions from foreign substances which are often found in steam-using appliances. I have found that by the use of the annular orifice formed between a piston and cylinder the registering of the piston with the tube, due to the repeated expansions and contractions constantly occurring in practice will clear away such obstructions and tend to keep the orifice clear, and that it also effectually prevents the buckling of the expansion-tube, and I believe I am the first to accomplish this result.

Having described my invention, I claim—

1. A controller for steam-heating appliances, composed of a fitting, an adjustable piston fitted therein, an expansion-tube supported on bearings in said fittings at one end thereof and axially in line with said piston, means for holding said tube stationary at one end, and means for connecting said chamber to the pipes of a steam appliance, substantially as described.

2. A controller for steam-heating appliances, composed of a fitting, an adjustable piston fitted therein, an expansion-tube supported on bearings in said fitting at one end, and axially alined with said piston a second fitting for holding said expansion-tube stationary at one end, means for holding said fittings in fixed relative positions, and a jacket-pipe surrounding the expansion-tube and connected to the fittings at each end thereof, substantially as described.

3. A controller for steam appliances, composed of a fitting, a chamber in said fitting, an adjustable piston fitted therein, an expansion-tube supported on one end in a bearing in said fitting communicating with said chamber axially alined with said piston, forming an annular orifice between said parts and means for connecting the parts together and to the pipes of a steam appliance, substantially as described.

4. A combined steam-trap and steam-controller, composed of a part employing a chamber or annulus, an expansion-tube journaled therein and an adjustable piston in axial alinement therewith forming normally an annular orifice between said parts, means for supporting said parts in relative position, and means for connecting the same to the discharge-pipe of a steam appliance, substantially as described.

5. A controller for steam-heating appliances, composed of a fitting, a chamber therein, a piston terminating in said chamber, an expansion-tube supported on bearings in said fitting at one end thereof in axial alinement with said piston, means for holding said tube stationary at the opposite end, and means for adjusting the relative position of tube and piston for regulating the area of the orifice between said members, substantially as described.

6. In a device of the class described, a longitudinally-expansible steam-conduit one end of which is fixed, and a piston supported in juxtaposition to the other end of the conduit, whereby an annular orifice is formed between them variable in area under the changing conditions of expansion and contraction of the conduit, substantially as described.

7. In a device of the class described, a longitudinally-expansible steam-conduit one end of which is fixed, a piston supported in juxtaposition to the other end of the conduit, forming an annular orifice between them, and means for adjusting one of said members relative to the other, substantially as described.

8. In a device of the class described a fitting, a chamber therein, an expansible steam-conduit fixed at one end in a second fitting, the other end having a slidable bearing in a wall of said chamber, and a closely-fitting piston supported in said chamber in juxtaposition to the movable end of said conduit, adapted to form a variable passage between them and adapted to pass the tube over the piston when the conduit is expanded beyond the normal point, substantially as described.

9. In a device of the class described, a chamber having a steam-orifice, an expansible steam-conduit fixed at one end, the other end having a slidable bearing in a wall of said chamber, a closely-fitting piston supported in said chamber in juxtaposition to the movable end of said conduit, the said piston being adapted to enter said movable conduit end when the conduit is expanded to

close the annular orifice, and means for relatively adjusting the piston and conduit to vary the normal size of the annular orifice formed between them, substantially as described.

10. In a device of the class described, a conduit, a closely-fitting piston adapted to pass into and out of one end of the conduit and an annular orifice between itself and the end of the conduit in the normal position, a seatless valve when the tube is expanded to cover the piston and means for utilizing the heat of the contents of the conduit to cause contraction and expansion whereby the said annular orifice is varied in area, substantially as described.

11. In a device of the class described, an expansible-tube conduit having an open end, a piston placed in juxtaposition to and adapted to fit within said open end, thereby forming an annular orifice between the opposing ends of said members, and means for utilizing the heating medium to expand and contract said expansible member for automatically controlling the area and for opening and closing said annular orifice, substantially as described.

In testimony whereof I have hereunto set my hand.

JOHN FEHRENBATCH.

Witnesses:
OLIVER B. KAISER,
LEO O'DONNELL.