Aug. 2, 1932. H. A. HYMER 1,869,897

METHOD OF AND APPARATUS FOR COMBUSTION OF FUELS

Filed Nov. 1, 1926 4 Sheets-Sheet 1

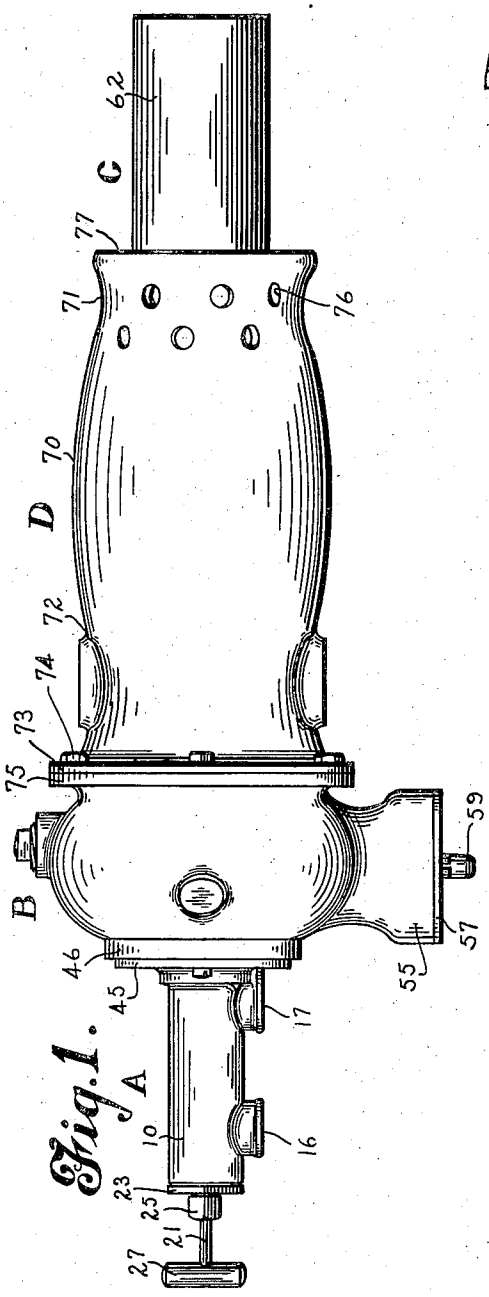


Fig. 1.

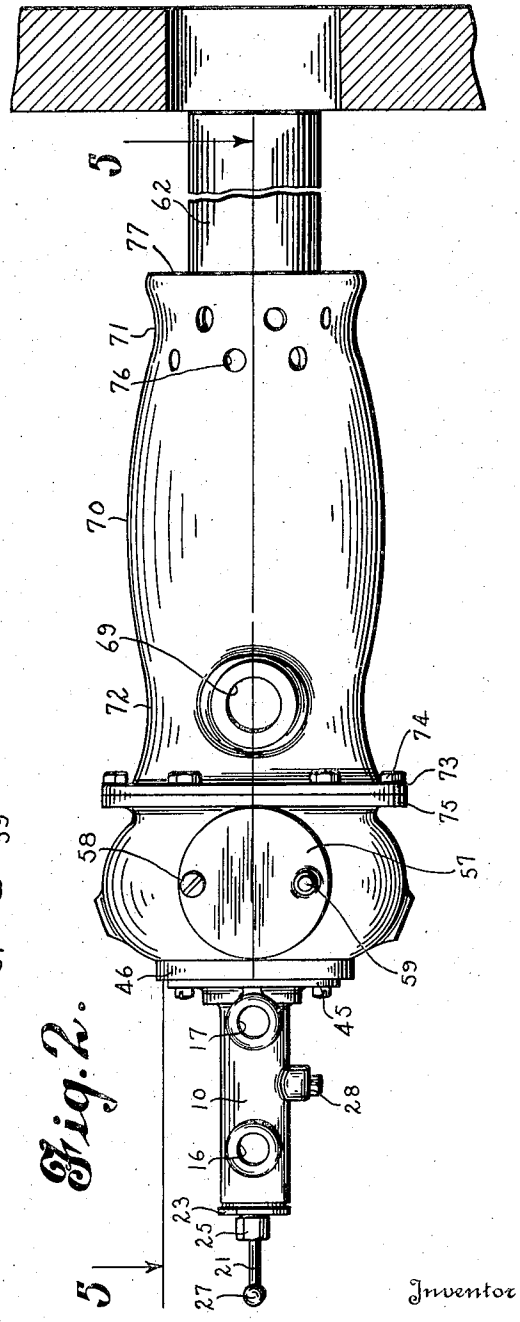


Fig. 2.

