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SEARCH ROOM

Dec. 7, 1965 E. E. FORBES, JR 3,221,497

RAMJET PROPULSION SYSTEM

Filed June 29, 1962

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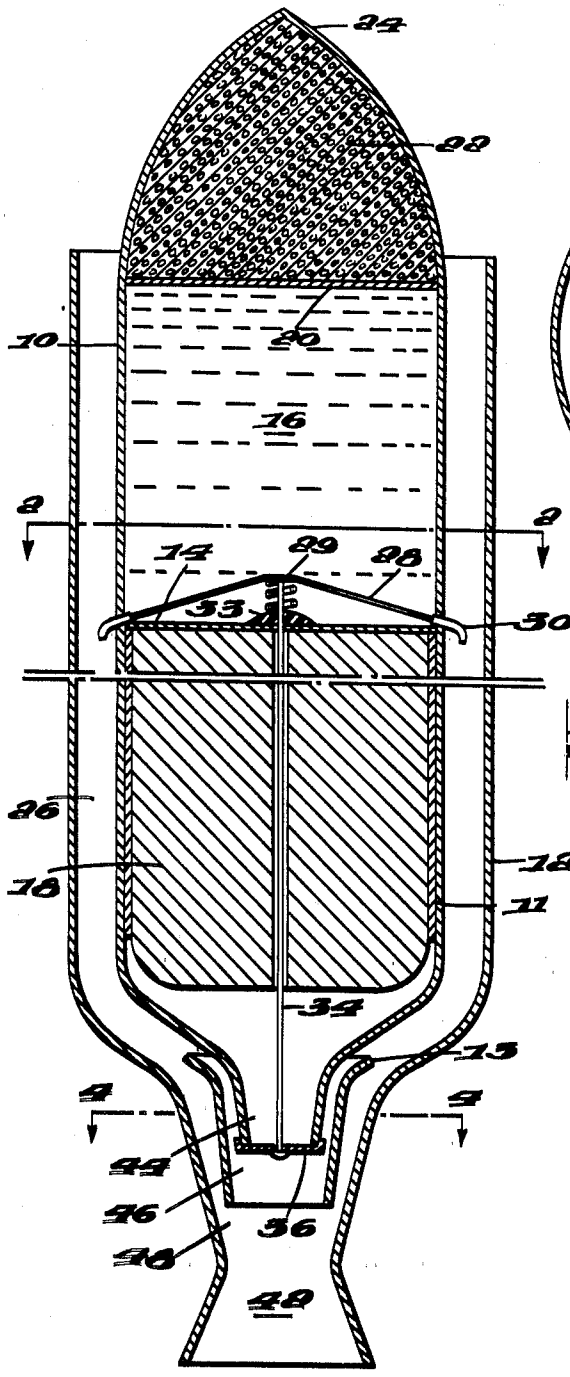


Fig. 1.

Fig. 2.

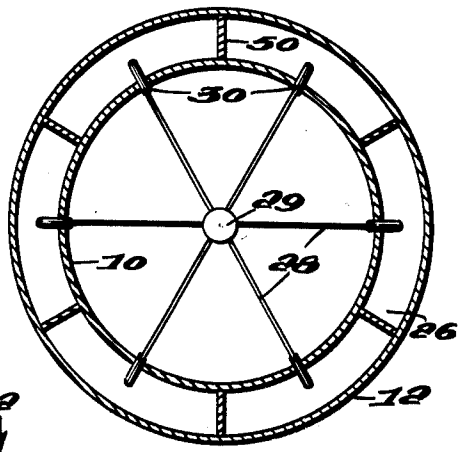


Fig. 3.

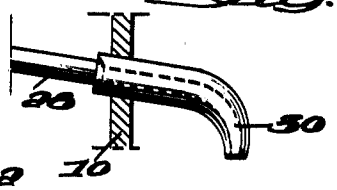
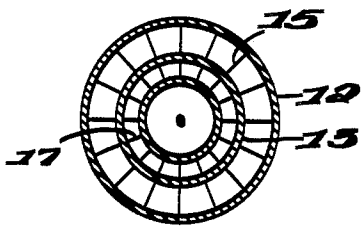


Fig. 4.



