Jan. 7, 1941. G. GRUBB 2,227,899

FUEL BURNER

Filed Oct. 8, 1936 2 Sheets-Sheet 1

Fig. 1.

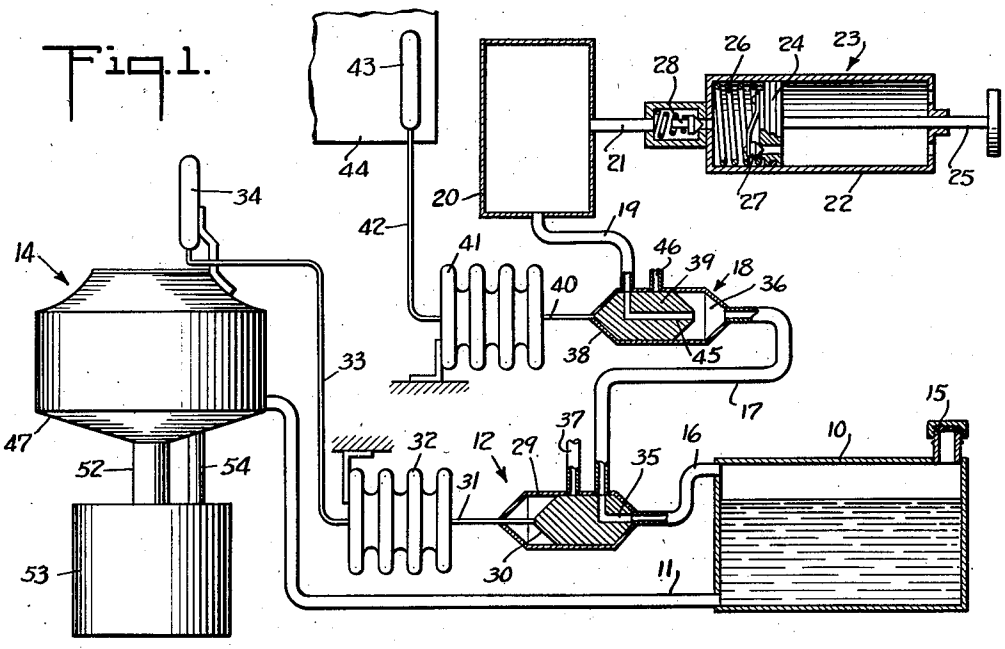


Fig. 2.

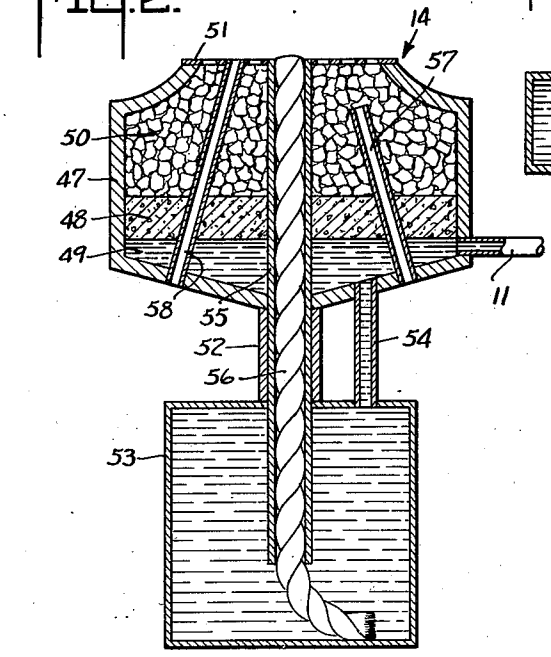
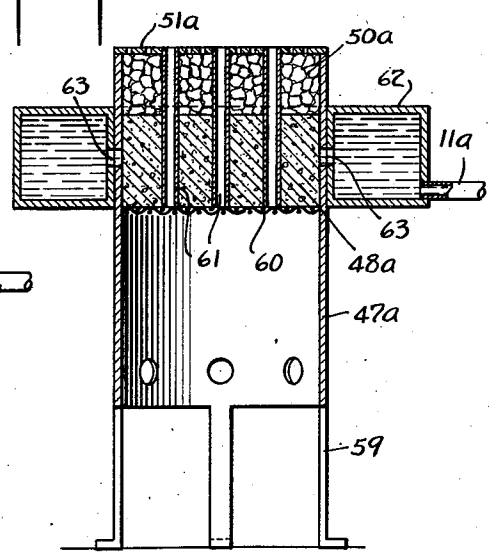


