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NOTICE

(6) All-Aluminum Transverse Platelet
Injector.

The Government-owned invention described herein is
available for licensing. Inquiries and requests for
licensing information should be addressed to:

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ALL-ALUMINUM TRANSVERSE PLATELET INJECTOR

ABSTRACT OF THE DISCLOSURE

Multielement injectors for bipropellant rocket engines fabricated from photoetched aluminum platelets which are diffusion bonded to each other with the bonded faceplate assembly electron beam welded to a machined aluminum injector body. The surface contaminants as well as the inherent aluminum oxide are first removed from the platelets. The platelets are then stacked and subjected to 300 psia load at a temperature of 1070 - 1080°F. The pressure and temperature are maintained for three hours using a vacuum furnace evacuated to 10^{-4} TORR or better. The finished bonded faceplate is then joined to the injector body using electron beam welding.

STATEMENT OF GOVERNMENT INTEREST

The invention described herein may be manufactured and used by or for the Government for governmental purposes without the payment of any royalty thereon.

BACKGROUND OF THE INVENTION

This invention relates to a bimetallic lightweight platelet injector and, more particularly, the invention is concerned

with providing a transverse platelet injector for use in a liquid rocket engine wherein both the injector body and the transverse platelet faceplate are fabricated of aluminum alloy. The platelet faceplate is attached to the body by electron beam welding.

Heretofore, it has been conventional to utilize the transverse platelet injector concept which has proven to provide cost and schedule advantages in the production of injectors for liquid rocket engines. The platelet injector allows pattern and element design flexibility and manifold volume control techniques which are not achievable with drilled orifice injector designs. The platelet injector generally incorporates several thin sheetmetal platelets which are chemically etched to provide discrete hydraulic flow passages and then bonded together. The resulting monolithic, porous structure may incorporate flow circuits and orifices of greater complexity than can be produced by drilling and other processes. The use of the photoetching process to fabricate the individual platelets decouples cost and fabrication time from orifice plate complexity because the etching process is unaffected by either the quantity or shape of the passages etched in each plate.

Up until now, substantially all injectors have been made of stainless steel. The smaller units use platelets

to construct both the orifice patterns and propellant manifolds. The larger units utilize machined bodies with platelet faceplates. The use of stainless steel for their construction was due to consideration of life and reuse as well as the availability of bonding processes developed for stainless steel.

Evaluation of the applicability of the transverse platelet concept to increasingly large engines and/or to weight limited systems discloses that the use of steel results in substantial weight and cost penalties. This is due to the injector body thickness being dictated by manifold volume requirements rather than operating stresses. Hence, there is very little weight advantage gained from the use of higher strength materials. Stainless steel is machined more slowly than aluminum and body manufacturing costs are higher. Injector weight and cost improvement is best achieved by the use of aluminum in place of stainless steel.

It is evident that the achievement of a low weight transverse platelet injector could be accomplished in either of two ways. One is to retain the stainless steel transverse platelet faceplate, which can be joined to a manifold made from a low density material. This would avoid departure from the developed etching and bonding processes although a platelet to body joining process or bimetallic

interface would have to be found and proven. The other is to simply convert the stainless steel platelet injector design to a low weight material, i.e., aluminum. This would require conversion of the etching and bonding processes to the low density material.

The hereinafter described lightweight platelet injector includes an aluminum transverse platelet faceplate joined to an aluminum body by electron beam welding using mechanical fixturing to hold the bonded platelet stack to the body.

SUMMARY OF THE INVENTION

The present invention is concerned with providing a multielement injector for a bipropellant rocket engine wherein the injector faceplate is fabricated from photo-etched aluminum platelets which are diffusion bonded to each other with the bonded faceplate assembly electron beam welded to the aluminum injector body. The surface contaminants including the inherent aluminum oxide are first removed from the platelets which are then stacked and subjected to 300 psia load at a temperature of 1070 to 1080°F. The pressure and temperature are maintained for three hours using a vacuum furnace evacuated to 10^{-4} OTRR or better. The finished bonded faceplate is then joined to the injector body using electron beam welding.

Accordingly, it is an object of the invention to provide an all aluminum transverse platelet injector suitable for

use in a bipropellant rocket engine wherein both the faceplate and the injector body are made entirely of aluminum alloy. The use of aluminum reduces the cost and weight of the finished injector unit to a minimum.

5 Another object of the invention is to provide an all aluminum transverse platelet injector wherein the faceplate includes a plurality of photoetched aluminum platelets diffusion bonded to each other by being stacked and subjected to 300 psia load at a temperature of 1070 - 1080°F for
10 three hours in a vacuum furnace evacuated to 10^{-4} TORR or better.

 Still another object of the invention is to provide an all aluminum transverse platelet injector wherein the finished bonded faceplate is joined to the aluminum injector
15 body by means of electron beam welding.

 A further object of the invention is to provide an all aluminum transverse platelet injector which satisfactorily replaces the previously developed steel injector with a reduction of nearly 60 percent in weight while producing
20 identical results in performance.

 These and other objects, features and advantages will become more apparent after considering the following detailed description taken in conjunction with the annexed drawing and appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a view in ~~cross~~ section of an all aluminum transverse platelet injector according to the invention showing the manifold body machined from aluminum with the aluminum faceplate attached thereto; and

Figure 2 is an enlarged view in cross section of a portion of the transverse platelet injector of Figure 1 showing the photoetched aluminum faceplate electron beam welded to the all aluminum injector body.

