Oct. 29, 1929. J. GOOD 1,733,792

COMBUSTION APPARATUS

Original Filed Oct. 9, 1917 2 Sheets-Sheet 1

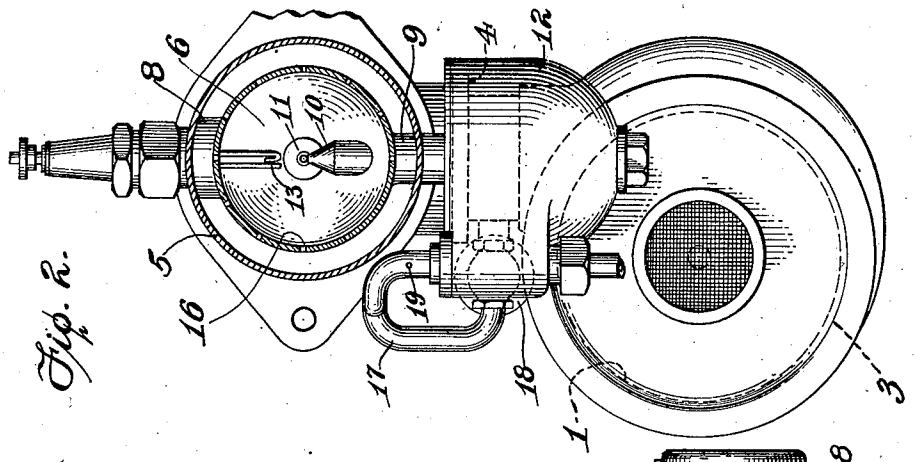


Fig. 2.