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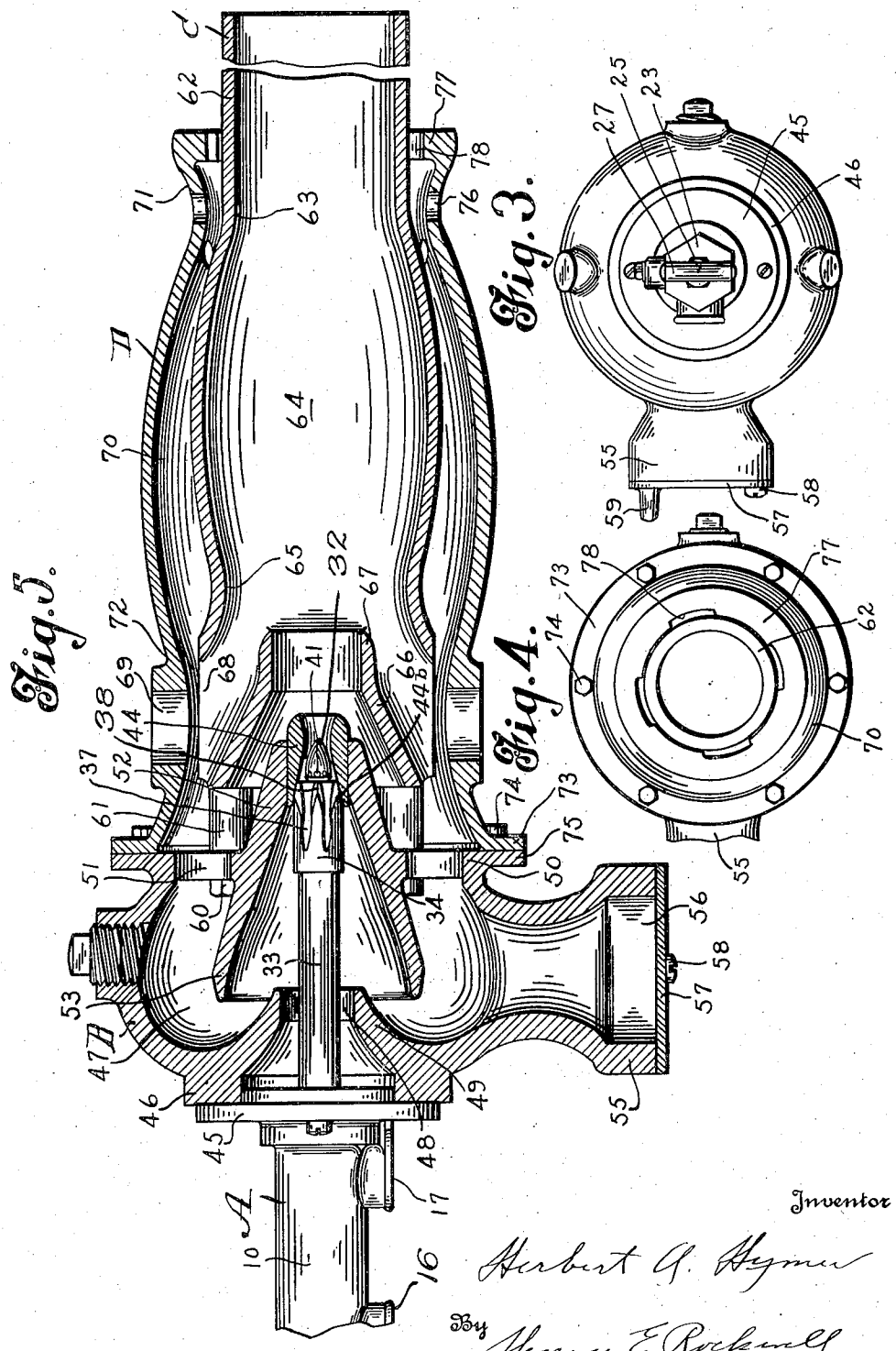


Fig. 5.

Fig. 3.

Fig. 4.

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METHOD OF AND APPARATUS FOR COMBUSTION OF FUELS

Filed Nov. 1, 1926 4 Sheets-Sheet 3

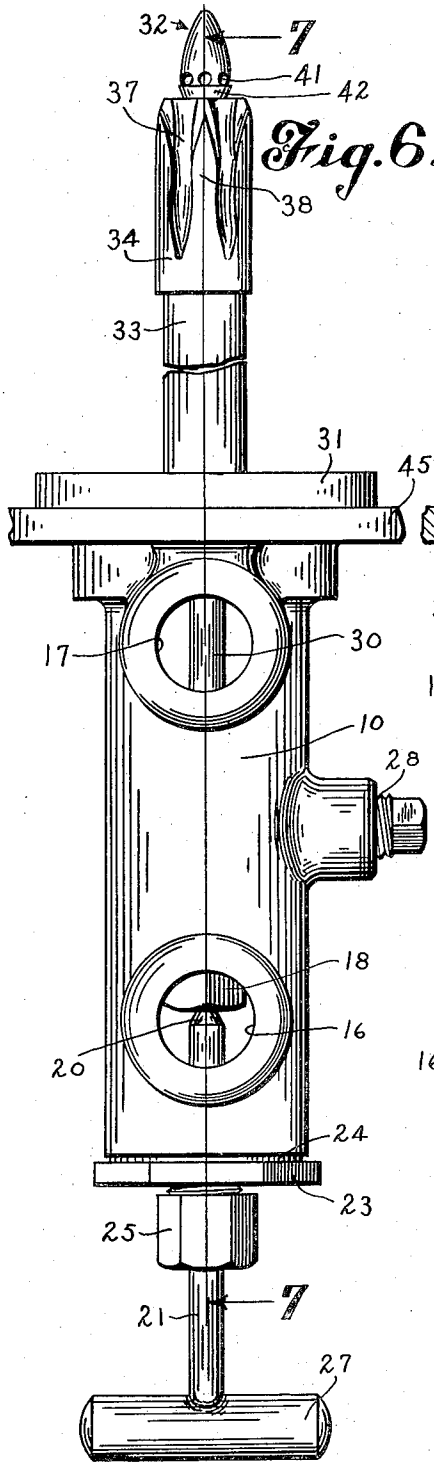


Fig. 6.

