Nov. 26, 1946. H. J. DE N. McCOLLUM 2,411,663

HEATER

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Fig. 2.

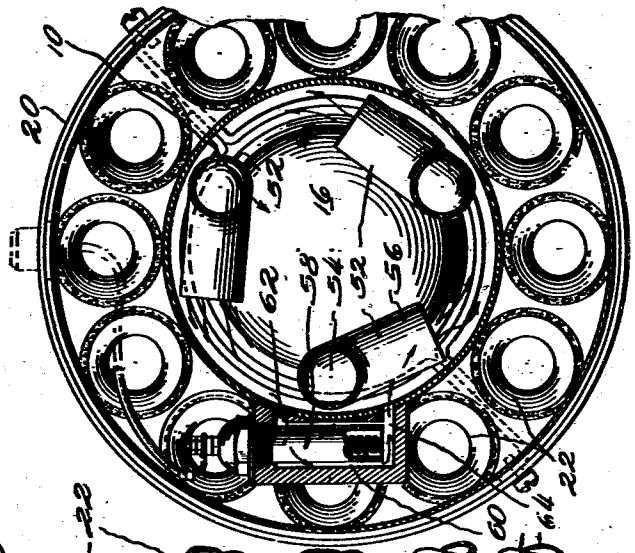
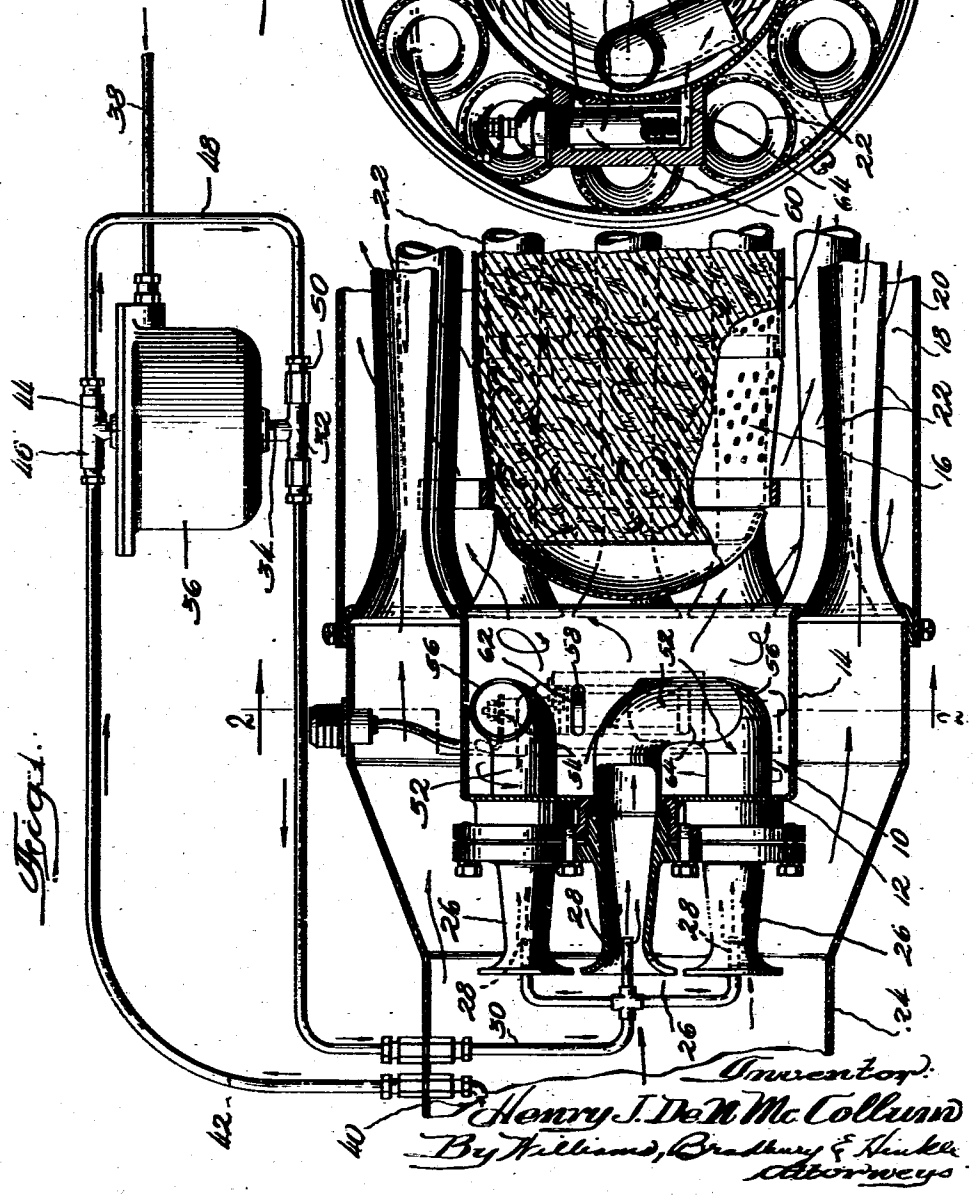


