

April 17, 1945.

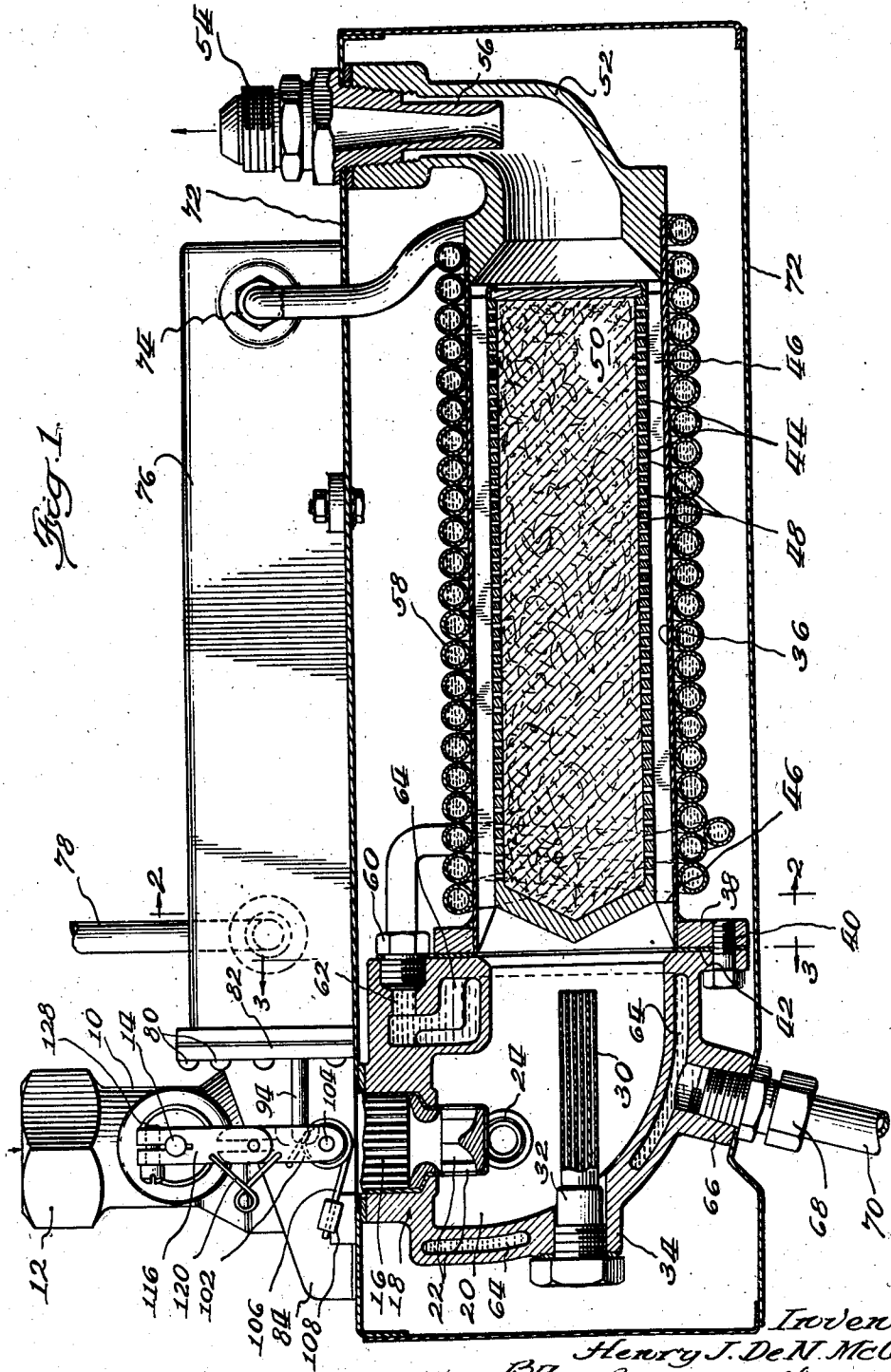
H. J. DE N. McCOLLUM

2,373,767

LIQUID HEATER

Filed July 27, 1942

3 Sheets-Sheet 1



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