The invention described herein, if patented, may be manufactured and used by or for the Government for governmental purposes, without the payment to me of any royalty thereon.

This invention relates to a steam injection water heater, more particularly to a heater that is adapted to inject steam into the water adjacent to the point of use, and to a safety shut-off device therefor.

This application is a continuation in part of my application Serial Number 459,783, filed June 5, 1943, Steam injection water heater, now abandoned.

One of the objects of the invention is the furnishing of a continuous supply of hot water at any desired temperature when steam is available as a heating means.

Another object of the invention is the provision of a device that can be employed where the outlet flow of hot water is intermittently shut off by the user at a point near the heater, for example, at a faucet at the end of a short hose or pipe, without danger to the user when the outlet is opened again.

A further object of the invention is to provide means for automatically cutting off the supply of steam to the line when the supply of cold water is interrupted.

The drawback of previously designed injection type heaters is the accumulation of water and steam which is trapped in the discharge line of the heater when the flow is shut off at the outlet. This water becomes highly heated under the steam pressure, and when the outlet is again opened an explosive flow of scalding water and steam is emitted. Furthermore, if for any reason the supply of water to the installation is cut off, the line is filled with steam and condensate, and any person who carelessly opens the outlet while holding his hands in the flow is likely to be severely scalded.

The present heater was developed to overcome these drawbacks, and eliminates the danger of the previous type of heater by an arrangement of the steam valve that will instantly and automatically shut off the steam where it enters the heater, when the flow of hot water is shut off at the outlet, and also by providing a safety shut-off for the supply of steam which operates when the cold water supply fails, even though the outlet is open.

The heater is also provided with means for manually regulating the temperature of the water at the outlet at any time. The units are small and compact and one of suitable size and proportion can be located at any place where hot water is needed, thus eliminating the use of a central heating tank and coil. It is also suitable for use at temporary installations, as in army and construction camps, where the ordinary types of water heaters are not suitable or available.

With the above objects and advantages in view, the invention consists of a construction and combination of parts which a preferred embodiment is illustrated in the accompanying drawing. Practical application may dictate certain changes or alterations and such changes may be made within the spirit of the invention as defined in the appended claims.

Referring to the drawing forming a part hereof and in which the invention is illustrated:

The single figure is a side elevation view partly in section of the structure embodying the invention.

Referring more in detail to the drawing, the water heater 10 includes a cold water inlet pipe 11, a steam inlet pipe 12 and a hot water outlet pipe 13 terminating in a flow controlling means such as the faucet indicated at 14. The steam pipe 12 is received in the inlet of a shut-off valve casing 15, and a valve seat 16 is formed in the casing 15. A valve seat 17 is movable toward and away from seat 16 to control the flow of the steam through the valve casing and is preferably provided with a sealing disc 18 of any suitable material to engage the seat and prevent leakage. Valve 17 is operated toward and away from its seat 16 by a valve stem 19, which is engaged with the diaphragm 20, preferably by screw threads not shown. The diaphragm 20 is positioned within a sealed diaphragm chamber 21.

A tubular member 22 is mounted on the bottom of the casing 15 and is threaded on the outside as shown in order that a nut 23 can be provided to support the yoke 24. An adjusting nut 25 is also mounted on the screw threaded portion of the member 22, and a compression spring 26 is mounted on the member 22 and the stem 19 between the nut 25 and the diaphragm 20. The spring 25 with the adjusting means 26 serves to balance the diaphragm between the steam and water pressures to control the opening of valve 17.

The diaphragm casing 21 is supported from the yoke 24 by means of rods 27 held in place by nuts 28. The lower parts of nuts 28 serve also to clamp the diaphragm casing forming pieces together with the diaphragm between the edges, where it serves as a sealing member for the casing.

The outlet port 29 of the valve casing 15 re-
ceives the pipe 30 therein and a temperature regulating valve 31 is connected to the pipe 30 at its other end. The valve 31 is connected to the inlet 32 of the injection jet 33 by means of a pipe 34.