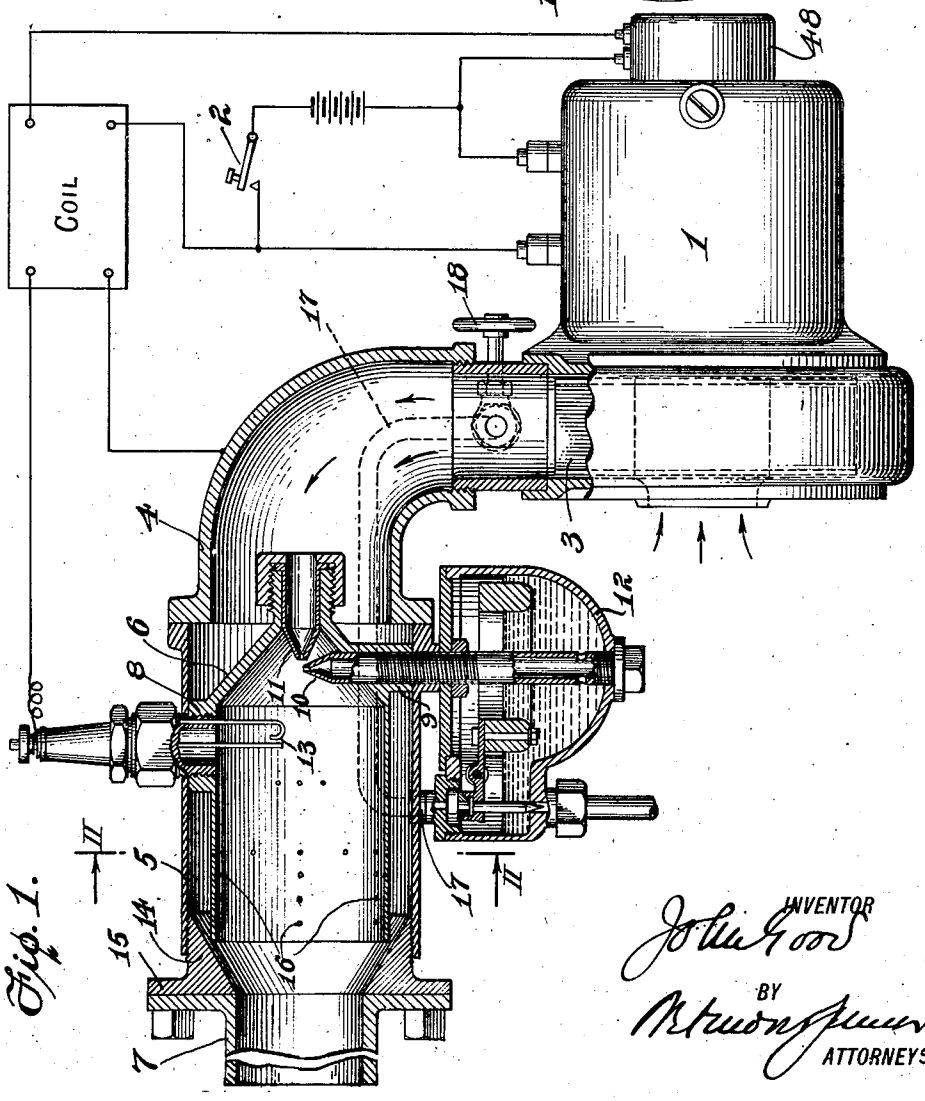


Fig. 1.

