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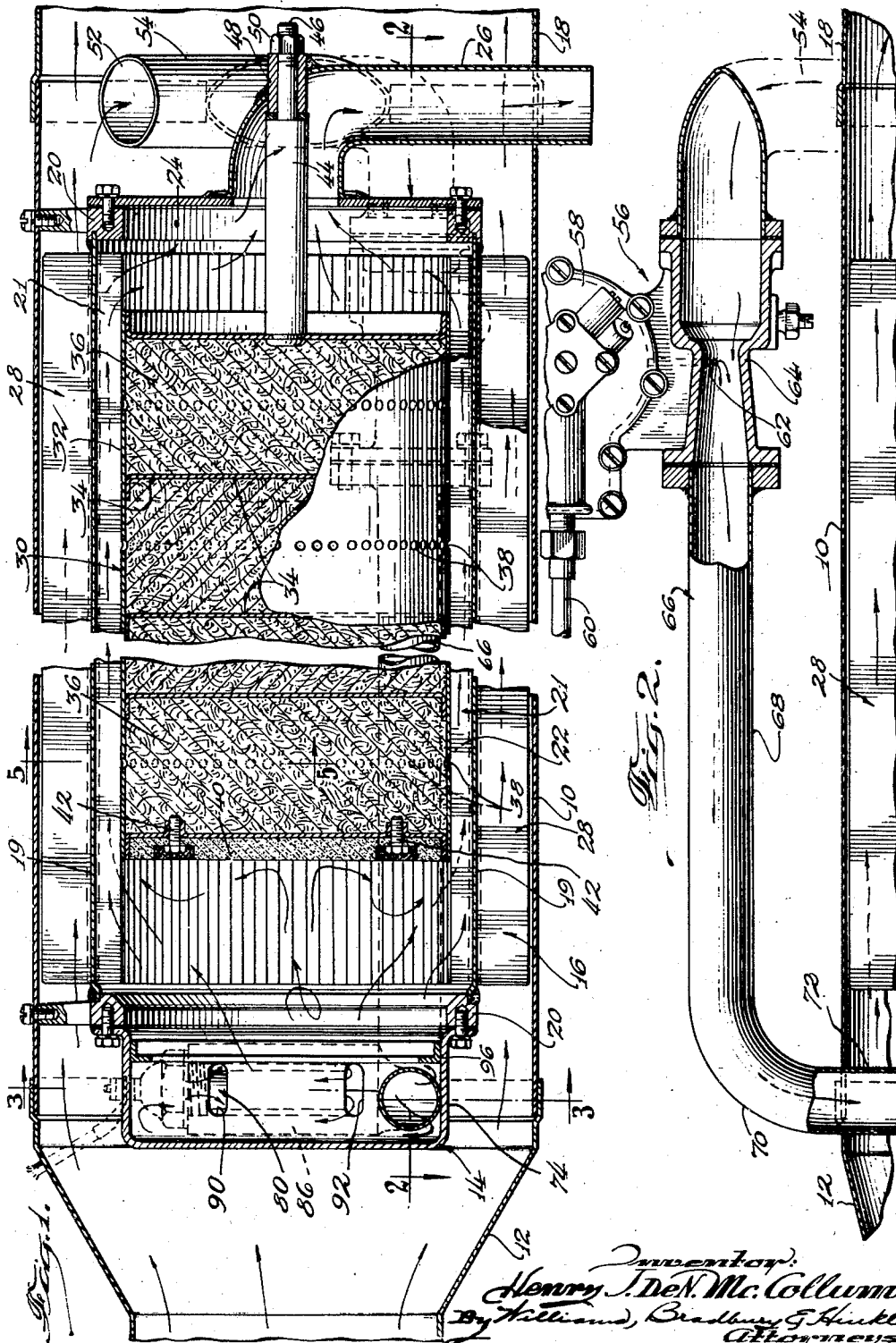
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2 Sheets-Sheet 1



