March 25, 1924. 1,488,238

J. GOOD

COMBUSTION APPARATUS

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Fig. 1,

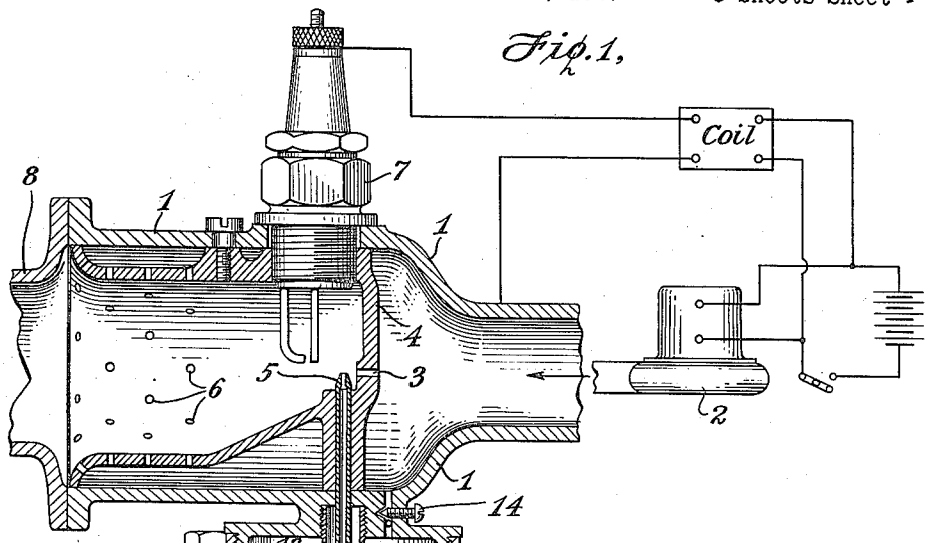
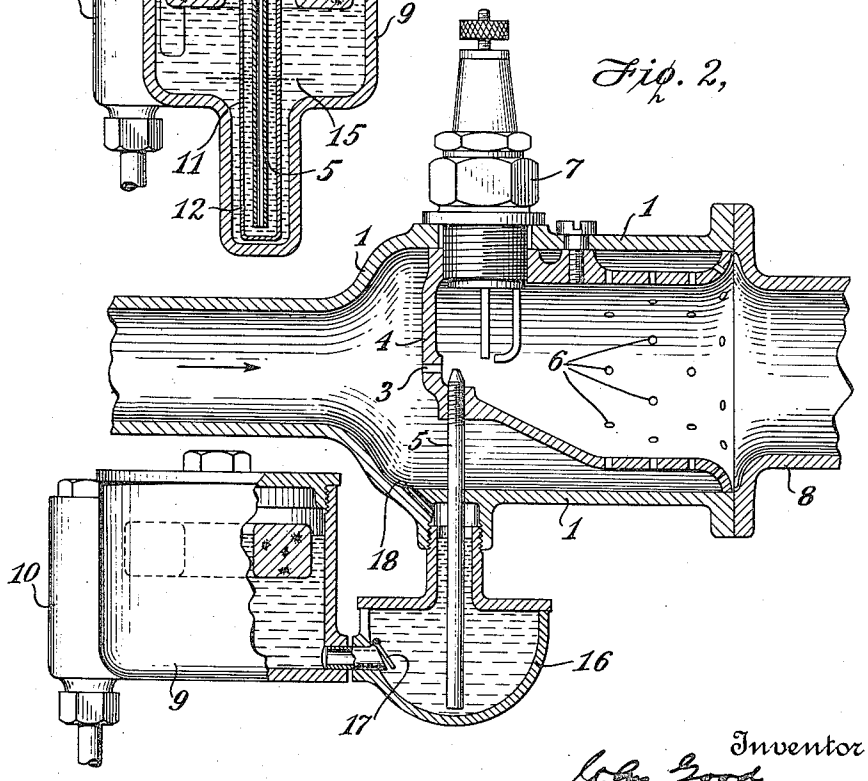


