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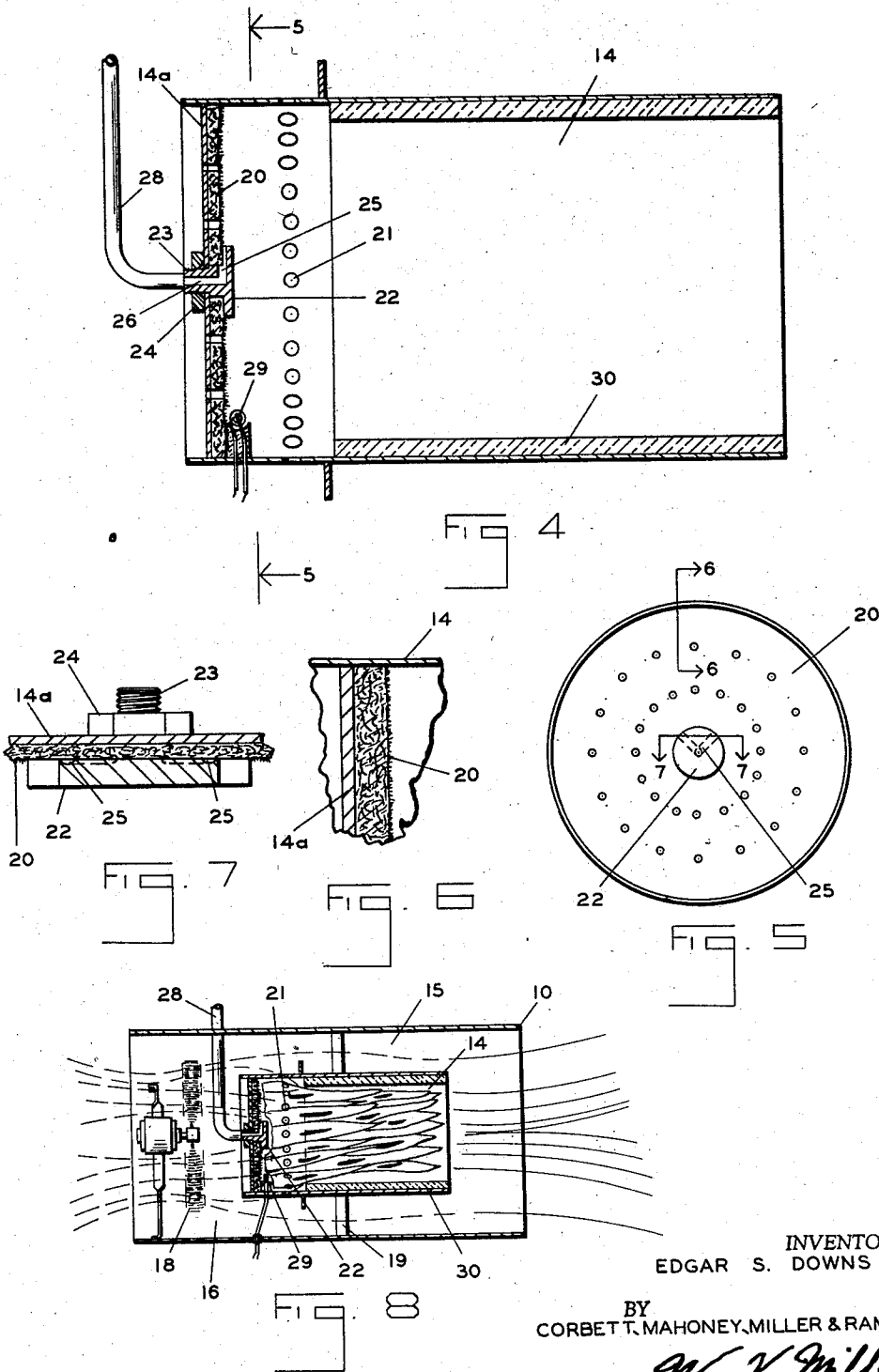
E. S. DOWNS

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LIQUID FUEL BURNING HEATER

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INVENTOR.
EDGAR S. DOWNS

BY
CORBET T. MAHONEY, MILLER & RAMBO

BY *Wm. V. Miller*
ATTYS

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LIQUID FUEL BURNING HEATER

Edgar S. Downs, Worthington, Ohio

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5 Claims. (Cl. 158—96)

My invention relates to a liquid fuel burning heater. It has to do, more particularly, with a heater of the oil-burning type.

