A. DOBLE.

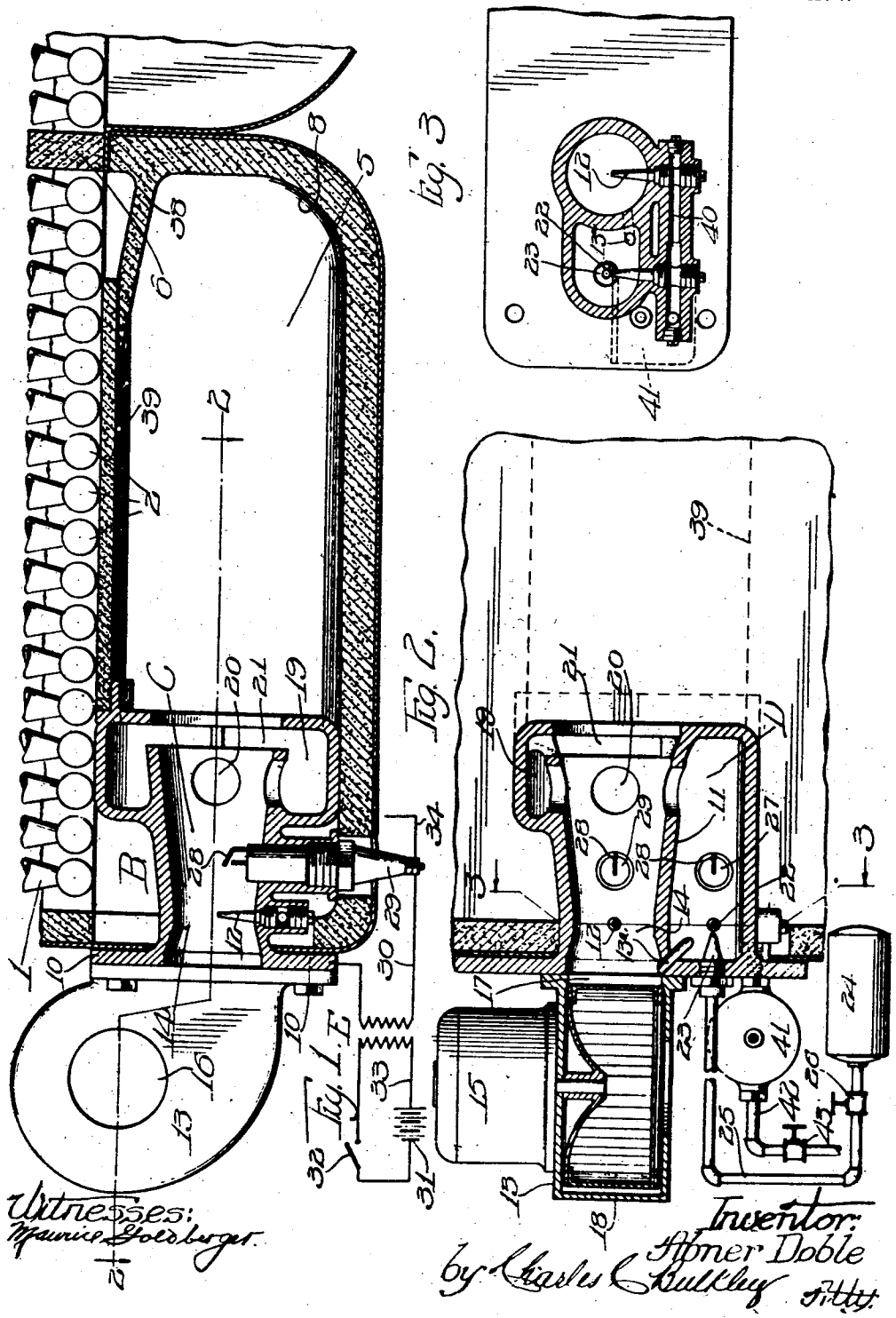
APPARATUS FOR BURNING FUEL.

APPLICATION FILED JAN. 2, 1917.

1,349,876.

Patented Aug. 17, 1920.

4 SHEETS—SHEET 1.



A. DOBLE.

APPARATUS FOR BURNING FUEL.