Fig. 2,



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Fig. 3,

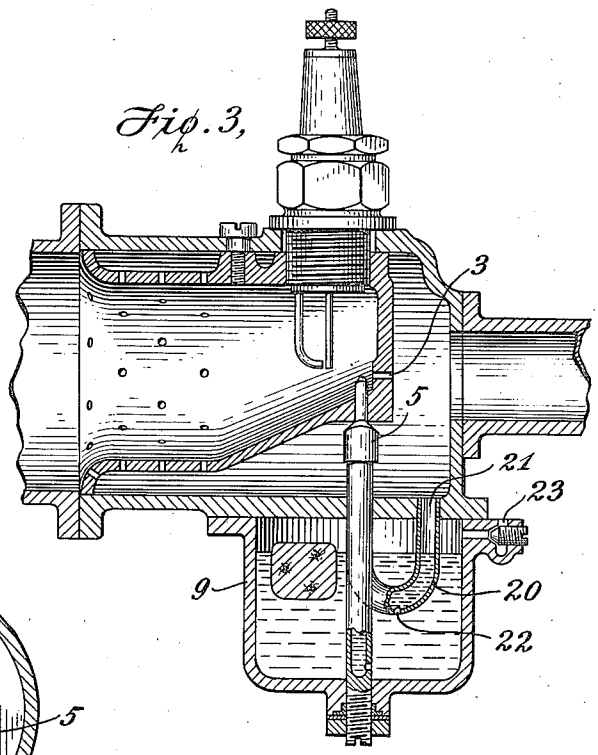


Fig. 4,

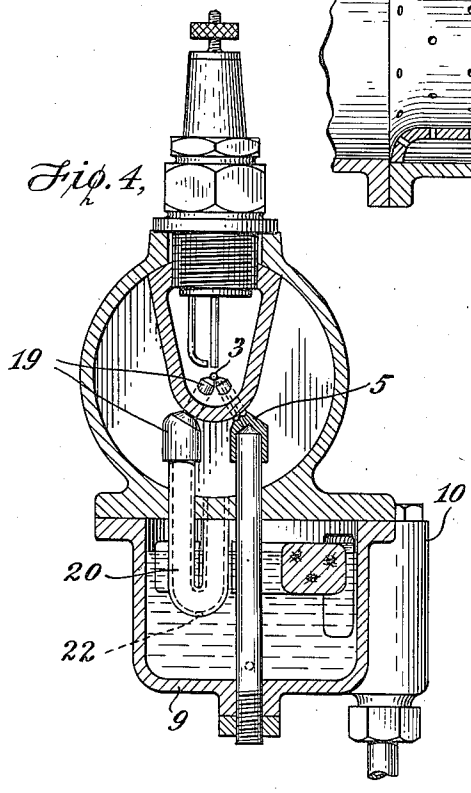
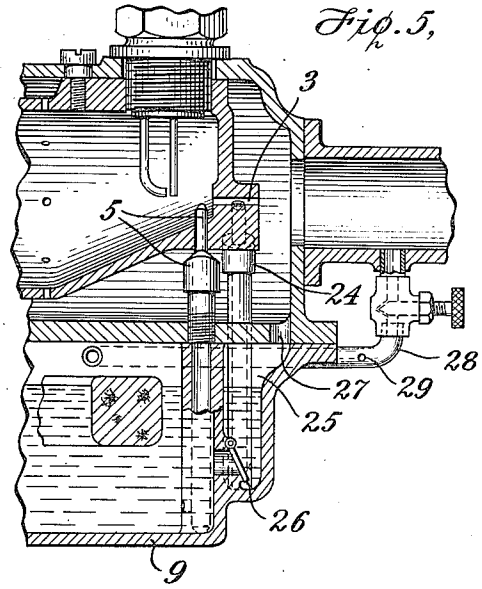


