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FLAME HOLDER AND FUEL DISTRIBUTING MECHANISM FOR RAM-JET ENGINES

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2 Sheets-Sheet 1

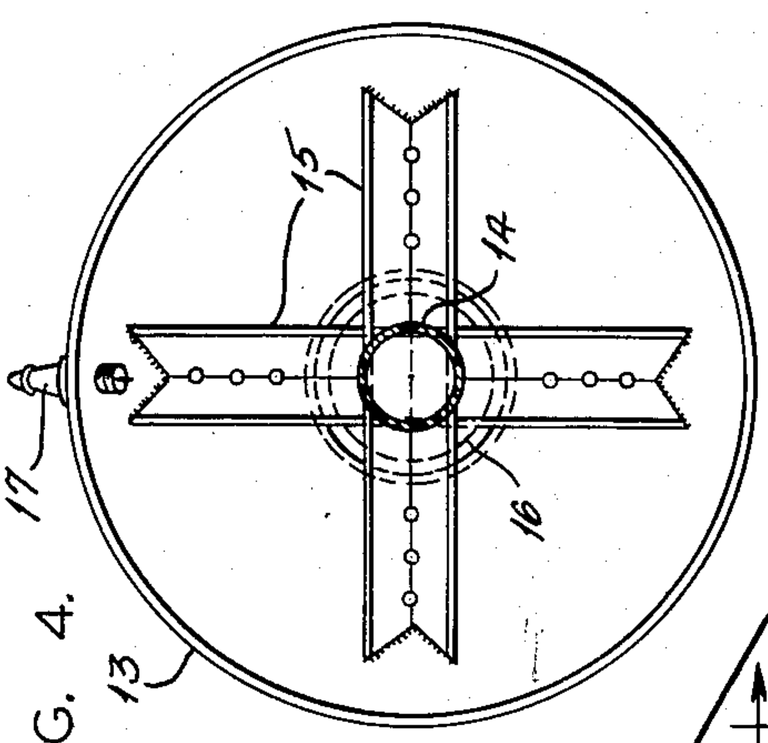

FIG. 4.

FIG. 1.

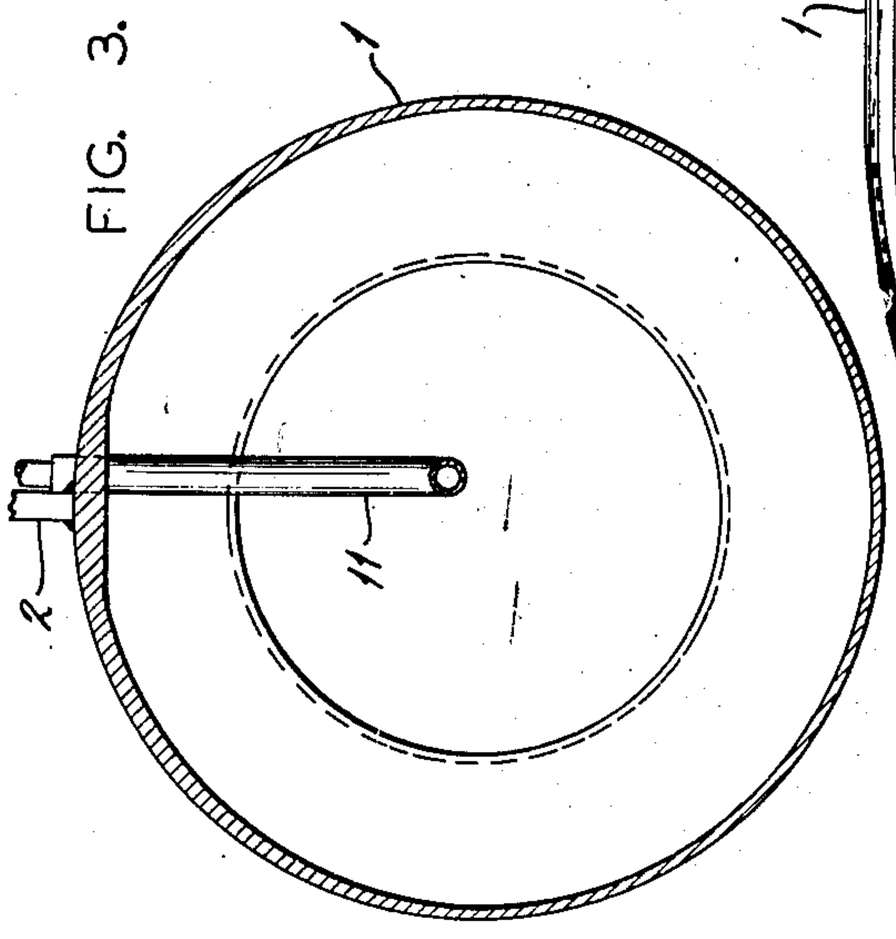

FIG. 3.

