

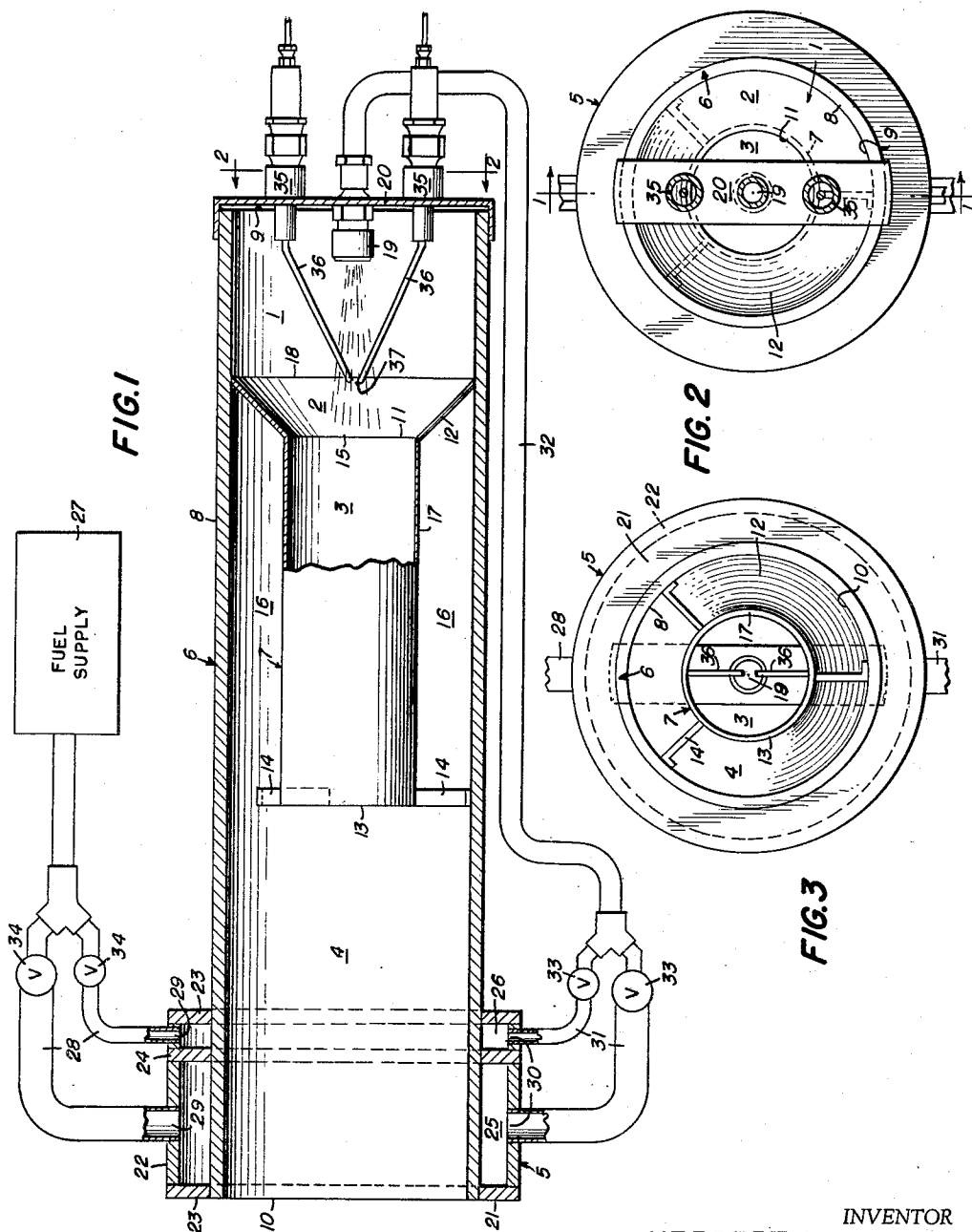
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JET BURNER

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2,996,112

JET BURNER

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This invention relates to jet burners and has for its primary object to provide an improved jet burner which is extremely sensitive to pressure variations and efficient over a wide range of pressures.

Another object of the invention is to provide an improved jet burner, wherein a combustion mixture is discharged from a mixing chamber abruptly into a combustion chamber of relatively large cross-section, thereby stabilizing the flame in the combustion chamber and eliminating flame pulsations.

