

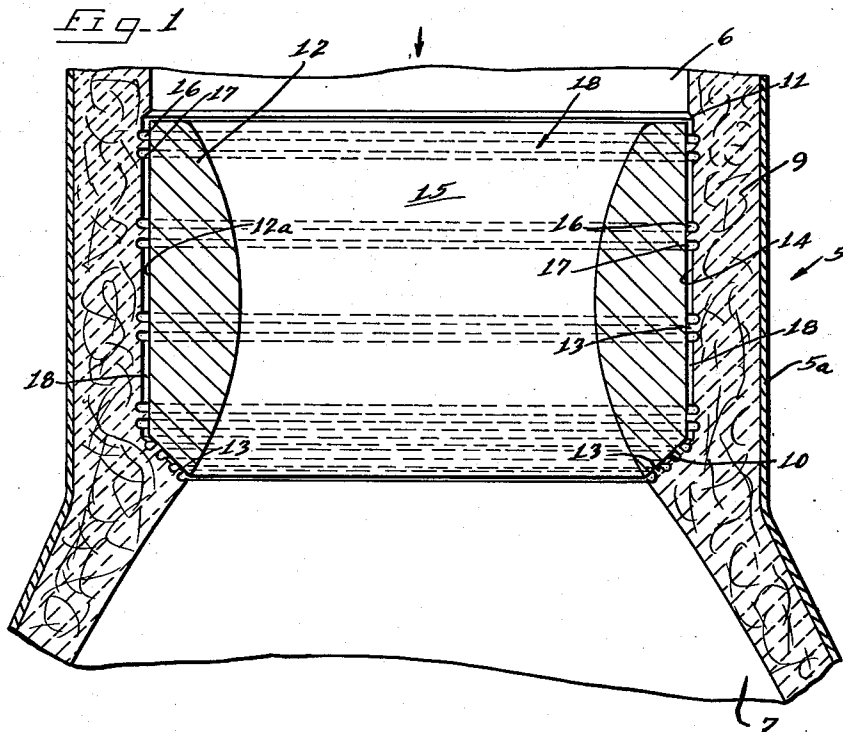
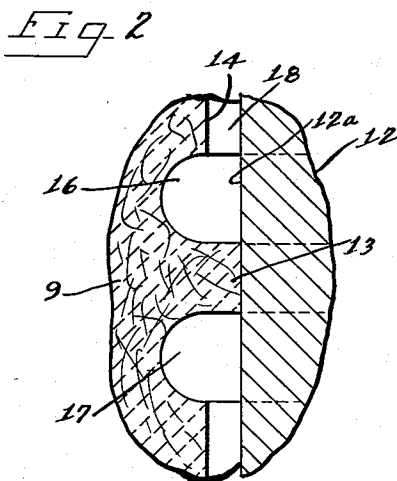
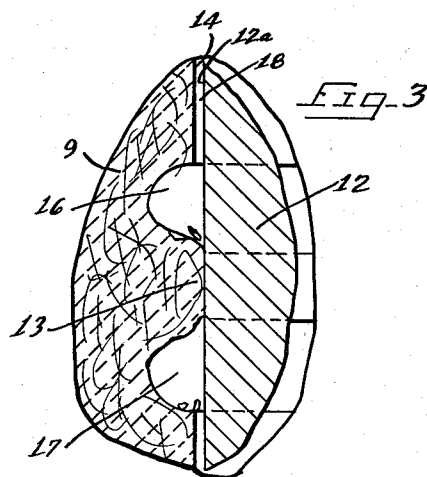
May 19, 1964

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3,133,411

ROCKET NOZZLE WITH EXPANDIBLE JOINTS

Filed Feb. 23, 1961



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3,133,411

ROCKET NOZZLE WITH EXPANDIBLE JOINTS
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Filed Feb. 23, 1961, Ser. No. 91,273
8 Claims. (Cl. 60—35.6)

This invention relates to air and space borne vehicles and is more particularly concerned with improved methods and means permitting thermal expansion of two or more materials, one of which provides support for the other.