Fig. 5,



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COMBUSTION APPARATUS

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Fig. 6,

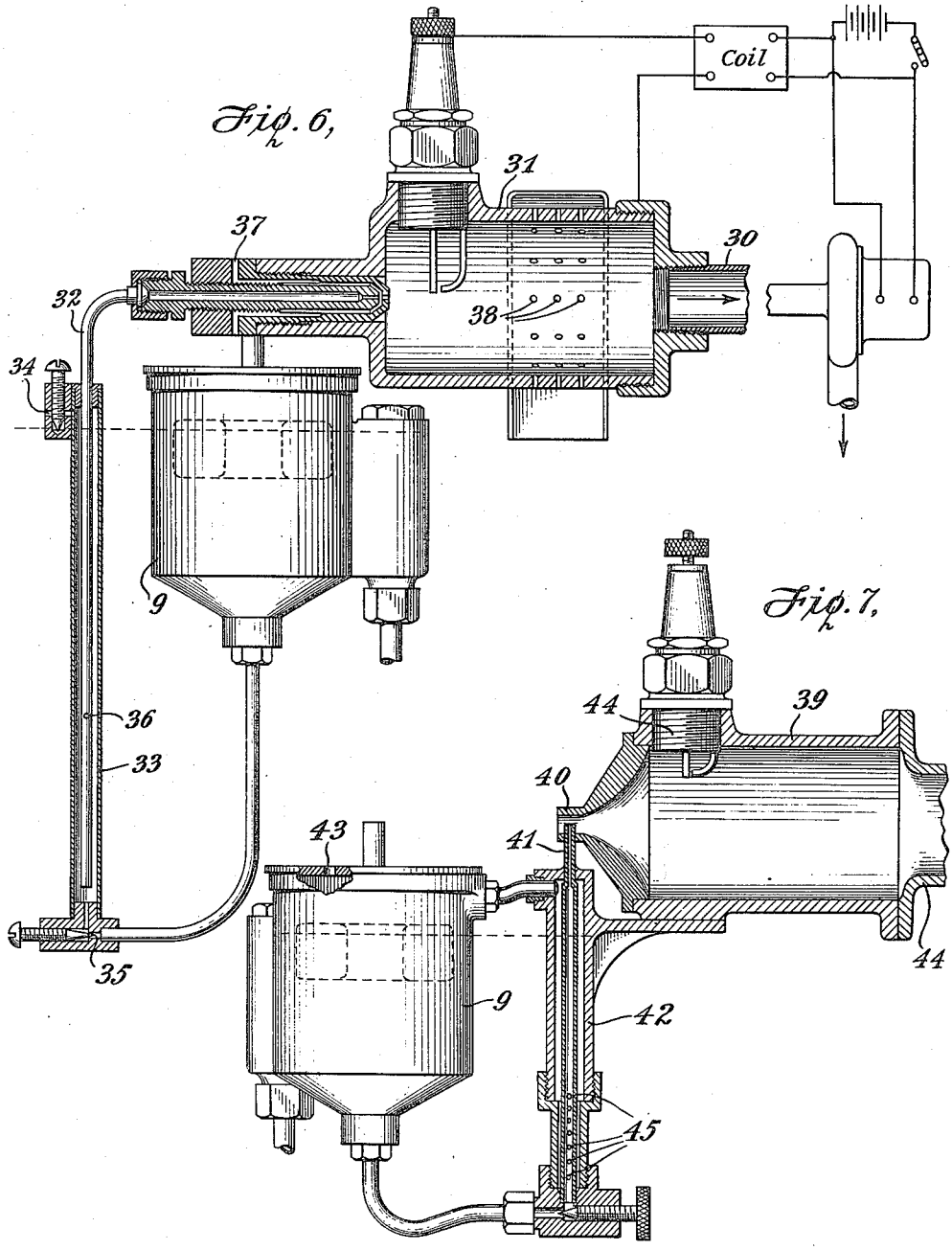


Fig. 7,

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Patented Mar. 25, 1924. 1,488,238

UNITED STATES PATENT OFFICE.

JOHN GOOD, OF GARDEN CITY, NEW YORK, ASSIGNOR TO GOOD INVENTIONS CO., OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

COMBUSTION APPARATUS.

Application filed February 11, 1920. Serial No. 357,846.

To all whom it may concern:

Be it known that I, JOHN GOOD, a citizen of the United States, residing at Garden City, Long Island, New York, have invented the following described Improvements in Combustion Apparatus.

The invention relates to liquid fuel combustion apparatus, particularly that class of apparatus in which the combustion is confined in a closed space or passage and in which it is required that ignition shall be established automatically within that passage whenever the apparatus is to be set in action.

The invention consists in the means and method hereinbelow described, for insuring prompt and reliable ignition in such apparatus, particularly after long periods of disuse or when the burner structure is cold and also when the fuel used is of low flammability.

The principle of the invention involves the use of a two-stage delivery of the fuel liquid to the ignition space, the first stage or delivery being at a rate specially predetermined to meet the requirements of electrical ignition of liquid fuel under the particular conditions, and the other being at a rate suited to the normal combustion operation of the apparatus, and one stage immediately following on the other automatically, so that when the electric motor or other device to operate the burner is set in action, normal combustion appears to occur instantly, although the ignition has in fact taken place first under special or abnormal conditions which are unsuited for continued combustion. The requisite variation of the fuel delivery to produce this two-stage result may be accomplished by various apparatus, several of which are herein described and will serve to illustrate the principle referred to.