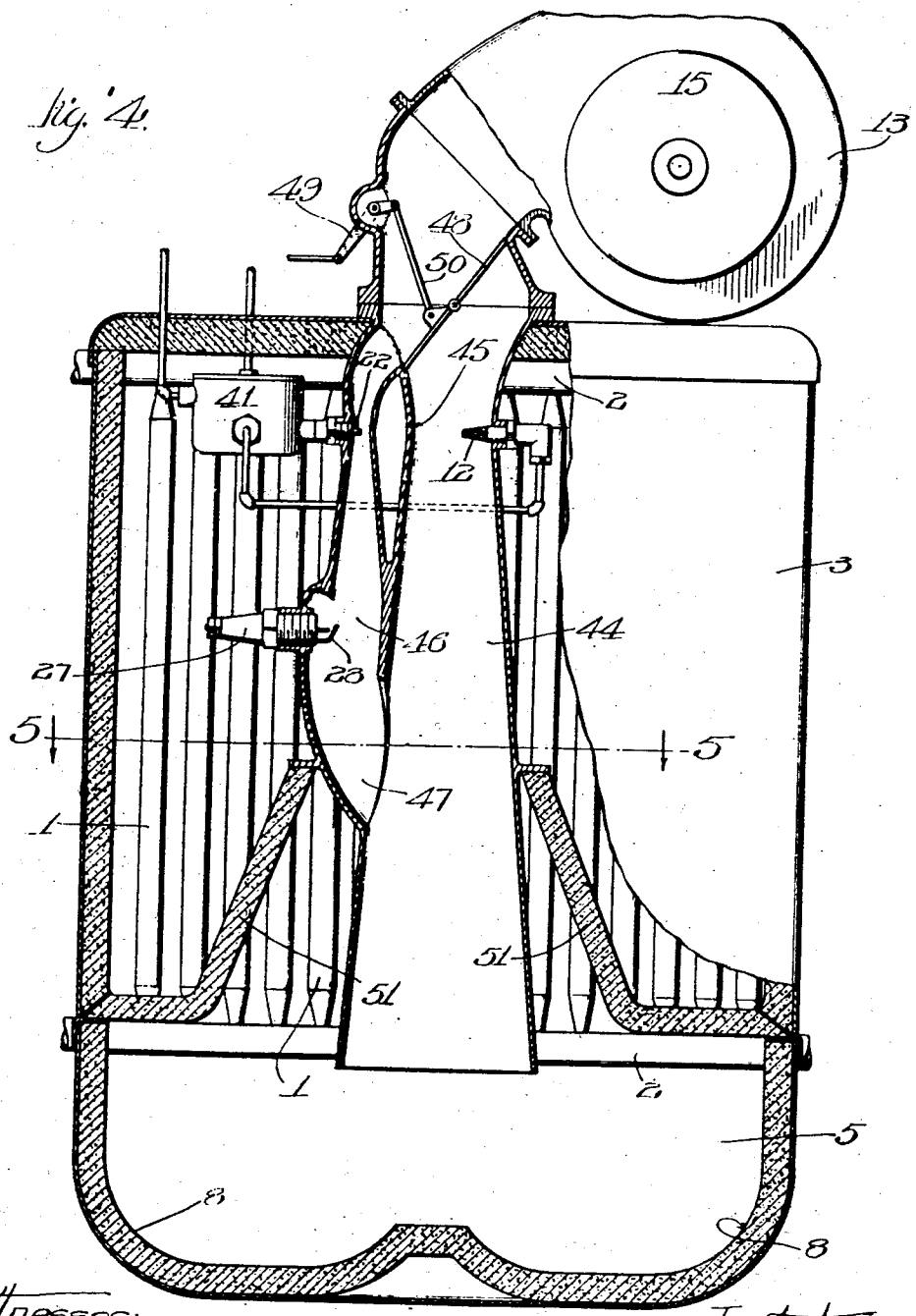
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4 SHEETS—SHEET 2.

Fig. 4.



Witnesses:
Maurice Goldberger

Inventor:
Abner Doble.
by: Charles C. Bulkley
Atty.

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4 SHEETS—SHEET 3.