Fig. 3.



INVENTOR
Gunnar Grubb
BY
E. A. Fenander
his ATTORNEY

Jan. 7, 1941. G. GRUBB 2,227,899

FUEL BURNER

Filed Oct. 8, 1936 2 Sheets-Sheet 2

Fig. 4.

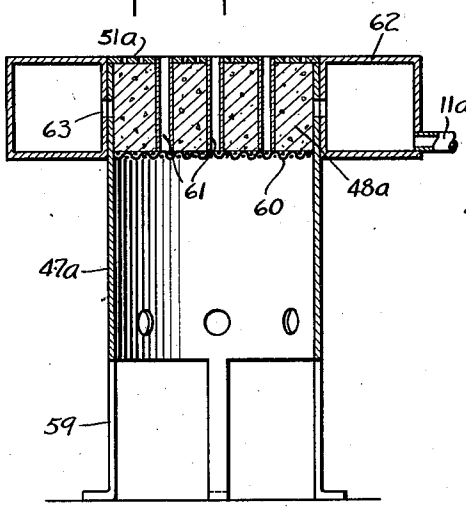


Fig. 5.

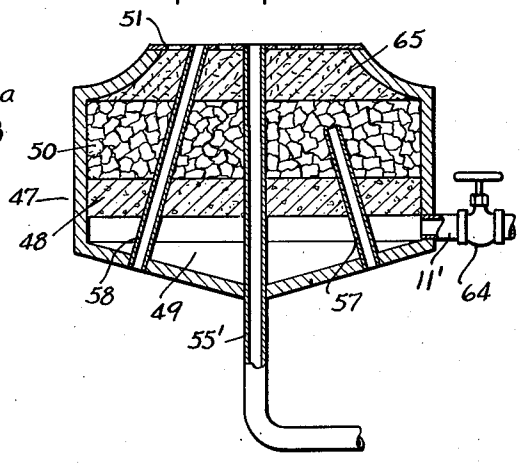
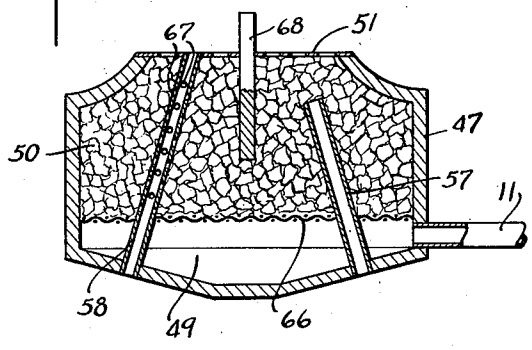


Fig. 6.



INVENTOR
Gunnar Grubb
BY
E. A. Fenander
his ATTORNEY

Patented Jan. 7, 1941 2,227,899

UNITED STATES PATENT OFFICE

2,227,899

FUEL BURNER

Gunnar Grubb, Stockholm, Sweden, assignor, by mesne assignments, to Servel, Inc., New York, N. Y. a corporation of Delaware

Application October 8, 1936, Serial No. 104,584
In Germany December 11, 1935

11 Claims. (Cl. 158—96)

My invention relates to the art of fuel burners.