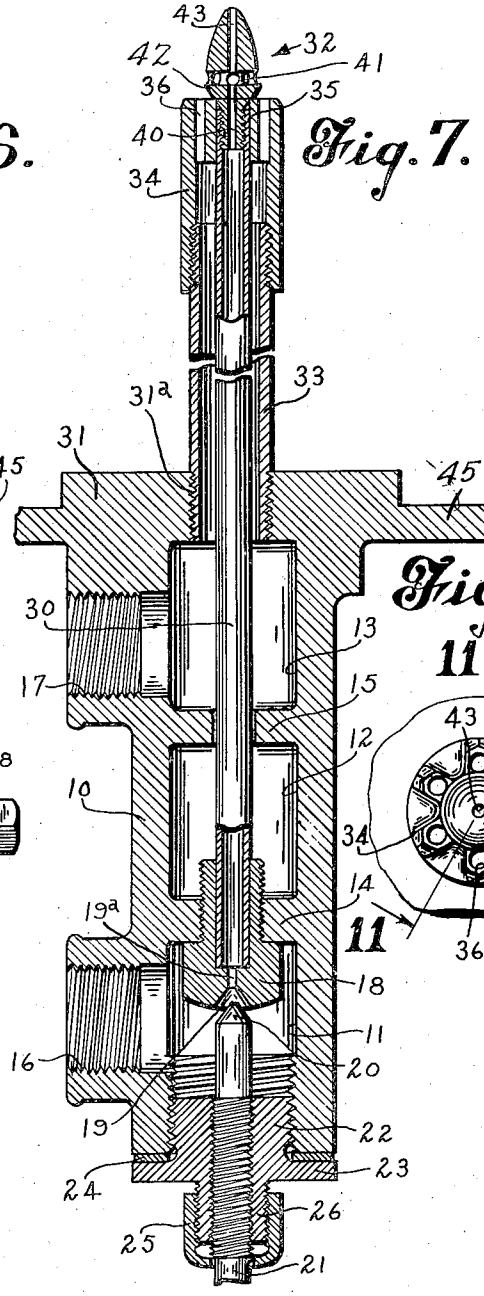


Fig. 7.

Fig. 8.

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METHOD OF AND APPARATUS FOR COMBUSTION OF FUELS

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Fig. 9.

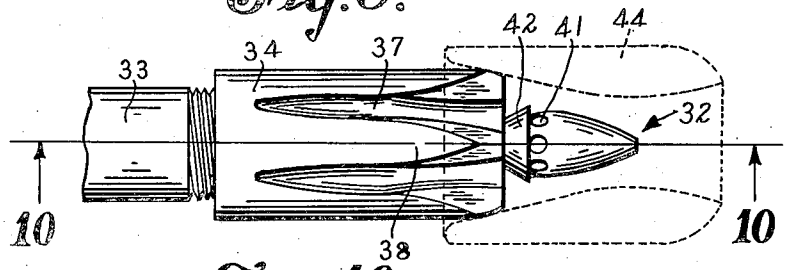


Fig. 10.

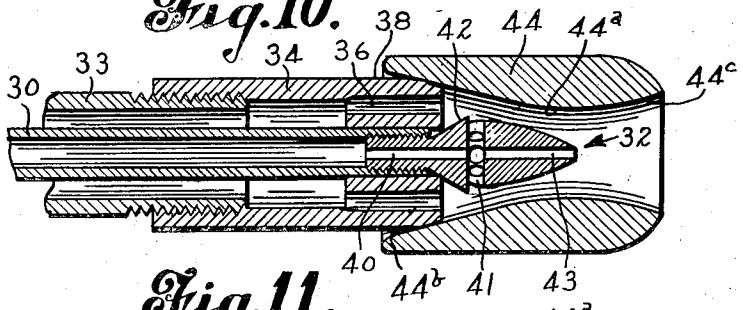
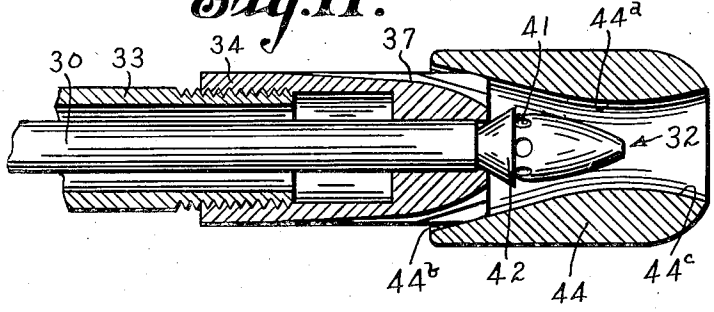


Fig. 11.



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UNITED STATES PATENT OFFICE

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METHOD OF AND APPARATUS FOR COMBUSTION OF FUELS

Application filed November 1, 1926. Serial No. 145,564.

This invention relates to fuel burners, and while I have illustrated as a preferred embodiment of my invention a burner employing a liquid fuel, it will be understood that certain principles of the invention are applicable to burners using gases or finely divided solid fuels as well. The preferred embodiment of my invention illustrated in the drawings is particularly adapted for employing fuel oil, and generally speaking consists of means for first atomizing the liquid oil, mixing the resulting mist or atomized liquid with a combustion supporting medium, delivering this medium to a combustion chamber wherein the combustion takes place. The parts are so designed and constructed that a particularly efficient apparatus is provided which not only develops a very high temperature, but also delivers a maximum number of heat units for a given quantity of fuel.