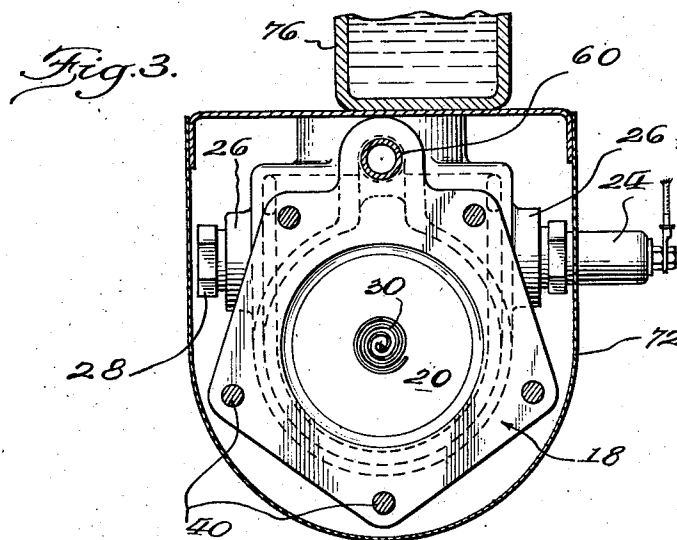
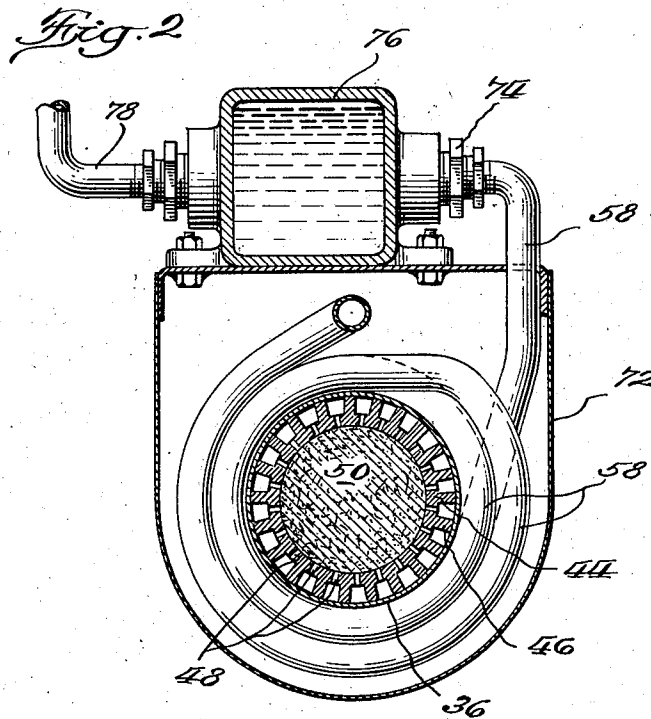
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LIQUID HEATER