In liquid fuel burners, particularly of the distillate type, the liquid fuel, such as kerosene, is caused to be heated and vaporized. The vaporized fuel is mixed with air to provide a combustible mixture. The amount of heat produced by the burner is dependent upon the rate of vaporization of the fuel which is most readily controlled by regulating the flow of liquid fuel to the burner. It is usually difficult to control the burner flame in this manner in any reasonable length of time without disturbing the operation of the burner. Thus, when it is desired to increase the size of the burner flame by increasing the rate of flow of liquid fuel, for example, a too rapid flow of liquid fuel often takes place which produces objectionable vapor flashes in the burner. Further, in many gas burners, the admission of an adequate quantity of air to insure complete combustion of the fuel tends to increase the likelihood of back-firing of the burner.

It is an object of my invention to provide an improved liquid or gaseous fuel burner in which the admission of an adequate quantity of air is insured to provide a flame which is odorless and substantially free from smoke and soot.

Another object of my invention is to provide an improved liquid or gaseous fuel burner which permits the admission of an adequate quantity of air to insure substantially complete combustion of the fuel and yet avoids the danger of back-firing of the burner.

A further object of my invention is to provide an improved burner which may be operated with liquid fuel and in which nice control of the burner flame is obtained.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the claims. The invention itself, however, both as to organization and method, together with further objects and advantages thereof, will be better understood by reference to the following description taken in connection with the accompanying drawings of which Fig. 1 diagrammatically illustrates a burner embodying my invention shown in connection with a liquid fuel supply system; Fig. 2 is a vertical sectional view of the burner shown in Fig. 1; and Figs. 3 to 6 inclusive are vertical sectional views illustrating modifications of the burner shown in Fig. 2.

Referring to Fig. 1 of the drawings I have shown my invention in connection with a liquid fuel supply system of the pressure type. It is to be understood, however, that my invention can be employed with other types of liquid fuel supply systems and operated with gaseous as well as liquid fuel. The liquid fuel supply system includes a supply vessel 10 from which fuel is conducted through a conduit 11 to a burner 14. The burner 14 is at a higher level than the liquid fuel in the supply vessel 10 and liquid fuel is caused to flow to the burner 14 by maintaining the liquid fuel under pressure in the supply vessel 10. This may be accomplished by providing the supply vessel 10 with an air-tight filling cap 15 and connecting the upper part of the supply vessel by means of a conduit 16, control valve 12, conduit 17, control valve 18, conduit 19, storage vessel 20 and conduit 21 to the cylinder 22 of an air pump 23. Within the cylinder 22 is arranged a piston 24 to which is connected a piston rod 25 which extends through an opening at the end of the cylinder and serves as a handle for the air pump. When the rod 25 is moved inward against the tension of spring 26 which is arranged within the cylinder, the air within the supply vessel 10 is compressed. The spring 26 causes the piston 24 and rod 25 to move to the right when the rod is released, and during such movement, a valve 27 at the inside of the piston 24 opens to admit air into the left-hand part of the cylinder which is compressed with the subsequent compression stroke of the rod 22. A check valve 28 is provided adjacent the air pump 23 to prevent air from flowing from the conduit 21 to the cylinder 22.

In order to stop the flow of liquid fuel to the burner 14 when the burner flame is extinguished, I provide the control valve 12 which is arranged to be responsive to the temperature of the burner flame. The control valve 12 comprises a cylindrical shaped casing 29 within which is accurately fitted a cylindrical shaped valve member 30 of smaller diameter than the casing 26. The valve member 30 is secured to a rod 31 which extends through an opening in the casing and is connected to an expansible bellows 32. The bellows 32 is connected by means of a tube 33 to a thermal bulb 34 arranged adjacent to the burner 14. The bellows 32, tube 33, and thermal bulb 34 constitute what is termed an expansible fluid thermostat which is filled with a suitable volatile fluid which increases and decreases in volume with corresponding changes of temperature.