INVENTOR

John Good

BY

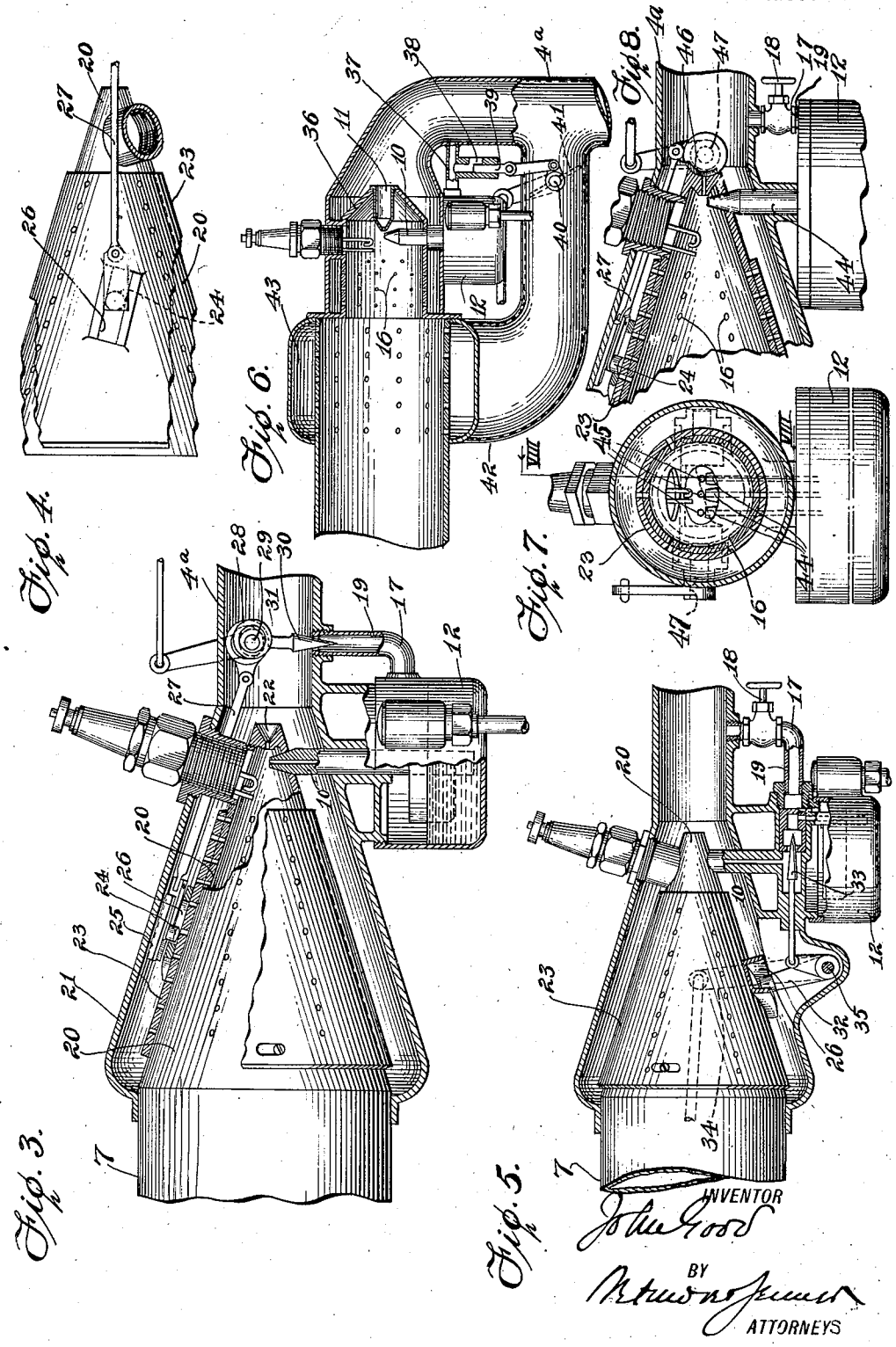
Brown Jenner

ATTORNEYS

Oct. 29, 1929. J. GOOD 1,733,792

COMBUSTION APPARATUS

Original Filed Oct. 9, 1917 2 Sheets-Sheet 2



INVENTOR

BY

ATTORNEYS

Patented Oct. 29, 1929 1,733,792

UNITED STATES PATENT OFFICE

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

COMBUSTION APPARATUS

Application filed October 9, 1917, Serial No. 195,506. Renewed July 24, 1924.

The invention relates to enclosed, automatically-igniting, forced-draft combustion apparatus for burning kerosene, alcohol and other liquid fuels. It is more particularly an improvement on the combustion apparatus disclosed in my Patent No. 1,231,152 and the improvements relate to various features hereinafter described and especially to the distribution of the air supply whereby the apparatus can be operated by air supplied to it at a single and very low pressure and hence with the expenditure of relatively less driving power than formerly, but nevertheless producing combustion of the fuel at the same or higher rate and with otherwise the same characteristics as to automatic ignition and continuous combustion. The improvements enable the air compressor mechanism to take the form of a single fan blower which can be driven by electric motor of smaller, or even miniature size such as can be made at low cost, using but little energy, but which is nevertheless capable of causing the generation, almost instantaneously, of a flame of such intensity and volume as to be suited for quickly heating small muffle and other furnaces, engine vaporizers or any other apparatus requiring the prompt attainment of high temperatures. Like the apparatus described in said patent, the present apparatus is set in operation to give instant ignition and intense combustion in a closed space or passage, merely by the application to it of mechanical power, and in the case of motor actuation, by the mere pressing of an electric button to start the motor. The invention further consists in the discovery and elimination of the causes of certain irregularities in action of said burner which arise from variations of efficiency of the positive blower used for producing the high pressure air for atomizing the liquid fuel. Any positive action air compressing mechanism, that it to say, one which draws the air into a confined space, compresses it therein and discharges it in a compressed condition, depends for its rate of air delivery, not only on its speed, but also on the presence of lubrication either as a means of reducing friction or as a sealing agent between the moving surfaces, and variation either of the amount of such lubrication or its viscosity, due to age or temperature, results in corresponding variation in the air delivery, and any disturbance of the rate of air supply to the burner head tends to prevent automatic ignition of cold liquid fuel. Perfect uniformity of air delivery can be obtained from fan-type air blowers which, being ball-bearing if necessary are free running and entirely independent of the condition of lubrication or of any sealing agent. When such blowers are driven by electric motor they deliver air at constant rate and pressure and begin such delivery practially simultaneously with the closing of the motor switch. By the special manner of air distribution above mentioned and herein described, such a blower delivering air at a pressure of say from 4 to 10″ of water, can be made to take the place of the positive blower referred to and a single fan can be made to supply air both for atomizing the fuel and supporting its combustion and to give proper and non-variable conditions for instant ignition and continued and clean combustion. The quickness with which such fan blowers pick up their speed results in a practically instantaneous development of their full pressure, regardless of any previous period of disuse or of the temperature condition and thereby eliminates the tendency for the oil to drip from the fuel nozzle prior to ignition—an objection to my prior apparatus except under favorable conditions and resulting in smoke and smell. Certain of the features herein shown particularly those relating to the regulation of the rate of combustion are likewise applicable with advantage to burners in which the air flow is created by suction applied to the exhaust end of the flame passage and are herein claimed without reference to whether the pressure difference is positive or by suction.