I have also employed a novel method of combustion which will be hereinafter described, and the apparatus shown is particularly adapted for the carrying out of this method.

One object of my invention is to provide a new and improved method of burning hydrocarbon fuels, such that the fuels will be burned in a very efficient manner and a high temperature developed therefrom.

Another object of my invention is the provision of an improved method for burning liquid fuels, such that a proper mixture of the fuel and combustion supporting medium will be delivered to a combustion chamber and there burned in such a manner that a very high temperature will result, and an efficient combustion of the fuel will be effected.

A further object of my invention is the provision of an improved burner for hydro-carbon fuels, such that the fuel delivered to the burner will be properly mixed with a combustion supporting medium, and the combustion will take place under such conditions as will cause a high degree of temperature to be developed in the burner, and will effect an efficient combustion of the fuel in that an increased number of heat units will be produced from a given quantity of fuel.

A still further object of my invention is to provide a burner of this character of improved efficiency, wherein combustion will take place at a rapid rate and therefore a high temperature will be developed.

To these and other ends, the invention consists in the novel arrangements and combination of parts which will hereinafter be described and claimed.

In the accompanying drawings:

Fig. 1 is a plan view of a burner, embodying my invention and adapted to carry out my improved process;

Fig. 2 is an elevational view of the burner, taken at right angles with respect to the view shown in Fig. 1;

Fig. 3 is an end view of the burner, showing the back or inlet end thereof;

Fig. 4 is an end view of the opposite end of the burner;

Fig. 5 is a sectional view through the burner on line 5—5 of Fig. 2;

Fig. 6 is an elevational view of the atomizer used in connection with the burner;

Fig. 7 is a sectional view on line 7—7 of Fig. 6;

Fig. 8 is an elevational view of the end of the atomizer;

Fig. 9 is a side elevational view of the parts, shown in Fig. 8;

Fig. 10 is a sectional view on line 10—10 of Fig. 9;

Fig. 11 is a view similar to Fig. 10, but taken at a slightly different angle, namely, on line 11—11 of Fig. 8.

As shown in Fig. 1 of the drawings, the burner consists generally of an atomizer A, a head B, a combustion shell C, and a shell casing or outer casing D.

As shown more particularly in Figs. 6 and 7 of the drawings, the atomizer consists of a casing or body 10, having in the form shown three chambers 11, 12 and 13 separated by the partitions 14 and 15. The chamber 11 is the oil chamber and is provided with a threaded inlet opening 16 to receive an oil pipe. Air, or some combustion supporting medium, is in like manner introduced into the chamber 13 through the inlet opening 17.

The partition 14 is provided with a threaded opening within which is mounted

a needle valve seat member 18, having a valve seat 19 for a needle valve 20, provided upon the end of a stem 21, having threaded engagement with the stuffing gland 22, which is in turn threaded into the end of the body 10 to close the oil chamber. This stuffing gland is provided with a flange 23 to abut the end of the body 10, and between this flange and the end of the body may be interposed a sealing washer 24. The valve stem 21 may be surrounded by a packing nut 25 threaded upon a boss 26 on the stuffing gland 22, and upon the end of the stem there is provided a manipulating handle 27. The chamber 12 may be provided with a plugged opening 28 for the insertion of an air gauge when desired.

The rear end of an oil tube 30 is mounted within the valve body 18, and extends forwardly therefrom, passing loosely through an opening in the partition 15, and through an opening 31ª in the front wall 31 of the atomizer body to project into the burner, as will be hereinafter described. An oil delivery plug 32 is mounted in the front end of this tube and, as illustrated, has a threaded engagement therewith. The tube 30 communicates with the valve seat 19 through a restricted passage 19ª.

The opening 31ª is considerably larger than the tube 30, and threadedly mounted in this opening is a primary air tube 33 which surrounds the tube 30, the tube 33 being of such size that a considerable space remains between its inner surface and the outer surface of the tube 30, for the passage of air. Secured at the end of the air tube 33 is a primary air cap 34, which at its forward end has a reduced opening 35 approximately the same size as the tube 30, so as to permit the adjacent end of the latter tube to be received in this opening and thereby supported in proper position. This reduced opening at the end of the cap 34, provides for a thickening of the metal of the wall of the cap at that point, and within this thickened wall are arranged a number of longitudinal air delivery openings 36, communicating with the interior of the cap 34, and likewise, with the space between the oil tube 30 and the primary air tube 33. As shown in Fig. 8 of the drawings, six of these openings are provided, although it will, of course, be understood that this number may be varied. Between these openings, the metal is cut away at the exterior surface of the cap to provide relief passages 37 as shown in Figs. 5, 6, 9 and 11, and leaving ribs or ridges 38 between these passages and about the openings 36.

The oil plug or tip 32 is somewhat conical in shape, and is provided with a central longitudinal oil passage 40. A number of radially disposed openings 41 are provided intermediate the ends of the plug or tip, and communicate with the passage 40 to permit the delivery of a spray of oil to the atomizing air. Rearwardly of and adjacent to the openings 41 is provided an inclined shoulder or apron 42, which projects slightly from the adjacent surface of the oil spray plug and shields the openings 41. The longitudinally disposed passage 40 is continued to the tip end of the plug 32 and forwardly of the openings 41 provides a passage 43 for the admission of air in a rearward direction, as will be hereinafter explained.