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RAMJET PROPULSION SYSTEM

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4 Claims. (Cl. 60—35.6)

This invention relates to a ramjet propulsion system, and more specifically to a ramjet propulsion system in which both a liquid and solid propellant are used. This application is a continuation-in-part of applicant's co-pending application on "Ram Jet Engine," filed April 5, 1961, and assigned Serial No. 100,913 and now abandoned.

Rocket engines and power plants used in missile systems which utilize liquid fuel are required to contain their own supply of oxygen to burn the liquid fuel. This adds tremendously to the weight of such system and reduces the effective payload capacity of the system. Oxygen, as it occurs in its natural state in the air, has not been utilized in these systems because no way has yet been found to compress sufficiently the air for the burning of liquid fuels.

In accordance with one feature of the present invention liquid fuel is mixed with air to utilize the oxygen in the atmosphere and ignited as it comes in contact with the solid fuel combustion products, thus producing a dual burner in the thrust section of the system.

Another feature of the invention is the provision of a propulsion system in which the principle of the injector pump is utilized to mix a liquid fuel with the products of combustion of a solid fuel to provide maximum efficiency.

A further feature of the invention is the provision of a ramjet propulsion system utilizing both liquid and solid propellants in which plural stages are provided for the injection of air-liquid fuel mixture into the products of combustion of the solid fuel.

The device of the present invention utilizes a plural stage burner. A substantially conventional rocket portion is provided with an outer steel tube spaced coaxially therewith to permit air to be drawn from the front of the rocket to the rear. The interior of the rocket contains a section with solid fuel, a section with liquid fuel and a payload section. The solid fuel is burned in position, and the products of combustion are exhausted out the rear portion of the rocket. The outer tube of the structure is constricted to form a venturi portion at the rear of the rocket, and spaced between this venturi portion and the solid fuel section is an additional nozzle portion forming a two stage injector pump. When the solid fuel is ignited, the liquid fuel valves are opened, and the resulting suction of the injector pump causes air to be drawn from the forward end of the rocket. This air, containing oxygen, mixes with the liquid fuel and is ignited when it mixes with the products of combustion of the solid fuel in the area beyond the injector pump at the rear of the device. This arrangement provides for the simultaneous utilization of the solid fuel and the liquid fuel to increase greatly the thrust of the rocket.

The foregoing and other objects, features and advantages of the invention will be apparent from the following more particular description of the preferred embodiment of the invention, as illustrated in the accompanying drawings in which:

FIG. 1 is a longitudinal section of the rocket embodying the principles of this invention;

FIG. 2 is a transverse sectional view taken along the line 2—2 of FIG. 1;

FIG. 3 is a detailed view of a liquid fuel nozzle; and

FIG. 4 is a cross-sectional view of the burner section taken along line 4—4 of FIG. 1.

The rocket shown in FIG. 1 comprises an inner shell 10 and a coaxial outer shell 12 having an air chamber

26 therebetween. The shells are spaced from one another by members 50, as shown in FIG. 2, which may be welded in position. A separating member 14 divides a forward liquid fuel container 16 from an aft solid fuel container 18. The forward end of the liquid fuel container 16 is closed by member 20. Forward of the member 20 is the payload section 22 which projects to the point 24. The section 22 may contain instruments or, in the case of a warhead, an explosive charge. A layer of insulating material 11 is disposed about the interior surface of a portion of the solid fuel container 18. The insulation does not cover the bottom portion of container 18, and the exposed metal of container 18 is instantly heated by the burning of the solid fuel. The heated portion of container 18 serves to preheat the incoming air-liquid fuel mixture in chamber 26 before it reaches the combustion area. When the solid fuel burns, the insulation 11 will eliminate pre-combustion of the air-liquid fuel mixture in the chamber 26 by preventing the temperature from reaching such a point that combustion will occur.