In all forms of the present invention it will be understood that ignition takes place within the closed burner head automatically and coincidently with the flow of air and even though the fuel be kerosene or a less volatile liquid and be cold and also that continuous, forced and substantially complete and clean combustion follows immediately upon igni-

tion within the flame passage and such action takes place non-explosively even though the fuel be more volatile than kerosene.

In the accompanying drawings:—

Fig. 1 represents, practically to actual scale, a general longitudinal section of the preferred form of the invention with the flame tube, which may be several feet in length, shown broken off for convenience.

Fig. 2 is a section on line II—II of the burner head;

Fig. 3 is a section of a burner head on the same principle but with combustion-regulating means applied;

Fig. 4 is a detail of this regulation;

Fig. 5 is an alternate form of regulation;

Fig. 6 is a development wherein a supplementary air supply is provided to extend the range of the regulation;

Fig. 7 a cross section of a burner head organized for regulation according to a modified principle; and

Fig. 8 is a section of Fig. 7.

In Figs. 1 and 2 the reference 1 represents an electric motor controlled by a switch or push button 2 and driving a rotary fan 3 the casing of which is formed in one structural part with the motor casing. In the actual subject of the illustration the motor rotates the fan at about 9,000 R. P. M. and delivers air to the short connection fitting 4 at a pressure of about 10 inches of water, more or less, whence such air enters the admission chamber within the casing 5 and passes thence through or around the edge of the sleeve or shell 6 which surrounds the end of the flame passage and thence into the flame tube 7 bolted to the forward end of the casing 5. The shell 6 is a separate thin-walled member mounted in central spaced relation to the burner casing 5 and secured in place therein by its threaded bosses 8 and 9 into which the spark plug and the fuel nozzle 10 are respectively screwed from the outside of the casing, no other attachment being necessary. The end of the shell toward the air source is closed by a conical wall which is imperforate save for a central air-jet aperture therein represented in these figures by a nozzle 11 which is clamped in position on the shell by a flanged nut or in any other suitable way. This nozzle serves merely as a convenient means of locating and directing the air-jet and can be substituted by a simple hole of proper size bored in the end wall of the shell itself. The air-jet is preferably disposed in axial alignment with the shell and in aspirating or spray-producing relation to the fuel nozzle 10 through which liquid fuel is drawn or delivered from the constant level fuel receptacle 12. The receptacle 12 is held to the casing 5 in the present case by the fuel nozzle 10 but might be otherwise mounted thereon or connected thereto, so long as it supplies fuel in a predetermined ratio to the air supply as later explained. The liquid level in the receptacle 12 is maintained substantially constant by means of a float-controlled valve of common design or by any other suitable means, insuring that the liquid will be at a predetermined level whenever the burner is started after a period of rest. The spark plug is located just beyond the fuel nozzle and comprises two electrode terminals, both somewhat longer than commonly employed in combustion engines and extended downward so as to make a spark at a point near the axis of the air jet and intercepting the spray from the nozzles, in which position it is most efficient for igniting the cold liquid fuel. One of the electrode terminals projects from the hollow interior of the plug and one or both terminals is hooked-shaped as shown at 13 for the purpose of avoiding a short-circuit by drops of liquid fuel. It should be stated here that the gap need not be wider than commonly used in engine spark plugs and that the spark may be obtained from the same or an equivalent electric source.