An additional object of the invention is to provide an improved jet burner for burning a mixture of fuel and air, wherein the fuel and air are admitted into an inlet chamber, led therefrom through a contracting passage into a tubular mixing chamber and abruptly discharged from the mixing chamber into a combustion chamber of relatively large cross-section, whereby eddy currents are created in the combustion chamber about the outlet of the mixing chamber, thereby holding the flame at the outlet end of the mixing chamber and eliminating flame pulsations and blow-backs.

A further object of the invention is to provide an improved jet burner, wherein the fuel is injected in vapor form and, by being directed through a contracting passage into a tubular mixing chamber, inspirates air into the chamber for admixing with the fuel, the combustion mixture being discharged abruptly into a combustion chamber of enlarged cross-section.

Another object of the invention is to provide an improved jet burner operable at either low or high flame and adapted to operate efficiently on liquid fuel at either flame by vaporizing the fuel prior to injection.

An additional object of the invention is to provide an improved jet burner having a compartmented vaporizer for separately vaporizing liquid fuel prior to injection through a common nozzle for both low- and high-flame operations, the particular operation and the heat released by each being regulated by valves, each associated with one of the compartments.

A further object of the invention is to provide an improved jet burner which is simple and compact in construction, economical to manufacture and efficient and of high heat release in operation.

Other objects and advantages of the invention will appear hereinafter in the detailed description, be particularly pointed out in the appended claims and be illustrated in the accompanying drawings, in which:

FIGURE 1 is a side elevational view of a preferred embodiment of the jet burner of the present invention with portions broken away and shown in section to more clearly illustrate certain of the details of construction;

FIGURE 2 is an end elevational view, partly in section, taken along the lines 2—2 of FIGURE 1; and

FIGURE 3 is an end elevational view illustrating the outlet end of the burner.

Referring now in detail to the drawings, in which like reference characters designate like parts, the improved

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jet burner of the present invention not only is applicable generally to installations requiring high heat release burners burning liquid or gaseous fuel, such as the crop drier of Raymond Arndt Patent No. 2,699,769 but, due to its peculiar characteristics, also may be employed advantageously as an after-burner of a jet engine and in other special applications.

Essentially, the jet burner of this invention is comprised of an inlet chamber 1 into which fuel and air are introduced, a contracting passage 2 leading from the inlet chamber to a mixing chamber 3 in which the fuel and air are mixed and a combustion chamber 4 of larger cross-section than the mixing chamber into which the combustion mixture is discharged abruptly from the mixing chamber. For applications in which it is to be fed with liquid fuel, the jet burner also will normally include a vaporizer 5 surrounding the combustion chamber 4 and utilizing part of the heat of combustion to vaporize the fuel before its introduction into the inlet chamber 1. Equipped with the vaporizer 5, the jet burner is ideally suited for use as an inspirating type burner in which the pressure of the fuel jet serves to inspire air into the mixing chamber for admixture with the fuel. However, the basic burner is also well adapted for use as a burner of the forced air type, as when installed as an after-burner of a jet engine, the fuel, gaseous or atomized, then being admixed with the exhaust from the jet engine and employing the excess oxygen therein for combustion when the after-burner is cut in.

The essential features and special characteristics resulting therefrom are exemplified in the illustrated embodiment, in which the jet burner of this invention has been adapted for use as an inspirating type burner fed with liquid fuel. The inlet, mixing and combustion chambers 1, 3 and 4, respectively, and the contracting passage 2 connecting the inlet and mixing chambers, may be bounded by a common casing or shell of unitary or multi-section construction formed to the required shape by drawing or casting or, if of multi-section construction, by welding adjoining sections together. However, it has been found satisfactory and economical in the case of the illustrated embodiment to make the burner of an outer tube or tubular or substantially cylindrical casing or shell 6 and to mount substantially concentrically within the casing intermediate its ends an inner tube or cylinder 7. The cylinder 7 is spaced inwardly radially of the side wall 8 and axially of the inlet and outlet ends 9 and 10, respectively, of the casing 6 and, conveniently, is supported or mounted in position at its inlet end 11 by an annular, inwardly tapering element or member 12 and at its discharge end 13 by circumferentially spaced radially directed brackets or feet 14, each extending between and fixed to the cylinder 7 and casing 6.

Spaced axially inwardly from and defining with the inlet end 9 of the casing 6 the axial or longitudinal extremities of the inlet chamber 1, the annular, inwardly tapering member 12 bounds the forwardly contracting passage 2 and may be a truncated cone or, if more exact adherence to the flow lines of the fluid passing through the passage is desired, a truncated conoid of the required inward curvature. Whether conical or conoidal, the inwardly contracting or converging passage 2 is not unlike passages employed in some other inspirating type jet burners for obtaining a maximum inspiration of air for a given pressure of fluid. However,

in such burners, in line with usual practice, the contracting passage is the forepart of a venturi tube in which the fuel and air are mixed and through which the combustion mixture is discharged into the combustion chamber, it being deemed essential for flame propagation that there be a minimum of turbulence in the combustion chamber.