Oil burners now in use are divided into two main types. One is the atomizing gun type which, though very efficient, is quite costly and if not cared for properly is dangerous in use. The other main type now commonly in use is the pot-type which is less costly but which tends to become clogged with carbon and soot and which, therefore, must be cleaned often to insure proper operation. This type is also dangerous if not cared for properly.

It is the object of my invention to provide a heater which includes a burner for liquid fuel that is inexpensive, will provide for efficient vaporizing and burning of the fuel with the formation of little carbon or soot, will require little or no maintenance and yet will be completely safe in operation.

This application is a continuous-in-part of my copending application Serial No. 622,203, filed November 14, 1956, now abandoned.

According to my invention I provide a burner in which liquid fuel, such as kerosene, fuel oil, or gasoline, is vaporized for combustion by a thin pad of indiscriminately disposed thin ceramic fibers made into a felt or paper. The material used in forming the pad has an extremely high degree of capillarity which permits it to move the fuel rapidly from the fuel inlet evenly over the face of the pad. This causes extremely rapid evaporation of fuel from all parts of the pad. The heat to accomplish this evaporation is that radiated from the flame which establishes a flame-front a fraction of an inch away from the fuel-wet ceramic pad. The high rate of evaporation tends to cool the liquid fuel in the pad and prevent formation of carbon on the pad through "cracking" of the liquid fuel. The fact that the pad is then also permits cooling by contact with the metal rear combustion chamber wall which supports it and is, in turn, cooled by air forced over it. Beside having high capillarity the pad must be able to withstand indefinitely the temperatures to which it is exposed and not be attacked by the chemical constituents of the fuel or products produced by oxidation or cracking of the fuel. The ceramic pad forms one wall of a combustion chamber and air is passed into the combustion chamber under forced draft through holes in the ceramic pad. The purpose of this air, designated as primary air, is to permit a very rapid and even mixing of air and oil vapor evaporated from the pad. This rapid mixing establishes the flame front in close proximity to the wet ceramic pad which provides heat by radiation to continue the rapid evaporation of the fuel.

In the accompanying drawings, I have illustrated one example of a heater made according to my invention but it is to be understood that it can take other specific forms without departing from the basic principles of my invention.

In these drawings:

Figure 1 is a side elevational view of an oil-burning heater in which my invention is embodied.

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Figure 2 is an end view of the heater.

Figure 3 is a vertical sectional view taken along line 3—3 of Figure 2 through the fan chamber and burner of the heater.

Figure 4 is an enlarged vertical sectional view through the burner and combustion chamber of the heater.

Figure 5 is a transverse sectional view taken along line 5—5 of Figure 4 showing the oil-vaporizing pad.

Figure 6 is an enlarged transverse section through the pad and support taken along line 6—6 of Figure 5.

Figure 7 is an enlarged transverse section taken along line 7—7 of Figure 5.

Figure 8 is a schematic longitudinal sectional view through the fan housing and combustion chamber illustrating the action in the burner and combustion chamber after the fuel is ignited.

With reference to the drawings, in Figures 1 and 2 I have illustrated the general arrangement of a heater in which my invention may be embodied. This heater is shown as being of the small portable type although it is to be understood that my invention may be embodied in various other types of heaters.

The heater shown comprises a tubular outer casing 10 carried on the supports 11, which serve as legs upon which the entire heater rests, and which extend upwardly above the housing to support an oil tank 12. A handle 13 is provided above the tank 12 and is connected to the supports 11 and can be used in carrying the heater.

Within the tubular casing 10 and in concentric relationship therewith is a tubular combustion chamber 14. As shown in Figure 3, this chamber 14 is of smaller diameter than the casing 10 so that an annular air passageway 15 is provided therebetween. Also, the chamber 14 is of less length than the casing 10 to form the fan chamber 16 at one end and the discharge throat 17 at the other end. The chamber 16 has the electric fan or blower 18 concentrically disposed therewithin and associated with the rear end of the combustion chamber 14 to force air thereinto. The chamber 14 is supported centrally within the casing 10 by means of spacer clips 19 which will not interfere with air flow through the annular space 15 which will also be produced by the fan 18.

As shown in Figures 3 and 4, the rear wall of the combustion chamber 14 is formed by the ceramic pad 20 in the form of a disc which completely covers the rear end of the member 14. Spaced slightly ahead of the pad 20 are the secondary air holes 21 formed at spaced intervals around and in the wall of the chamber 14.