The end of the air cap 34, and likewise the oil spray plug 32 are adapted to be inserted into the bore of a Venturi member 44, which is supported by the head of the burner, as will be hereinafter described.

Adjacent its forward end, the atomizer body 10 is provided with a flange 45 to abut against and be secured to the flange 46, at the rear end of the head B. This head is hollow and is provided in the form shown with an interior air chamber 47 and a rear opening 48 through which the air tube 33 is received, about which opening a boss or projection 49 of frusto-conical shape is formed on the rear inner surface of the head. A web or spider 50 is provided at the front part of the head through which a number of openings 51 are formed. Between these openings, a frusto-conically shaped boss 52 projects forwardly from the web 50, which boss has a skirt portion 53 projecting rearwardly into the chamber 47, and over and in spaced relation to the boss 49. The Venturi member 44 is seated in the open end of the boss 52, the assembled relation of these parts, together with the oil spray plug 32 and the air cap 34 being shown more particularly in Fig. 5.

The head B is provided with a laterally projecting neck 55, having an air opening 56 covered by a shutter 57, pivotally secured at 58 to the wall of the neck. A manipulating pin 59 is arranged on the shutter by which it may be moved to admit the desired quantity of air. It will be understood that in some of the uses of the burner, the shutter 57 will remain entirely closed, but as will be hereinafter explained, in certain instances, it may be desirable to admit a certain amount of air through this opening into the chamber 47.

The combustion shell or chamber C, shown more particularly in Fig. 5, is secured at its rear end to the web 50 by bolts 60, these bolts passing through spacing members 61 to maintain the shell in proper position relatively to the head. The shell is provided with a somewhat contracted front end 62, of substantially cylindrical shape, which from a point 63 is enlarged to form a portion 64, substantially of an ellipsoidal shape, the shell contracting again adjacent the point 65 and thereafter expanding toward its rear end. The rear end of the shell is open and about

the opening is provided an entraining frusto-cone shaped sleeve 66, terminating in a substantially cylindrical front portion 67 through which the charge of mixed fuel and air is delivered into the ellipsoidal portion 64 of the combustion chamber.

In the outer wall of the shell and at the rear end thereof are provided ignition openings 68, which are disposed substantially opposite to ignition openings 69 in the outer or shell casing D. This shell casing surrounds the combustion shell C and substantially conforms thereto in shape, having an ellipsoidal intermediate portion 70, a contracted portion adjacent its forward end 71, and a contracted portion 72 adjacent the openings 69. Behind the openings 69 the outer shell is slightly expanded and terminates in an annular flange 73 which is secured by bolts 74 to the flange 75 of the head. Adjacent the forward end portion of the outer casing are provided a number of air openings 76 for the admission of air to the casing about the combustion shell C, as will be hereinafter explained. The forward end of the casing D is slightly expanded beyond the openings 76 and at the extreme outer end is provided with an internally projecting flange 77, the inner edge of which lies closely adjacent the outer surface of the forward portion 62 of the shell C. The flange 77 is notched at a number of points about its periphery, as shown at 78, whereby additional openings for the admission of air thereinto are provided.

As shown in Fig. 10, the bore of the Venturi member 44 has a constricted central portion, as shown at 44^a, behind which it flares outwardly so that the bore is considerably larger adjacent the inner end thereof at 44^b. Between these points it is substantially frusto-conical in shape, and generally speaking parallels the outer surface of the oil plug 32 for a part of its length. Beyond the contracted portion 44^a the bore of the Venturi member again flares outwardly to its mouth 44^c. The shape of the bore of the Venturi member just described is adapted to bring about a thorough and intimate mixture of the fuel and combustion supporting medium before the charge is delivered to the combustion chamber.

The oil plug 32, as clearly shown in Figs. 9 to 11, is tapered toward the forward end so that it terminates in a relatively small end surface and is so designed as to provide a streamline body effect. This shape of the oil plug is conducive to the free passage of air and fuel thereabout and prevents the formation of a partial vacuum at the end thereof such as would be caused if the plug were provided with a blunt end, and the charge which is directed inwardly across the outer end of the passage 43 in effect brings about a pressure at the mouth of this passage such that in conjunction with the reduction of pressure in passages 40 and 43 in a manner to be hereinafter pointed out causes air to pass into the passage in a direction opposite to that of the fuel flowing through the passage 40, which air mixes with the fuel and assists in the atomizing thereof.

As shown in the drawings, the radially disposed openings 41 are preferably equal in number to the air passages 36, and register with these passages. This is clearly shown in Fig. 9 where one of the openings 41 is shown directly registering with the center of one of the ribs 38 through which an opening 36 is formed. By this arrangement the air passing through the opening 36 will flow directly over one of the openings 41 so that an efficient mixture and atomizing of the air and fuel is effected.