When the burner 14 is being operated the volatile fluid in the expansible bellows 32 increases in volume and the valve 30 is in the position shown in Fig. 1. In this position the passage 35

of the valve 30 communicates with the conduits 16 and 17 and the supply vessel 10 is in open communication with the storage vessel 20, so that the fuel in the supply vessel is maintained under pressure. If for any reason the burner flame is extinguished, the expansible bellows 32 contracts and the valve 30 is moved toward the left, and, when the vertical portion of the passage 35 is moved adjacent to the opening 37 in the casing 29, the air under pressure in the supply vessel 10 is discharged to the atmosphere to stop the flow of fuel to the burner.

A second control valve 18 may be connected to the conduits 17 and 18 for automatically controlling the operation of the burner 14. The control valve 18 includes a cylindrical shaped casing 38 within which is accurately fitted a cylindrical shaped valve member 39 of smaller diameter than the casing 38. The valve member 39 is secured to a rod 40 which extends through an opening in the casing and is connected to an expansible bellows 41. The bellows 41 is connected by means of a tube 42 to a thermal bulb 43 which is arranged to be responsive to a temperature condition affected by a part of apparatus, diagrammatically indicated at 44, which is adapted to be influenced by the operation of the burner. The bellows 41, tube 42, and bulb 43 also constitute an expansible fluid thermostat which may be filled with a suitable volatile fluid which increases and decreases in volume with corresponding changes of temperature. When the part 44 of the apparatus tends to fall below a desired temperature, the volatile fluid becomes reduced in volume and causes the expansible bellows 41 to contract and move the valve member 39 to the position shown in Fig. 1. In this position the passage 45 in the valve 39 communicates with the conduits 17 and 19 and liquid fuel in the supply vessel is maintained under pressure and will flow to the burner 14.

When the part 44 of the apparatus tends to rise above the desired temperature, the increase in volume of the volatile fluid causes the expansible bellows 41 to expand and move the valve member 39 toward the right. With such movement of the valve 39, the conduits 17 and 19 are blocked to disconnect the storage vessel 20 from the fuel supply vessel 10; and, as the passage 45 in the valve 39 moves adjacent to the opening 46 of the casing 38, the air in the supply vessel 10 is permitted to discharge into the atmosphere whereby the pressure therein is gradually released so that fuel is no longer caused to flow to the burner 14.

The control valve 18 and expansible fluid thermostat associated therewith are preferably so arranged that, when the part 44 of the apparatus is substantially at the desired temperature, the valve 39 assumes such a position that the vertical portion of passage 45 is between the connection of the casing 38 to the conduit 19 and the opening 46, whereby the storage vessel 20 is blocked off without completely reducing the pressure in the supply vessel 10. With the storage vessel 20 blocked off the pressure in the supply vessel 10 gradually becomes smaller as liquid fuel flows to the burner 14 with the result that the burner flame becomes reduced in size. The reduction in size of the burner flame decreases the amount of heating effected by the burner and avoids completely shutting off the supply of liquid fuel to the burner 14. Only when the part 44 of the apparatus rises above the predetermined temperature is the valve 39 moved toward the right such a distance that the passage 45 communicates with the opening 46, whereby the pressure in the supply vessel 10 is released and the flow of liquid fuel to the burner 14 is stopped.

In accordance with my invention the burner 14 includes a metallic shell 47 within which is arranged a body 48 of porous material of substantially the same cross-sectional area as the shell. The body or plate 48 of porous material is spaced from the conical shaped bottom of the shell to provide a chamber 49 into which the liquid fuel discharges from conduit 11. Above the plate 48 is provided a second body 50 of porous material which extends to the top of the shell 47 at which region the burner flame is maintained. A perforated cover plate 51 is secured in any suitable manner to the top of the shell 47.

A sleeve 52 depends downward from the bottom of the shell 47 and communicates with a small vessel 53 which is connected by a vertical conduit 54 to the chamber 49 of the shell 47. A tubular member 55 extends downward from the cover plate 51 through the bodies 50 and 48 of porous material and sleeve 52 into the vessel 53. Within the tubular member 55 is disposed a wick 56 which provides a small ignition flame at the top perforated cover 51 of the burner.

