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2,780,916

PILOT BURNER FOR JET ENGINES

Filed Aug. 22, 1952

3 Sheets-Sheet 1

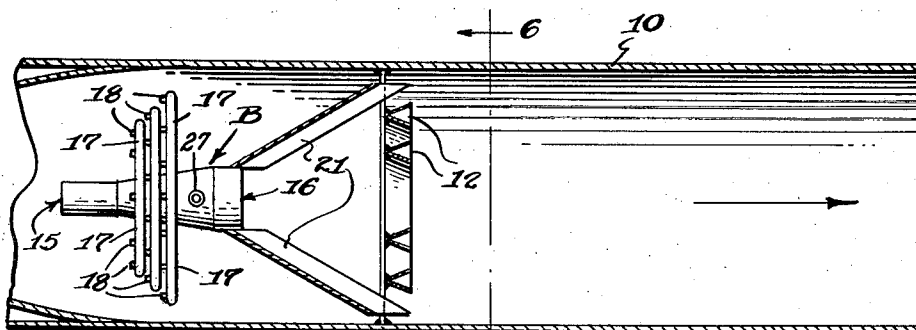
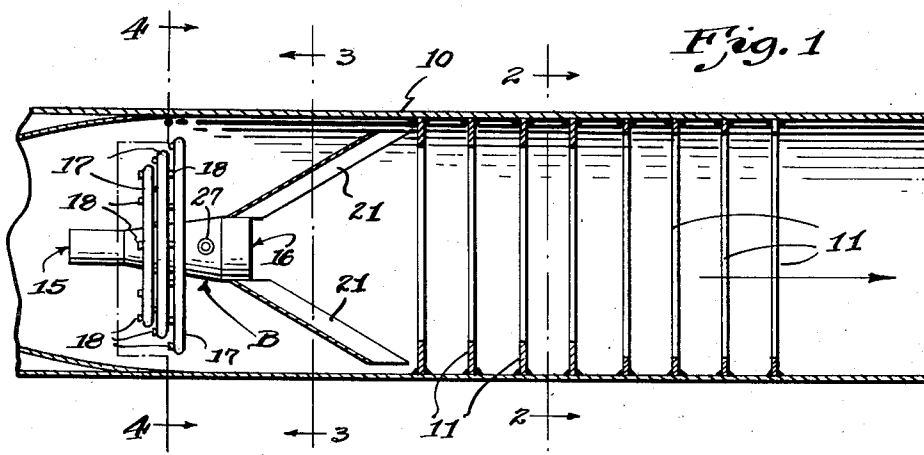