In the operation of my device, it will be understood that oil is introduced into the chamber 11 through the opening 16, and likewise the opening 17 is connected to a source of compressed air. The oil is introduced into the openings 16 under a certain amount of pressure, which pressure will be sufficient to cause the oil to pass through the oil tube 30 and issue through the openings 41 in the oil plug 32, the oil being thus broken up into relatively small streams. The air supplied to the chamber 13 will also be under pressure, which pressure may vary according to conditions from a few pounds to one hundred or more pounds per square inch. With enlarged openings in the air cap 34 the burner may operate with as low a pressure as eight ounces per square inch. The air passes through the air tube 33 into the cap 34 and through the openings 36 impinging upon, mixing with, and serving to atomize the oil flowing through the openings 41. The oil plug is thus surrounded by the air currents coming from the openings 36 which, being under pressure, will also have a tendency to entrain and draw the oil through the openings 41 thus causing a reduction of pressure therein and in the passage 40. Due to the difference in pressure existing at the tip of the oil plug 32 and in the passage 40 and openings 41, a mixture of air and oil will flow rearwardly through the passage 43, meeting and mixing with the oil entering the plug through the passage 40, and passing out through the openings 41 together with the oil. This tends to break up the oil stream, spreading or mushrooming it out, and assisting in the atomizing and mixing operations. The air rushing out of the openings 36 passes over the collar 42 which shields the oil openings 41 and prevents a tendency of the pressure of the air to impede the issuance of the oil through these openings. It may be stated, however, that while I have found that the operation of the burner is improved by the provision of this collar, it is

not absolutely essential, and the burner may in some instances be operated without it.

The passage of the air through the bore of the Venturi member from the passages 36, serves to draw in additional air through the relief passages 37 from the interior of the frusto-cone shaped boss 52 and apron 53. This air is drawn from the chamber 47, and most of it enters this chamber through the openings 76 adjacent the end of the shell casing D. The air entering through these openings passes between the combustion shell C and the outer shell D for substantially the entire length of the outer shell, and as the combustion shell C is very hot during the operation of the burner this air is preheated to a relatively high temperature, and also serves to cool the combustion shell to enable it to withstand the high temperature developed therein. In passing through the chamber 47 and about the apron 53 it is cooled to some extent before it is permitted to impinge upon the air tube 33. This cooling of the air before it is permitted to enter the Venturi member avoids any possibility of ignition or combustion at a point too low in the burner and before the charge is delivered to the combustion shell, for it is of course recognized that the more concentrated the combustion or the more confined the combustion zone the higher the degree of temperature which will be developed, as compared with a condition wherein partial combustion may take place over a relatively great area until the fuel may be entirely consumed. Likewise the frusto-cone shaped boss or projection 49 about the opening 48 of the head prevents this air impinging upon the rear end of the tube 33, and serves to direct it forwardly within the apron 53 after it has been somewhat cooled by contact with the wall of the head B, so as to avoid a possibility of overheating the atomizing air within the tube 33.

Additional air may in some instances be admitted to the chamber 47 through the shutter 57. This air is prevented by the apron 53 from passing into the Venturi member until it is mixed with the preheated air in the chamber 47. The amount of air permitted to enter past the shutter 57 depends upon the conditions under which the burner is used. For instance, if the shutter 57 is closed and all of the air used by the burner is drawn through the openings 76, this air will serve to cool the combustion shell C, and will cause the combustion to take place nearer the forward end of this shell.

If the shutter 57 is opened less air will be drawn through the openings 76, and as a result the combustion shell will become hotter, and this will cause the combustion to take place closer to the end of the Venturi member 44. It is, of course, desirable to permit the burner to receive as much air as possible through the openings 76 and opening 56, in order to cut down as far as possible the amount of compressed air necessary, as the production of the latter is an item of expense. When the burner is used in connection with a furnace, as shown in Fig. 2, it is usually desirable to only partially open the shutter 57 in order to permit a large quantity of the indrawn atmospheric air to enter through the openings 76 in order to cool the combustion shell as much as possible.

We have, therefore, issuing from the Venturi member a charge consisting of a mist of atomized air and oil in a substantially thoroughly and intimately mixed condition. This charge is permitted to expand in the forward end of the Venturi tube, and while its velocity is thereby increased its pressure is decreased. While passing through the member 67 more air is entrained through the cone shaped sleeve 66. To a large extent this air passes about the spacing members 61 and comes directly from the space between the outer and inner shells, without first passing into the chamber 47 and, like the air drawn through the relief passages 37, has been preheated, but even to a greater extent than the latter. This air is likewise directed across the mouth of the Venturi tube, and is thereby mixed with the charge issuing therefrom. This mixed charge of fuel and air enters the ellipsoidal portion 64 of the combustion chamber, where the charge is caused to burn under pressure within a confined space, and is burned so rapidly that it may be described as an explosive combustion; that is, when the charge enters the confining combustion chamber in the proper proportions the combining of the fuel and oxygen takes place substantially instantaneously, and the result is that an explosion or multiplicity of explosions occur rather than a quiet or "flash" burning of the fuel. It is also due to the initial pressures with which the fuel and air are introduced into the burner, the passage of the charge through the combustion chamber being resisted by the pressure waves set up by the explosions within the shell, the waves being reflected from the ellipsoidal wall of this chamber so as to cause a turbulence of the charge therein, which also adds to the pressure of the mixture and assists in keeping the charge within the chamber a sufficient length of time to be completely burned. The back pressure due to the combustion is borne to some extent by the restricted portion 65 of the shell, and likewise the forward pressure is borne by the restricted portion 63. The result is, therefore, that combustion takes place at a very high rate of speed and develops a very high temperature.

Some air may also be drawn into the burner through the ignition openings 69, although these openings are of relatively

smaller area than the combined areas of openings 76 and 78, and the pressure within the combustion shell under ordinary conditions probably prevents the entry of any great quantity of air through these openings. In fact under some conditions of adjustment flame will issue therefrom showing that the pressure adjacent thereto is greater and not less than atmospheric pressure. Furthermore, as shown in Fig. 5 of the drawings, the construction of the combustion chamber or shell C is such that opposite the openings 69 it is close to the inner surface of the shell D, while between the openings 69 the shell C is relatively widely spaced from the shell D, thus permitting the free flow of air between shells C and D into the chamber 47 and frusto-conical shaped sleeve 66.