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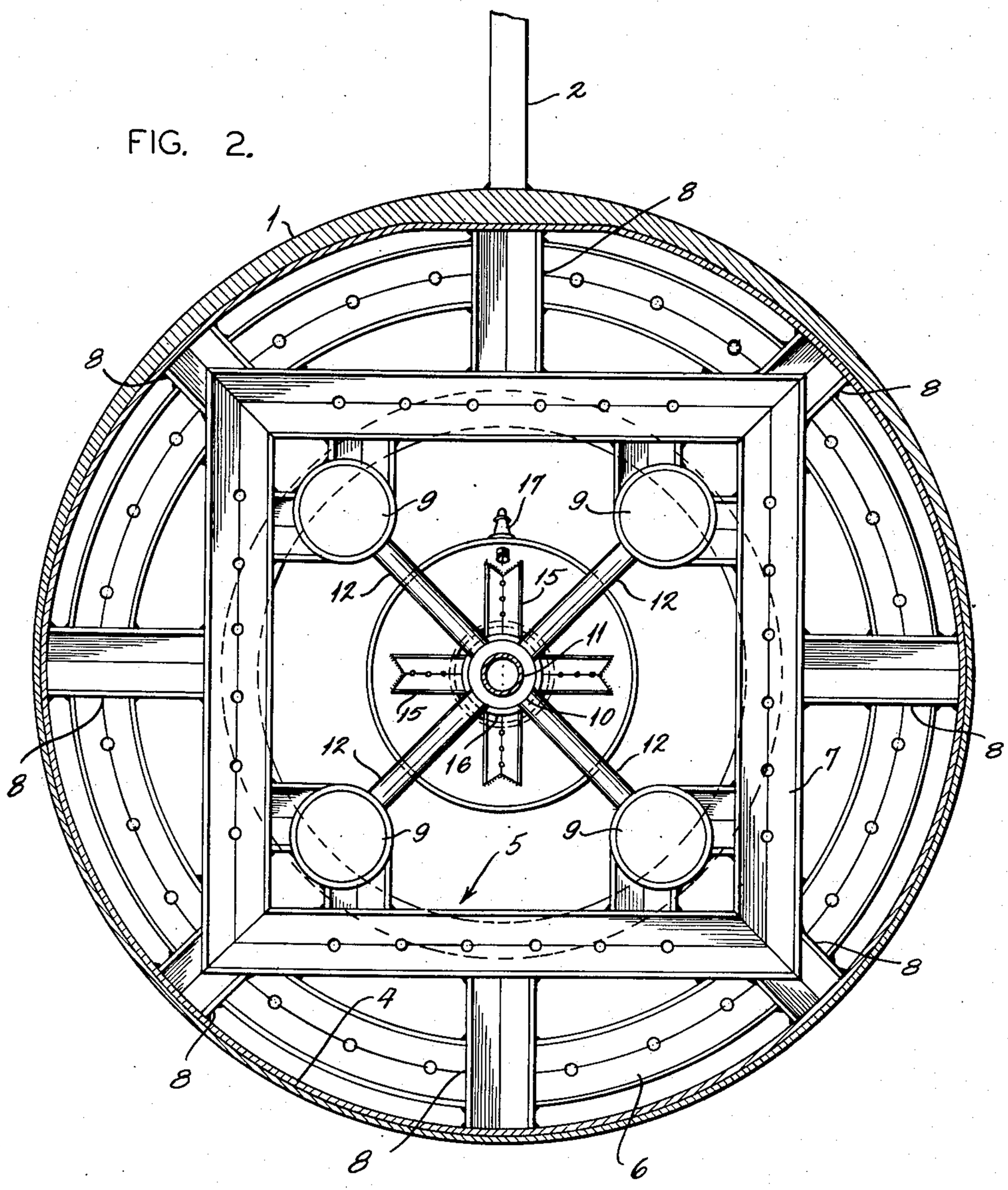
FIG. 2.



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FLAME HOLDER AND FUEL DISTRIBUTING MECHANISM FOR RAM-JET ENGINES

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16 Claims. (Cl. 60—35.6)

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This invention relates to ram jet engines and is more particularly directed to a mechanism for controlling fuel flow and distribution in the engine for the purpose of obtaining a higher thrust output.