Fig. 5

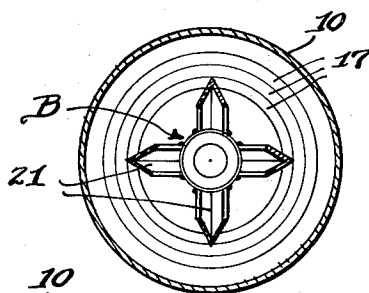


Fig. 3

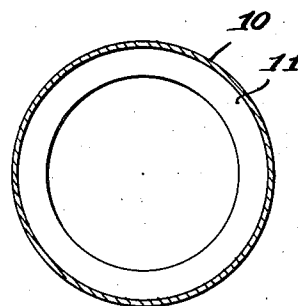


Fig. 2

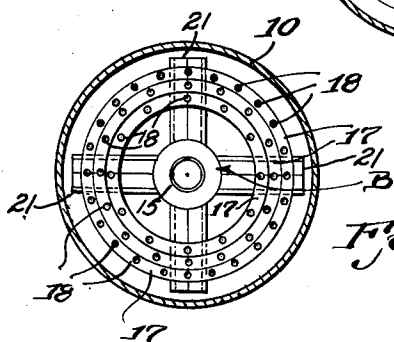


Fig. 4

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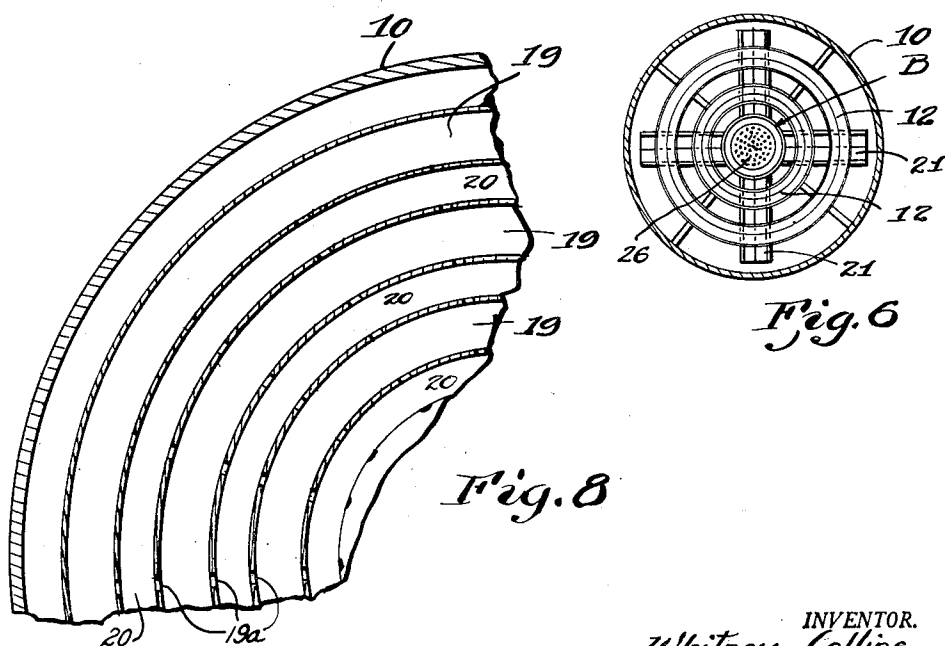