The flame end of the casing 5 is attached by means of screw threads in the present case, to an annular junction piece 14 having an interior coned surface, the smaller end of which is of less diameter than the shell. The flange 15 on this piece serves as the means by which the casing is bolted to the flame tube 7, or vice versa and the screw threads permit the convergent surface to be screwed toward the end of the shell to make or close an annular entrance passage through which air may flow into the flame passage. The junction piece thus constitutes an adjustment device but is not necessarily adjustable inasmuch as the proper air distribution may be obtained with the said piece initially fixed in place either completely or partially closing or shutting off the flow of air around the end of the shell. The cylindrical or lateral walls of the shell 6 are further provided with a number of fine holes 16 uniformly distributed around the shell and located slightly in advance of the spark plug terminals 13 or in such relation to them that they do not make a mixture of fuel and air inside the shell having the qualities of an explosive mixture, at the spark which, if ignited by the spark, would result in a series of explosions instead of steady combustion. The annular entrance passage around the end of the shell 6 and the apertures 16 through the shell constitute together the entrance for the combustion-supporting air and such air as does not flow through this entrance must pass through the air jet entrance 11. The relative areas of the two entrances are so proportioned that with the fuel delivery means properly organized, the air-jet will deliver only so much liquid fuel as the air through the other entrance will accommodate with complete combustion, or, in other words, the annular entrance and the air holes 16, one or both, are

made so restricted in respect to their aggregate or total area as to give a pressure condition at the air jet nozzle 11 suitable for producing an ignitable spray delivery from the fuel supplying means. Such a relation is practicable even with an air supply at as low as four inches of water. It is desirable that the restriction to the combustion-supporting air be made at or in the shell to give a high needle-jet velocity entrance into the flame passage and a corresponding vigorous mixing and shattering effect upon fuel particles therein and uniformly distributed around about all sides of the flame. The preferred relation of the two air entrances, as determined by extensive experiments, can be best explained to the skilled mechanic by saying that the air-jet hole 11 may be formed by a No. 52 B. S. drill and the admission holes 16 by a No. 55 drill, there being some thirty-five of the latter holes distributed around the periphery of the shell in the case in hand and for such relation the liquid level should be arranged very close to the level of the liquid nozzle orifice (by locating the receptacle at one side of the casing) or else be subjected to a moderate pressure as presently explained, and the junction piece 14 should be set to within .007 of an inch of contact with the end of the shell 6. With this particular arrangement very satisfactory results are obtained, although the described structure is subject to a very considerable modification while still preserving the essential principle of air distribution, the main supply being divided, part used for fuel delivery and the remainder for supporting the combustion but both at the same pressure. It should be noted that liquid fuel falling upon or toward the shell 6 is immediately thrown upwards with a rapid mixing and shattering effect by the needle-jets of air from the holes 16, which fact contributes not only to the cleanliness of the burning but tends to make the apparatus indifferent to the mechanical condition of the fuel jet as it enters the shell and ignition may in some forms occur from a spray from one of the rearmost holes 16 as well as from the central air jet. Where pressure is applied to the liquid supply it is sufficient to connect the liquid receptacle to the outlet of the fan by a small tube 17 as indicated, and the latter is vented by a very small bleeding-hole 19, so that the air will have no tendency to build up a pressure in the liquid receptacle to create an excessive or disproportionate liquid delivery from the fuel nozzle and the said pressure connection is subject to regulation by means of the valve 18 therein, by means of which the fuel delivery can be initially adjusted so as to conform to the air distribution and give clean and complete combustion. Said valve is between the fan and the vent 19. Adjustment of valve 18, by controlling the richness of the spray, controls the character of the flame and to some extent the temperature but is not intended for the regulation of the latter. It is designed to be initially set for a condition of use and to remain permanently in such setting. The heat of the internal combustion may be utilized in various ways, for example, by extending the flame tube 7 through or around the object to be heated, or forming such object as a flame passage, but in any event such passage should have a freely open exhaust outlet, at least at the moment when ignition takes place, so that an excessive back pressure will not disturb the stream proportions within the burner head.