Referring to the drawings:

Fig. 1 represents a form of the invention for use in enclosed burners when operated under a plus pressure, as by an air flow supplied to the burner structure by a fan blower or other source of pressure.

Fig. 2 represents the same type of burner incorporating another form of the invention.

Figs. 3 and 4 are longitudinal and cross sections, respectively, of still another form of the invention.

Fig. 5 is a longitudinal section illustrating another form.

Fig. 6 illustrates the invention as applied to a burner operated by minus pressure, as by suction flow through the burner.

Fig. 7 illustrates the application of the invention to a form of suction burner in which ignition is effected by a spark located in the complete mixture.

Referring first to Fig. 1, the burner comprises a casing 1, supplied with a flow of air under a moderate pressure from an air source such as indicated by the motor-driven fan 2. Part of this air flows through a hole 3 in an air-distributing shell 4 within the casing, forming an air jet in aspirating or atomizing relation to the fuel nozzle 5, and adapted to project a finely atomized fuel spray into the space within the shell. The rest of the air enters this interior space through the other holes 6, to mix with the spray therein. An electric igniter, a spark plug 7, is screwed into the casing and shell, with its spark gap situated in the path of the atomized spray and this plug is connected through an ordinary circuit and spark coil with the current source of the fan motor, so that closing the electric switch will cause the delivery of air and spray and coincident energization of the igniter resulting in combustion within the casing and within the flame tube 8 connected thereto. The combustion proceeds in this tube entirely isolated from the atmosphere. The two-stage fuel delivery is made in this form entirely through the single nozzle 5 and from the single fuel receptacle 9, the liquid level of which is kept constant by a float-controlled valve mechanism 10, as indicated. The nozzle tube 5 extends downwardly within and toward the bottom a well tube 11, fitted within the receptacle 9. This tube is provided with a restricted fuel entrance 12, below the liquid level and near the lower end of the tube, and with other holes 13 above the liquid level. The hole 12 is of less area than that of the fuel nozzle. The air pressure delivered to casing 1 is communicated to receptacle 9 through the adjustable connection 14 and to the interior of the well tube through the holes 13.

When the apparatus is at rest the liquid level in the well is equal to that in the surrounding receptacle because of the connection 12 below the liquid level. When the

apparatus is set in action, as by starting the air flow, the pressure acting on the liquid in the well causes much of the liquid therein to pass immediately into the fuel nozzle 5, lowering the level in the well and giving an initially high rate of fuel delivery to the ignition space. This high rate of delivery continues until the liquid level in the well reaches a certain lower level at about the point marked 15, and which is determined by the flow capacity of the hole 12, the air pressure, and also, to some extent, the aspirating effect of the air jet 3 if the spraying means is of the aspirating type. The level will remain at this point during the continued or normal combustion of the apparatus, other conditions remaining constant. Now, the initially high rate of fuel delivery is predetermined by adjustment of the size of the hole 12 with reference to the air supply and the other conditions, to suit the ignition requirements of the fuel and the igniter, and also the general design of the ignition and mixing space. The proper rate can be readily determined and is considerably more than is required to produce complete combustion or to make perfect explosive proportions in the flame tube 8. Ignition under adverse circumstances can be reliably obtained when the fuel is delivered at this rate but the period of such copious delivery is no longer than necessary to effect ignition and an initial warming up. It may desirably last for two or three seconds and can be made shorter or longer by varying the cross-sectional area of the liquid column in the well tube. The initial delivery at the high igniting rate is immediately followed by delivery at the normal rate, no attention being required by the operator and no outward change in the operation of the apparatus being observable. When the combustion is stopped and the well is again allowed to fill to the level in receptacle 9, the same cycle will be again and automatically repeated whenever the air flow is started. One of the particular difficulties in burners of this class, their failure to light immediately, is thus quite eliminated and without the use of any moving part. The air pressure communicated to the receptacle 9 assists the lifting of the fuel in both stages of delivery; it is an optional addition depending upon the level to which the fuel is to be lifted.