Fig. 1.



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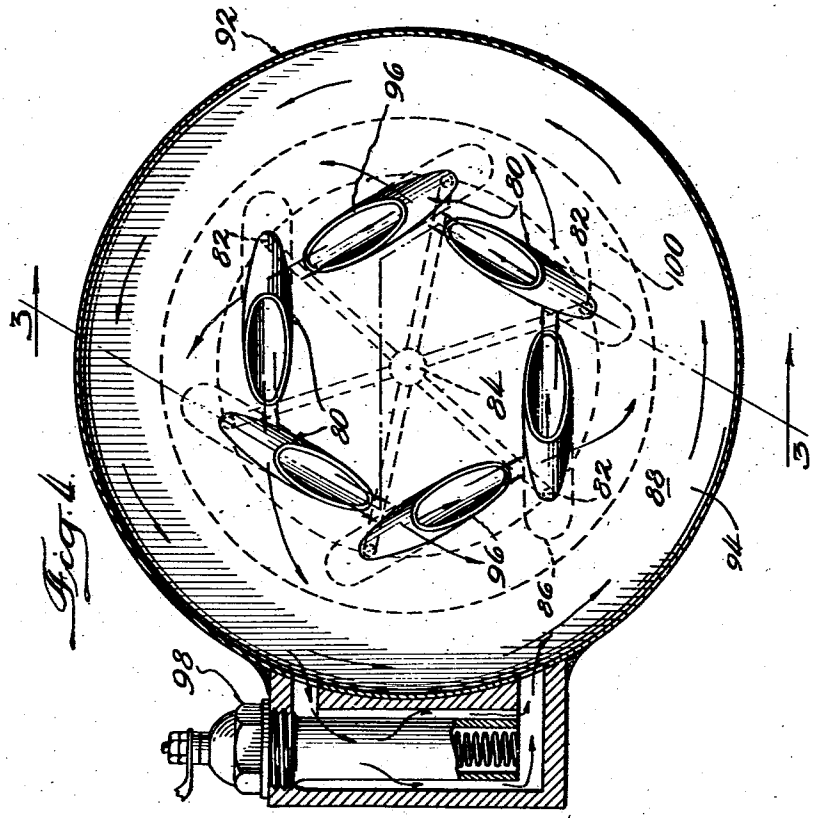


Fig. 4.

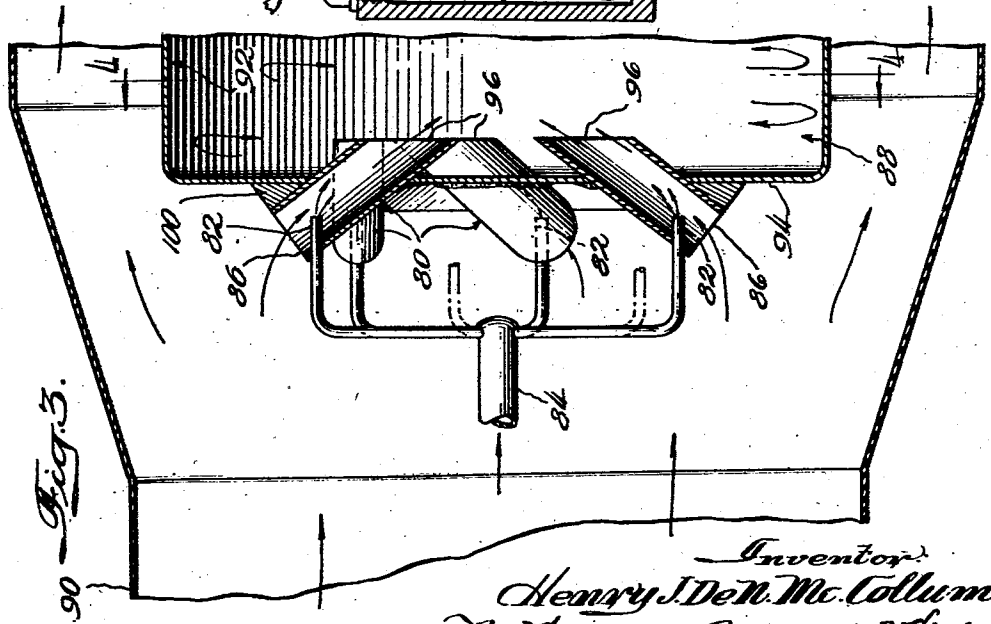


Fig. 3.