Heretofore, difficulty has been encountered in the design of liners for reaction motor nozzles and reaction chambers, heat protective sleeves, and gas discharge nozzle inserts, such as throat inserts, particularly in the method in which the insert or liner was supported in the associated structure. High temperature bonding materials must be employed for such applications. However, utilization of such bonding materials in addition to support arms and spiders required the selection of materials on the basis of the similarity of thermal expansion ratios, since the supported structure and supporting structure were subjected to high temperatures in the reaction motor, nozzle, and other high temperature apparatus. Thus, the materials of construction which could be employed to support inserts, liners and sleeves were limited by the thermal expansion coefficients of the supported and supporting structures.

In addition, the stresses imposed by such thermal expansion on the supported and supporting members had to be taken into consideration in their design as well as the degree of heat conducted through such members. Another problem associated with high temperature applications involve the possibility of leakage of the high temperature medium between the supported and supporting structures.

By employment of the present invention, I substantially eliminate the problems and difficulties of the prior art and afford a means of minimizing stresses induced by the differential in thermal expansion or deflection under load of two or more materials while maintaining the desired amount of support therebetween.

It is therefore an object of the present invention to provide improved means for supporting members subjected to high temperatures.

It is another object of the present invention to provide improved means for supporting members constructed of different material and which are subjected to high temperatures.

It is still another object of the present invention to provide improved means including spaced shoulders for supporting a member subjected to high temperatures.

A further object of the present invention is to provide an improved shoulder arrangement for supporting refractory inserts for reaction motors and the like of air and space borne vehicles.

Yet another object of the present invention is to provide improved means for supporting members subjected to high temperature flow of fluids.

These and other objects, features and advantages of the present invention will become more apparent from a careful consideration of the following detailed description, when considered in conjunction with the accompanying drawing, illustrating preferred embodiments of the present invention, and wherein like reference numerals and characters refer to like and corresponding parts throughout the several views.

On the drawings:

FIGURE 1 is a fragmentary view in longitudinal sec-

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tion of a reaction motor nozzle having a throat insert supported in accordance with the present invention.

FIGURE 2 is an enlarged, fragmentary view in section illustrating the preferred support structure taken along lines II—II of FIGURE 1.

FIGURE 3 is a fragmentary enlarged view in section illustrating the effect of thermal expansion of the supported member on the supporting member.

As shown on the drawings:

Briefly stated, the present invention involves a relatively rigid support member having support projections extending therefrom which contact the supported member and which are constructed from a material having a low modulus of elasticity to thereby permit crushing thereof in response to thermal expansion of the supported member. The supporting member or body is grooved on each side of the projection to permit flow of the crushed projection therein and thereby preventing substantial translation of the supported member during thermal expansion thereof thereby minimizing the possibility of changes in the direction of flow in the high temperature fluid flowing through the supported member. Such directional changes, become quite pronounced, particularly at high flow velocities, and, the effects of such changes, on the orientation of an air or space borne vehicle where the support member is employed in the reaction chamber or gas discharge nozzle of the vehicle, are readily apparent.

Although the present invention has a variety of applications, the specific embodiment appearing in FIGURE 1 illustrates utilization of the invention in connection with the gas discharge nozzle assembly, generally indicated by the numeral 5, of an air or space borne vehicle.

The nozzle assembly 5 includes a gas entrance portion 6 communicating with the reaction chamber of the vehicle with which the nozzle is associated (not shown), an opposed gas exit portion 7 separated by a throat section, generally indicated by the numeral 8.

The wall 5a of the nozzle assembly 5 adjacent the throat section 8 is provided with a supporting liner 9 of insulating material having tapered seat 10 at one end and is generally recessed as at 11 to receive a throat insert 12 constructed of refractory material, such as graphite. The insert 12, it will be appreciated, has a modulus of elasticity or thermal expansion coefficient greater than the insulating wall 9 of the nozzle assembly 5. The wall 5a may be constructed of a suitable material, such as 321 stainless steel; however, it will be appreciated, that depending upon the temperature of the exhaust gases flowing through the nozzle assembly in the direction indicated by the arrow, will be constructed of material and of a wall thickness sufficient to withstand the temperatures involved and conducted thereto from the insulating member 9.