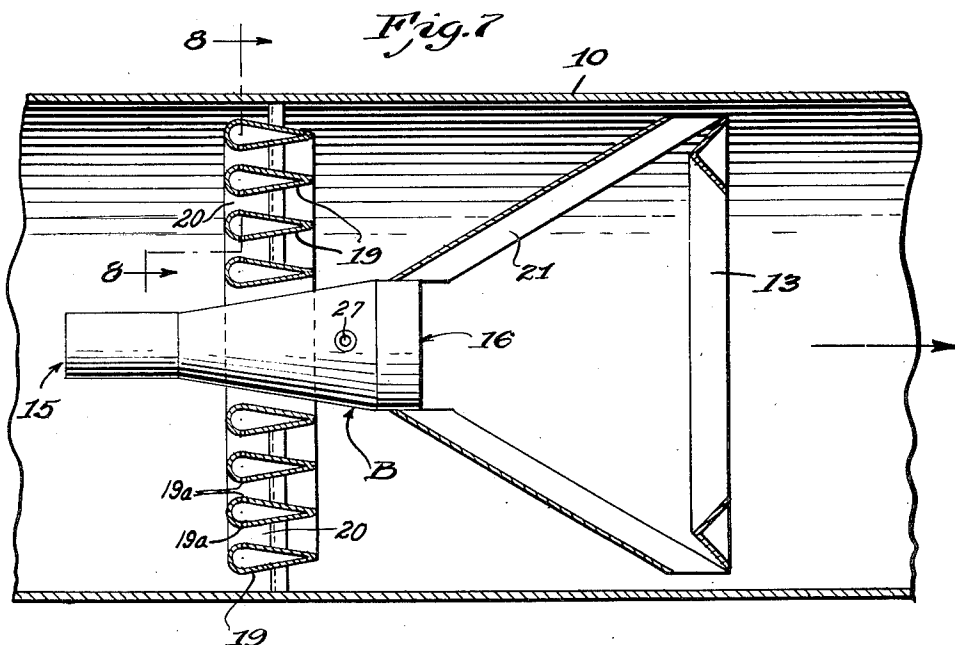
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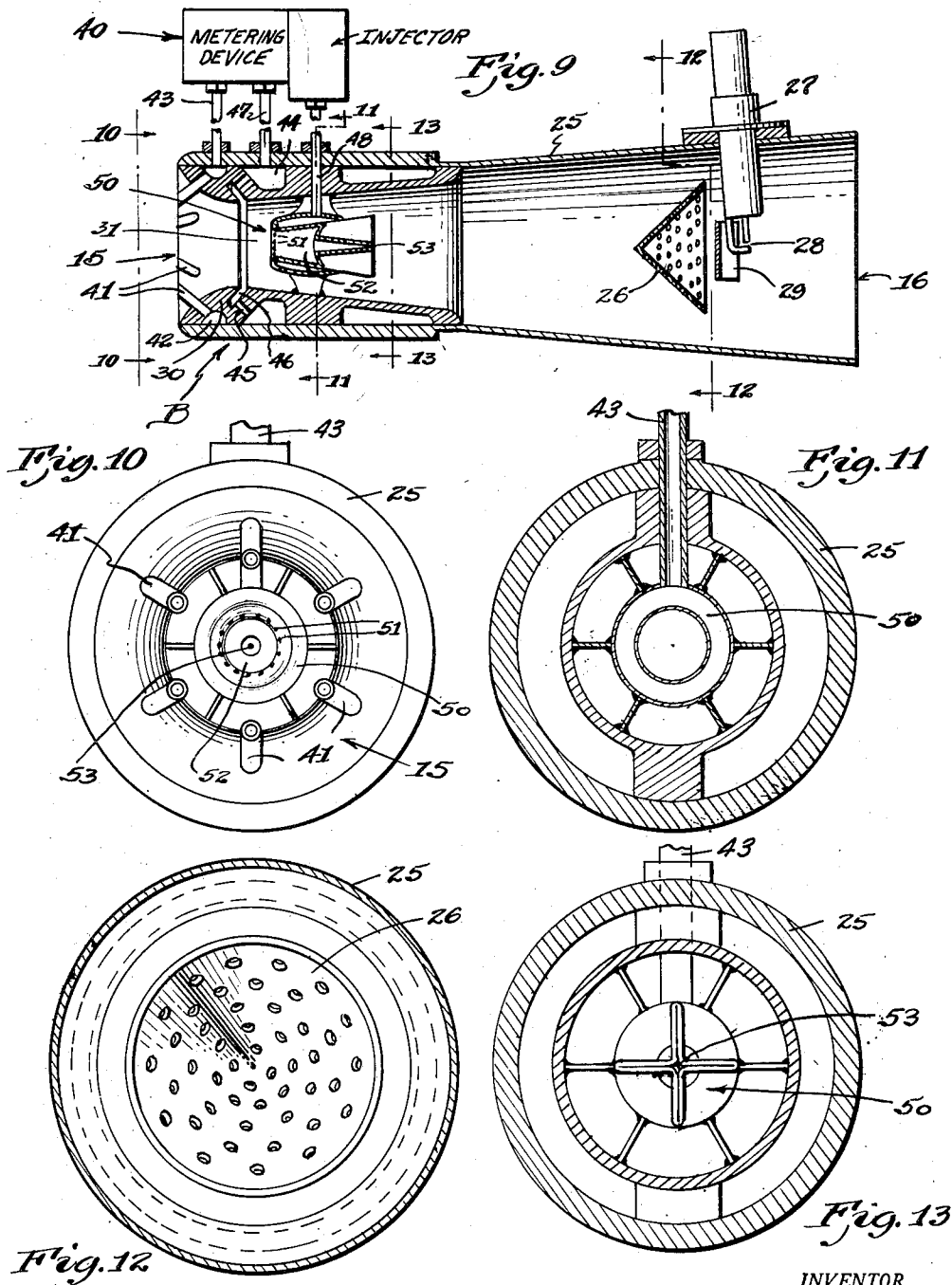
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PILOT BURNER FOR JET ENGINES