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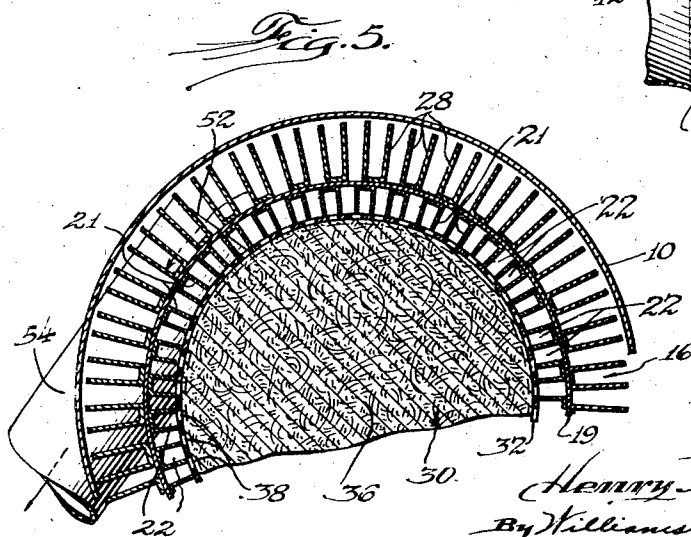
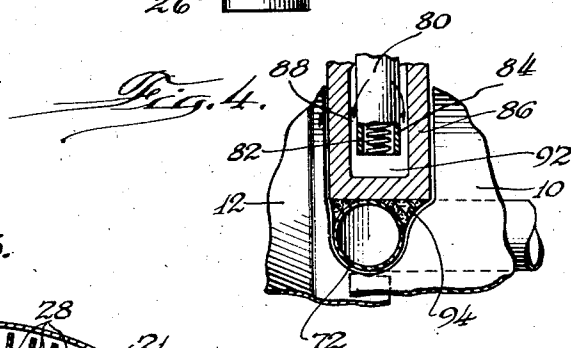
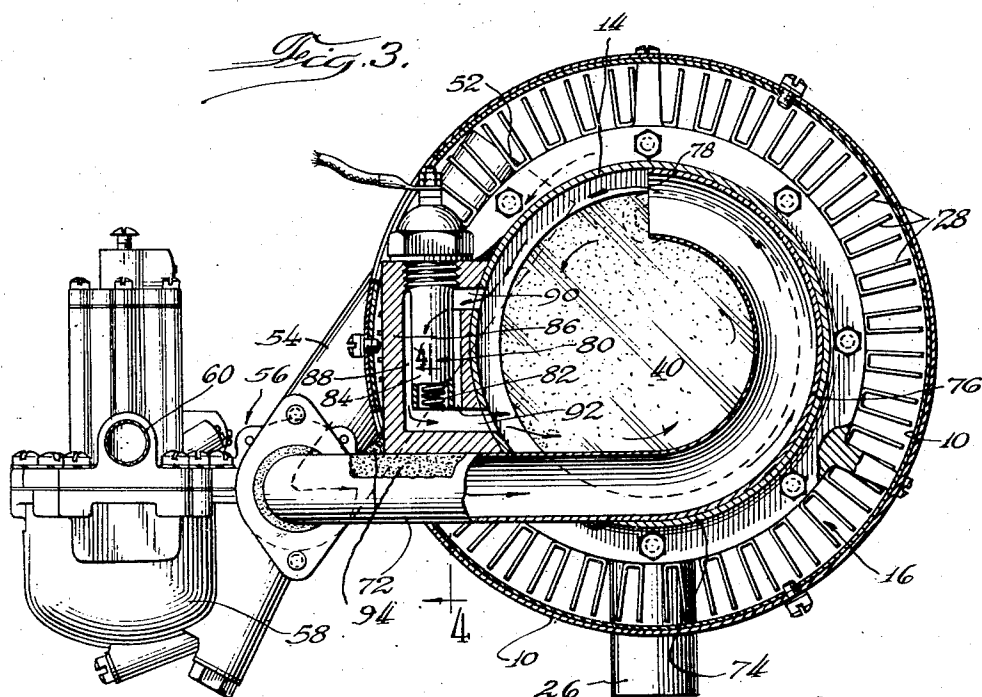
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2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

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HEATER HAVING MEANS FOR DIVERTING
AND IGNITING A FUEL-AIR MIXTURE

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Application March 6, 1943, Serial No. 478,258

4 Claims. (Cl. 158—28)

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My invention relates to heaters and is more particularly concerned with, but not limited to, internal combustion heaters for aircraft.

An object of my invention is to provide a heater having new and improved means for igniting the fuel and air mixture supplied to the combustion chamber.

Another object of my invention is to provide a heater having electrical igniting means which consumes a minimum of current and which is effective to ignite the fuel and air mixture supplied to the combustion chambers of large capacity heaters.

Another object of my invention is to provide a heater having igniting means which is effective at extremely low temperatures.

Another object of my invention is to provide a new and improved heater which can be easily started in all positions.

Another object of my invention is to provide a heater having improved igniting means which is particularly effective with heavy fuels.