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UNITED STATES PATENT OFFICE

2,411,663

HEATER

Henry J. De N. McCollum, Chicago, Ill.; Thelma McCollum, executrix of said Henry J. De N. McCollum, deceased, assignor to Stewart-Warner Corporation, Chicago, Ill., a corporation of Virginia

Application March 1, 1943, Serial No. 477,507

12 Claims. (Cl. 126—116)

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My invention relates to heaters, and more particularly to heaters of the internal combustion type.

An object of my invention is to provide an internal combustion type of heater wherein the combustion will be more uniform and thorough, whereby the efficiency of the heater is increased.

Another object of my invention is to provide a heater having an improved arrangement of induction tubes for delivering a combustible mixture to the combustion chamber.

Another object of my invention is to provide a heater having improved means for supplying combustible mixture simultaneously to different parts of the combustion chamber.

Another object of my invention is to provide a heater having improved means for preheating the combustible mixture delivered to the combustion chamber.

Another object of my invention is to provide a heater having a more even distribution of flame in the combustion chamber.

Other objects and advantages will become apparent as the description proceeds.

In the drawings:

Fig. 1 is a partial longitudinal section through a heater embodying one form of my invention;

Fig. 2 is a transverse section taken on the line 2—2 of Fig. 1;

Fig. 3 is a view similar to Fig. 1 but showing a modified form of my invention; and

Fig. 4 is a transverse sectional view taken on the line 4—4 of Fig. 3.

The heater shown in Figs. 1 and 2 comprises a combustion chamber 10 having an end wall 12 and a cylindrical wall 14. When combustion takes place in the combustion chamber 10, the hot gases resulting from this combustion flow from the open righthand end of the combustion chamber around the nose of a muffler 16 and into the annular gas passage 18 formed between the sides of the muffler 16 and a cylindrical casing 20.

As the hot gases flow lengthwise of the annular passage 18, these gases pass between and around ventilating air tubes 22 which extend lengthwise of the passage 18 in spaced relationship to each other and are arranged circumferentially about this passage. The tubes 22 are preferably of Venturi shape, and the construction and arrangement of these tubes, the muffler 16 and casing 20 constitute a heat exchanger which may be identical with that disclosed and claimed in my copending application, Serial No. 477,908, filed March 4, 1943. As the gases flow lengthwise of the annular passage 18, these gases give up their heat to the ventilating air tubes 22. The cooled gases of combustion are discharged to atmosphere from the righthand end of the passage 18, whereas the ventilating air, having absorbed heat from the walls of the tubes 22, is delivered to the cabin of an airplane or other space to be heated.

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The heater has an air inlet 24 which may be supplied with air by a ram, blower or any other suitable means. Part of this air flows around the combustion chamber 10 and enters the ventilating air tubes 22 to be heated by the hot products of combustion flowing around these tubes. The remainder of the air entering the inlet 24 flows into the open lefthand ends of the three identical Venturi tubes 26, where it mixes with an extremely rich mixture of fuel and air delivered to each of these Venturi tubes by a jet 28. The jets 28 are connected by piping 30 to a T 32 having a restricted branch 34 communicating with the bottom of a float bowl 36 connected by pipe 38 to any suitable source of fuel. A ram 40 located in the heater inlet 24 is connected by pipe 42 and branch 44 of a T 46 to the top of the float bowl 36. A pipe 48 connects the T's 32 and 46 and has a restriction 50 at its point of connection to the T 32.

The pressure difference between the ram 40 and throat of the Venturi tubes and the hydrostatic head of the fuel in the float bowl 36 causes this fuel to flow through restricted branch 34 into T 32 where it mixes with air flowing into this T through restriction 50. An exceedingly rich mixture of fuel and air is formed in the T 32 and delivered through piping 30 and jets 28 to the throats of the Venturi tubes 26. The mixture delivered by the jets 28 is too rich to burn, and a combustible mixture is not formed until the rich mixture delivered by the jets has intermixed with the combustion air which enters the open lefthand ends of the Venturi tubes.