DESCRIPTION OF A PREFERRED EMBODIMENT

Referring now to the drawings, Figure 1 shows an all aluminum transverse platelet injector according to the invention. Preferably, the injector 13 includes a body 15 which is fabricated of either 3003 aluminum alloy or 5086 aluminum alloy. The faceplate 17 is made up of a plurality of 3003 aluminum photoetched platelets which are diffusion bonded to each other with the bonded faceplate assembly 17 then being electron beam welded at each land 19 to the machined aluminum body 15 with the electron beam welds 21. This allows the fabrication of an all aluminum transverse platelet injector capable of replacing the previously developed all stainless steel configuration to achieve a weight reduction of nearly 60 percent.

The bonding of the aluminum platelets 17 requires removal of surface contaminants as well as the inherent

aluminum oxide coating. It was determined that a 50 microohm surface resistance defined aluminum cleanliness sufficient for satisfactory bonding of 3003 aluminum alloy. There was no appreciable increase in surface resistance following 12 hours exposure of the cleaned parts to ambient conditions.

The bonding process for assembling the photoetched aluminum platelets requires that the stacked platelets be subjected to 300 psia load while at a temperature of 1070 - 1080°F. Pressure and temperature are maintained for three hours in a vacuum furnace evacuated to 10^{-4} TORR or better to accomplish satisfactory bonding of 3003 aluminum alloy platelets. Proper cleaning of the parts to be bonded and prevention of contamination during the furnace cycle are important considerations for obtaining satisfactory bonding.

The finished bonded faceplate 17 is then joined to the machined injector body 15 using the electron beam welds 21. Pressure tight welded interfaces were obtained using mechanical constraint to hold the faceplate 17 to the body 15. The single electron beam weld 23 used to attach the faceplate 17 to each land 19 of the injector body 15 provides a leak-tight intermanifold metallurgical joint.

From the foregoing description it can be seen that the weight of the transverse platelet injector shown is reduced

to a minimum by fabricating the faceplate 17 and the injector body 15 of aluminum alloy. The weight of the all aluminum transverse platelet injector 13 is about 40 percent of that of an equivalent all steel unit. This weight advantage increases with larger, higher thrust engine application. The process of photoetching aluminum platelets 17 can utilize the etching parameters developed for fluidic devices made from stainless steel. The effective joining of the aluminum platelets is dependent upon the aluminum cleaning (oxide removal) processes, furnace temperature and time, loading, furnace atmosphere and platelet material and configuration.

Although the invention has been illustrated in the accompanying drawings and described in the foregoing specification in terms of a preferred embodiment thereof, the invention is not limited to this embodiment or to the preferred configuration shown. It will be apparent to those skilled in the art that my invention could have extensive use in other operations where it is necessary to provide platelet injectors for rocket engines which have substantial weight and cost advantages over those presently in use. Although lighter and less costly, the all aluminum platelet injectors performed consistently and equally for more than 500 complete thermal cycles with no indication of deterioration or damage.

Having thus set forth the nature of my invention, what
I claim and desire to secure by Letters Patent of the
United States is:

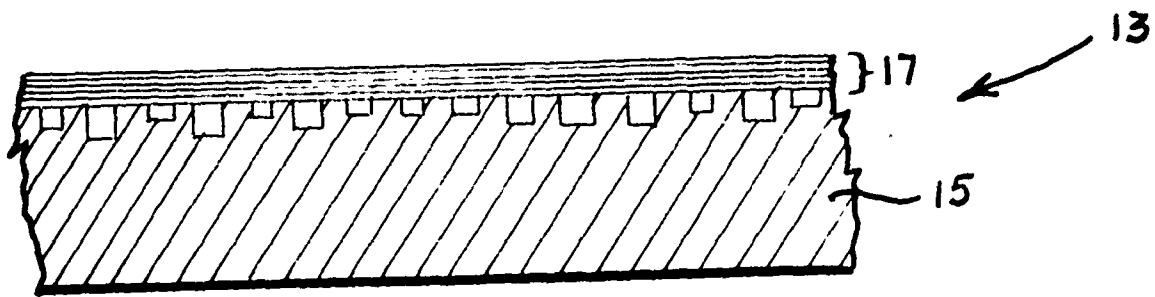


FIG. 1

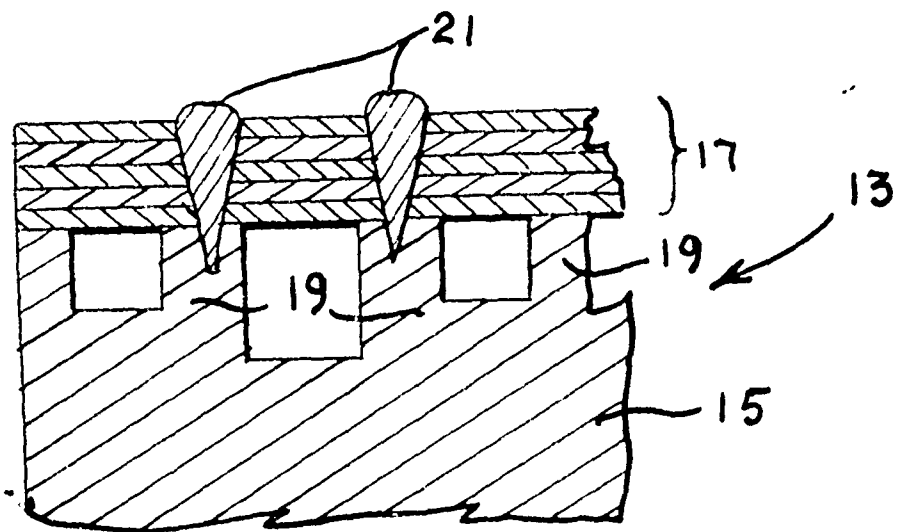


FIG. 2