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3 Sheets-Sheet 3



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PILOT BURNER FOR JET ENGINES

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10 Claims. (Cl. 60—39.28)

My invention relates to a pilot burner for a ram jet engine and more particularly to a venturi type pilot burner constructed for igniting the fuel as swept through and past the burner at very high velocities and for maintaining a proper proportioning of the fuel and air mixture under all flow conditions.

One of the difficulties with ram jet engines is the ignition of the fuel and the stabilizing of the flame on the flame holders in order to prevent the flame from blowing out.

It is an object of the invention to construct an efficient and reliably operated ram jet engine by providing a pilot burner capable of reliable operation under varying conditions, and which will supply flaming gases to the main ram jet flame holder so that ram jet burners can be operated at higher velocities, lower pressures, and with wider mixture ratios than would otherwise be possible.

For a more detailed understanding of the invention, reference may be had to the accompanying drawings illustrating preferred embodiments of the invention wherein like characters refer to like parts throughout the several views, and in which

Fig. 1 is a longitudinal sectional view through a ram jet engine.

Figs. 2, 3 and 4 are transverse sectional views taken substantially on the lines 2—2, 3—3 and 4—4 of Fig. 1, respectively.

Fig. 5 is a longitudinal view of a modified ram jet engine.

Fig. 6 is a transverse sectional view taken on the line 6—6 of Fig. 5.

Fig. 7 is a fragmentary longitudinal sectional view of still another form of a ram jet engine.

Fig. 8 is an enlarged fragmentary transverse sectional view taken in the line 8—8 of Fig. 7.

Fig. 9 is a longitudinal sectional view through the pilot burner, such as is used in Fig. 1.

Fig. 10 is an enlarged front end view thereof as seen from the section line 10—10 of Fig. 9, and

Figs. 11, 12 and 13 are enlarged transverse sectional views of the pilot burner taken respectively on the lines 11—11, 12—12, and 13—13 of Fig. 9.

Figs. 1, 5 and 7 respectively illustrate three forms of ram jet engines, all of which embody a main combustion tube or pipe 10 provided with a fuel atomizing and injecting device and with various styles of flame holders. Fig. 1 provides a plurality of annular flanges 11 extending radially inward from the pipe 10 to pick off and slow down flow of the burning mixture around the periphery of the combustion so that the flame will not blow out. Fig. 5 illustrates a pair of concentric V-grooved flame holders 12, and Fig. 7 illustrates one annular V-grooved flame holder 13. All these flame holders as illustrated in Figs. 1, 5 and 7 are located downstream from the pilot burner B, which has an inlet 15 upstream from the main fuel supply means and an outlet 16 downstream from the main fuel supply means. In Figs. 1 and 5 the

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main fuel supply means comprises a plurality of annular fuel supply pipes 17 encircling the pilot burner, each having a plurality of fuel ejector nozzles 18 spraying fuel upstream against the flow of air supplied to the pipe 10.

5 In Fig. 7 the fuel supply means comprises a plurality of stream lined annular pipe sections 19 which provide venturi passages 20 therebetween and the pipe sections having fuel discharge ports or nozzles 19a in the walls which discharge the fuel preferably across substantially the narrowest portion of these venturi passages.

The flaming gases discharged from this pilot burner are picked up by the outwardly diverging channeled flame spreaders 21 which serve as flame holders and also readily spread the flame radially outwardly toward the walls of the pipe so that substantially all the combustible mixture flowing through the pipe is exposed to the flame and thus uniformly ignited.

This venturi type pilot burner B shown in detail in Figs. 9 to 13 inclusive comprises a pipe 25 which is outwardly flared on the downstream portion (see Fig. 9) and is provided with a cone shaped flame holder 26 near the outlet 16 and closely adjacent is the spark plug or other suitable igniter 27, the points 28 of which are preferably disposed behind a shield 19. The flame holder 26 is formed of perforated material to allow some of the combustible mixture to flow into the cone and be substantially slowed down to facilitate its ignition. After once being ignited, a sufficient amount of fuel-air mixture is always supplied to the interior of the cone flame holder 26 to maintain a flame at this point for igniting all the combustible mixture as it is being discharged through outlet 16 of the pilot burner.

This pilot burner is designed to ignite the ram jet under very high burner velocities and to assist in stabilizing the flame down to very low burner pressures. Some of the air from the high velocity air stream enters the pilot burner at the forward end, which is provided with an insert sleeve 30 forming a venturi inlet passage 31. The diverging walls of this venturi passage 31 slow down the air flow, fuel is mixed with the air and is conducted to the flame holder 26 where same is ignited. Thus, this separately fueled pilot burner supplies flaming gases to the main ram jet flame holder enabling the ram jet burner to be operated at higher velocities, lower pressures, and wider mixture ratios than would otherwise be possible.

One of the main features of this pilot burner is its use of an independent fuel supply and fuel metering system which permits, for example, maintenance of a constant or optimum fuel-air ratio regardless of conditions in the main combustion system. This will allow for automatic ignition or re-ignition for starting, rich or lean blowout, etc. It also increases the overall flexibility of the system by permitting the use of fuels especially suited for ignition under extreme temperatures or pressures.