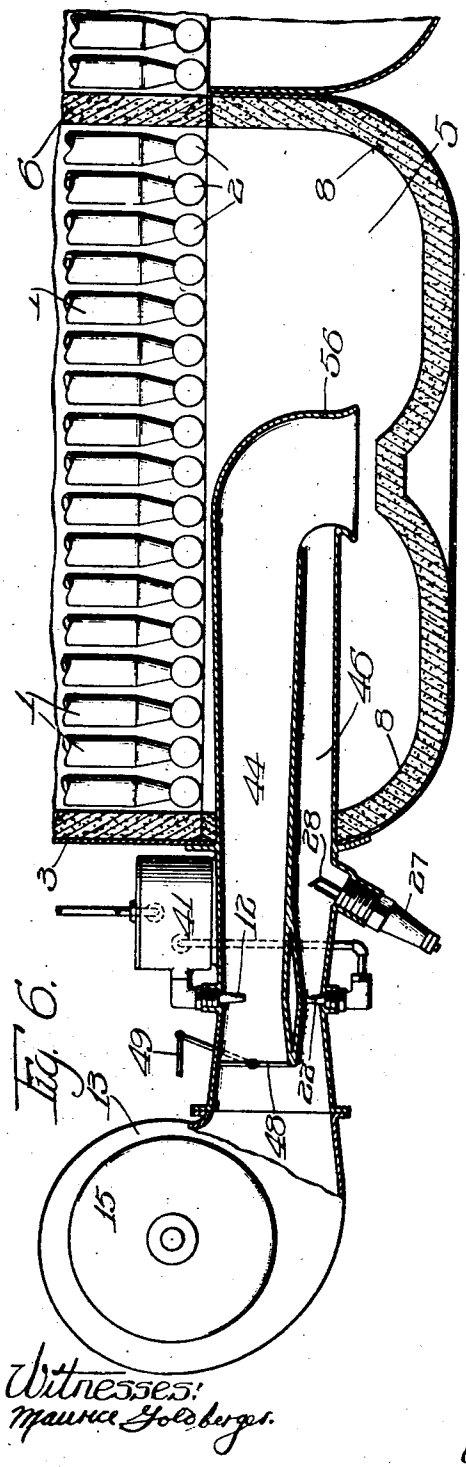


Fig. 6.

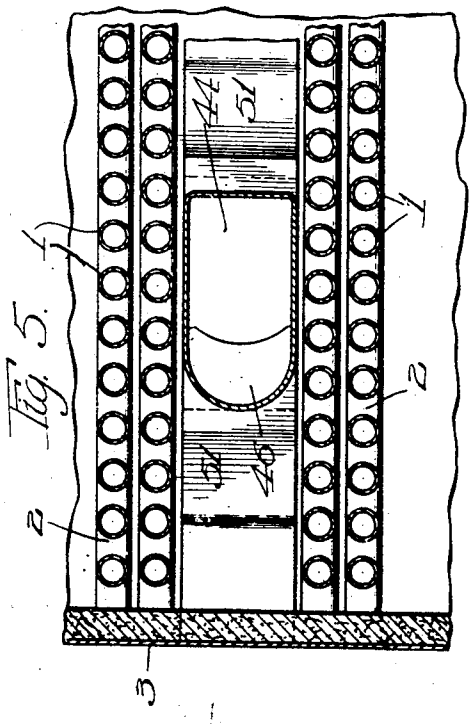


Fig. 5.

Witnesses:
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APPARATUS FOR BURNING FUEL.