The injection jet 33 receives the cold water inlet pipe 11 at the inlet 35. The outlet port 36 of the injection jet is connected to the inlet 37 of a Venturi tube 38, and the outlet 39 of the venturi 33 is connected to the hot water outlet pipe 13. At this point the steam and cold water are thoroughly mixed while passing through the Venturi tube 38 to the outlet.

Port 40 is positioned at the low pressure point in the venturi 38 and is adapted to receive a short coupling 41 which is connected to the safety shut-off device 42. Under ordinary conditions water passes freely from the venturi to the lower part of the diaphragm casing 21 through the device 43 and the coupling pipe 44.

In operation, water enters the injection jet 33 through port 39 and flows through the Venturi tube 38 to the hot water outlet 13. Steam, the line 12 passes through the shut-off casing 15, the valve being open when the heater is in operation, and water is being drawn from the outlet 14, then through temperature regulator 21 to the jet 33. The steam combines with and heats the water at this point. As the water passes through the restricted section of the Venturi tube 38 to the outlet, the resulting low pressure on the diaphragm 20, with the aid of the compression spring 26, keeps the steam shut-off valve 17 open when hot water is being used.

When the hot water supply at the outlet 13 is shut off at any point 14 whether near to or remote from the heater, the pressure of the water is conducted to diaphragm chamber 21 through pipe 41, shut-off device 43 and pipe 44. This pressure on the diaphragm 20 is sufficient to overcome compression spring 26 and the pressure of the steam supply and close the valve 17, thus shutting off the steam and preventing further heating of the water trapped between the heater 10 and the outlet at the end of the pipe 13. The valve 17 is kept close by the water pressure on the diaphragm 20, until the outlet is again open. This releases the pressure on the diaphragm 20, which allows the valve 17 to open and steam to enter and mix with and heat the cold water entering from inlet 11.

In order to prevent the escape of steam unmixed with water if the outlet 16 should be opened while the water supply is shut off, a shut-off device 43 is provided. The shut-off device 43 comprises a housing 45 holding a differential pressure operated two-way valve body 46. The valve body 46 consists of two cylindrical portions of different diameters, the smaller head 47 being at the top and the portion of the valve above it communicating with the pipe 45 leading to the upper part of the shut-off valve chamber 48. The part of the valve chamber below the larger valve face 49 receives the pipe 41 leading to the venturi. The valve body 47 is freely slideable within the chamber, but is biased to its upper position by the spring 50. The screw adjusting means 51 provides for adjusting the tension of the spring 50 to balance the valve 47 in accordance with the steam and water pressure available at any particular installation.

When the valve 47 is in its upper position the water pressure from the venturi is transmitted through the spring containing portion of the chamber without interruption and to the diaphragm chamber 21 through pipe 44. A by-pass 52 is provided, however, between the upper portion of the valve chamber and the passage 53 which receives the pipe 44. When the water pressure in the venturi is non-existent the steam pressure through the line 48 is sufficient to displace the valve body 46 downwardly, although it operates on its smaller face 47. The steam pressure is then by-passed through the passage 52 and pipe 44 to the diaphragm chamber 21, where it operates to keep the valve 17 closed.

Thus it will be seen that the water pressure from the heater operates on the larger face 49 of the valve body and with the aid of the spring 50 overcomes the pressure of the steam on the smaller face 47, thus opening the lower port 53 and closing the by-pass 52. When the water supply fails there is no water pressure in the lower valve chamber, and the pressure of the steam on the upper face 47 of the valve body overcomes the force of the spring 50 and moves the valve body or piston 46 down, thereby opening the by-pass 52. The steam supplies through the pipe 48 then enters the diaphragm chamber 21 through by-pass 52, passage 53 and pipe 44, closing the steam valve 17 and preventing the steam from entering the heater when no water is present. The shut-off device will operate whether the hot water outlet 11 is open or closed, and thus guards against the discharge of steam or scalding water from the faucet 14 in case of failure of the water supply.