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3 Sheets-Sheet 2



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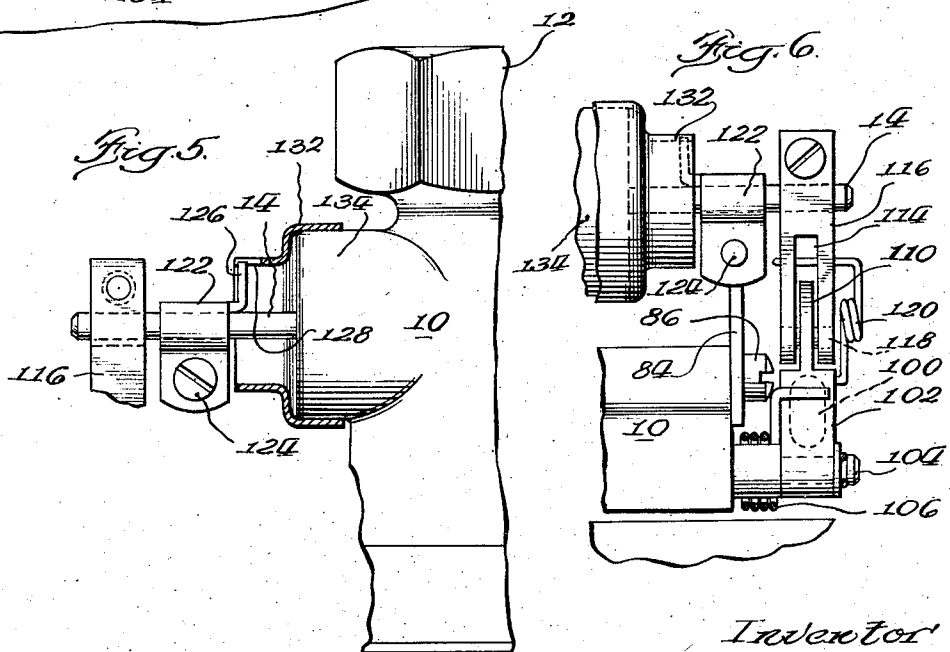
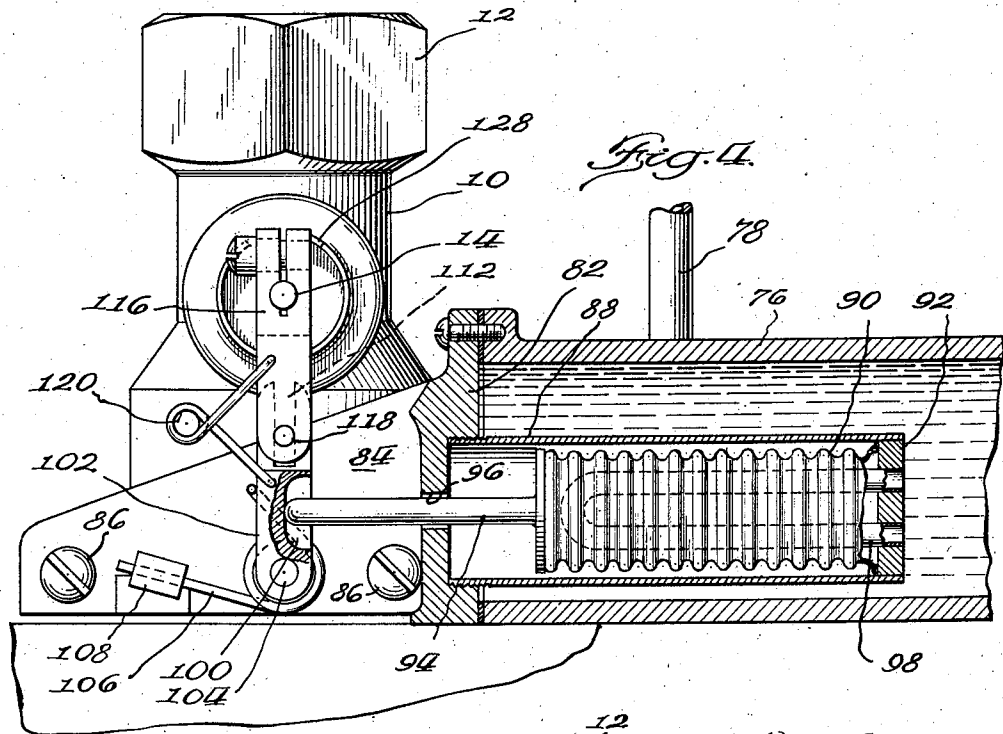
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LIQUID HEATER

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3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

2,373,767

LIQUID HEATER

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Application July 27, 1942, Serial No. 452,538

5 Claims. (Cl. 236—32)

The present invention relates to liquid heaters and is more particularly directed to liquid heaters of the internal combustion type adapted for use in aircraft or other vehicles in which maximum heat production is desired from a heater of minimum size and weight.