One of the objects of the invention is to provide a ram jet engine equipped with suitably arranged frame members functioning as flame holders in order to obtain a more efficient utilization of fuel injected into the ram jet engine.

Another object of the invention is to provide a ram jet engine equipped with V-shaped flame holders supporting a truncated cone centrally disposed with respect to a plurality of nozzles which cone serves as diffusing element that causes the fuel injected centrally of the engine to flow toward the walls of the ram jet engine casing in order that a maximum thrust may be obtained from the fuel. The cone has a spark plug or other initial ignition device mounted therein rearwardly of the V-shaped flame holders and facilitates ignition at high inlet velocities and also serves as a flame holder for the center of the ram jet casing.

The invention consists of a tubular member open at both ends whose forward end is contracted to form a diffusing chamber and having a flame holder arranged therein in which a plurality of fuel injection nozzles are assembled which introduce fuel into the tubular member ahead of the flame holder.

In the drawings:

Fig. 1 is a longitudinal view, partly in section, of a ram jet engine embodying the invention,

Fig. 2 is a sectional view taken substantially along the line 2—2 of Fig. 1,

Fig. 3 is a sectional view taken substantially along the line 3—3 of Fig. 1; and

Fig. 4 is a sectional view taken substantially along the line 4—4 of Fig. 1.

The ram jet engine consists of a tubular casing 1 provided with a bracket 2 for securing it to the outboard end of a rotor blade or other support. The forward end of the tubular casing 1 is partially curled about and secured to ring 3 and a liner 4, also partially curled about and secured to ring 3, flares inwardly and outwardly into the casing to form a diffusing chamber therein and is suitably secured to the inner wall of the tubular casing 1. The liner 4 defines one wall of the diffusing chamber that aids in the control of air flow into the combustion chamber of the ram jet engine. The rear or exhaust end of the tubular casing is open and is somewhat restricted so as to define a discharge nozzle the size of which will

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aid in determining the speed of the gases issuing from the ram jet engine.

A flame holder assembly 5 is supported in the tubular casing at a point adjacent to the inner end of the liner 4. The flame holder comprises an open circular frame 6 and an open rectangular frame 7, the rectangular frame being disposed within the circular frame. The frames are formed by hollow V-shaped members whose ridges or apices face toward the forward end of casing 1. Both of the frames are secured together and to the inner wall of the tubular casing 1 by a plurality of radial struts 8 of air foil profile. The apex or ridge of each frame has a plurality of spaced perforations for the purpose of admitting air into the V members so that no dead air spaces or captive air can be contained therein.

Assembled in each corner of the rectangular frame is fuel injection nozzle 9 that projects toward the forward end of casing 1. The nozzles 9 inject the fuel into the diffusing chamber in a fine spray, the fuel being under a pressure of approximately 3,000 pounds per square inch.

Suitably supported in the flame holder is a fuel distributing head 10 which has a conduit 11 connected thereto that passes through the wall of the tubular casing 1 and thence leads to a source of fuel supply. A plurality of conduits 12 extend from the distributing head 10 to the fuel nozzles 9, the conduits preferably having an air foil profile so as to reduce the air friction of the air passing through the jet engine.

A truncated diffuser cone 13, whose outer surface forms another wall of the diffusing chamber, is supported on projection 14 of head 10 by radially disposed crossed V members 15 whose ridges or apices may have spaced apertures therein whose function is similar to those in frames 6 and 7 that also serve as flame holders. The crossed V-shaped members are apertured to pass over projection 14 whose outer end is threaded. The members 15 are clamped to a shoulder on projection 14 by a nozzle 16 whose forward end terminates just aft of the small end of cone 13. The discharge orifice in nozzle 16 projects fuel forwardly toward the open small diameter end of cone 13. The large end of the cone terminates just past the members 15. An initial ignition means in the form of a spark splug 17 is threaded into the wall of cone 13 adjacent to the larger end of the cone and is suitably connected to an ignition coil (not shown). This plug is only used until fuel has been ignited after which the burning process is continuous.

The zone of combustion extends from the aft or trailing edges of the flame holders 6 and 7 for the full length of the maximum diameter of the casing 1. Flame may also be held on the trailing edges of members 15 and some flame can be held on the trailing edge of cone 13. Combustion is completed by the time the gases reach the reduced diameter portion of casing 1.

