60-251

SEARCH ROOM

Dec. 6, 1966 B. L. IWANCIOW 3,289,412

HYBRID INJECTOR

Filed March 29, 1965

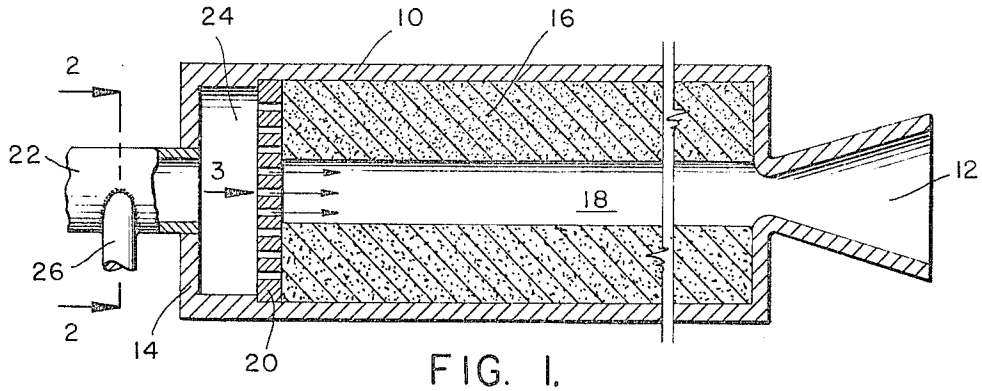


FIG. 1.

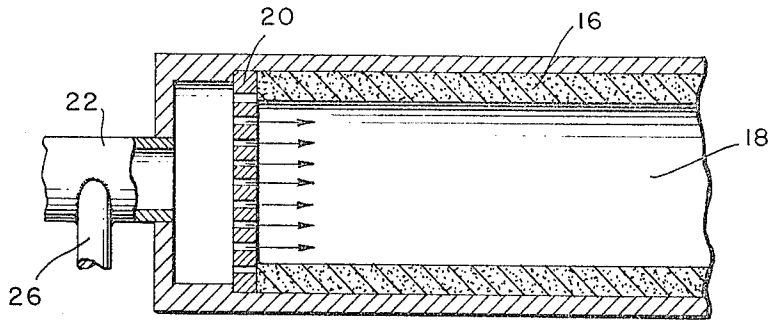


FIG. 1A.

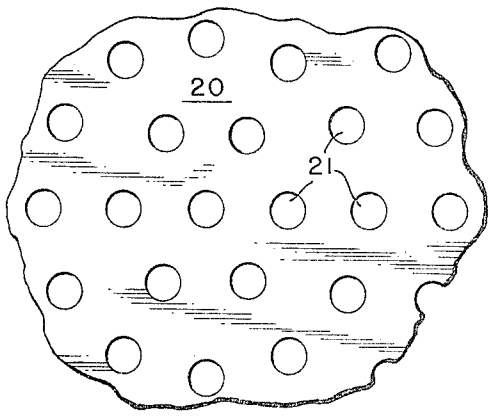


FIG. 3.

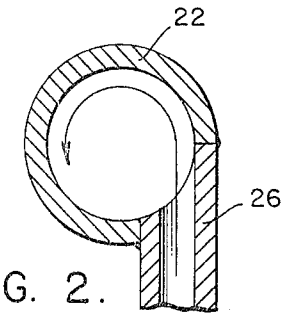


FIG. 2.

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3,289,412

Patented Dec. 6, 1966

3,289,412

HYBRID INJECTOR

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Filed Mar. 29, 1965, Ser. No. 443,724
3 Claims. (Cl. 60—251)

This invention relates to gas producing motors of the hybrid type which combust a solid and liquid propellant, and more particularly to improvements in method and apparatus for injecting the liquid propellant.

It has been conventional practice to inject a liquid propellant, such as the oxidant, into the central aperture or port of a solid internal burning grain, such as the fuel, by spray nozzles located at the front end of the motor which spray the liquid into the port in a predetermined spray pattern, as determined by the spray nozzle configuration. As the inner surface of the solid grain burns, increasing the diameter of the port, the spray pattern, if optimum at the begining of burning, for example, may no longer be optimum at a later stage of burning. This has resulted in localized burning of the grain, rather than the desired uniform burning which would consume the final annular portion of the grain at substantially the same time. As will be apparent, this erratic and non-uniform burning renders predicted performance difficult, and in some instances may cause rupture of the motor tube, due to premature exposure to the hot gasses, before the solid grain is entirely consumed.