A typical use for a heater of this type is to provide a source of hot water for use on large airplanes of the type which must remain away from their bases for extended periods. This hot water may be needed for washing, shaving and other purposes. Another typical purpose for which a heater of this type may be used is for heating a liquid which is then circulated through radiators in the space occupied by the crew. For this purpose glycol is the liquid frequently used as a heat exchange medium. These uses are merely illustrative and others will be apparent from the following description.

It is an object of my invention to provide an improved heater of the internal combustion type particularly adapted for heating water, glycol or other liquids.

A further object is to provide an improved internal combustion liquid heater which maintains the temperature of the liquid substantially constant regardless of the quantity of liquid passed through the heater.

A further object is to provide an improved internal combustion type liquid heater which can be economically constructed, which will be highly efficient, which will operate satisfactorily under varying conditions, which will be small in size and weight, and which will have a long, useful life.

Other objects will appear from the following description of a preferred embodiment of my invention.

In the drawings in which similar characters of reference refer to similar parts throughout the several views:

Fig. 1 is a side elevation of a heater embodying the present invention with a portion thereof shown in longitudinal section;

Fig. 2 is a transverse sectional view taken in the direction indicated by the arrows along the line 2—2 of Fig. 1;

Fig. 3 is a transverse sectional view taken in the direction of the arrows along the line 3—3 of Fig. 1;

Fig. 4 is a fractional side elevation of the upper left hand fraction of Fig. 1 drawn to larger scale with portions thereof broken away to illustrate the mechanism interiorly thereof;

Fig. 5 is a back view of a portion of the mechanism illustrated in Fig. 4; and

Fig. 6 is a front elevational view of a portion of the mechanism illustrated in Figs. 4 and 5.

Heaters of the type to which the present invention relates are supplied with a combustible mixture of air and fuel, such as gasoline from a carburetor or, when utilized on a vehicle having an internal combustion engine supercharger, the combustible mixture can be drawn from the outlet of the supercharger. Normally, flow of combustible mixture through the heater is produced by a pressure differential brought about either by connecting the exhaust outlet of the heater to a suction producing apparatus, or by connecting the combustible mixture inlet to a source of combustible mixture under pressure. For instance, when the heater is used in conjunction with a vehicle having a non-supercharged internal combustion engine, flow can be produced through the heater by connecting the exhaust heater fitting to the intake manifold of the vehicle's internal combustion engine. If the vehicle engine is supercharged, combustible mixture can be fed under pressure from the supercharger in which case no suction producing means is needed at the exhaust fitting.

In Fig. 1 of the drawings, a valve fitting 10 has its inlet end 12 internally threaded for attachment to a conduit through which combustible mixture is supplied to the heater. Within the fitting 10 is located a throttle valve of the butterfly type. This valve is not shown but the rotatable shaft on which it is mounted is indicated by the numeral 14. This throttle valve by its position controls the rate of flow of combustible mixture through the heater apparatus.

The lower end of the fitting 10 is tubular and contains a bundle of small diameter tubes 16 formed of a metal having good heat conducting properties, such as copper, for instance. The sum of the bores through these tubes together with the spaces between the tubes provides a passage that offers little resistance to the flow of combustible mixture therethrough. The tubes, however, prevent flame from flashing back into the valve 10 in a well known manner.

The valve fitting 10 is suitably secured to an elbow-shaped casting 18 having a hollow portion 20 which serves as a combustion chamber, the combustible mixture entering this chamber through radial ports 22 located below the flame arrester 16. The radial ports 22 are formed by striking out vanes from a cylindrical member and

therefore the combustible mixture enters the combustion chamber 20 with a swirling motion.