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

In the drawings:

Fig. 1 is a longitudinal, sectional view through a heater embodying my invention;

Fig. 2 is a view showing a partial, longitudinal section taken on the line 2—2 of Fig. 1;

Fig. 3 is a view showing a transverse section taken on the line 3—3 of Fig. 1;

Fig. 4 is a partial, sectional view of a detail and is taken on the line 4—4 of Fig. 3; and

Fig. 5 is a view showing a partial, transverse section taken on the line 5—5 of Fig. 1.

The heater shown in the drawings comprises a cylindrical casing 10 connected to an air inlet 12 supplied with air by a ram, blower, or any other suitable means. The air flowing into the inlet 12 passes over and around a combustion chamber 14 and into the ventilating air passages formed between a heat exchanger 16 and the casing 10. As the air passes over the heat exchanger 16, its temperature is raised by absorption of heat from the heat exchanger and the heated ventilating air passes from the heat exchanger 16 and into the outer or righthand end of the casing 10 which is illustrated as communicating with a duct 18 leading to a cabin or other space or spaces to be heated.

The heat exchanger 16 comprises a cylindrical shell 19 of copper or other suitable material supported in rings 20 located at opposite ends thereof and attached to the casing 10 in any suitable manner. The shell 19 has brazed, or otherwise

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suitably attached to its inner wall, a series of U-shaped copper strips 21 providing inwardly projecting fins forming longitudinally extending gas passages 22 for gases traveling from the combustion chamber 14 to an outlet chamber 24 from which these gases are discharged to atmosphere through an exhaust pipe 26. U-shaped strips 28 of copper or other suitable material have their bases brazed or otherwise suitably secured to the outer wall of the shell 19 and form outwardly projecting longitudinally extending fins.

A muffler 30 is located in the heat exchanger and serves to direct the hot gases of combustion into the lefthand or inlet ends of the gas passages 22. This muffler comprises a sheet metal shell 32 provided with metal partitions 34 which divide the shell into a plurality of compartments filled with sound absorbing material 36, such as stainless steel wool or glass wool. Each compartment has an annular series of openings 38 providing acoustic couplings between the interior of the compartment and the gas passages 22. The lefthand end of the muffler is provided with a heat insulating disc 40 of fire clay or other suitable material secured in place by screws 42.

The muffler is freely slidable in the heat exchanger 16 and is held in place by a pin 44 attached to the righthand end of the muffler and having a threaded extension 46 passing through the sleeve 48, welded or otherwise secured in a wall of the exhaust pipe 26. A nut 50 is threaded to the end of the extension 46 and firmly secures the muffler in fixed position. This muffler is claimed in my co-pending application, Serial No. 478,259, filed March 6, 1943, and requires no further description herein. Part of the heated air leaving the heat exchanger enters the inlet 52 of a combustion air pipe 54 leading to a carburetor 56. The particular carburetor shown is of the altitude compensating type and has the usual float bowl 58 connected by a pipe 60 with any suitable source of fuel. A jet 62 located in the throat of the Venturi tube 64 supplies fuel to the air flowing through this Venturi tube. As best shown in Fig. 3, the inlet 52 of the combustion air pipe 54 is considerably higher than the carburetor float bowl 58 and Venturi tube 64. This arrangement makes it impossible for fuel to flow from the carburetor through the combustion pipe 54 to the ventilating air duct 18 and casing 10 if flooding of the carburetor should occur. This is an important feature of my invention, since discharge of fuel into the ventilating air might result in explosions or fire which would destroy or damage the aircraft and its occupants or might result in

the discharge of unhealthy fumes into the aircraft cabin.

The Venturi tube 64 delivers a mixture of fuel and air to the inlet end of an induction pipe 66 having a relatively long portion 68 extending lengthwise of the casing 10. The induction pipe 66 is provided with an elbow 70 connecting the long straight portion 68 with a short straight portion 72 passing through the casing 10 and cylindrical wall 74 of the combustion chamber 14 and connecting with a preheating portion 76 which is curved about the axis of the combustion chamber and lies closely adjacent the wall 74 of this chamber. The induction tube 68 is preferably of uniform diameter and has an internal surface free from obstructions and interruptions. The outlet end 78 of this induction tube delivers the combustible mixture to the combustion chamber in a direction tangential to the cylindrical wall of this chamber whereby the combustible mixture whirls about the axis of the combustion chamber, as fully explained and claimed in my co-pending application, Serial No. 477,080, filed February 25, 1943.