The operation of the ram jet engine is initiated by moving the engine through the air up to a predetermined speed after which fuel is injected into the engine through nozzle 16 and is initially ignited by the spark plug 17. The fuel, however, is injected into the incoming air stream from all nozzles and tends to flow back upon itself and through the flame holder assembly 5. The path of fuel flow is substantially as indicated by the lines leading from the discharge end of nozzles 9 and 16 which also show the exact point at which fuel is introduced into the casing 1. The diffuser cone 13 directs most of the fuel that is injected from nozzles 9 toward the center of the engine in the direction of the inner periphery of the tubular casing 1, as well as some of the fuel injected into diffuser cone 13 from nozzle 16, the remainder being burned in the central portion of casing 1. The apertures provided in ridges or apices of frames 6 and 7 permit air to enter the interior of the hollow V members. Were these apertures not present, a quantity of fuel would be introduced into and retained in the interiors of the hollow V members and would gradually carbonize and subject them to considerable heat. The apertures allow air to enter the interior thereof and whatever fuel may enter the hollow V members by reason of eddying effects is immediately driven therefrom and consumed along with the fuel that ordinarily passes the flame holder assembly 5. The diffuser cone 13 has an additional function in that it enables the overall length of the tubular casing 1 to be very materially reduced. If this member were not present, the fuel that is injected and moves into the central portion of the tubular member would not be consumed until it had traveled a considerable distance from its point of injection and possibly beyond the length of the tubular casing 1 so that combustion of the fuel might not occur until after it had passed the exit nozzle of the casing 1. The fuel, however, with the diffuser cone installed, is burned centrally of the casing or is forced toward the inner periphery of the tubular casing and is there burned along with the other fuel that has passed the circular and rectangular frames 6 and 7 and is burned in the tubular casing where it will produce the maximum thrust. The flame holders 15 also aid in causing combustion to occur in the center of casing 1.

What I claim is:

1. A ram jet engine comprising a tubular casing having open rear and forward ends; a flame holder assembly consisting of a plurality of suitably arranged V members mounted in said casing near the forward end thereof; a plurality of fuel discharge nozzles assembled in said flame holder assembly and arranged for discharging fuel into said casing forwardly of said flame holder assembly; and a member mounted on said flame holder for controlling and directing the flow of fuel discharged from said nozzles and causing the fuel to burn in close proximity to the inner wall surface of said casing.

2. A ram jet engine comprising a tubular casing having open rear and forward ends with the diameter of the ends of the casing being less than the diameter thereof at a point between said ends; a flame holder assembly comprising a plurality of suitable V-shaped members mounted in said casing near the forward end thereof; a plurality of fuel discharge nozzles assembled in said flame holder assembly and arranged for discharging fuel into said casing forwardly of said flame holder; and a member mounted on said flame holder for controlling and directing the flow of fuel discharged from said nozzles and causing the fuel to burn in close proximity to the inner wall surface of said casing.

3. A jet engine comprising a tubular casing; a plurality of radially spaced open frame flame holders arranged in said casing, one of said holders being circular in shape and the other being rectangular; and means for introducing fuel into said casing ahead of said flame holders.

4. A jet engine comprising a tubular casing having a contracted forward end; a plurality of concentrically disposed V-sectioned flame holder members mounted in said casing near the forward end thereof, each apex being projected toward the forward end of said casing; means for introducing fuel into said casing ahead of said flame holders; and means disposed ahead of said flame holders for causing the fuel introduced into the casing to burn in close proximity to the interior wall thereof.

5. A jet engine comprising a tubular casing having a contracted forward end; a plurality of concentrically disposed V-sectioned flame holder members mounted in said casing near the forward end thereof, each apex being projected toward the forward end of said casing; means for introducing fuel into said casing ahead of said flame holders; and means disposed forwardly of said flame holders for diffusing the air stream and the fuel entering said casing and for causing the fuel to burn in close proximity to the interior wall of said casing.

6. A jet engine comprising a tubular casing having a contracted forward end; a circular frame V-sectioned flame holder disposed within said casing whose apex projects toward said forward end; a rectangular frame V-sectioned flame holder disposed within said casing and arranged in said circular frame, the apex of said rectangular frame projecting toward the forward end of said casing; and means for introducing fuel into said casing ahead of said flame holders.

7. A jet engine comprising a tubular casing having a contracted forward end; a circular open frame V-sectioned flame holder disposed within said casing whose apex projects toward said forward end; a rectangular open frame V-sectioned flame holder disposed within said casing and arranged in said circular frame, the apex of said rectangular frame projecting toward the forward end of said casing; means for introducing fuel into said casing ahead of said flame holders; and means disposed forwardly of said flame holder for diffusing the air stream passing said flame holders.