Within the combustion chamber, the combustible mixture is ignited by an igniter plug 24 of the hot wire type, which is threaded through a boss 26 formed as a portion of the casting 18. Inasmuch as it may be desirable in different installations to have the igniter plug 24 on different sides of the heater, two threaded bosses 26 are provided opposite each other. The igniter is screwed into either one of these bosses, while the other is closed by a plug 28. If desired, two igniters may be used in some installations. The igniter 24 is of the hot wire type in which the wire resistance element is electrically heated to a temperature sufficient to initiate combustion of the mixture flowing into the combustion chamber. Once the combustion has been initiated, the igniter 24 can be deenergized either manually or thermostatically, inasmuch as a reigniter 30 serves to re-kindle the combustible mixture if for any reason combustion should be temporarily interrupted. The reigniter 30 comprises a spirally wound sheet of inconel or other heat and corrosion resistant metal which is quickly heated by the combustion within the combustion chamber to a temperature sufficient to kindle the combustible mixture. This reigniter is more fully disclosed in my copending application Serial No. 410,039 filed September 8, 1941. For convenience, the reigniter 30 is secured to the end of a plug 32 threaded into a boss 34 formed at the end of the casting 18.

From the combustion chamber within which the combustible mixture is burned, the hot products of combustion pass through a heat exchange tube 36, the inlet end of which is provided with a flange 38 secured to the combustion chamber casting 18 by means of cap screws 40, the joint between the members being sealed by a gasket 42.

Within the heat exchange tube 36 the hot products of combustion pass around a cylindrical muffler structure 44 spaced from the side wall of the tube 36 by a plurality of longitudinally extending ribs 46, the structure thereby providing a plurality of longitudinally extending channels which straighten out the eddies in the hot products of combustion so as to produce a smooth flow. The side wall of the cylindrical structure 44 is provided with a multiplicity of perforations 48 while the interior is packed with sound damping material, such as stainless steel wool 50, for instance. The arrangement thus provided damps out pulsations in the hot products of combustion, and serves as a muffler to quiet the operation of the heater as well as preventing periodic pulsations of the type known as motor boating.

The hot products of combustion leaving the heat exchange tube 36 are collected in an L-shaped end cap 52 and are passed outwardly through an exhaust fitting 54 threaded for attachment to an exhaust conduit to be connected to a space of lower pressure than that of the fuel mixture supply. At its inner end the exhaust fitting 54 is threaded into the end cap 52 and has a Venturi shaped restricting tube 56 which serves to stabilize the rate of flow of combustible mixture through the system by compensating for changes in the relative pressure between the fuel mixture supply and exhaust. This device functions in a manner more fully disclosed in my prior Patent No. 2,191,173.

The heater so far described operates to heat

the heat exchange tube 36 and this heat is transferred to a tube 58 of copper or other good heat conducting material wound therearound in closely formed turns, the inlet end of this tube being wound back upon itself and connected to an inlet fitting 60 threaded into the casting 18 where it communicates with a bore 62 leading to a cored out liquid jacketing space 64. This liquid jacketing space 64 formed in the casing 18 substantially completely surrounds the combustion chamber, and at a low point on the casting 18 is connected by means of an internally threaded spud 66 to a liquid inlet fitting 68, this fitting in turn being connected to an inlet pipe 70.

The opposite end of the tube 58 passes outwardly through a sheet metal shell 72 which encloses the combustion chamber and heat exchange portions of the apparatus and is connected to a fitting 74 threaded into a longitudinally extending header tank 76. This tank extends from a position adjacent the outlet fitting 54 nearly to the inlet fitting 12 and near its forward end is connected on the opposite side to an outlet pipe 78.

At its forward end the tank 76 is flanged and is secured by screws 80 to a similar flange on a cap 82, this cap having a forwardly extending vertical web-like member 84 secured by screws 86 to the inlet fitting 10, thereby forming a solid structure. The inner face of the cap 82 is formed to provide a threaded cylindrical recess into which one end of a thermostatic tube 88 is threaded. This tube contains a thermostatic bellows 90 closed at its inner end by a plug 92 sealed to the inner end of the tube 88. The opposite or forward end of the bellows is attached to a plunger 94 which extends through an opening 96 in the cap 82 with its outer end in a position substantially beneath the butterfly valve shaft 14.