The combustion rate may be varied in the apparatus above described, within limits, by varying the rate of air supply without change in the burner but is more effectively controlled by one or more of the means indicated in Figs. 3 to 8.

In Figs. 3 and 4 the distributing shell 20, perforated and arranged around the end of the flame passage as above described, is conical and made as the terminal of the flame tube 7, the air admission chamber being formed by a casing 21 fixed around the base of the cone and connected at its outer end to the delivery pipe 4^a of the fan blower, not shown in these figures. The central air-jet 22 is drilled at the apex of the cone in aspirating relation to the fuel nozzle 10, and the latter is supplied from a constant level liquid receptacle 12. The perforations in the wall of the distributing shell are subject to regulation in area by means of a rotary cover sleeve or shutter 23, fitted snugly over, and to rotate upon the shell and perforated in registry with the perforations therein. Rotary motion is given to this sleeve by means of a stud 24 mounted to move upon a longitudinally disposed slideway 25 fixed to the inner face of the casing 21 and engaging an oblique slot 26 carried by the sleeve 23. The stud 24 is reciprocated on slideway 25 by a connecting rod 27 from an eccentric 28 on a small rock shaft 29 journalled crosswise in the air pipe 4^a and provided with an outside crank arm for manipulation. It will be apparent that movement of this arm will advance or retract the stud 24 and thereby impart a minute rotary movement to the cover sleeve 23 due to the obliquity of slot 26 and thereby either enlarge or restrict the area of the openings or air passages through the shell 20 to the flame space. The same movement of the rock shaft 29 also controls the position of a needle valve 30 which is operated therefrom by another eccentric 31 thereon. The needle valve 30 controls the entrance to the pressure tube 17 and is arranged to enlarge such opening in proportion to the enlargement of the air passages 16. The pressure tube is vented between the valve and receptacle as in the case of Fig. 1. When the rock shaft 29 is set for the minimum delivery

of fuel and air the relation of the aggregate area of the apertures representing the entrance for combustion-supporting air to the area of opening of the air-jet nozzle 22 may be that which establishes ignition by spark as above explained. When ignition has occurred, the coincident enlargement of the pressure communication and the entrance for combustion-supporting air as above described will increase influx of air and fuel, while preserving predetermined proportions and thereby increase the rate of combustion; in other words, the burner can then be turned up and down at will but the proportions are always constant, which is a matter of great importance in closed combustion apparatus. The regulation of the fuel delivery is in this case automatic through the control of the vented pressure communication 17. Automatic control of the liquid delivery, can also be accomplished by varying the area of the flow path from the receptacle 12 to the fuel inlet 10 as shown for example in Fig. 5. In this form a small bell crank 32 journalled within the air admission chamber of the burner head engages the oblique slot 26 on the shutter sleeve 23 to adjust the area of the combustion-supporting air entrance and one of the arms of this crank is connected to a metering pin 33 occupying a restricted orifice through which the liquid moves to the fuel inlet. This pin is tapered according to some predetermined curvature or is otherwise organized with reference to the slot 26 so as to maintain a constant ratio of fuel to air throughout all adjustments. The pressure communication 17 having the adjustment valve 18 and the air vent 19 as before, is used also in this form but as previously stated, can be omitted if the liquid level in the liquid receptacle 12 is brought close enough to the level of the liquid fuel nozzle orifice as for example could be done by placing the liquid receptacle at one side of the burner head instead of underneath it. A crank arm 34 fixed to the rock shaft 35 of the bell crank 32, outside of the burner head serves as the controlling member by means of which this burner may be turned up and down.