A fuel metering and injector device 40, of standard construction, many of which can be obtained from various injector manufacturers, is employed in conjunction with this pilot burner. Tubes 41 are carried by the venturi insert 30 and the air pressure at the intake end 15 is transmitted through tubes 41 to annular groove 42 and thence by conduit 43 to the metering and injecting device 40. Groove 44 is connected by holes 45 and slot 46 to the narrowest part of the venturi passage 31 and the static pressure at this point is communicated to the metering device 40 through conduit 47 connected with groove 44. The injector device 40 injects fuel through conduit 48 to the fuel atomizing and mixing device 50 located centrally in this venturi passage 31, the fuel being sprayed radially inwardly from jets 51 to the inner passage 52 where it is mixed with the air and the fuel-air mixture is discharged from the outlet jet 53 down-

stream of the passage 31 towards the flame holder 26, this fuel-air mixture spreading and mixing with the air stream and being substantially slowed down so that same is readily ignited and maintained burning.

The pilot burner thus receives the correct metered amount of fuel under all conditions of operation, the metering device being responsive to the air pressure at the intake 15 and the static pressure at the narrowest part of the venturi passage, and thereby varying the amount of fuel being delivered to the fuel atomizing and mixing device 50 to provide for a constant or optimum fuel-air ratio regardless of conditions in the main combustion system.

While I have illustrated but one preferred form of my invention, it will be apparent to those skilled in the art to which my invention pertains that various modifications and changes may be made herein without departing from the spirit of my invention or from the scope of the appended claims.

I claim:

1. A pilot burner for a ram jet engine having a main combustion pipe, said pilot burner supported in said pipe and comprising a venturi type structure having an upstream inlet and a downstream outlet, means acting on a portion of the air stream in said pipe flowing into said venturi to slow same down in passing therethrough, means trapping a portion of the air flowing into said venturi structure and means for mixing fuel therewith and discharging said fuel and air mixture into said burner venturi, whereby to provide a combustible fuel and air mixture for said pilot burner of optimum fuel and air ratio, regardless of conditions in said main combustion pipe, a flame holder located in said burner venturi adjacent the outlet, and ignition means located downstream of said flame holder but in said burner passage.

2. A pilot burner for a ram jet engine having a main combustion pipe, said pilot burner supported in said pipe and comprising a venturi type structure having an upstream inlet and a downstream outlet, means acting on a portion of the air stream in said pipe flowing into said venturi to slow same down in passing therethrough, a fuel metering and injection device associated with said burner and having fuel metering means operable in response to the velocity and pressures of the air entering said burner for injecting metered quantities of fuel into the slower moving air in said burner to provide a combustible mixture of an optimum fuel-air ratio regardless of conditions in the main combustion pipe, and a flame holder and associated igniter in said burner venturi adjacent the outlet.

3. A pilot burner for a ram jet engine having a main combustion pipe, said pilot burner supported in said pipe and comprising a venturi type structure having an upstream inlet and a downstream outlet, means acting on a portion of the air stream in said pipe flowing into said venturi to slow same down in passing therethrough, means for mixing fuel with the slower-moving air in said burner venturi, a flame holder located in said burner venturi adjacent the outlet, and ignition means located downstream of said flame holder but in said burner passage, said fuel-air mixing means comprising venturi structure axially located in said burner venturi immediately downstream of the narrowest part of said burner venturi and having a constricted nozzle pointing down stream to spray a fuel-air mixture into the air stream flowing through said burner upstream from said flame holder.

4. A pilot burner for a ram jet engine having a main combustion pipe, said pilot burner supported in said pipe and comprising a venturi type structure having an upstream inlet and a downstream outlet, means acting on a portion of the air stream in said pipe flowing into said venturi to slow same down in passing therethrough, a fuel metering and injection device associated with said burner and having fuel metering means operable in response to the velocity and pressures of the air entering said burner

for injecting metered quantities of fuel into the slower moving air in said burner to provide a combustible mixture of an optimum fuel-air ratio regardless of conditions in the main combustion pipe, and a flame holder and associated igniter in said burner venturi adjacent the outlet, said burner carrying a plurality of tubes facing the air stream at the entrance to the burner venturi, and means connecting the tubes to the fuel metering device to subject said device to velocity pressure, and means placing said metering device in communication with the zone at the narrowest part of said burner venturi to subject said device to static pressures of this zone.