The bellows 90 contains either or other easily vaporized substance which develops a sufficient range of vapor pressures within the temperature range of operation of the device to operate the throttle valve through the mechanism to be described presently. To enhance the rate of heat transfer to the liquid within the bellows 90, a U-shaped heat transfer tube 98 extends well within the bellows and has its ends sealed in and projecting through the cap 92 so that liquid within the header tank 76 can circulate through the tube 98, thus bringing the liquid within the tank into intimate heat transfer relation with the liquid within the bellows 90.

The outer end of the plunger 94 is seated in a slotted socket 100 formed in the edge of a lever 102 pivoted at its lower end upon a transversely extending pin 104 secured to the inlet member 10. The upper end of the lever 102, therefore, is free to move backwardly and forwardly under the influence of similar movement of the plunger 94. This lever is biased against the end of the plunger by a grasshopper spring 106 coiled about the pin 104 with its upper end resting against the face of the lever 102 opposite the plunger 94, while its lower end rests in a slot in an abutment 108 formed as a projection on the web 84 of the cap 82.

The upper end of the lever arm 102 is of thinner section than the lower portion so as to provide an upstanding thin finger 110 transversely slotted as indicated at 112. This finger is located within a longitudinally extending slot 114 formed in a downwardly extending arm 116 clamped at its upper end to the butterfly valve shaft 14. A transversely extending pin 118 is located in the

slot 112 in the upper end of the lower lever 110 and is secured at its ends in the upper lever 116. Thus, fore and aft movement of the upper end of the lower lever 102 will be transmitted to the upper arm 116 through the pin 118 so as to cause similar fore and aft movement of the lower end of this upper arm. This angular motion is in turn transferred to the shaft 14, thereby causing the butterfly valve partially to be closed upon expansion of the bellows 90.

In order to prevent rattles and to take up any lost motion which may exist, the arm 116 and the lever 102 are connected to opposite ends of a light weight floating grasshopper spring 120. The motion of the arm 116 and hence the rotation of the shaft 14 is limited by a stop member 122 clamped to the shaft 114 by screw 124. This stop member has an outwardly radiating finger 126 which moves back and forth with rotation of the shaft 14 in a slot 128 formed in the edge of a cup-shaped member 132 press-fitted over a cylindrical surface 134 formed as a portion of the inlet fitting casting 10. Thus the shaft 14 is free to rotate back and forth upon contraction and expansion of the bellows 90 until the finger 126 is brought against either the forward or backward end of the slot 128, beyond which no motion can take place.

Assuming that with a heater of the above type properly installed, it is desired to supply hot liquid, such as water or glycol, the heater is started, that is, a flow of combustible mixture is produced through the device and the igniter 24 is energized. This initiates combustion of the combustible mixture, soon after which the igniter can be deenergized, inasmuch as the reigniter 30 will immediately re-kindle the combustible mixture if combustion for any reason momentarily fails. The hot products of combustion pass through the heat exchange portion of the apparatus and transfer the heat therein to the heat exchange tube 58. The liquid passing through the liquid jacket space 64 and through the tube 58 is, therefore, heated, and passes into the header tank 76 from which it is withdrawn through the pipe 78. After the liquid within the header tank 76 has reached the desired operating temperature, the ether or other substance within the bellows 90 will be vaporized, thus causing the bellows to expand somewhat. This movement of the bellows is transferred through the plunger 94 to the lower lever 102 and rocks the upper end of this lever forwardly, the motion being transferred by the pin 118 to the upper arm 116. This motion in turn produces rotation of the butterfly valve 14, thus restricting the opening through the inlet fitting 10, thereby decreasing the rate of flow of combustible mixture through the heater. With this system it will be seen that the higher the temperature of the liquid within the tank 76, the less the amount of combustible mixture that will be permitted to flow through the heater. Similarly, if the temperature within the tank 76 drops, the bellows 90 will contract, thereby rotating the butterfly valve toward open position.