As the air necessary to support combustion is admitted within the burner and, therefore, the charge does not have to issue from the mouth of the shell C in order to mix with the surrounding air before being burned, combustion of the charge takes place within the combustion shell C. The zone of combustion begins adjacent the forward end of the member 67, and extends forwardly from this point into the contracted cylindrical end 62 of the combustion shell.

The combustion shell C is preferably made sufficiently long so that substantially complete combustion of the fuel takes place within this chamber. The cross-sectional size of this shell is such that the charge is confined between the walls thereof, and the explosive waves being reflected from the walls creates the turbulence heretofore referred to which aids in keeping the charge within the combustion chamber or shell until it is substantially completely burned. It will be seen, therefore, that the length of the shell depends somewhat upon the point at which combustion begins to take place: that is, the further the beginning of combustion in front of the Venturi member the longer the tube must be in order that unburned gases do not issue therefrom. In some instances, such as when the burner is used with a furnace, it is not always undesirable to have a small amount of the charge burned without the combustion shell, and this may be regulated by controlling the supply of air and fuel. I believe, however, that the most efficient conditions prevail and the highest temperature is developed when complete combustion takes place before the charge leaves the shell. Under ordinary circumstances the length of the combustion shell should be not less than three times its diameter at the ellipsoidal portion.

It will be noted that the Venturi member 44 projects forwardly from the oil spray plug 32, so that after the air issuing through the openings 36 and through the relief passages 37 meets the oil issuing from the openings 41 a passage or chamber is provided within the Venturi tube wherein the oil and air may mix before passing into the member 67 for delivery to the combustion chamber. By confining the air and oil within the Venturi tube at this point, and on account of the turbulence created within this passage in the tube a more intimate mixture of the fuel and combustion supporting medium, which is preheated, is effected. By this arrangement a finely divided mist or supply of fuel and air is delivered to the combustion chamber ready to be exploded upon reaching the combustion zone.

In lighting the burner it is usual to admit at first a limited quantity of fuel and air, the supply of fuel of course being regulated by the needle valve 20. A flame is then applied to the ignition opening 69, and the charge lighted. The supply of fuel and air can then be increased to the desired extent to meet the conditions under which the burner is used.

It will be apparent that the air in the air chamber 13 will pass rearwardly into the chamber 12 about the tube 30, and the air pressure can be readily measured by the removal of the plug 28 and the substitution of an air gauge therefor.

I have shown and described, as a preferred embodiment of my invention, a burner designed to use a liquid or finely divided solid fuel which employs the same general principles employed by the gas burner shown and described in my copending application, Serial No. 23,109, filed January 27, 1925, but it will be understood that my invention is not limited to all the details shown, but is capable of modification and variation within the spirit of the invention and within the scope of the appended claims. For instance, it has been determined that by removing the oil plug 32 from the end of the tube 30 the burner shown in this application is admirably adapted for using natural gas as a fuel, and without other changes will burn this gas in a very efficient manner. The oil plug may of course readily be removed, due to its threaded connection with the tube by which it is supported.

What I claim is:

1. A burner for liquid fuels, comprising a fuel supply tube having laterally directed outlets for the fuel, an air supply tube, said air supply tube directing a current of air peripherally about the fuel supply tube to meet and mix with the issuing fuel streams, a member having a passage therethrough, positioned on said air supply tube and enclosing said air and fuel outlet openings, and said air supply tube having relief cuts therein communicating with the passage in said member to permit atmospheric air to enter said passage between the member and the air supply tube.

2. In a burner for liquid fuels, a fuel supply member comprising a plug having a lon-

gitudinal opening therethrough, and lateral fuel outlet openings communicating therewith, said plug having a projecting shoulder on its surface rearwardly of and shielding said outlet openings and being tapered rearwardly from said shoulder.

3. In a burner for liquid fuels, a fuel supply member comprising a plug having a longitudinal opening therethrough and lateral fuel outlet openings communicating therewith, said plug having a projecting shoulder on its surface rearwardly of and shielding said outlet openings and being tapered rearwardly from said shoulder, and the surface of said plug also tapering forwardly in front of said shoulder.

4. In a burner for hydrocarbon fuels, a fuel supply tube having a fuel outlet adjacent one end thereof, a hollow member into the passage of which the outlet end of said tube is inserted, an air delivery member surrounding the fuel supply member and likewise inserted into the passage of said hollow member, said air supply member having outlet openings directed into said passage and having relief cuts on its exterior surface also communicating with said passage.

5. In a burner for hydrocarbon fuels, a fuel supply tube having a fuel outlet adjacent one end thereof, a hollow member into the passage of which the outlet end of said tube is inserted, an air delivery member surrounding the fuel supply tube and likewise inserted into the passage of said hollow member, said air delivery member having outlet openings directed into said passage, the wall of said air delivery member fitting closely the hollow member and there being provision for the entry of air between the walls of said hollow member and said air delivery member.