A plurality of liquid fuel nozzles 30 are disposed around the bottom peripheral portion of the liquid fuel container 16. Each nozzle 30 projects into the space 26 between coaxial inner and outer shells 10 and 12. A plurality of valve rods 28 are positioned to close nozzles 30, and be held in closed position by lanyard 34. Lanyard 34 is attached to a mechanical gate 36 disposed over the exhaust port in the solid fuel section 18. A compression spring member 32 keeps the lanyard 34 under tension, and a suitable seal 33 is provided at the points where lanyard 34 passes through separating member 14. Lanyard 34 is coupled to the ends of valve rods 28 by member 29, which forms a flexible connection.

The duel stage injector pump is formed by metallic section 13, which is positioned to form nozzle sections with the lower portion of inner tube 10 and outer tube 12. The section 13 is spaced from the inner tube 10 by metallic fins 17; and section 13 is spaced from the outer tube 12 by metallic fins 15. The fins 15 and 17 may be welded in position or otherwise suitably fastened.

In operation the solid fuel 18 is ignited by a suitable electrical control arrangement (not shown), such as is conventional in the art. The solid fuel, when ignited, builds up a pressure in chamber 18 which causes gate member 36 to be blown off. When gate member 36 is blown off, either lanyard 34 is broken, or else the connection of lanyard 34 to gate member 36 is severed, thereby allowing spring 32 to be released upwardly. When spring member 32 moves upwardly, the valve rods 28 are removed from their seated positions in nozzles 30, thereby opening nozzles 30 and allowing the liquid fuel in compartments 16 to be drawn into space 26. In space 26 the liquid fuel is vaporized by the air in space 26 and directed to the rear exhaust area 42.

The hot gases of combustion from the solid fuel chamber 18 pass rearwardly out of nozzle 44. The solid fuel exhaust from nozzle 44 draws in the preheated air-liquid fuel mixture from chamber 26 through nozzle 46. The mixture is ignited upon contact with the hot exhaust gases, thereby increasing the rearward thrust. A second charge of preheated air-liquid fuel mixture is drawn into the exhaust through nozzle 48 and ignited to produce another increase in thrust. Additional nozzle stages could be added, as space permits, to increase the thrust to any desired amount.

From the foregoing description it will be appreciated that the rocket of the present invention is capable of a greatly increased thrust in comparison with conventional rockets. The arrangement, which employs the principle of the injector pump, provides for the simultaneous ignition of the two fuels to obtain maximum thrust per pound

of fuel. The rocket of the present invention is simple in construction, inexpensive and highly reliable. In addition to obtaining increased thrust by the employment of the fuel injection pump principle, added thrust is obtained by taking the air at the front of the rocket to a position to be mixed with the liquid fuel and thus reducing the pressure at the front of the rocket by creating a partial vacuum.

It will be understood that the foregoing disclosure relates to a preferred embodiment of the invention and that numerous modifications and alterations may be made therein without departing from the spirit and scope of the invention as set forth in the claims.

What is claimed is:

1. A ramjet engine utilizing solid and liquid propellants comprising an inner shell adapted to contain a propellant and having an exhaust nozzle in one end for the exhaust of said propellant, an outer shell concentric with said inner shell and having a chamber therebetween open at the front and rear portions of said outer shell, said rear portion of said outer shell including an exhaust area, a liquid propellant within said inner shell, a solid propellant within said inner shell, means separating said liquid and solid propellants, fuel nozzle means for said liquid propellant communicating with said chamber, valve means normally closing said fuel nozzle means, a closure member positioned over the exhaust nozzle of said inner shell, means connecting said closure member and said valve means to hold said valve means in position to close said fuel nozzle means, whereby the exhaust gases from the solid propellant will blow off the closure member and release the valve means to open the fuel nozzle means and permit the liquid propellant to pass into said chamber where it will be vaporized and directed to the rear exhaust area to increase the thrust.

2. The combination according to claim **1** including an additional nozzle structure located in said exhaust area whereby the vaporized liquid propellant is introduced into the exhaust gases from said solid propellant in two separate stages to produce additional increases in thrust.

3. The combination according to claim **2** wherein said inner shell is provided with a liner of insulation to prevent pre-combustion of the liquid propellant while permitting a desired amount of pre-heating.

4. The combination according to claim **3** wherein said means connecting said closure member and said valve means comprises a lanyard held in tension by a compressed spring member, said spring member serving to remove said valve means from said fuel nozzles when the lanyard connection is broken.

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