Oil is supplied from the tank 12 to the rear side of the pad 20 by means of a line 28. An inlet fitting 22 for this line 28 is provided at the center of the pad 20. The inlet fitting 22 forms part of a clamp for clamping the pad 20 to the rear metal wall 14a of the chamber 14. The fitting 22 is provided with a rearwardly extending threaded boss 23, which extends through aligning central openings in the pad 20 and the wall 14a, and which receives a clamp nut 24. The front or disc-like part of the fitting 22 is provided with channels 25 arranged in a V and communicating at their lower ends with the central bore 26. It will be noted from Figure 7 that these channels 25 are semicircular in cross-section and open rearwardly against the face of the pad 20.

The two face channels 25 formed by the half circular cross-section, prevent clogging of the oil inlet by providing openings through which solids may float up and out. If such face channels 25 are not present, experience has shown that dirt and waxes in the oil will form a continuous film on the upstream side of the ceramic fiber pad 20, thereby stopping oil flow. This inlet 22 also has the advantage of putting the oil on the forward, or flame, side of the ceramic pad 20 thereby preventing clogging and giving a more even pattern of oil on the ceramic

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fiber pad. The oil is introduced to the pad 20 slightly above the center of the pad thereby compensating for the slight effect of gravity on the normal movement out on the pad by capillary action. By pointing the channels 25 upward at 45° left and right from the vertical, direct spillage of oil out of the open channels is prevented, even though the heater may be tipped considerably to the right or left. An electric spark igniting device 29 may be provided just ahead of the pad 20.

The chamber 14 is preferably provided with a lining 30 of insulation to aid the combustion action. This liner will extend from a point just ahead of the secondary openings 21 to the outer end of the chamber 14.

The pad 20 is shown best in Figures 5 and 6. It is made in the form of a loose felt or mat which is composed of ceramic fibers that are resistant to high temperatures. The important characteristics of this pad are set forth below.

The pad 20 is of densely packed random direction ceramic fibers preferably of short lengths ranging from about 1/4" to 1/2" and in actual practice I have used lengths of about 3/8". Density and fiber diameter must be such as to assure high capillarity with respect to normally used liquid fuels such as kerosene, fuel oil #1, fuel oil #2, and gasoline. Density and fiber diameter must be even over the face of the pad. The fiber diameter should be from submicron to 10 microns, preferably 2 microns. The bulk density of the ceramic pad should range from 2 to 25 pounds per cubic foot but is preferably 15 pounds per cubic foot.

An example of a suitable material is Fiberfrax paper produced from Fiberfrax fibers by the Carborundum Company with the following chemical composition:

Al_2O_3 —51.2%; SiO_2 —47.1%; B_2O_3 —0.6%; Na_2O —0.6%

Approximate fiber diameter: Submicron to 10 microns (mean 2 1/2 microns).

Another example of a suitable material is Micro-Quartz felted insulation made by LOF Glass Fibers Co. This material is 98% pure quartz.

Approximate fiber diameter: .1 micron.

A high degree of capillarity is present in the pad to provide lateral flow over the face of the pad 20 in sufficient quantity to keep the pad well saturated with fuel. The high rate of evaporation from this wet pad provides a strong cooling action due to the latent heat of evaporation of the fuel. This cooling action tends strongly to prevent cracking of the fuel in the liquid state by lowering the temperature of the pad.

In this type of vaporizing pad 20 virtually all the heat for evaporating the oil is supplied by radiant heat transfer from the flame front formed immediately in front of the pad to the fuel filled pad.

The pad is composed of fibers that will result in a white surface so that reflectivity of radiant energy from the flame front will be at a maximum and absorptivity from the same source at a minimum so that the temperature of the pad will remain low. Experiments have shown that if the pad has a gray or black surface, pad temperature will rise, causing cracking of fuel on the pad and consequent formation of carbon and coke thereon. If the pad is white a satisfactory heat balance is established between heat radiated from the fire to the pad on the one hand and heat transferred to the rear surface of the pad by conduction to the cool metal surface forming its rear wall and conversion of sensible to latent heat during the evaporation of oil from the pad surface on the other hand.

For effective and carbon free operation the pad 20 is thin—not less than .020" and not more than .200" in thickness, and a thickness which I have found very satisfactory is .070". This thin section permits further cooling action by conduction of the radiant heat received through the pad to the air cooled metal plate backing it up.

The pad 20 rests against a metal plate over which air

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flows, such as the wall 14a. This plate acts as a barrier to prevent tearing and distortion of the thin, mechanically weak ceramic fiber pad, from pressure of the air behind it. To provide flow through the primary air holes, the air pressure must be higher on the rear of the pad than on its front face.