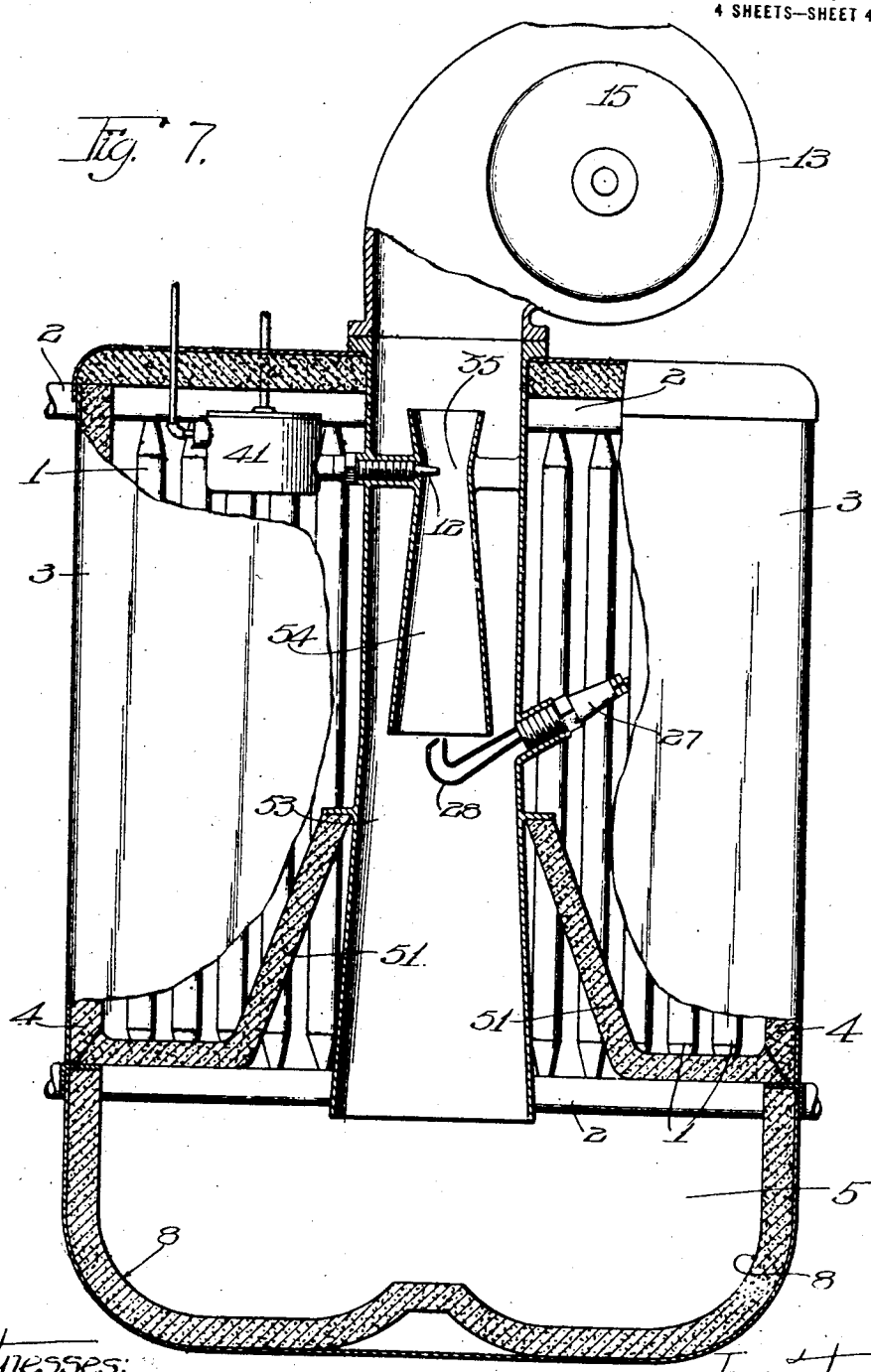
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4 SHEETS—SHEET 4.

Fig. 7.



Witnesses:
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Inventor:
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by: Charles C. Bulkley Atty.

UNITED STATES PATENT OFFICE.

ABNER DOBLE, OF DETROIT, MICHIGAN, ASSIGNOR, BY MESNE ASSIGNMENTS, TO DOBLE-DETROIT STEAM MOTORS CO., OF DETROIT, MICHIGAN, A CORPORATION OF DELAWARE.

APPARATUS FOR BURNING FUEL.

1,349,876. Specification of Letters Patent. Patented Aug. 17, 1920.

Application filed January 2, 1917. Serial No. 140,020.

To all whom it may concern:

Be it known that I, ABNER DOBLE, a citizen of the United States of America, and resident of Detroit, Wayne county, Michigan, have invented a certain new and useful Improvement in Apparatus for Burning Fuel, of which the following is a specification.

The object of my invention consists in the provision of means whereby to make possible the combustion of a liquid fuel hydrocarbon in its liquid state within a combustion chamber without preliminary gasification.

Other objects of my invention will appear hereinafter.

In the drawing I illustrate various improved structures which embody my invention, and which effectively carry out the principles of my improved method.

Referring to the drawings:

Figure 1 is a vertical central section through the burner and combustion hearth of a structure embodying my invention.

Fig. 2 is a horizontal section on the staggered line 2—2 of Fig. 1.

Fig. 3 is a section on the line 3—3 of Fig. 2.

Fig. 4 is a sectional view similar to Fig. 1 but of a modified structure in which the burner is disposed in vertical relationship to the combustion hearth.

Fig. 5 is a sectional view on the line 5—5 of Fig. 4.

Fig. 6 is another similar section to Fig. 1 involving a modification of the horizontal type of Fig. 1.