The structure for producing the rich mixture of fuel and air is claimed in my copending applications, Serial No. 456,335 filed August 27, 1942, and Serial No. 460,970 filed October 6, 1942. One advantage of utilizing this structure lies in the fact that a very slight pressure differential between the ram 40 and jets 28 suffices to form a rich mixture of fuel and air and to lift this mixture an appreciable distance where it is inconvenient to have the float bowl at substantially the level of the Venturi tube or tubes. In the particular forms of heater shown in this application, it is especially desirable to supply the fuel to the jets 28 in the form of a rich mixture of

fuel and air than in the form of liquid fuel, since the greater volume of the rich fuel and air mixture facilitates the division and distribution of the fuel supply among the several Venturi tubes.

Each Venturi tube **26** delivers a mixture of fuel and air to an induction tube **52**. These induction tubes are identical and each comprises a tube of substantially uniform diameter providing a smooth, unobstructed and uninterrupted passage through which the mixture flows to the combustion chamber **10** at a rate of flow greater than the rate of flame propagation, so that combustion is confined to the combustion chamber and does not take place in the induction tubes **52**. Each induction tube extends in an axial direction through the end wall **12** of the induction chamber and has a curved portion **54** leading to a straight outlet end section **56** which extends along a chord of the cylindrical wall **14**. The combustible mixture is discharged from these straight sections toward and along the circular wall **14** and is ignited by an electrical igniter **58** to form a ring of flame in the combustion chamber **10**. The electrical igniter is located in a pocket **60** to one side of the combustion chamber and communicating with this chamber by way of passages **62** and **64** in such manner that centrifugal force causes a flow of combustible mixture through the pocket **60** for ignition by the igniter **58**. The particular arrangement of the igniter **58** is disclosed and claimed in my copending application, Serial No. 478,258 filed March 6, 1943. The structure and arrangement of the induction tubes **52** is claimed more broadly in my copending application, Serial No. 477,080 filed February 25, 1943, which application, however, discloses a heater having only a single induction tube.

Where only a single induction tube is utilized, the combustible mixture discharged therefrom must enter the combustion chamber at a high rate of flow in order to form a complete circle of flame about the cylindrical wall of the combustion chamber. Such an arrangement is eminently satisfactory in a heater of large capacity, whereas in a heater of smaller capacity and requiring less combustible mixture, difficulties have been encountered in providing a sufficient rate of discharge of the combustible mixture from a single induction tube to provide a ring of flame extending completely about the annular wall of the combustion chamber. With my present arrangement, however, it is only necessary that the combustible mixture discharged by each induction tube form a relatively short arc of flame in order to provide a complete circle of flame in the combustion chamber. The outlet end of each induction tube is adjacent the curved portion **54** of the next induction tube in the direction of mixture discharge, so that the burning mixture from one induction tube envelops and heats the outlet end **56** of the next induction tube and assures adequate preheating of the mixture delivered thereby. The length of those parts of the induction tubes which are in the combustion chamber may be varied to give different degrees of mixture preheating and thus accommodate the heater to light or heavy fuels.

The number of induction tubes and the particular arrangement thereof may be varied to secure any desired results. In Figs. 3 and 4 I have shown a modified form of my invention utilizing six identical induction tubes **80**. A rich mixture of fuel and air is delivered directly to these tubes by the jets **82** connected to a common pipe **84** which is supplied with a rich mixture of fuel and air by the means shown in Fig. 1 or by any other suitable means. Each induction tube **80** is a straight section of pipe of uniform diameter and has an inlet end **86** located outside of the combustion chamber **88** and positioned to receive air from the heater inlet **90**.

Each induction tube **80** is inclined relative to the axis of the cylindrical wall **92** of the combustion chamber **88** and extends through the rear wall **94** of this combustion chamber. The inner end of each induction tube **80** terminates in an outlet **96** located in a plane perpendicular to the axis of the combustion chamber. The outlet ends of the induction tubes **80** are located a substantial distance from the circular wall **92** of this chamber, and are so positioned that the mixture discharged by these tubes whirls about the axis of the combustion chamber and forms a ring of flame therein when ignited by the electrical igniter **98**.