5. A pilot burner for a ram jet engine having a main combustion pipe, said pilot burner supported in said pipe and comprising a venturi type structure having an upstream inlet and a downstream outlet, means acting on a portion of the air stream in said pipe flowing into said venturi to slow same down in passing therethrough, means for mixing fuel with the slower moving air in said burner venturi, a flame holder located in said burner venturi adjacent the outlet, and ignition means located downstream of said flame holder but in said burner passage, and diverging channel shaped flame holders associated with the pilot burner outlet and operable to hold and spread the flame transversely of the main combustion pipe.

6. A pilot burner for a ram jet engine having a main combustion pipe, said pilot burner supported in said pipe and comprising a venturi type structure having an upstream inlet and a downstream outlet, means acting on a portion of the air stream in said pipe flowing into said venturi to slow same down in passing therethrough, means for mixing fuel with the slower moving air in said burner venturi, a flame holder located in said burner venturi adjacent the outlet, and ignition means located downstream of said flame holder but in said burner passage, and diverging channel shaped flame holders associated with the pilot burner outlet and operable to hold and spread the flame transversely of the main combustion pipe, and secondary flame holders supported in said main combustion pipe downstream of said pilot burner and its associated flame holder and spreader.

7. A pilot burner for a ram jet engine having a main combustion pipe, said pilot burner supported in said pipe and comprising a venturi type structure having an upstream inlet and a downstream outlet, means acting on a portion of the air stream in said pipe flowing into said venturi to slow same down in passing therethrough, means for mixing fuel with the slower moving air in said burner venturi, a flame holder located in said burner venturi adjacent the outlet, and ignition means located downstream of said flame holder but in said burner passage, and diverging channel shaped flame holders associated with the pilot burner outlet and operable to hold and spread the flame transversely of the main combustion pipe, and main fuel supply means located in said main combustion pipe downstream of said pilot burner inlet.

8. A pilot burner for a ram jet engine having a main combustion pipe, said pilot burner supported in said pipe and comprising a venturi type structure having an upstream inlet and a downstream outlet, means acting on a portion of the air stream in said pipe flowing into said venturi to slow same down in passing therethrough, means for mixing fuel with the slower moving air in said burner venturi, a flame holder located in said burner venturi adjacent the outlet, and ignition means located downstream of said flame holder but in said burner passage, and diverging channel shaped flame holders associated with the pilot burner outlet and operable to hold and spread the flame transversely of the main combustion pipe, and main fuel supply means located in said main combustion pipe downstream of said pilot burner inlet, said fuel supply means comprising annular fuel rings encircling said pilot burner and provided with fuel nozzles spraying fuel into the main air stream.

9. A pilot burner for a ram jet engine having a main

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combustion pipe, said pilot burner supported in said pipe and comprising a venturi type structure having an upstream inlet and a downstream outlet, means acting on a portion of the air stream in said pipe flowing into said venturi to slow same down in passing therethrough, means for mixing fuel with the slower moving air in said burner venturi, a flame holder located in said burner venturi adjacent the outlet, and ignition means located downstream of said flame holder but in said burner passage, and diverging channel shaped flame holders associated with the pilot burner outlet and operable to hold and spread the flame transversely of the main combustion pipe, and main fuel supply means located in said main combustion pipe downstream of said pilot burner inlet, said fuel supply means comprising annular fuel rings encircling said pilot burner and provided with fuel nozzles spraying fuel into the main air stream, said nozzles ejecting fuel substantially upstream to facilitate atomization of the fuel.

10. A pilot burner for a ram jet engine having a main combustion pipe, said pilot burner supported in said pipe and comprising a venturi type structure having an upstream inlet and a downstream outlet, means acting on a portion of the air stream in said pipe flowing into said venturi to slow same down in passing therethrough, means for mixing fuel with the slower moving air in said burner venturi, a flame holder located in said burner venturi

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adjacent the outlet, and ignition means located downstream of said flame holder but in said burner passage, and diverging channel shaped flame holders associated with the pilot burner outlet and operable to hold and spread the flame transversely of the main combustion pipe, and main fuel supply means located in said main combustion pipe downstream of said pilot burner inlet, said fuel supply means comprising annular fuel rings encircling said pilot burner and provided with fuel nozzles spraying fuel into the main air stream, said nozzles ejecting fuel substantially upstream to facilitate atomization of the fuel, said annular fuel supply rings disposed concentrically and providing venturi air passages therebetween, said fuel being injected directly into the venturi passages between said annular fuel supply rings.

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