Fig. 6 illustrates a means of further enlarging the range of the up and down turning. In this form the air distributing shell 36 is constructed the same as that of Fig. 1 and with the same function as respects the condition for ignition. The air pressure of the pipe 4^a is communicated to the float chamber or liquid receptacle 12 through a restricted opening to the pressure communication 37 which latter is provided with a variable vent 38 controlled by a small plunger 39 adjusted by a crank connection with a rock shaft 40. This rock shaft also controls the position of an air damper 41 in a branch pipe 42 which leads from the air source to a supplementary air admission chamber 43 surrounding the interior flame passage at the junction of the perforated shell 36 with the flame tube. From this chamber the air enters the ignited and burning spray through a number of fine holes distributed uniformly round about the axis of the flame. When the rock shaft 40 is set to admit air through the supplemental passage the vent 38 is closed or nearly closed as the case may be, so that the resulting pressure on the liquid in the receptacle 12 is thus proportioned to give it the proper delivery of liquid fuel.

In Figs. 7 and 8, three fuel nozzles 44 are mounted crosswise at the end of the distributing shell and each one is in aspirating relation to one of the air jet apertures 45. A rotary shield or other form of valve 46 connected to or mounted on the controlling rock shaft 47 serves to open one or more of the air jets 45 according to the desired fuel delivery. The rock shaft 47 is connected by the rod 27 to the means which enlarges or restricts the entrance for combustion-supporting air which may be the same as already described and is organized with reference to the position of the valve 46, so that when ignition has taken place with the use of one or more air-jet sprays enlarged or diminished combustion may be obtained by cutting the jets in or out with a corresponding control of air effected by rod 27. It is possible to combine the several means for regulation above described, and also to make the apparatus ignite with any other than the minimum rate of liquid delivery.

In all of the forms of Figs. 3 to 8 it will be understood that the air pressure may be obtained from a fan blower such as shown in Fig. 1 driven by an electric motor from a circuit which also includes an igniting coil and an interrupter 48 driven by the motor or by any other equivalent means, the said circuit being controlled by a single switch or press button 2, the closure of which starts the burner in action and the opening of which stops it.

Claims:

1. Automatically igniting, combustion apparatus comprising a burner head containing liquid fuel spraying means, an electric igniter for the spray and a passage for admitting combustion-supporting air to the ignited spray, combined with means for varying the area of said passage and coincidently and proportionally varying the rate of fuel supply.

2. Automatically-igniting, forced-combustion apparatus comprising a burner head connected to a source of single pressure air and containing a liquid fuel spraying means and an igniter therefor, in combination with a liquid fuel receptacle connected to said spraying means and a pressure communication between the receptacle and the air source provided with a vent-hole.

3. Combustion apparatus of the kind described comprising a burner head receiving air at a single pressure and having a shell or wall enclosing one end of the flame space and controlling the admission of air thereto, said shell being provided with one air entrance in spray-producing relation to a liquid fuel inlet and another entrance for air to support combustion, the latter entrance being restricted in definite relation to the former and so as to provide an electrically ignitible fuel spray at the end of said flame space and a high velocity mixing effect of the air for supporting the combustion of said mixture, in combination with means for simultaneously varying the entrance for combustion-supporting air and the rate of fuel delivery from said inlet.

4. In a fuel charge heater for internal combustion engines, the combination with a burner head; of a nozzle for admitting fuel spray; ignition means for said spray; means for admitting combustion air to said burner head; and air distributing means located within the burner head including provisions for causing combustion air to be mixed with the spray at points varying distances from the nozzle, said provisions being constructed to provide for increasing the admission of air the greater the distance from the nozzle.

5. Combustion apparatus comprising a mixing flame chamber, a liquid fuel receptacle having a duct communicating with said chamber, a source of air supply for said chamber having vented communication with said receptacle and means for conjointly varying said air supply and controlling the vent.

6. Combustion apparatus comprising an air source, an air passage, a shell in said passage continuously receiving air therefrom at a substantially constant pressure and constituting a mixing chamber, a fuel tube entering said shell from outside the passage and an electric igniter extended through said passage and through an opening in the wall of said shell.