The application of Donald K. Matthews for Hybrid Injector, filed concurrently herewith, and otherwise identified as Navy case 37,930, discloses apparatus for obviating the disadvantage of the prior art referred to. The present invention relates more particularly to improvements which may be utilized in the various modifications disclosed in the Matthews application.

One of the objects of the invention is to mix an inert fluid with the liquid propellant to prevent undesired local reactions between the liquid propellant and the solid grain.

Another object is to impart a rotary or spiral motion to the liquid propellant, by the inert fluid, in a manifold just prior to delivery into the central port of the solid grain.

Still further objects, advantages and salient features will become more apparent from the description to follow, the appended claims, and the accompanying drawing, in which:

FIG. 1 is a longitudinal central section through a gas producing motor, employing the subject of the invention, at the beginning of the combustion process;

FIG. 1A is a like section near the end of the combustion process;

FIG. 2 is an enlarged section taken on line 2—2, FIG. 1; and

FIG. 3 is an enlarged end elevation as viewed in the direction of arrow 3, FIG. 1.

Referring now to the drawing, motor tube **10** is of any conventional construction, having a nozzle **12** at its rear end and a closure **14** at its front end and containing a solid propellant grain **16**, having an axial perforation or port **18**. The grain may be suitably inhibited from burning (not shown) at its outer surface, as well known in the art, and is commonly referred to as an internal burning grain.

Exemplary injection apparatus comprises a circular disk **20**, having apertures **21** extending between its opposite

faces, which is disposed adjacent the front annular face of the grain and sealed to the same so liquid may pass only through the apertures which are not covered by the grain, that is, the apertures surrounded by the periphery of port **18**. In FIG. 1, illustrating commencement of combustion, liquid may flow through a relatively small portion of the apertures and in FIG. 1A, illustrating a later stage of combustion, the liquid may flow through a considerably larger portion of the apertures. At any stage of combustion, the liquid flows axially of the grain and with an outlet area equal to the area of the apertures which are not blocked by the forward annular end of the grain.

The liquid propellant is supplied through a pipe **22** communicating with a chamber or manifold **24** adjacent the forward face of the disk. The inert fluid which may be a gas or liquid, is injected through pipe **26**, in a tangential direction, as illustrated in FIG. 2, which produces a rotary motion to the liquid propellant and inert fluid, which motion continues within manifold **24**, from which the two liquids are thence delivered in parallel axial directions into the grain port.

The inert fluid serves a dual purpose. Firstly, it fills those ports **21** which are blocked by the yet unburnt propellant grain, preventing premature and undesired local reactions, and secondly, it maintains the liquid propellant in swirling motion, thereby aiding in the distribution of the liquid propellant to the apertures after they have been uncovered by the propellant grain.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. In a hybrid bi-propellant rocket motor of the type wherein one of the propellants is a solid cylindrical grain having a central port extending between opposite ends thereof and the other propellant is a liquid adapted to be injected axially of the port, the improvements, in combination, comprising:

(a) a nozzle disk of foraminous material abutting the annular end surface at the front end of the grain having spaced apertures extending therethrough communicating with said port at the commencement of combustion and other like apertures blocked from communication by the annular end surface of the grain, said other apertures adapted to communicate with the port as it enlarges in diameter when the annular end surface reduces in area,

(b) a manifold disposed forwardly of said nozzle plate communicating with all of said apertures,

(c) means for delivering the liquid propellant to said manifold, and

(d) means for delivering an inert fluid to the manifold in such direction to produce a rotary motion to the liquid propellant and inert fluid within the manifold, said inert fluid adapted to fill apertures blocked by the unburnt grain to thereby obviate premature local reaction between the liquid propellant and the grain.

2. Apparatus in accordance with claim **1** wherein said inert fluid is a gas.

3. Apparatus in accordance with claim **1** wherein said inert fluid is a liquid.

No references cited.

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