A group of conduits 57, only one of which is shown, extend upward from the bottom of the shell 47 and terminate in the interior of the body 50 of the porous material. A second group of conduits 58, only one of which is shown, extend upward from the bottom of the shell 47 through the bodies 48 and 50 of porous material and at their upper ends are substantially flush with the perforated cover plate 51.

When the burner is being operated, the chamber 49 and small vessel 53 are filled with a liquid fuel, such as kerosene, which is under pressure. The wick 56 fits tightly within the tubular member 55 whereby liquid fuel is prevented from freely flowing upward through the tubular member 52. The body 48 of porous material preferably is formed of a material, such as calcined or burned clay, pressed asbestos, porous coal, or any other suitable fibrous organic material, for example, which is capable of causing distribution of fuel therein. The body 48 offers a certain resistance to the flow of liquid fuel therethrough, and, in addition to bringing about a distribution of the fuel, also serves to reduce or lower the pressure of the fuel due to the pressure drop which takes place therein. The rate at which fuel reaches the body 50 of porous material at a given pressure of the liquid fuel in the chamber 49, therefore, is largely dependent upon the pressure drop of the fuel in the body 48 of porous material.

The body 50 of porous material preferably consists of a material, such as the oxides of calcium, strontium or barium, sandstone, or charcoal or the like, for example, which is in the form of grains or granules and capable of bringing about a distribution of the liquid fuel. The material forming the body 50 may be slightly compressed and possesses such physical properties that the liquid fuel is distributed uniformly in the body by capillary forces. The density or porosity of the body 50 as well as the size thereof relative to the quantity of fuel passing therethrough are preferably so chosen that the material is never saturated with liquid fuel.

Due to the relatively large surface presented by the grains or granules of material forming

the body 50, the liquid fuel evaporates at a relatively high rate in this body. In the particular embodiment shown in Fig. 2, a relatively high evaporation of the liquid fuel in the body 50 is assured by the provision of conduits 57 for admitting air within the body. In this manner a sufficient quantity of air can be mixed with vaporized fuel to provide a combustible gas mixture even before the fuel reaches the cover plate 51 at which region the burner flame is maintained. Due to the suction action of the burner flame, the admission of air through the conduits 57 into the body 50 of porous material is facilitated. The suction action of the burner flame is also effectively utilized for drawing additional air through the conduits 58 into the region of the flame to insure complete combusion of the fuel. When the burner is being operated, the top part of the body 50 of porous material is heated above the evaporating temperature of the fuel and in this manner accelerates the evaporation of fuel in the upper layer of material.

When the expansible fluid thermostat associated with the control valve 18 becomes operative to move the valve member 39 toward the right to permit the air in the supply vessel 10 to discharge into the atmosphere, the level of the liquid fuel in the vertical portion of the conduit 11 is lowered and air is drawn downward through the bodies 50 and 48 of porous material. In this manner vaporized and liquid fuel is drawn off the bodies of porous material whereby a continued odorless burning of the ignition flame is insured. The likelihood of odors being produced when the main flame of the burner 14 is extinguished is not very great when substances such as charcoal are used, inasmuch as such substances are capable of adsorbing odors in relatively large quantities.

Fig. 3 illustrates a modification of the embodiment just described and differs therefrom in that the porous body 48*a* is so arranged that air is permitted to pass therethrough. The burner shown in Fig. 3 includes a cylindrical casing 47*a* which may be provided with legs or supports 59. Within the casing 47*a* are arranged the bodies 48*a* and 50*a* of porous material which are similar to the bodies 48 and 50 shown in Fig. 2. To the casing at the lower surface of the body 48*a* is secured a protective perforated sheet of material 60, such as a wire screen. A plurality of conduits 61 extend vertically upward through the bodies 48*a* and 58*a* from the bottom surface of the body 48*a* to the perforated cover plate 51*a* arranged at the top of the casing 47*a*.