In the usual heater installation, the exhaust pipe 26 passes through the wall of the aircraft fuselage and discharges to atmosphere toward the rear of the aircraft so that operation of the aircraft creates a suction in this exhaust pipe which serves to draw a mixture of fuel and air into the combustion chamber and to draw the hot gases formed in this chamber through the passages 22 in the heat exchanger. The pressure drop across the carburetor which is available for discharging fuel through the jet 62 is very slight, with the result that the fuel is not discharged by this jet in a continuous uniform spray. Instead this spray is interrupted and irregular, although of uniform volume over any appreciable period of time. However, the lack of uniformity in this spray makes the mixture of fuel and air delivered to the induction pipe 66 vary somewhat in richness and where such a varying mixture is delivered to the combustion chamber, the heater operates with a sputtering noise which is difficult to muffle.

A feature of my present invention lies in the particular arrangement of the carburetor and the pipes 54 and 66 whereby the carburetor is close to the inlet of the combustion air supply pipe 54 and remote from the outlet of the induction pipe 66. The long induction pipe 68 permits the variable fuel and air mixture supplied to it by the carburetor to mix more thoroughly and acquire a more homogeneous composition before entering the combustion chamber. This thinning out of the fuel and air mixture is aided by the preheating of the combustion air which is supplied to the carburetor 56 through the elevated inlet 52.

The combustion mixture supplied to the combustion chamber 14 is ignited by an electrical igniter 80 to form a ring of flame in the combustion chamber. This igniter may be of the conventional type having a hot wire 82 located in the lower end of a sleeve 84 and is screwed into a housing 86 projecting to one side of the combustion chamber and attached to the cylindrical wall of this chamber by welding or in any suitable manner. The housing 86 has a cylindrical passage 88 of slightly larger diameter than the sleeve 84. An inlet 90 connects the upper end of passage 88 with the interior of the combustion chamber and an outlet 92 connects the lower end of the passage 88 with this chamber.

When the heater is first started, the igniter wire 82 attains ignition temperature in a very few seconds and the sleeve 84 almost immediately reaches a fairly high temperature. The fuel and air mixture delivered to the combustion chamber by the induction pipe 66 is unheated and any liquid fuel contained in this mixture flows along the cylindrical wall of the combustion chamber and passes through inlet 90 into passage 88 where it is vaporized by the hot sleeve 84. A certain amount of air also enters the inlet 90, as indicated by the arrows, and flows downwardly between the sleeve 84 and walls of the passage 88. The vaporization of the liquid fuel in this passage produces a rich mixture of fuel and air which is readily ignited by the hot wire 82. The resulting combustion produces a torch-like flame which is blown out of the outlet 92 along the adjacent wall of the portion 76 of the induction tube to meet this tube and ignite the mixture in the combustion chamber 14. After the heater has attained normal operating temperature, the ring of flame formed in the combustion chamber suffices to maintain combustion therein and the igniter 80 is disconnected from its source of electrical current by the usual thermostatic switch.

In some instances, all of the fuel in the mixture delivered to the combustion chamber will be mixed with air and there will be no liquid fuel to flow along the wall of the combustion chamber and through the inlet 90 to the passage 88 around the igniter 80. However, the richer part of the mixture of fuel and air is the heaviest part of this mixture and tends to follow around the wall of the combustion chamber, whereas that portion of the entering air which contains little fuel is less responsive to centrifugal force and more readily flows toward the center of the combustion chamber. The rich mixture of fuel and air following along the wall of the combustion chamber enters the inlet 90 and flows downwardly between the igniter 80 and walls of the passage 88 to be ignited by the hot wire 82.

The particular arrangement of the igniter illustrated and described has proved particularly advantageous with all sizes of heaters to which extremely cold air is supplied, for example, where an airplane is operating under atmospheric temperatures of 30° to 60° below zero. This arrangement has also proved particularly advantageous in heaters of large capacity even where these heaters are supplied with air at relatively mild temperatures. In heaters of large capacity, a single electrical igniter is usually incapable of creating sufficient heat in the combustion chamber to ignite the fuel and air mixture therein and it has been common practice to provide such large heaters with a plurality of igniters which operate simultaneously. Such an arrangement is costly and the several igniters consume an undesirably large amount of current, whereas my novel arrangement utilizes a single igniter of conventional size and is more effective in starting combustion in large heaters than are the several igniters heretofore used.