Contrary to usual practice and the theory on which it is based, it has been found that if, instead of being passed through a venturi tube into the combustion chamber, the fuel and air are mixed in a tubular mixing chamber and abruptly discharged therefrom into a combustion chamber of larger cross-section, a jet burner is made much more efficient, extremely responsive in its heat release to changes in the fuel pressure and practically free of blow-backs, as well as much quieter than its conventional counterpart. This marked improvement in all-around performance appears to result from the creation of turbulence in the form of eddy currents in the combustion chamber about the outlet end of the mixing chamber and the consequent reduction in the pressure in that area which stabilizes or holds the flame in the combustion chamber at the discharge end of the mixing chamber and eliminates flame pulsations. In any case, it is the exceptional efficiency and responsiveness to fuel pressure, coupled with the marked reduction in noise, that peculiarly adapt the jet burner of this invention for use as an after-burner of a jet engine.

In the illustrated embodiment, the desired eddy current effect is obtained by holding the inside diameter or cross-section of the cylinder 7 throughout its length substantially to that of the throat 15 of the contracting passage 2, so that the cylinder forms in effect a tubular or cylindrical prolongation or extension of the throat, and terminating the cylinder abruptly in the combustion chamber 4 of relatively large diameter contained in the casing 6 intermediate the discharge end 13 of the cylinder and the outlet end or port 10 of the casing. At the same time, by-passing or flow of fluid about or around the cylinder 7 in the annular space 16 between the side wall 17 of the cylinder and that 8 of the casing 6 is blocked or prevented by the forwardly tapering or conical member 12 which, at its throat 15 and outer or feed end 18, sealingly engages the inlet end 11 of the cylinder and side wall 8 of the casing, respectively. Thus, the fuel jet or stream, injected by a nozzle 19 mounted in the inlet end 9 of the casing substantially concentric of the cylinder 7 and projecting into the inlet chamber 1, and air inspired by the force or suction of the fuel jet through the inlet end 9 of the casing, are forced or directed by the contracting passage 2 to pass into the mixing chamber 3 contained in the cylinder 7. When the combustion mixture of fuel and air admixed in the mixing chamber 3 is then discharged from the discharge end 13 of the mixing chamber into the combustion chamber 4, the sudden enlargement in the cross-sectional area of the space occupied by the gas creates the desired turbulence in the form of eddy currents around or about the discharge end of the mixing chamber. Conveniently, the nozzle 19 may be mounted on a strap 20 fixed to or rigid with the casing 6 and straddling and partially interrupting its inlet end 9.

Operating most efficiently when the fuel ejected from the nozzle 19 is in vapor or gaseous form, the illustrated jet burner is designed to vaporize or volatilize liquid fuel in advance of the nozzle so as to adapt it for use in any location with commonly available packaged or "bottled" fuels such as propane and butane or mixtures thereof. The vaporizer 5 is formed by a jacket 21 surrounding or encircling the outlet end portion of the casing 6 about the combustion chamber 4. The jacket includes a cylindrical or tubular side wall 22 spaced radially from the side wall 8 of the casing 6 and connected thereto by axially spaced end walls 23. The annular space defined by the end and side walls 23 and 22 and the included portion of the side wall 8 of the casing 6 is partitioned or di-

vided by a partition 24 into a plurality of compartments, here two in number, one 25 for high- and the other 26 for low-flame operation of the burner. Each of the compartments 25 and 26 is individually connected to a fuel supply 27 by an individual inlet pipe or conduit 28 entering the related compartment through an inlet port 29. The compartments 25 and 26 also are individually connectable to the common nozzle 19, each through an outlet port 30 circumferentially spaced from and preferably diametrically opposite its inlet port 29, by an outlet conduit or pipe 31, the two outlet conduits 31 conveniently merging into a single feed pipe or conduit 32 to the nozzle 19. Each of the outlet conduits 31 is provided with a regulating valve 33 and, if desired, a like valve or a one-way valve 34 may be interposed in each of the inlet conduits 28 to control flow between the liquid fuel supply 27 and the compartments 25 and 26.