About the casing 47*a* adjacent to the body 48*a* is tightly fitted a hollow annular shell 62 which is connected by means of a conduit 11*a* to the source of fuel supply. The casing 47*a* and the inner wall of the shell 62 are provided with a plurality of aligned openings, as indicated at 63, for admitting fuel to the interior of the body 48*a* of porous material.

When the burner is being operated, air is drawn upward through the conduits 61 into the region of the burner flame to insure complete combustion of the fuel. Since the lower surface of the body 48*a* is exposed to the atmosphere, air is drawn into this porous mass at its lower surface due to the suction action of the burner flame, as in the embodiment shown in Fig. 2, and passes upward therethrough into the body 50*a*. The fuel introduced into the body 48*a* through the openings 63 passes upward into the body 50*a* in which it is vaporized and mixes with air entering through the body 48*a* to provide a combustible mixture. In this modification, as in the embodiment described above, the density of the body 50*a* as well as the size thereof relative to the quantity of fuel passing therethrough, are chosen so that the material is never saturated with liquid fuel. Preferably the pressure of the liquid fuel supplied to the burner is adjusted so that, in the event the burner flame is extinguished, the pressure of the liquid fuel in the portion of the body 48*a* near the lower surface, which is exposed to the atmosphere, is sufficiently small to insure the adherence of liquid fuel within the body due to the capillary action of the porous material.

My invention may assume many different forms. It is possible and, in view of the varying properties of different fuels, it is even necessary and desirable to make various changes in practicing the invention. When operating with liquid fuel, such as kerosene, for example, it is necessary to take into consideration the properties of the fuel, such as its volatility and flash point, and accordingly determine the size and density of the upper porous body which effects distribution and evaporation of the fuel and the size and density of the lower porous body which serves to reduce the pressure of the fuel.

When liquid fuel of relatively low volatility is used, for example, the lower body of porous material may be used alone and thereby serve as an evaporator body as well as effect distribution of the fuel. Such a modification is shown in Fig. 4 in which parts similar to those shown in Fig. 3 are designated by the same reference numerals. In Fig. 4 the body 48*a* extends upward to the top perforated cover plate 51*a* and the burner flame is maintained at the top surface thereof.

Under certain conditions it may be desirable to employ catalysts in the upper body of porous material which have the property of absorbing oxygen from air and of releasing such oxygen at a higher temperature to the fuel. This subsequent release of oxygen to the fuel is dependent upon the affinity of the fuel for oxygen, and the greater such affinity the more actively is the oxygen released. Among the catalysts which may be used for this purpose are the peroxides of the alkaline earth metals, especially of barium, and the higher oxides of manganese, iron, and chromium. It is not necessary that the fuel itself absorb the oxygen from the material employed as a catalyst because so-called activated oxygen which is released from such materials may unite chemically with the fuel in the burner flame.

In the embodiment shown in Fig. 2, for example, catalysts of the character just described may be added to the body 50 of porous material or used as the upper porous body above the plate 48. It is particularly desirable in many instances to use such catalysts to form the upper layer of the body 50 of porous material. This is shown in Fig. 5 with parts similar to those shown in Fig. 2 designated by the same reference numerals. The modification shown in Fig. 5 differs from Fig. 2 in that it is modified for gas operation with the conduit 11′ and central tubular member 55′ adapted to be connected to a suitable source of supply of gaseous fuel. A valve 64 may be provided in the conduit 11′ to control the pressure of the gas delivered to the chamber 49. The tubular member 55′ permits the flow of a small quantity of gas to provide an ignition or pilot flame for starting the burner. Above the body 50 of porous material is provided an upper layer 65 of material adapted to serve as a catalyst whereby a so-called auto-oxidation of the fuel is effected or

activated oxygen is produced, as described above. Such a layer of material may be also used when the burner is adapted to be operated with a suitable liquid fuel, such as kerosene.