The form of burner shown in Fig. 2 is the same as already described. The fuel nozzle 5 receives fuel liquid from an intermediate fuel chamber 16 supplied with fuel through a non-return valve 17 from the constant level receptacle 9. This intermediate chamber is formed in two sections or compartments, the upper compartment being of relatively small cross-sectional area and the lower being considerably larger. Air pressure is admitted to both through the pressure communication 18. When this apparatus is at rest, the liquid level in the upper small compartment of the intermediate chamber is equal to that in the receptacle 9, and when the apparatus is set in motion by starting the air flow and energizing the igniter, the considerable hydrostatic head represented by the column of liquid in the smaller compartment causes an immediate rush of liquid through the fuel nozzle until the level has fallen to the top of the lower compartment of the chamber whereupon it remains substantially constant or gradually diminishing until the contents of the chamber 16 have been exhausted. No further supply of fuel can enter the chamber while the burner is in action because the pressure in the chamber 16 keeps valve 17 closed. There is thus provided in this apparatus an initially high rate of fuel delivery followed by a lower rate, the former being suited for ignition purposes and the latter for continuous combustion as long as the chamber contains fuel.

In Figs. 3 and 4 the initial high rate of fuel delivery is accomplished by the supplementary effect of an extra fuel nozzle 19, which is operative only for the first few moments. This nozzle is supplied with liquid fuel from the U-tube 20 submerged below the level of the liquid in the constant level receptacle 9 and subject to the air pressure supplied to the burner through the passage 21. In the lower part of this tube is a small hole 22 through which the tube fills with fuel equal to the surrounding level, as indicated in Fig. 3. When the apparatus is started, the pressure acting through passage 21 immediately blows the liquid in the U-tube out through the nozzle 19 where it is atomized by the air jet 3 coincidentally with delivery and atomization from the other normal fuel nozzle 5, which is also disposed in atomizing relation to the same air jet. Immediately following evacuation of the U-tube, the fuel delivery is under normal conditions through the nozzle 5 alone and no function is served by the U-tube except to communicate the air pressure through hole 22 to the receptacle 9. An adjustable vent for such pressure is shown at 23.

Fig. 5 employs the same principle but in this case the supplemental nozzle 24 delivers to the interior of the air jet 3 and draws its liquid from an intermediate fuel chamber 25 supplied from the float chamber 9 through a non-return valve 26. Pressure of the operating air admitted to this intermediate chamber through passage 27 forces all the liquid therein through the nozzle and into the air jet, supplementing the delivery from the normal nozzle 5 to make an initial high delivery rate. The tube and set screw 28 represent the pressure communication to the

receptacle 9 for the normal supply, 29 being a small vent to atmosphere.

In Fig. 6 the flame pipe 30 and burner 31 are connected to some device which creates an air flow into the latter by suction, so that combustion occurs under a minus pressure. The casing 31 is provided with a spray nozzle receiving fuel liquid through tube 32 which extends towards the bottom of a well 33, the latter being vented to atmosphere at 34 at its top, and connected at its bottom through an adjustable restricted passage 35 with the constant level fuel receptacle 9. The normal level of the liquid in the well may be substantially at the dotted line. A small hole 36 is provided in the side of the tube 32, somewhere below its center. The spray nozzle is provided with one or more entrances 37 for air and the casing of the burner is also provided with air entrance holes 38 leading direct from atmosphere. When this apparatus is set in action the suction effect acting on the spray nozzle at first draws the liquid fuel freely from the well and therefore at an initially high rate until the level in the latter reaches the hole 36 whereupon the level remains constant and the flow of fuel is then as regulated by the adjustment of the restricted passage 35. The initially high rate of fuel delivery insures reliable ignition in this as in the other forms.

In the burners so far described the spark gap is situated at a point in the fuel spray in the ignition and mixing space where said spray has not yet been mixed with all the air with which it is to burn, that portion not used for the spray being admitted beyond the plug through the holes 6 or 38, as above described. This division or separation of the air supply is an advantage in that it produces ignition and highly efficient combustion even without resorting to the use of an initially high rate of fuel delivery at the instant of starting. The improvement effected by the present invention, however, in respect to ignition under adverse conditions, is of such a degree that the separation of the air in this manner is not always necessary and may be omitted in some cases, especially where the fuel used is not very heavy, and with corresponding saving in cost of construction.