In that form of my invention shown in Figs. 3 and 4, the portions of the induction tubes which extend into the combustion chamber are relatively short. This has the advantage of permitting the use of a combustion chamber which is extremely short but provides relatively little preheating of the combustible mixture by heating of the inwardly extending portions of the induction tubes. An appreciable part of the preheating of the combustion mixture is attained through heating the external portions of the induction tubes **80** by heat transmitted to these tubes from the end wall **94** of the combustion chamber through metal fillers **100** interposed between the wall **94** and the external portions of the induction tubes. Any desired amount of preheating may be obtained by increasing or decreasing the lengths of the external portions of the induction tubes and the extent of the metal fillers connecting these tubes with the combustion chamber wall **94**.

Except as herein illustrated and described, the embodiment of my invention shown in Figs. 3 and 4 may be identical with that shown in Figs. 1 and 2. In each of these embodiments, the combustible mixture is supplied to the combustion chamber through induction tubes of uniform diameter and through which the mixture normally flows at a rate greater than the rate of flame propagation. If the rate of air delivery to the heater inlet should be temporarily reduced, the flow of combustible mixture in the induction tubes would be correspondingly reduced and some combustion might then take take place in these tubes. Such combustion, however, could not under any circumstances extend all the way back to the fuel jets since the mixture of fuel and air delivered by these jets is too rich to be combustible and a combustible mixture is not formed until the rich mixture delivered by these jets has traveled an appreciable distance and has intermixed with combustion air. As soon as the air flow in the heater inlet has returned to normal, all burning gases are blown out of the induction tubes and into the combustion chamber, and no combustion thereafter continues in the induction tubes.

While I have illustrated and described only two embodiments of my invention, it is to be understood that my invention is not limited to the details shown and described but may assume numerous other forms, and that the scope of my invention is defined in the following claims.

I claim:

1. A combustion chamber means having a cylindrical wall, a plurality of induction tubes having outlet ends in a plane perpendicular to the axis of said wall, the axes of said tubes being inclined to said plane, said tubes arranged to discharge combustible mixture tangentially to said wall, means for supplying combustible mixture to said induction tubes, means for igniting said mixture, and means providing an igniter pocket communicating at each end with said combustion chamber whereby combustible mixture is circulated through said pocket and over said igniter by the tangential discharge from said induction tubes.

2. A heater of the class described, comprising means forming a combustion chamber having a longitudinal axis and a cylindrical wall, a plurality of induction tubes having outlet ends equally spaced in a circle about said axis, each of said outlet ends being directed at an acute angle to said cylindrical wall and arranged to discharge a combustible mixture substantially tangentially to said wall, an igniter for igniting said mixture, means cooperating with said combustion chamber to provide an igniter pocket communicating at each end with said combustion chamber whereby a combustible mixture is circulated through said pocket and over said igniter by the tangential discharge from said induction tubes, means for supplying combustible mixture to said induction tubes, a heat exchanger receiving hot products of combustion from said combustion chamber, and means supplying air to said induction tubes and said heat exchanger.

3. A heater of the class described, comprising means forming a combustion chamber having a longitudinal axis and a cylindrical wall, a plurality of straight uniform diameter induction tubes for supplying combustible mixture to said chamber arranged in a circle about said axis and inclined with respect to said axis, each tube being arranged to discharge toward said cylindrical wall at an acute angle thereto and arranged to cause the mixture to sweep around the wall tangentially thereof, an igniter, means forming an igniter pocket communicating at each end with said combustion chamber whereby combustible mixture is circulated through said pocket and over said igniter by the tangential discharge from said induction tubes, a fuel jet in each of said tubes, and common means for supplying fuel to all of said jets.

4. A heater of the class described, comprising means forming a combustion chamber having a cylindrical wall, several induction tubes for supplying combustible mixture to said chamber, said induction tubes being straight and in non-parallel relationship to each other, each tube being arranged to discharge toward said cylindrical wall at an acute angle thereto and arranged to cause said mixture to sweep around said wall tangentially thereof, and means for supplying fuel and air to said induction tubes, an igniter, and means providing an igniter pocket communicating at each end with said combustion chamber whereby combustible mixture is circulated through said pocket and over said igniter by the tangential discharge from said induction tubes.