Fig. 7 is a vertical section like that of the structure of Fig. 4 but illustrating a modification of the vertical type of Fig. 4.

The structures which I have shown in the drawings, and which I have chosen for the purpose of illustrating the principles and functions underlying my invention, have been designed more particularly with a view to their use in the power plants of steam propelled automobiles, but it will be obvious to one skilled in the art, after having obtained an understanding of my invention from the disclosures herein made, that the principles and functions which characterize my invention may, without departing from the scope and spirit thereof, be embodied in other and different structures for the purpose of applying the invention to other requirements and conditions even to the extent of stationary steam and water heating plants,—in fact under any conditions where liquid fuels and particularly the heavier oils, such as kerosene, are to be used.

Since, as I have before mentioned, the particular structures shown have been designed for use in automobile power plants, I indicate them in their operative relation to a steam generator or boiler which is especially applicable to automobile power plants and which is of the type constituting the subject matter of my co-pending application, Serial Number 129,852, filed November 6, 1916.

Only such description of this generator as is necessary to an understanding of its relation to my improved fuel burning mechanism will be given.

This steam generator is of the water tube type and involves a plurality of vertically disposed water tubes 1 which are arranged in groups or units, the tubes of each group being provided with upper and lower headers 2 common thereto. These units are arranged in parallel relation without enough space therebetween for the heated products of combustion from the burner to pass upwardly, and they are contained within a casing or inclosure 3, the walls of which are lined with refractory heat insulating material 4 to confine the heat absorption to the boiler tubes.

In carrying out my method of burning fuel, I provide a burner or hearth member which, in contradistinction to the usual and previously existing types of burner, is imperforate. Instead the combustible fuel mixture is projected or impinged in proximity to or against the surface of this hearth member on the side thereof or in the zone in which the combustion takes place. This hearth member is capable of withstanding high temperatures and is capable of being, and in fact does become, highly incandescent under the action of the burning mixture. Having become incandescent, it acts to accelerate and intensify the combustion of the incoming fuel mixture and build up and sustain an intensely heated zone which, being in proximity to the steam generator, operates to quickly and effectively generate steam in the minimum space of time. In other words, the incandescent condition or state of the hearth member maintains an intense combustion zone into which the fuel mixture flows and its combustion brought about and completed. This building up and

sustaining the process of combustion is initiated by igniting the fuel, preferably while in an atomized or finely divided state by means of an electric spark or by initial heat generated electrically. It is pointed out, however, that the initiating and building up of the process of combustion to a normal operating condition, in actual practice occupies but a few seconds of time, there being sufficient heat generated in this period of time to actually generate steam in the boiler for the propulsion of the automobile.

In the various structures which I have disclosed in the drawings this combustion hearth takes the form of a rectangular bowl or dish-shaped member 5, which is open at its top and which is positioned with its open top beneath the lower end of the evaporator and superheater portion of the boiler so that the superheater gases and products of combustion will pass directly upwardly into the casing and the heat directly absorbed by the boiler. The bowl-shaped hearth is substantially square and embraces the lower open portion of the boiler casing or inclosure up to the partition wall 6 which divides the boiler into two compartments, the upper edge of the burner member being fitted to the boiler to prevent any egress of the heat or entrance of air from the exterior. The burner member or hearth, while being generally square to conform to the boiler, has its lower corners and angles 8 rounded off or curved to form a generally rounded interior surface to direct the incoming fuel as will hereinafter appear. This bowl or dish is deep enough to provide beneath the boiler a suitable combustion chamber in which the fuel, whether it enters in an atomized or finely divided state, or in the form of vapor, is intensely burned. The combustible mixture is introduced into the combustion zone, and the refractory hearth, particularly its interior surface, becomes highly incandescent, and by reason of its presence in the combustion zone it acts catalytically to enhance and intensify the process of combustion. In order that the catalytic action of this hearth member shall be effective to a high degree, I prefer that the hearth member, or at least its interior surface, be of a very porous or cellular nature, or materially roughened whereby to retard the movement of the gases and retain them in the zone of combustion, and especially upon the surface of the combustion for a longer period of time, and further, to increase the effective area of the surface subject to the heat of combustion. I prefer also that it shall be absorbent to a considerable degree so that in the event that any fuel should reach the hearth in a liquid state it will be instantly absorbed and then gradually released and evaporated as the hearth becomes heated and incandescent. I prefer, therefore, that this burner or hearth member be of the type capable of becoming highly incandescent and constructed in accordance with the method or process which constitutes the subject matter of my co-pending application, Serial No. 140,730, filed January 5, 1917, in order to secure the best results.