8. A jet engine comprising a tubular casing having a contracted forward end; a circular open frame V-sectioned flame holder disposed within said casing whose apex projects toward said forward end; a rectangular open frame V-sectioned flame holder disposed within said casing and in said circular frame, the apex of said rectangular frame projecting toward the forward end of said

casing; means for introducing fuel into said casing ahead of said flame holders; and means disposed forwardly of said flame holder for diffusing the air stream passing said flame holders comprising a cone-shaped member arranged centrally and forwardly of said flame holders.

9. A ram jet engine comprising a tubular casing having forward and rear open ends; a flame holder assembled in said casing near the forward end thereof; a plurality of fuel discharge nozzles uniformly spaced about said flame holder and adapted for discharging fuel into said member forwardly of said flame holder; a centrally disposed fuel discharge nozzle; and a truncated cone-shaped fuel flow control member disposed about said centrally disposed nozzle and whose smallest end is projected forwardly of said member.

10. A ram jet engine comprising a tubular casing having forward and rear open ends; a flame holder assembled in said casing near the forward end thereof and including a plurality of V-sectioned members; fuel discharge nozzles assembled in said flame holders and adapted to discharge fuel into said casing forwardly of said flame holder; a fuel discharge nozzle centrally disposed in said casing and forwardly of said flame holders; and a truncated cone fuel flow control member concentrically mounted on said centrally disposed nozzle and whose smallest end projects toward the forward end of said casing, the smallest end of said cone arranged forwardly of said centrally disposed nozzle.

11. A ram jet engine comprising a tubular casing having forward and rear open ends; a flame holder assembled in said casing near the forward end thereof and including a circular open frame and a rectangular open frame disposed within said circular frame; a fuel discharge nozzle assembled in each of the corners of said rectangular frame and adapted to discharge fuel into said casing forwardly of said flame holder; a truncated cone fuel flow control member disposed forwardly of said flame holders; and a centrally disposed nozzle arranged in said casing and supporting said cone, the central nozzle arranged adjacent to but rearwardly of the smallest end of said cone.

12. A ram jet engine comprising a tubular casing having forward and rear open ends; a flame holder assembled in said casing near the forward end thereof including a pair of V-sectioned members, one member being in the form of a circular frame and the other being in the form of a rectangular frame that is fitted within said circular frame, the apices of each frame projecting toward the forward end of said member and having apertures therein that permit air to pass therethrough for preventing carbonization of fuel therein; a fuel injection nozzle assembled in each corner of said rectangular frame for injecting fuel into said casing forwardly of said flame holder; means for controlling the flow of fuel through said flame holder which includes a truncated cone whose smallest end projects toward the forward end of said casing; and a centrally disposed nozzle in said casing on which said cone is concentrically supported, the nozzle arranged rearwardly of the smallest end of said cone.

13. A ram jet engine comprising a tubular casing having open rear and forward ends; a V-sectioned flame holder means assembled in said casing near the forward end thereof; and a plurality of fuel discharge nozzles assembled in said flame holder means and arranged for discharging fuel into said casing forwardly of said flame holder and for causing the fuel to burn in close proximity to the interior wall of said casing.

14. A jet engine comprising a casing having a forward end; a plurality of radially spaced open frame flame holders arranged in said casing, said flame holders being hollow and V-shaped in section, the apex of said V projecting toward the forward end of said member; and means for introducing fuel into said casing ahead of said flame holders and for causing the fuel to burn in close proximity to the interior wall of said casing.

15. A jet engine comprising a tubular casing having a forward end; a flame holder assembly complemental in shape to the diametrical cross section of said casing and consisting of a plurality of V members arranged transversely to each other, whose apices point toward the forward end of said casing and having some of the several V members composing the assembly arranged parallel to each other; means mounted in said assembly for introducing fuel into said casing forwardly of said assembly; means for delivering fuel to said last mentioned means, and means disposed ahead of said flame holder assembly for causing the fuel introduced into the casing to burn in close proximity to the interior wall thereof.

16. A jet engine comprising a tubular casing; a flame holder assembly complemental in shape to that of the casing and consisting of a plurality of V members arranged transversely to each other and extending across said casing; means for supporting said flame holder assembly in said casing; means mounted in said flame holder assembly for introducing fuel into said casing ahead of the frame holder assembly; means for delivering fuel to said last mentioned means; and means disposed ahead of said flame holder assembly for causing the fuel introduced into the casing to burn in close proximity to the interior wall thereof.

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References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
1,629,767	Valdés	May 24, 1927
2,385,833	Nahigyan	Oct. 2, 1945
2,482,505	Pierce	Sept. 20, 1949
2,520,388	Earl	Aug. 29, 1950
2,529,506	Lloyd et al.	Nov. 14, 1950