Since the fuel consumed during high-flame operation will be much greater than that used for the low flame, which generally will serve as the pilot flame, the high-flame vaporizing compartment 25 will be much larger than the other or low-flame compartment 26. Deriving the heat by which the liquid fuel is vaporized by conduction through its several walls from the heat generated in the combustion chamber 4, the vaporizer 5 may also be varied in size in accordance with the particular fuel employed. Thus, for the preferred fuels propane and butane, the compartments 25 and 26 may be relatively small for the more volatile propane, larger for mixtures of propane and butane and at maximum for butane. However, it usually will be preferred to have the compartments of sufficient size for the least volatile of the liquid fuels with which the burner is to be used and rely on valving by the regulating valves 33 to control the amounts flowing to the nozzle 19.

For initial starting, the burner is provided with a pair of ignition electrodes 35, which conveniently may be mounted on the strap 20, mounting the nozzle 19 on either side of the latter and the rods 36 of which converge inwardly to provide a spark gap 37 beyond the nozzle for igniting the fuel. Ordinarily, the starting electrodes 35 will be employed to ignite the fuel only for low- or pilot-flame operation and the pilot flame in turn depended on to ignite the flame in the combustion chamber 4 for high-flame operation. Consequently, since the pilot flame normally will be contained substantially in the inlet chamber 1, the spark gap 37 may be located in that area. While during low-flame operation the gaseous fuel will be supplied entirely from the low-flame vaporizing compartment 26, during high-flame operation the fuel may be supplied from either the high-flame compartment 25 or, if a still higher in-put is desired, simultaneously from both compartments.

The illustrated jet burner operates efficiently without provision for regulating the amount of air inspired through the open inlet end 9 of the casing 6, apart from variation in the pressure of the fuel jet. However, if more exact proportioning of the air and fuel is deemed necessary in a particular application, this may readily be afforded by providing at the inlet end 9 a variable air inlet such as provided on the lower tube of the heat exchanger of Arndt Patent No. 2,699,769.

In operation, the jet burner of this invention has been found capable of releasing much more heat per square inch of outlet port area than is obtainable with conventional atmospheric type burners using the same fuel. This exceptionally high heat release is the consequence not only of vaporizing of the fuel prior to injection and stabilizing and eliminating pulsations in the flame by the eddy current effect about the discharge end 13 of the combustion chamber 4, but to the particular relations in the preferred construction of the burner between the contracting passage 2 and the nozzle 19 on the one hand and the throat 15 of the contracting passage or the mixing chamber 3 and the combustion chamber 4 on the other. By contrast, in the burner of this invention, the distance

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between the nozzle 19 and the throat 15 of the contracting passage 2 is substantially one and one-half times the diameter of the throat and the latter is substantially one-half the diameter of the combustion chamber 4 so that the cross-sectional area of the throat or the mixing chamber 3 is substantially 25% of that of either the combustion chamber or the outlet port 10 of the casing 6. The particular construction of the burner of this invention also permits a range of inlet gas pressures of from 4 to 60 p.s.i., as opposed to the range of a conventional burner of from less than 1 to 25 p.s.i., this in turn affording greater gas consumption and giving correspondingly higher heat release.

From the above detailed description, it will be apparent that there has been provided an improved jet burner of exceptional performance and wide application. It should be understood that the described and disclosed embodiment is merely exemplary of the invention and that all modifications are intended to be included which do not depart from either the spirit of the invention or the scope of the appended claims.

Having described my invention, I claim:

1. In a jet burner, an imperforate outer tube having open inlet and outlet ends, an imperforate inner tube of about one-half the diameter of said outer tube and disposed coaxially within said outer tube with open inlet and outlet ends spaced longitudinally inwardly from the respective inlet and outlet ends of the outer tube, an imperforate inwardly contracting wall member spaced from the inlet end of the outer tube and connecting the outer tube to the inlet end of the inner tube, a fuel discharge nozzle located within said inlet end of the outer tube for discharging gaseous fuel under pressure at high velocity into said outer tube axially thereof to inspire air into said inlet end of the outer tube to form a combustible mixture that is accelerated as it moves through the contracting member and into the inlet end of the inner tube, the space within said outer tube between the outlet end of the inner tube and the outlet end of the outer tube constituting a combustion chamber into which the rapidly moving combustible fuel mixture is abruptly expanded as the mixture enters the combustion chamber from the outlet end of said inner tube.