The mechanism for atomizing or finely dividing the liquid fuel, for initially igniting it, and for properly mixing it with air to form a combustible mixture is, in the present structures, located so as to direct the fuel mixture into the combustion zone and against the interior surfaces of the hearth member.

In the structures of Figs. 1, 2 and 3 I provide a chambered member B which is disposed substantially horizontally and is mounted in an opening in one side wall of the combustion hearth, this member having flanges 10 by which it may be suitably secured in position. This member is preferably made as a casting and is provided with a plurality of chambers or passages,—in this case two arranged side by side and referred to by the characters C and D, and being separated by a wall or partition 11. The chamber or passage C is preferably circular in section and is in the nature of a delivery tube which directs the fuel mixture into the combustion zone. However, its walls are tapered to form a venturi which in conjunction with a fuel nozzle 12 and a blower 13 operates as a spray nozzle to atomize or finely divide the fuel and project it into the combustion zone. The tapering of the tubular passage reduces the area of the throat 14 of the passage and increases the velocity of the current of air at the point where the liquid fuel nozzle 12 is located, and these parts are so proportioned that the proper amount of liquid fuel is drawn from the fuel nozzle and sprayed or finely divided and the proper amount of air supplied by the blower to form a combustible mixture. While it is entirely practicable to employ compressed air or other fluid instead of the blower for the purpose of atomizing or finely dividing the liquid fuel and supplying air for the combustible mixture, it would require a comparatively large storage tank for the compressed air and in automobile practice would thus be more or less prohibitive. I prefer therefore to use a volume blower of a suitable or standard construction such as I have shown, and which is preferably driven by a small electric motor 15 bolted to the blower casing. This blower has a casing which is fastened to the member B and which has an air inlet port 16 at one side thereof. Its outlet or discharge port 17 is positioned to communicate with the outer end of the Venturi passage C. The blower casing contains a rotary multi blade fan wheel 18 which is

mounted on the motor shaft to supply a current of air for the atomizing or spraying operation. The motor may be connected to any suitable source of current such as a storage battery carried on the vehicle, and the control thereof is preferably accomplished by a suitable switch at the operator's position on the vehicle.

The other chamber or passage D is closed at its outer end but at its inner end it merges with an annular chamber 19 which is formed by an enlargement of the member B and which surrounds the inner end of the Venturi delivery nozzle or tubular chamber C. This chamber 19 communicates with the chamber C by means of an annular series of holes or openings 20 in the wall of the chamber C and also by an annular passage 21 at the end of the Venturi nozzle C. In the chamber D is an atomizer or spraying mechanism consisting of a liquid fuel nozzle 22 projecting upwardly to about the center of the chamber, and an air nozzle 23 disposed at substantially right angles to the fuel nozzle and extending through the rear wall of the chamber D, so that the air from said nozzle operates to atomize the liquid fuel and blow a spray thereof toward the inner end of said chamber. The air nozzle is preferably connected with a suitable source of compressed air such as a storage tank 24 carried by the vehicle. In this case, however, it is entirely practicable to use compressed air because, as will hereinafter appear, it is used but very infrequently and for very short periods, hence a comparatively small storage tank is necessary. In the wall between the two chambers C and D is a communicating port 13^a which, as shown, is pointed toward the fuel nozzle 22 and which directs a portion of air from the blower toward this nozzle for the purpose of supplying an additional quantity of air to the chamber D in the event for instance that the quantity of air supplied by the nozzle 23 becomes reduced as by partial failure of compressed air. The pipe-line 25 leading from the tank has a suitable manual valve 26 by which the air supply to the atomizer is controlled, but of course such control may be automatic if desired.