7. Combustion apparatus comprising a mixing chamber, a liquid fuel receptacle connected thereto and an air passage also connected to said chamber, and to said receptacle, in combination with an auxiliary air passage for delivering air to the flame, means appurtenant to the latter passage for controlling the air flow therethrough, and a device for conjointly controlling said means and the air connection to said liquid fuel receptacle.

8. Electrically ignitible combustion apparatus comprising a burner-casing continuously receiving air at a single positive pressure, an air-distributing shell in said casing having a fuel-spraying air-jet aperture and a liquid fuel inlet, and providing a separate entrance for air to support combustion of the spray, said supporting-air entrance being sufficiently restricted to maintain a pressure condition at said air-jet aperture adapted to produce without appreciable compression or pre-heating in electrically ignitible liquid spray from said inlet, in combination with an electric igniter intercepting said spray prior to its complete mixture with air from said entrance, and means for energizing said igniter coincidently with the supplying of air to the burner head.

9. Combustion apparatus in which the entire air supply is furnished by an electric-motor-driven fan-type blower, comprising means for distributing such air to the ignition and combustion space, said means including a liquid-atomizing air jet and a separate entrance path or paths for the remainder of the air supplied by said blower, a receptacle for liquid fuel, an inlet orifice for said liquid placed in spraying relation to said air-jet and producing without appreciable compression or pre-heating an electrically ignitible spray of said liquid fuel, means forming a pressure communication between said blower and the liquid surface in said receptacle, an electric igniter intercepting said spray and a source of current for coincidently operating said blower and igniter.

10. Automatically-igniting, forced-combustion apparatus for liquid fuels, comprising a burner head connected to a single pressure air source and deriving its entire air supply from said source and containing a liquid fuel inlet and an electric igniter disposed therein to intercept the path of a fuel spray from said inlet, combined with means for dividing the air supply entering said head and distributing the divided parts thereof at equal pressures, one part into spraying relation to said fuel inlet to produce without appreciable compression or pre-heating an ignitible spray therewith and the other part into mixing and combustion-supporting relation to the spray in combination with a liquid fuel receptacle connected to said inlet and a pressure communication from the said air source to said receptacle.

11. Combustion apparatus comprising a mixing chamber, passages for liquid fuel and air connected to said chamber and delivering an electrically ignitible spray and an electric igniter situated in and igniting the spray produced by said passages, in combination with an auxiliary air passage for delivering air to the flame, means appurtenant to the latter passage for controlling the air flow therethrough, and means for coincidently controlling said means and the rate of fuel delivery to said mixing chamber.

12. Combustion apparatus comprising a mixing chamber, a single entrance for liquid fuel thereto, an air passage connected to said chamber and an electric igniter intercepting the mixture produced by the air therefrom, in combination with an auxiliary air passage

for delivering air to the flame beyond said chamber, a valve in the latter passage, a valve controlling the delivery of liquid fuel and a mechanical connection between said valves.

13. Combustion apparatus comprising a motor-driven air blower, an air passage, a shell in said passage continuously receiving air therefrom at substantially constant pressure and constituting a mixing chamber, a fuel tube entering said shell from outside the passage, a liquid fuel receptacle adapted to supply fuel through said tube at a predetermined rate in relation to the air delivery, electric igniting means extended through said passage and through an opening in the wall of said shell, and a single current source for energizing said motor and igniter.

14. Combustion apparatus comprising an air blower, an air passage, a shell in said passage continuously receiving air therefrom at substantially constant pressure and constituting a mixing chamber, a fuel tube entering said shell from outside the passage, a liquid fuel receptacle to supply fuel through said tube and an electric igniter extending through said passage and through an opening in the wall of said shell, said shell having a series of air admitting openings at successively greater distances away from said igniter.

In testimony whereof, I have signed this specification.

JOHN GOOD.

CERTIFICATE OF CORRECTION.

Patent No. 1,733,792. Granted October 29, 1929, to

JOHN GOOD.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 5, line 69, claim 8, for the word "in" read "an"; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 26th day of November, A. D. 1929.

(Seal)

M. J. Moore,
Acting Commissioner of Patents.