In many instances it is possible to employ a burner adapted to be operated with liquid fuel wherein only the upper porous body formed of grains or granules is used. With such burners, as shown in Fig. 6, the body 50 of porous material may be of the same cross-sectional area as the casing 47. In the modification shown in Fig. 6, the small supply vessel 53 is omitted although it may be provided in a manner similar to that shown in Fig. 2. The body 50 of porous material may be supported on a sheet of perforated material 66, such as a wire screen, which is spaced from the bottom of the casing 47 to provide the chamber 49 into which the fuel discharges from the conduit 11. When a relatively small flame is desired, difficulty has usually been encountered in liquid fuel burners to adjust and maintain a low rate of flow of fuel to the burner. In accordance with my invention the path of flow of fuel in the burner need not be made small to produce a small flame and it is only necessary to adjust the air pressure under which the fuel is maintained at the supply vessel or the elevation of the supply vessel with respect to the burner where gravity feed of fuel is employed.

In instances where a relatively volatile liquid fuel is employed there is always present in the upper layer of the porous body practically a combustible gaseous mixture. If desired, therefore, the top of the burner may be connected by a suitable conduit to a nozzle or burner of the Bunsen type.

A burner of the character shown in Fig. 6 may be operated with a gaseous fuel, particularly when the gas pressures are not too high. A gas mixture rich in air can easily be obtained by the provision of conduits 57 and 58 for drawing air into the interior of the body 50 and to the top of the burner due to the suction action of the flame. If desired, the conduits 58 may be provided with a plurality of spaced openings 67 along their length within the body 50.

The conduits 58 may also be effectively used to conduct heat from the region of the burner flame into the body or bodies of porous material. If it is desired to increase the evaporation of fuel in the body of porous material by the heating effect of the burner flame, rods or conduits 68, one of which is indicated in Fig. 6, may be provided, such rods extending from a point above the top cover plate 51 downward into the body of porous material. The use of such rods is particularly desirable when fuel of relatively low volatility is used.

In view of the foregoing, it will be understood that I have provided a burner which insures substantially complete combustion of the fuel and yet avoids danger of back-firing. The burner is especially useful where continuous operation is desired, such as for refrigeration apparatus or hot water heaters, without the necessity of frequent servicing. Further, the burner structure is such that a simple automatic control therefor may be provided even when operated with liquid fuel. Although I have shown and described several embodiments of my invention, such variations and modifications are contemplated as fall within the true spirit and scope of my invention, as pointed out in the following claims.

What is claimed is:

1. A burner including a casing, a body of porous material arranged within said casing and through which liquid or gaseous fuel is adapted to flow, said body being capable of causing distribution of the fuel therein, a layer of material contiguous to said body within said casing and at the outer surface of which the flame is maintained, means to permit air to be drawn into the interior of said body by the suction action of the flame to form a combustible mixture with the distributed fuel, and said layer of material being capable of absorbing oxygen from the air and releasing such oxygen at a higher temperature to the fuel.

2. A burner including a casing, a body of porous material arranged within said casing, said body being capable of causing distribution of fuel therein, the flame being maintained at one surface of said body, means to permit air to be drawn into the interior of said body by the suction action of the flame to form a combustible mixture with the distributed fuel, and the layer of said body adjacent the outer surface at which the flame is maintained including a substance which is capable of absorbing oxygen from the air and releasing such oxygen at a higher temperature to the fuel.

3. A burner including a casing and a body of porous material therein and at the upper surface of which the burner flame is produced and maintained, means to conduct and supply liquid fuel to the lower surface of said body to cause flow of fuel therethrough, a chamber adapted to receive liquid fuel conducted to said body, a wick extending from said chamber to the upper surface of said body to provide an ignition flame, and said chamber being constructed and arranged to receive and hold a quantity of liquid fuel even when the supply of fuel to said body is shut off.