The mechanism just described is employed as a combustion initiating system for the main burner. I provide an electric spark plug or igniter 27 which is removably mounted in a suitable threaded socket in the member B, and this igniter has its sparking terminals or electrodes 28 directly in the path of the spray of fuel from the atomizer in the chamber D and comparatively close to the nozzle so that the spark at the plug terminals is in a zone of comparatively rich mixture which instantly ignites at the instance of a spark at said electrodes. As an additional safeguard I provide another and similar spark plug 29 in the main atomizer with its electrodes in the same relative position to the spray nozzle. In starting ignition these two igniters are preferably operated simultaneously so that in the event of failure of the preliminary atomizer to ignite, as for instance by reason of the failure of the supply of compressed air, the spray in the main atomizer will ignite. The high tension current for the spark igniters may be produced in any suitable or approved manner, as by means of the usual magneto or by means of a spark coil E such as I have indicated diagrammatically in Fig. 1. The spark plug 29 is shown as being connected in the secondary circuit 30 of said coil, and a battery 31 and control switch 32 in the primary circuit 33 thereof. The spark plug 27 is also included in the secondary circuit of the spark coil, the conductor 34 being extended thereto. Upon being ignited in this manner the preliminary burner flame plays in the passage D reaching and entering the Venturi passage C through the openings 20 and annular passage 21 where it instantly ignites the spray of fuel in the main burner nozzle. It is desirable, though not necessary, to discontinue the preliminary flame upon the ignition of the main burner, and this may be accomplished either automatically or manually by simply shutting off the supply of compressed air at the manual valve 26. The flame from the main burner is projected into the combustion zone along and adjacent to the interior surface of the hearth where combustion of the incoming fuel occurs. In the construction of the type where, as in Fig. 1, the flame is projected horizontally into the combustion chamber I provide an arch member which is made in two parts 38 and 39, the part 38 being preferably integral with the hearth member and the part 39 comprising a separate plate or member of refractory material and supported by ledges formed on the member B and integral portion 38 respectively. This arch is substantially as wide as the member B and serves to deflect the burning fuel back into the combustion zone and maintain it in circulation within said zone until the process of combustion of the fuel is complete. The fuel nozzles are in the form of removable plugs which are threaded into suitable openings in the walls of the member B, and both of these nozzles are connected by a common fuel passage 40 formed in said member B. A float chamber 41 is mounted on the member B and connected with the fuel passage 40. It is of any suitable or approved construction such as is commonly used in connection with carbureters for internal combustion engines for controlling the flow of fuel. This float chamber is connected to the pipe line 42 which leads to a suitable supply of liquid

fuel. A manual valve 43 is interposed in the pipe line for regulating the flow of fuel.

The structures shown in Figs. 4, 6 and 7 embody the principles of my invention, but in Figs. 4 and 7 the atomizers are disposed vertically and positioned between sections of the steam boiler tubes, some of the central sections thereof being eliminated to provide room for the burner mechanism. I provide a comparatively long delivery tube or Venturi nozzle 44 extending from the top of the boiler, and terminating at the lower end thereof within the combustion zone and in position to direct the fuel mixture upon the bottom interior surface which is modified to the extent of providing a hump or raised portion in the center of the combustion hearth to properly deflect the fuel and assist in the distribution thereof over said surface. This venturi is formed by a tubular member which is substantially circular in section at its throat or contracted portion 45 and which increases in size to its lower end, this lower end assuming a rectangular form to properly fit in the space between the sections of the boiler as shown in Fig. 5. The fuel nozzle receives fuel from the source of liquid fuel through the float valve chamber hereinbefore mentioned. In this structure the blower is positioned above the boiler and its discharge outlet 17, as shown in Fig. 1, is connected to the upper end of the Venturi tube. The preliminary ignition burner comprises a smaller atomizer formed at the side of the main venturi 44. This smaller atomizer involves a Venturi passage 46 which at its upper end merges into the upper end of the main venturi 44 and its enlarged lower end 47 merges into the main venturi substantially midway of the upper and lower ends of said main venturi. Both of these Venturi passages or tubes are provided with fuel spray nozzles 12 and 22 respectively and these nozzles are connected with the float valve chamber hereinbefore mentioned. In this structure the use of compressed air for spraying the fuel in the preliminary atomizer is dispensed with and instead the current of air therefor is supplied by the same blower which supplies the main atomizer. I provide a valve 48 at the discharge outlet of the blower at the upper end of both Venturi atomizers, so that in starting the process of combustion the valve may be positioned to direct the blast of air from the blower into the smaller venturi and to cover the end of and prevent the air from passing through the main venturi. This smaller atomizer produces a comparatively small spray of rich mixture which is initially ignited by the spark at the electrodes 28 of the spark plug 27 as hereinbefore described, the spark plug being positioned with its electrodes in the path of the spray and removably mounted in a threaded socket in the wall of the Venturi tube. Having ignited the preliminary burner in this manner the spark may be discontinued and the valve 48 opened to permit the current of air from the blower to flow through the main venturi. The spray of mixture from this main atomizer is then ignited by the flame from the preliminary burner at the lower end thereof. In this construction the preliminary atomizer remains in communication with the blower and continues to operate as an additional atomizer supplying fuel mixture to the main burner and thence to the combustion zone, but this is not necessary and the preliminary burner may be discontinued if desired after the main burner has been ignited. I have shown a valve operating lever 49 journaled in the casing and connected to the valve 48 by means of a link 50, this valve lever being connected to a manual or automatic operating mechanism as desired. The space provided for the burners extends across the entire width of the steam boiler because of the removal of unit sections of boiler tubes and in order that this excess space may not divert the heated gases from passing around the boiler tubes, I provide refractory partitions or walls 51 between the burner and the walls of the boiler casing. These are removably positioned in this space and are substantially V shaped and reach upwardly to about midway the length of the atomizer tube. They are upwardly inclined so as to provide some space adjacent the lower portions of the atomizer tube which subjects the lower portion of the delivery or atomizer tube to heat from the combustion zone.