6. A burner for hydrocarbon fuels comprising a hollow head member having a chamber therein, a combustion chamber adjacent the head, an outer shell surrounding the wall of the combustion chamber in spaced relation thereto, the space between said wall and shell being in communication with the head chamber, said shell being provided with air openings and said head being provided with an air inlet opening, means to induce a flow of air from said head chamber into the combustion chamber, and means to regulate the flow of air through said last named opening into said head.

7. A burner for hydrocarbon fuels comprising a chambered head member, a fuel and air mixing device supported by said head member, a combustion shell adjacent the head member and receiving the charge from said mixing device, means for subjecting air to the temperature of the combustion shell, said head chamber having openings for receiving the heated atmospheric air and an additional intake opening for receiving unheated air, and means for causing the fuel to be mixed with the chamber air before passing into the combustion chamber.

8. A burner for hydrocarbon fuels comprising a chambered head member, a fuel and air mixing device supported by said head member, a combustion shell adjacent the head member and receiving the charge from said mixing device, means for subjecting air to the temperature of the combustion shell, said head chamber having openings for receiving the heated atmospheric air and an additional intake opening for receiving unheated air, means for causing the fuel to be mixed with the chamber air before passing into the combustion chamber, and means to cause the charge to entrain preheated air directly from the space about the shell.

9. A burner for hydrocarbon fuels comprising a chambered head member, a combustion shell mounted adjacent the head member and an outer shell surrounding the combustion shell in spaced relation thereto, said space being in communication with the head chamber and also with the combustion shell, means for passing a supply of fuel and air through the head chamber into the combustion shell, and means to cause the supply of fuel and air to entrain during its passage preheated air from the chamber in said head member and also preheated air directly from the space between the combustion and outer shells.

10. In a burner for hydrocarbon fuels, a chambered head member having openings at the front surface thereof, a combustion chamber having a wall thereof mounted adjacent said openings, a casing mounted on said head member and surrounding said combustion chamber whereby air entering the head member through said openings is subjected to the temperature of the wall of the chamber, the head chamber having an additional air inlet opening, means to conduct a supply of fuel and air through said head chamber to the combustion chamber, means to cause said supply to entrain additional air from the head chamber, and means to cause the air entering said head chamber through said additional opening to be mixed with the preheated air entering the head chamber through the first-named openings before being entrained by the supply of fuel and air.

11. A burner for hydrocarbon fuels comprising a chambered head member, a combustion shell mounted adjacent said head member, means for supporting a fuel and air mixing device from the head member, a hollow tapered member supported by the head into which the mixing device extends, said mixing device being in communication with the interior of said hollow tapered member to entrain air from the interior thereof, means to preheat air by the combustion shell, said head chamber having openings adjacent the combustion shell to admit air heated

thereby, and an additional opening to admit unheated air and said tapered member having a skirt portion adapted to cause the heated and unheated air to mix before passing to the mixing device.

12. A burner for hydrocarbon fuels comprising a chambered head member having supported adjacent the front face thereof a tapered hollow member, a combustion shell supported adjacent the head member, a fuel and air mixing device supported within said hollow tapered member and extending to the smaller end thereof, means for conducting air about the combustion shell into the chamber of the chambered head member, the air being preheated by the combustion shell, means for admitting unheated atmospheric air into the chamber, said mixing device entraining air from said interior of said hollow tapered member, and a baffle adjacent the unheated air intake to prevent direct passage of such air to the interior of the hollow member.

13. A burner for hydrocarbon fuels comprising a chambered head member having supported adjacent the front face thereof a tapered hollow member, a combustion shell supported adjacent the head member, a fuel and air mixing device supported within said hollow tapered member and extending to the smaller end thereof, means for preheating air by the combustion shell, said head having means for admitting to its chamber such air preheated by the combustion shell and also unheated atmospheric air, said mixing device entraining air from said interior of said hollow tapered member, said tapered hollow member having a skirt portion extending rearwardly in front of the intake opening but terminating short of the chamber wall to permit communication between the interior of such member and the head chamber.

14. In a burner for hydrocarbon fuels, a head, an outer casing supported by the head, a combustion shell supported by the head within said casing and spacing members to space said shell from the front surface of the head, a hollow tapered member supported at the front surface of the head and extending into the combustion shell and said combustion shell having a tapered member surrounding and in spaced relation to the end of said first named tapered member, the passages formed interiorly of said tapered members being in communication with the interior of the head.

15. In a burner for hydrocarbon fuels, a head, an outer casing supported by the head, a combustion shell supported by the head within said casing and spacing members to space said shell from the front surface of the head, a hollow tapered member supported at the front surface of the head and extending into the combustion shell and said combustion shell having a tapered member surrounding and in spaced relation to the end of said first named tapered member, the passages formed interiorly of said tapered members being in communication with the interior of the head, and means to introduce a mixed charge of fuel and air from said first named tapered member through said last named tapered member into the combustion shell.

16. In a burner for hydrocarbon fuels, a head, a casing supported by the head, a combustion shell supported by the head within the casing, spacing members to space said shell from the front surface of the head, a hollow tapered member supported at the front surface of the head and extending into the combustion shell, means for discharging a combustible mixture through said tapered member into the combustion shell, and said combustion shell having a tapered member surrounding and in spaced relation to the end of said first named tapered member, the space between said tapered members communicating with the space between the combustion shell and the casing, the combustible mixture discharged through said first named tapered member entraining air from the space between said tapered members, and said first named tapered member having a skirt portion extending rearwardly into the head.

In witness whereof, I have hereunto set my hand this 27 day of October, 1926.

HERBERT A. HYMER.