While I have shown and described a particular embodiment of my invention, it will be apparent to those skilled in the art that numerous modifications and variations may be made without departing from the underlying principles of the invention. I therefore desire, by the following claims, to include within the scope of the invention all such modifications and variations by which substantially the results thereof may be

obtained by the use of substantially the same or equivalent means.

I claim:

1. In a liquid heater, the combination of an internal combustion type heater having means forming a combustion chamber, and a heat exchange conduit connected to said combustion chamber and adapted to receive the hot products of combustion therefrom, an inlet connection adapted to be connected to a source of combustible mixture, a throttle valve in said inlet connection, conduit means for conveying combustible mixture from said throttle valve to said combustion chamber, liquid conducting means in heat exchange relation with said heat exchange conduit, a header connected to one end of said liquid conducting means and adapted to receive and store the liquid after it has been circulated through said liquid conducting means, thermostatic bellows means arranged in heat exchange relation to the liquid in said header, and means operated by expansion and contraction of said bellows means for partially opening and closing said throttle valve.

2. In a liquid heater, the combination of an internal combustion type heater having means forming a combustion chamber, and heat exchange means connected to said combustion chamber and adapted to receive the hot products of combustion therefrom, conduit means adapted to convey combustible mixture to said combustion chamber, throttle valve means in said conduit means, liquid conducting means in heat exchange relation with said heat exchange means to interchange heat from the hot products of combustion to the liquid in said liquid conducting means, a header for receiving the heated liquid from said liquid conducting means, thermostatic means connected to operate said throttle valve and adapted to alter the setting of said throttle valve upon an increase or decrease in temperature of the liquid in said header, and means to interchange heat between the liquid in said header and said thermostatic means.

3. In a liquid heater, the combination of an internal combustion type heater having means forming a combustion chamber, and a heat exchanger connected to said combustion chamber and adapted to receive the hot products of combustion therefrom, an inlet connection adapted to be connected to a source of combustible mixture, a throttle valve in said inlet connection, conduit means for conveying combustible mixture from said throttle valve to said combustion chamber, liquid conducting means in heat exchange relation with said heat exchanger to interchange heat from the hot products of combustion to the liquid in said liquid conducting means, a header for receiving the heated liquid from said liquid conducting means, thermostatic means arranged in heat exchange relation to the liquid in said header, means operated by expansion and contraction of said thermostatic means for partially opening and closing said throttle valve, and stop means to limit the movement of said throttle valve to less than the full range of movement provided by said thermostatic means, whereby the amount of heat produced by the internal combustion heater will vary inversely with the temperature of the liquid in said header.

4. In a liquid heater, the combination of an internal combustion type heater having means forming a combustion chamber, and a heat exchanger connected to said combustion chamber

and adapted to receive the hot products of combustion therefrom, an inlet connection adapted to be connected to a source of combustible mixture, a throttle valve in said inlet connection, conduit means for conveying combustible mixture from said throttle valve to said combustion chamber, liquid conducting means in heat exchange relation with said heat exchanger to interchange heat from the hot products of combustion to the liquid in said liquid conducting means, thermostatic means arranged in heat exchange relation to the liquid issuing from said liquid conducting means and responsive solely to the temperature thereof, and means operated by expansion and contraction of said thermostatic means for partially opening and closing said throttle valve.

5. In a liquid heater, the combination of an internal combustion type heater having means forming a combustion chamber and heat exchange

means connected to said combustion chamber and adapted to receive the hot products of combustion therefrom, conduit means adapted to connect said combustion chamber to a source of combustible mixture, liquid conducting means in heat exchange relation with said heat exchange means to interchange heat from the hot products of combustion to the liquid in said liquid conducting means, a header connected to said liquid conducting means for receiving the heated liquid, a thermostatic element in heat exchange relation to the liquid in said header a throttle valve operated by said thermostatic element, said throttle valve being located in said conduit means, and a housing enclosing the internal combustion type heater and said liquid conducting means and separating them from said header and said thermostatic element.

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