The structure shown in Fig. 7 is similar to that just described in connection with Fig. 4 in so far as its relation to the boiler and combustion hearth is concerned. But in this case the main tubular member 53 is arranged to form an air passage from the blower to the combustion chamber, its upper end being directly connected to the discharge outlet of the blower. Within this tubular member and preferably concentrically arranged with respect thereto is a Venturi tubular member 54 which is considerably shorter in length and considerably less in diameter than the main tube 53. This smaller venturi is in direct communication at both its upper and lower ends with the interior of the tubular member 53 and thereby forms a separate and independent passage through which a certain amount of the air is diverted from the main tubular member. Within the contracted or throat portion 35 of this smaller venturi is positioned the fuel nozzle 12 which is connected with fuel supply through the float chamber. This smaller venturi with the nozzle contained therein atomizes the fuel and produces a spray thereof which is emitted from

its lower end and mixes with an additional quantity of air passing through the main tubular member 53 to form a combustible mixture of the proper proportions to burn within the combustion chamber. This smaller Venturi atomizer in itself produces a comparatively rich mixture of fuel and air which is ignited by a spark at the terminals 28 of the spark plug, as hereinbefore described. In this case the spark plug 27 itself is threaded into a suitable socket in the wall of the tube 53 but its electrodes 28 are extended so that they are positioned directly in the path of the atomizer, this point being just at the lower end of the smaller venturi. Thus the blower supplies a quantity of air for mixture with the fuel but a portion of this air is diverted to atomize the fuel.

Referring now to the structure shown in Fig. 6, it will be observed that a combustion hearth of the type shown in Figs. 4 and 7 is employed and the combustible mixture directed upon its upper surface. In this construction, however, the atomizers are disposed horizontally as in the case of the structure in Fig. 1, but the inner end 56 of the main Venturi tube is turned downwardly so as to direct the fuel upon the bottom wall of the combustion hearth. Both the main and starting smaller atomizers are provided with fuel nozzles 12 and 22 respectively in their contracted portions and connected to the fuel supply. The blower is common to both atomizers. A butterfly valve similar to the valve 48 is arranged so that in initially operating the mechanism the main atomizer may be closed, and the air from the motor diverted into the smaller atomizer. After the spray from the small atomizer has been ignited by the spark as heretofore described the valve may then be operated to open the main atomizer. The fuel mixture from the main atomizer will be ignited by the flame at a point adjacent the inner end of the atomizer tube, at which point the auxiliary atomizer tube opens into and merges with said main atomizer tube.

I claim:

1. In a steam power plant, a liquid fuel burning device comprising a main Venturi tube having a fuel nozzle therein, a blower, means for operating the blower, a by-pass in the main venturi and means for momentarily diverting air from said blower through said by-pass, and an igniter and an auxiliary fuel nozzle in said by-pass.

2. In a steam power plant, a liquid fuel burning device comprising a main venturi having a fuel nozzle therein, an auxiliary venturi so positioned relative to the main venturi as to receive air from the blower, and an igniter and fuel nozzle in the auxiliary venturi.

Signed by me at Chicago, Illinois, this 23rd day of Nov., 1916.

ABNER DOBLE.

Witnesses:
E. H. CLEGG,
AMY JEHLE.