2. In a jet burner, an imperforate outer tube having open inlet and outlet ends, an imperforate inner tube of about one-half the diameter of said outer tube and disposed coaxially within said outer tube with open inlet and outlet ends spaced longitudinally inwardly from the respective inlet and outlet ends of the outer tube, an imperforate inwardly contracting member spaced from the inlet end of the outer tube and connecting the outer tube to the inlet end of the inner tube, a fuel discharge nozzle in said inlet end of said outer tube having its final fuel discharge orifice spaced from the inlet end of the inner tube in a distance equal to substantially one and one-half times the diameter of said inner tube and operable to discharge gaseous fuel under pressure at high velocity into said outer tube axially thereof to inspire air into said inlet end of the outer tube to form a combustible mixture that is accelerated as it moves through the contracting member and into the inlet end of the inner tube, the space within said outer tube between the outlet end of the inner tube and the outlet end of the outer tube constituting a combustion chamber into which the rapidly moving combustible fuel mixture is abruptly expanded as the mixture enters the combustion chamber from the outlet end of said inner tube.

3. In a jet burner, an imperforate outer tube having open inlet and outlet ends, an imperforate inner tube of a diameter substantially less than the diameter of said outer tube and forming an elongated mixing chamber disposed coaxially within said outer tube with open inlet and outlet ends spaced longitudinally inwardly from the respective inlet and outlet ends of the outer tube, an imperforate inwardly contracting wall member spaced from the inlet end of the outer tube and connecting the outer tube

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to the inlet end of the inner tube to form a closed tapered passage discharging into said inner tube, a fuel supply nozzle within the inlet end of said outer tube discharging gaseous fuel under pressure and at high velocity into said outer tube axially thereof to inspire air into said inlet end of the outer tube to form the combustible mixture that is to be burned and which combustible mixture is accelerated to high velocity as it moves through the contracting member and into the inlet end of the inner tube, the space within said outer tube between the outlet end of the inner tube and the outlet end of the outer tube constituting a combustion chamber into which the rapidly moving combustible fuel mixture is abruptly expanded as the mixture enters the combustion chamber from the outlet end of said inner tube to reduce the speed of the mixture for burning thereof in said combustion chamber.

4. In a jet burner, an elongated imperforate cylindrical outer casing with one end portion thereof serving as a fuel injection zone and with an opposite end portion thereof serving as an unobstructed combustion zone, a separate fuel mixing chamber concentrically supported within said casing substantially between the two zones, the mixing chamber comprising an imperforate cylindrical tube open at one end to receive fuel in the fuel injection zone and open at its other end in the combustion chamber for discharge of ignited fuel and having an imperforate upstanding frusto-conical flange and forming an inwardly tapering throat with a free edge extending from the open fuel receiving end of the mixing tube, the free edge of the flange abutting a circumferential adjacent inner wall portion of said outer casing and forming a partition which separates and seals off and isolates the injection zone from the combustion zone, the mixing tube being substantially one-third the length of the outer casing and substantially one-half the diameter of said outer casing thus forming a circumferential chamber between the outer surfaces of the frusto-conical flange and the mixing tube and adjacent inner surfaces of the outer casing, the chamber being in substantial unobstructed communication with the combustion zone only at the discharge end of the mixing tube, the mixing tube being many times greater in length than the width of the frusto-conical flange but of substantially less length than the outer casing, fuel injection means at the open end of the casing adjacent the fuel injection zone, ignition means at the entrance of said throat in the path of fuel ejected from the fuel injection means.

5. In a jet burner, an elongated imperforated cylindrical outer casing with one end portion thereof serving as a fuel injection zone and with an opposite end portion thereof serving as an unobstructed combustion zone, an imperforate hollow cylindrical fuel mixing tube concentrically fixedly mounted in the casing and forming with adjacent surfaces of the interior surface of the casing a circumferential chamber being in unobstructed communication only with the combustion zone at the discharge end of the mixing tube, said tube being of substantially half the diameter of the casing and substantially one-third the length of the casing, an imperforate upstanding frusto-conical flange having a free edge forming an inwardly tapering throat at one end of the tube extending from the open fuel receiving end of the mixing tube, the free edge of the flange abutting the circumferential adjacent inner wall portion of said outer casing and forming a partition which separates and seals off and isolates the injection zone from the combustion zone, said mixing tube serving as the only communication between the fuel injection zone and the combustion zone, the mixing tube being many times greater in length than the width of the frusto-conical flange but of substantially less length than the outer casing, fuel and air means only at the open end of the tube adjacent the fuel injection zone, ignition means at the entrance of said throat in the path of fuel ejected from the fuel injection means.

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