While my igniter is located in a pocket outside of the combustion chamber proper, this pocket is so arranged that it can not become filled with liquid fuel. The lower end of this pocket or passage 88 communicates with the combustion chamber through outlet 92 so that any liquid fuel supplied to this pocket and not ignited therein flows back into the combustion chamber through outlet 92 instead of forming a pool of liquid in the lower end of the pocket.

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Where the heater is intended to be used with kerosene or other relatively heavy fuel, it is desirable to establish a heat transfer path between the lower end of the housing 86 and the adjacent portion 72 of the induction tube. In Figs. 3 and 4, I have shown this heat transfer path as being built up by an accumulation of silver solder 94 which forms a heat conductor for transferring heat from the housing 86 to the adjacent portion 72 of the induction tube. In starting my heater with kerosene, the igniter 80 is preferably turned on for several minutes before air is admitted to the inlet end of the heater. The heat from the hot wire 82 causes the entire igniter 80, housing 86 and portion 72 of the induction tube to become quite hot and as soon as these parts have reached the desired temperature, air is admitted to the heater inlet. The resulting flow of fuel and air mixture to the combustion chamber is sufficiently preheated by the section 72 of the induction tube to ignite readily upon entering the combustion chamber and coming in contact with the igniter 80. Where the heater is operated with gasoline or other light fuels, air is ordinarily admitted to the heater at the same time the igniter switch is closed and the silver solder 94 may be dispensed with.

Where the heater is used in the horizontal position shown in Fig. 1, there is a tendency for any liquid fuel entering the combustion chamber to pass from the righthand end of this chamber before it travels along the cylindrical wall of this chamber a sufficient distance to enter the inlet 90 leading to the igniter 80. I, therefore, provide the outlet end of the combustion chamber with a ring 96 which causes liquid fuel entering the combustion chamber from the induction pipe to follow along the circular wall of this chamber and pass through inlet 90 and into the space around the igniter 80. As previously explained, the heat of the igniter vaporizes this liquid fuel and produces a rich fuel and air mixture which is readily ignited by the hot wire 82.

Where the heater is operated in an inclined position with the righthand end of the heater substantially elevated, the force of gravity prevents liquid fuel from leaving the combustion chamber before it has followed around the walls of this chamber sufficiently to enter the passage around the igniter 80. Under these conditions, the ring 96 is unnecessary and is preferably, but not necessarily, omitted.

From the foregoing description taken in connection with the accompanying drawings, it will be apparent that the advantages which I have described are provided by a simple, lightweight structure which is economical to manufacture and which is sturdy and capable of long, trouble-free service. While my heater is particularly adapted for use on aircrafts, it is not limited to such use, but may be used for general application. Although I have illustrated and described only a single embodiment 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. In a heater of the class described, means forming a combustion chamber having a cylin-

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drical wall, a housing attached to said wall exteriorly thereof, said housing including a passage which extends in circumferential direction with relation to said cylindrical wall, said wall having an inlet therethrough connecting one end of said passage with said combustion chamber and an outlet therethrough connecting the other end of said passage with said combustion chamber, means for supplying a combustible mixture to said combustion chamber tangentially thereof, causing said mixture to flow around the chamber and toward said inlet, and an igniter located in said passage, said igniter being of smaller cross-section than said passage to permit flow therethrough.

2. In a heater of the class described, means forming a combustion chamber having a wall provided with an arcuate segment, means for delivering a combustible mixture of fuel and air at one end of said segment and in a direction to flow along said segment, means providing a passage outside of said combustion chamber but in communication with said chamber adjacent said end of said segment whereby fuel and air flowing along said segment enters said passage by the action of centrifugal force, and an igniter for vaporizing liquid fuel in said passage and igniting combustible mixture therein, said passage having an outlet communicating with said combustion chamber at the other end of said segment through which outlet the ignited mixture flows into the combustion chamber.

3. In a heater as defined in claim 1, said means for supplying the combustible mixture comprising an induction tube intersecting the cylindrical wall of the combustion chamber and having its terminal portion curved around the inner surface of said wall whereby the mixture flowing through said curved portion of the tube absorbs heat from the combustion proceeding in said chamber.

4. In a heater as defined in claim 1, said means for supplying the combustible mixture comprising an induction tube intersecting the cylindrical wall of the combustion chamber and having its terminal portion curved around the inner surface of said wall, said combustion chamber having an end wall and an annular flange extending inwardly from its cylindrical wall in spaced relation to said end wall, said curved terminal portion of the induction tube and said inlet and outlet of the igniter housing being disposed between said end wall and said flange.

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