4. A burner including a casing and a body of porous material therein and at the upper surface of which the burner flame is produced and maintained, means to conduct and supply liquid fuel under pressure to the lower surface of said body to cause flow of fuel therethrough, a tube extending vertically through said body and terminating at the upper surface thereof, a wick in said tube extending into liquid fuel under pressure to provide an ignition flame at said upper surface, and said wick fitting tightly in said tube to prevent free flow of liquid fuel therethrough.

5. A burner including a casing and two bodies of porous material disposed therein one above the other and contiguous to each other, the upper body being of greater porosity with the burner flame being produced and maintained at the upper surface thereof, means to conduct and supply fuel to the lower body and cause flow of fuel successively through said lower and upper bodies, one or more hollow members extending into the interior of said upper body and through which air is drawn by the suction action of the flame, and one or more additional hollow members extending through said upper body and terminating at the upper surface thereof and through which air is drawn into the region of the flame by the suction action thereof.

6. A burner including a casing and a body of porous material disposed therein and at the upper surface of which the burner flame is produced and maintained, means to conduct and supply fuel to the lower surface of said body to cause flow of fuel therethrough, one or more hollow members extending into the interior of said body and through which air is drawn by the suction action of the flame, and one or more additional members

extending through said body and terminating at the upper surface thereof and through which air is drawn into the region of the flame by the suction action thereof.

7. A burner including a casing and a body of porous material disposed therein and at the upper surface of which the burner flame is produced and maintained, means including a chamber below said body of porous material to conduct liquid or gaseous fuel to the lower surface of said body to cause upward flow of fuel therethrough to said upper surface, and one or more hollow members extending through said chamber into the interior of said body and through which air is drawn by the suction action of the flame to cause the air to flow in the same direction as the fuel in said body.

8. A burner including two bodies of porous material of which the porosity of one is greater than that of the other, the burner flame being produced and maintained at a surface of said body of greater porosity, means to cause flow of fuel successively through said bodies with the fuel passing first through said body of least porosity, and a region within said body of greater porosity being in communication with surrounding air whereby air can flow into the interior of said body and mix with fuel therein.

9. A burner including a first body of porous material and a second body of porous material at a surface of which the burner flame is produced and maintained, means to conduct fuel under pressure to said first body to cause flow of fuel successively through said first and second bodies, the burner being so constructed and arranged that air will flow into the interior of said second body and mix with fuel distributed therein, and said first body being of such porosity that it is primarily effective to reduce the pressure of the fuel and the second body being of such porosity that it is primarily capable of causing distribution of the fuel therein by capillary action.

10. A burner including a casing and a body of porous material disposed therein and at the upper surface of which the burner flame is produced and maintained, means including said casing providing a chamber at the upper boundary of which is disposed substantially all of the lower surface of said body of porous material, means including a conduit connected to said chamber for causing flow of fuel through said body, said body being capable of causing distribution of fuel therein with the fuel entering said body from said chamber substantially uniformly at the lower surface thereof, and means extending from a point above said surface into the interior of said body for transmitting heat from the flame to fuel within the body.

11. A burner including a body of porous material and a second body of material of greater porosity at the surface of which the burner flame is produced and maintained, means forming a chamber adjacent to said first body and at least as great in lateral extent as said first body, said chamber being formed and arranged to provide communication between said chamber and a plurality of portions of the peripheral area of said first body, means including a conduit connected to said chamber to conduct fuel under pressure to said chamber and to cause flow of fuel therefrom successively through said first and second bodies during operation of the burner, said first body of least porosity possessing such physical properties that it is primarily effective to reduce the pressure of the flow of the fuel, and the second body of greater porosity possessing such physical properties that it is primarily capable of causing distribution of the fuel therein by capillary action.

GUNNAR GRUBB.