Fig. 7 illustrates the application of the invention to this latter form of burner. The ignition and mixing space in the casing 39 may be assumed to be connected to any source of suction by means of a pipe 44 wherein the combustion is to be utilized, and draws in all the air for combustion from atmosphere through a single nozzle entrance 40. The fuel nozzle 41 is situated in atomizing relation to this air flow and draws its liquid supply from the well 42 on the same general principle as described in connection with Fig. 6. The air vent at the top of the well 42 is in this case connected to the air space above the constant level receptacle 9, which air space is vented to atmosphere at 43. The spark plug 44 is located directly in the path of all the air and fuel and except for the initially high rate of fuel delivery, constituting this invention, would not be capable of igniting such a mixture. The liquid accumulating in the well 42, during a period of rest, is first rapidly drawn off by the suction acting on the spray nozzle causing the level therein to fall until it reaches the first of a series of fine holes 45 in the nozzle tube. During this stage the delivery is at a high rate permitting ignition by the spark, but too high to produce clean or satisfactory combustion if continued; as the liquid level continues to fall and uncovers the first hole 45, air is admitted to the latter, and as successive holes are uncovered, more air is admitted, thereby effecting a control on the proportions of fuel and air entering the burner, which keeps them very accurately constant notwithstanding a considerable fluctuation in the suction effect to which the burner is subjected. For any given suction a corresponding level will exist and be maintained in the well, representing proportions which are suitable for the normal or continuous burner operation. The initial delivery is not required to be at a constant rate if it is copious enough at some point or points in its range to produce ignition; nor is it necessary in this or any of the forms described, that the fuel delivery for the normal combustion process be at a constant rate. If it is sufficient to maintain the desired combustion effect when once reliably started, it will be satisfactory, and as a matter of fact, when the burner structure is once well heated considerable variation in fuel delivery may occur without extinguishing the flame. Thus in Fig. 2, when the upper part of the two-part fuel chamber in that form has become evacuated to the top of the other part, the normal combustion then ensuing will consume fuel at a diminishing rate, ending with a fuel rate which would be impossible or impracticable if the burner parts were not by that time well heated. It is of course desirable that the normal burner proportions shall be substantially constant, as occurs in the other figures, and the conditions obtaining in Fig. 2 are noted only to guard against any unwarranted limitation to this invention.

It is to be noted also that in each case the fuel delivery is coincident with or results from the existence of the air flow, whether that be caused by pressure or suction, and that the initial increase and subsequent decrease of fuel delivery is with reference to such flow but is effected by control of

the fuel supply rather than the air supply. In this respect the present invention differs from my co-pending application Serial No. 174,185, filed June 12, 1917, wherein I have disclosed and broadly claimed a burner structure producing the same results, particularly by controlling the air supply. The invention herein claimed incorporates the same principle but without employing moving parts and in that respect is an improvement upon the enclosed burner referred to.

Claims:

1. Liquid fuel combustion apparatus comprising an ignition and mixing space, means for maintaining coincident inflow of air thereinto and exhaust therefrom, an igniter therein, means operating independently of control through the air flow for supplying a two-stage delivery of fuel to said space, the first stage being at a rate predetermined to suit the ignition characteristics of said space and the second stage to suit the requirements of continued normal combustion therein.

2. Liquid-fuel combustion apparatus comprising in combination an ignition and mixing space, connected to an enclosed flame passage, an igniter in said space, means for maintaining coincident air flow thereinto and exhaust therefrom, means independent of the rate of air flow for supplying liquid fuel thereto initially at a high rate and later at a less rate, and means for coincidently operating said igniter and air-supplying means.

3. Liquid fuel combustion apparatus comprising an ignition and mixing space, an igniter therein, means for causing coincident inflow of air and fuel to said space and exhaust therefrom, a two-part fuel supply chamber from which the fuel flow is taken, one of said chamber parts being arranged to be quickly evacuated during the initial period of the air flow thereby providing a higher rate of fuel delivery for ignition than for normal combustion and means for operating said igniter during said initial delivery.

4. Liquid fuel combustion apparatus comprising an ignition and mixing space containing an igniter and having means for causing coincident inflow of air and fuel thereto and exhaust therefrom, and a fuel supply chamber therefor adapted to deliver liquid from a higher liquid level on the starting of the air flow, and from a lower level for normal combustion.

5. Liquid fuel combustion apparatus comprising an ignition and mixing space containing an igniter and having a flame passage connected thereto, means for causing coincident inflow of air and fuel into said space and exhaust therefrom, a fuel supply chamber therefor including a chamber part forming a liquid column, a restricted communication between said column and the other part, a nozzle or fuel tube drawing liquid fuel directly from said liquid column and thereby adapted to conduct an initially large fuel delivery to said space.

In testimony whereof, I have signed this specification.

JOHN GOOD.