Concentric, matching holes 20a are provided in the ceramic fiber pad and in the metal plate 14a immediately behind it. Due to a higher air pressure outside the metal plate than at the inside surface of the ceramic fiber pad, a carefully measured amount of air, called primary air, forming 1/4 to 1/2 total air supplied for combustion and not sufficient to wholly complete combustion, is admitted into the combustion chamber 14 formed by the metal plate-ceramic fiber pad in the rear and the metal walls on the side. By admitting this air through the saturated pad at carefully spaced intervals, intimate and rapid mixing of air and fuel vapor is permitted. This causes a flame front to be established immediately in front of the ceramic fiber pad, which in turn radiates heat back to the saturated pad for the continuing evaporation of liquid fuel.

To furnish additional air to completely and cleanly burn the fuel secondary air is admitted through the carefully spaced holes 21 in the sides of the combustion chamber 14.

The ceramic fiber pad is composed of fibers that will withstand approximately 2000° F. for long periods of time without noticeable deterioration. These fibers must also withstand the effects of hot fuel and the products formed by chemical reaction of the fuel, either by oxidation or "thermal cracking" for long periods without noticeable deterioration.

The action of the ceramic pad 20 and the heater is illustrated in Figure 8. Oil is supplied to the pad 20 and will spread therethrough. The fan 18 is started and the oil is ignited. The oil will vaporize as it is supplied to the heater and the pad will burn cleanly. The spaced openings 20a provided through the pad 20 permit forcing a part of the combustion air (primary air) through the pad at various locations on the pad. While the quantity of air so introduced is not sufficient to complete combustion, it is sufficient to support combustion and establish a flame front in close proximity to the ceramic pad. This air at numerous places mixes rapidly with vaporized fuel which it entrains and carries toward the exit of the combustion chamber 14 of the heater. Radiant heat produced by this active flame front in close proximity to the saturated pad furnishes heat to continue evaporation of the fuel at a high rate. In fact, an active and vigorous flame may be maintained with the temperature of the incoming air as low as -40° F. As the flame moves down the combustion chamber 14 sufficient air is introduced through the secondary air holes 21 to complete combustion.

It will be apparent that I have provided a burner in which the liquid fuel is readily vaporized for combustion by using a simple ceramic pad having high capillarity. This pad is composed of a felt or paper made of fibers of ceramic material which will readily resist temperatures up to 2000° F. without deterioration. The pad is of such a nature that the primary air for combustion may be directed through it when it is used to form the wall of a combustion chamber. This will result in clean and complete combustion of the fuel fed to the pad. The burner made according to my invention is relatively inexpensive, will provide for efficient burning of the fuel, will require little or no maintenance and yet will be completely safe in operation.

Various other advantages will be apparent.

Having thus described my invention, what I claim is:

1. A burner for burning liquid fuel comprising a combustion chamber, a pad having an exposed face at the inner surface of a wall of said combustion chamber, said pad being composed of indiscriminately disposed thin

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ceramic fibers, said fibers being white and being capable of withstanding high temperatures for long periods without substantial deterioration and discoloration, said fibers having a diameter ranging from submicron to 10 microns, said pad being of a thickness ranging from .020" to .200" thickness and having a bulk density of from 2 to 25 pounds per cubic foot, means for supplying the liquid fuel to said pad so that it will be absorbed thereby and distributed throughout the pad by the capillary attraction of the material of the pad, said wall of said combustion chamber including a rigid plate backing up said pad, said rigid plate and said pad having aligning primary air openings extending through both the rigid plate and the pad to the exposed face of the pad, means for positively forcing primary air through said openings in said rigid plate and pad into said combustion chamber where the oil will be vaporized and burned adjacent to the exposed face of said pad, the heat for vaporizing the oil in the pad being received from the flame which forms in front of the exposed face of the pad, and the wall of the combustion chamber just beyond the face of the pad in the direction of flow of the primary air there-through being provided with air inlet openings for supplying secondary air to said combustion chamber to aid in complete and clean burning of the fuel in the combustion chamber.

2. A burner according to claim 1 in which the ma-

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terial of the pad has fibers which have a mean diameter of approximately 2 microns, the pad is approximately .070" in thickness, and the material of the pad has a bulk density of approximately 15 pounds per cubic foot.

3. A burner according to claim 1 in which the material of the pad has the following approximate chemical composition:

Al_2O_3 —51.2%; SiO_2 —47.1%;
 B_2O_3 —0.6%; Na_2O —0.6%

4. A burner according to claim 1 in which the material of the pad is approximately 98% pure quartz.

5. A burner according to claim 1 in which the axis of the combustion chamber is substantially horizontal and the pad is toward one end of said chamber, said fuel supplying means comprising an inlet leading through the center of the pad and having branches leading upwardly over the exposed face of the pad, each of said branches opening rearwardly against the face of the pad.

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