5. A heater of the class described, comprising means forming a combustion chamber of substantially cylindrical form and having an end wall, a plurality of induction tubes extending through said end wall, each of said induction tubes having a relatively short outlet portion located in said combustion chamber and directed at an acute angle to the cylindrical wall thereof and arranged to discharge a combustible mixture substantially tangentially to said wall and adjacent the end wall of the chamber, means for igniting said mixture in the chamber, each of said induction tubes having a portion external to said chamber, heat transmitting means connecting said end wall with external portions of said tubes for preheating fuel and air supplied by said tubes to said combustion chamber, and means for supplying fuel and air to said tubes.

6. A heater of the class described, comprising means forming a combustion chamber having an axis, a plurality of induction tubes extending into said chamber and inclined with respect to said axis, said tubes having outlet ends arranged in a circle about said axis, said tubes being arranged so that mixture discharged by said tubes tends to whirl about said axis, means for supplying fuel and air to said tubes, and means for igniting said mixture, together with means providing an igniter pocket which communicates at each end with said combustion chamber whereby combustible mixture is circulated through the pocket and over the igniting means by the whirling discharge from said induction tubes.

7. A heater of the class described, comprising means forming a combustion chamber having an axis and including a wall disposed around said axis, a plurality of straight induction tubes of uniform diameter inclined with respect to said axis and arranged to deliver combustible mixture to said combustion chamber in substantially tangential relation to said wall, said tubes having inlet ends outside of said chamber, a jet in each of said tubes, means for supplying a rich mixture of fuel and air to each of said jets, means for supplying air to said inlet ends, an igniter, and means providing an igniter pocket communicating at each end with said combustion chamber whereby combustible mixture is circulated through said pocket and over said igniter by the tangential discharge from said induction tubes.

8. A heater having a heat exchanger and means for supplying air thereto, said heater comprising means forming a combustion chamber having an end wall and a cylindrical side wall, said cylindrical side wall being attached to said heat exchanger, a plurality of induction tubes passing through said end wall and secured thereto, each of said induction tubes having an end located in said combustion chamber and lying in a plane of a chord of said side wall, each of said tubes having a second end in open communication with said air supply means and receiving combustion air therefrom, a fuel jet in each of said induction tubes, said fuel jets being external of said combustion chamber and located in said induction tubes adjacent the last-named ends thereof, means attached to said cylindrical side wall and providing an igniter pocket communicating at each end with the interior of said combustion chamber, an electrical igniter in said pocket, and means for supplying liquid fuel to said jets.

9. A heater of the class described comprising means forming a combustion chamber having a substantially cylindrical wall with an igniter pocket therein communicating with the interior of the combustion chamber, a plurality of tubes for supplying combustible mixture to said chamber, each of said tubes having an outlet end directed toward said wall and arranged to discharge combustible mixture which burns as an

arc-like part of a complete ring of flame in said combustion chamber, each of said tubes having a portion of substantial length outside said chamber which constitutes an independent carburetor and has an inlet end remote from the combustion chamber for receiving air from a source common to all said tubes, a jet in each tube adjacent said inlet end for delivering fuel thereto and so arranged that a combustible mixture is created in each tube, and means for supplying liquid fuel to said jets.

10. A heater of the class described, comprising means forming a combustion chamber having an end wall, a plurality of induction tubes extending through said end wall for supplying combustible mixture to said combustion chamber, each of said tubes having an outlet end within the chamber constructed to discharge said mixture toward another of said tubes to pre-heat the latter, each tube having a portion of substantial length outside said end wall of the combustion chamber with an inlet end remote therefrom, means for supplying the inlet ends of said tubes with a combustible mixture of liquid fuel and air, and means in the chamber for igniting said mixture.

11. A heater of the class described, comprising

means forming a combustion chamber having a cylindrical wall and an end wall, an induction tube of substantially uniform diameter extending through said end wall in a direction axial with respect to said cylindrical wall, said induction tube having a discharge end portion extending along a chord of said cylindrical wall and located closely adjacent this wall, a pocket opening into said wall with igniting means in said pocket, and means for supplying a combustible mixture of liquid fuel and air to said induction tube at a substantial distance from said combustion chamber.

12. A combustion chamber means having a cylindrical wall and an end wall, a plurality of induction tubes of substantial length extending through said end wall for supplying combustible mixture to said chamber, each of said tubes having an outlet end arranged to discharge combustible mixture toward said cylindrical wall and toward the outlet end of another tube, the inlet end of each tube remote from said combustion chamber being open to an air supply, and means for supplying a rich mixture of liquid fuel and air to said inlet ends of said tubes for addition to air entering said tubes from said supply.

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