The temperature of the heated water is manually controlled by the temperature regulator valve 31. Since the valve 17 acts merely as a check valve when the pressure in the Venturi tube is low and the pressure in the steam line is exerted to open the valve 17, the quantity of steam passing to the mixing chamber is positively controlled by adjusting the valve 31. The maximum capacity of the valve 31 should be approximately equal to the maximum capacity of the valve 17. When the valve 31 is partly closed the check valve 17 need not open fully. If less steam per unit of time passes through the valve 31 while the quantity of water passing through the mixing chamber remains the same, the temperature of the heated water will be lower.

Thus it will be seen that a supply of hot water can be provided wherever steam and water are available. The heater provides hot water as used, thus eliminating the necessity of providing a storage tank with the consequent loss of heat from the stored hot water. The use of a steam valve controlled by the opening and closing of the hot water outlet and the steam shut-off device operating when the water supply fails, together eliminate the danger of excessive amounts of steam and scalding water getting into the line when hot water is not being drawn from the outlet, and there is consequently no need to shut off the steam supply manually when the faucet is closed. This heater is particularly useful in steamships and other steam-powered installations and in military organizations for providing hot water in washhouses at camps and with field equipment.

Having thus described my invention what I claim and desire to secure by Letters Patent is:

1. A steam injection water heater comprising supply lines for steam and water to a Venturi mixing chamber connected to said lines and having an outlet, a valve in said steam line, means comprising a diaphragm and a diaphragm chamber for operating said valve, a pressure-conducting
means interconnecting said diaphragm chamber with said mixing chamber and said steam supply line, and a two-way differential pressure operated valve in said pressure conducting means for admitting water from said venturi or steam from said supply line to said diaphragm chamber depending on the relative pressures in said steam line and mixing chamber.

2. A steam injection water heater comprising a steam supply pipe having a valve and a water supply pipe, a Venturi mixing chamber connected to said pipes and having a closable outlet, a diaphragm-controlled operating means for said valve, said means having pressure transmitting lines to said steam supply and to said venturi, and a two-way valve common to said lines, said two-way valve having a slidable body adapted to close the steam pressure transmitting line when water pressure in the venturi reaches a predetermined point.

3. A steam injection water heater comprising supply lines for steam and water, a Venturi mixing chamber connected to said lines and terminating in an outlet, a valve in said outlet, means controlled by the Venturi effect of water flowing from the outlet to admit steam to the chamber, a bypass from the steam supply to the steam supply control means, and a valve in said bypass exposed to pressures from the venturi and the steam supply line and adapted to be opened by extreme low pressure in the venturi to cut off the steam supply.

4. A steam injection water heater comprising a steam supply pipe, a valve therein, a water supply pipe, a mixing chamber connected to said pipes and having a closable outlet, control means for said valve, said control means having pressure-transmitting lines to said steam supply pipe and said chamber, a two-way valve common to said lines and including a valve body, a spring engaging one end of said valve body to normally close off the steam pressure-transmitting line, said valve body being exposed to pressures from said chamber and from said steam line, whereby the operation of the two-way valve is controlled by the differential pressures in said steam line and said mixing chamber in conjunction with said spring, and means communicating with the two-way valve and responsive to pressure passing therethrough to operate the first-mentioned valve.

5. A steam injection water heater comprising a steam supply pipe, a valve therein, a water supply pipe, a mixing chamber connected to said pipes and having a closable outlet, control means for said valve, said control means having pressure-transmitting lines to said steam supply pipe and said chamber, a two-way valve common to said lines and including a valve body, said valve body being exposed to pressures from said chamber and from said steam line, whereby the operation of the two-way valve is controlled by the differential pressures in said steam line and said mixing chamber, and means communicating with the two-way valve and responsive to pressure passing therethrough to operate the first-mentioned valve.

MARLIN C. MOORE.

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