Thus, the throat insert, or supported member 12, and the supporting member, the wall 9, are constructed of different materials having different thermal coefficients of expansion. It will also be appreciated that the deflection coefficients of the wall and insert may also be different.

In accordance with the present invention, the supporting wall 9 is provided with a plurality of annular projections 13 which extend beyond the surface 14 of the support wall 9. The distance from the wall 14 which the projections 13 extend is dictated by the size of the insert 12. The projections 13 are constructed of a material which will deflect under load, which will char, and will be crushed and sacrifice themselves to permit the heated support member or wall 9 and supported member, insert 12, to expand without physical rupture or damage to either

the support or supported member. Thus, as the projections 13 are deflected or crushed, the elastic support provided by the projection minimizes the stresses imposed by the translation load of the insert 12 and by employing a number of projections 13, the deflection or translation will not effect high velocity flow through the nozzle throat chamber 15.

On each side of the projections 13, the wall 9 is provided with an annular groove 16 and 17 to receive the crushed projection and particles thereof. The spacing 18 between the wall surface 14 and wall surface 12a of the insert 12 permits thermal expansion of both the insert and wall 9 in the directions indicated by the arrows in FIGURE 3.

The projections 13, it will be observed, also provides positive sealing means against leakage of exhaust gases through space 18. The space 18 also provides a thermal barrier minimizing heat conduction into the supporting wall 9. The tapered seat 10 of the wall 9 is also provided with the projections 13 and grooves 16 and 17.

Thus, the projection or shoulder 13 is readily adaptable for supporting members subjected to high temperature conduction and thermal expansion in addition to deflection of the supported member under applied loads.

Although minor modifications of the present invention will be readily apparent to those versed in the art, it will be appreciated that I wish to embody within the scope of the patent warranted hereon all such embodiments as reasonably and properly come within the scope of my contribution to the art.

I claim as my invention:

1. A supporting member adapted to permit the thermal expansion of a supported member relative thereto when said supported member is subjected to high temperatures comprising:

- (a) a body portion,
- (b) a low modulus of elasticity projection on said body sized for supporting engagement with a supported member permanently deformed by, and to permit, said thermal expansion of the supported member relative to said supporting member, and
- (c) a recess formed in said supporting member adjacent said projection to receive the portions of said projection permanently deformed by stresses produced by said thermal expansion.

2. An insulating supporting member adapted to permit the thermal expansion of a refractory supported member relative thereto when said refractory supported member is subjected to high temperatures comprising:

- (a) an insulating body portion,
- (b) a low modulus of elasticity rib-like projection on and integral with said body sized for supporting engagement with a refractory supported member and permanently deformed by, and to permit, said thermal expansion of the supported member relative to said supporting member, and
- (c) at least one groove formed in the supporting member adjacent and along side of said rib-like projection to receive the portions of said rib-like projection permanently deformed by the stresses produced by said thermal expansion.

3. An outer annular and strength-supplying supporting member adapted to permit the thermal expansion of a refractory supported member relative thereto when said refractory supported member is subjected to high temperatures comprising:

- (a) a body portion,
- (b) a plurality of spaced apart, low modulus of elasticity and crushable projections on said body portion sized for supporting engagement with a refractory supported member and crushed by, and to permit, said thermal expansion of the supported member relative to said supporting member, and
- (c) a plurality of recesses formed in the body of said supporting member with at least one adjacent each

said projection to receive said crushed portions of said projection.

4. An insulating and strength-supplying annular outer member adapted to support an annular throat insert of a gas discharge nozzle assembly of a reaction motor comprising:

- (a) an annular, insulating and strength-supplying sleeve sized to receive and locate,
- (b) a throat insert of refractory material thermally expanded by firing of said motor,
- (c) at least one low modulus of elasticity and crushable annular projection extending from said sleeve for supportingly engaging and locating contact with said throat insert and permanently deformed by the thermal expansion thereof, and
- (d) at least one annular groove formed in said sleeve adjacent said annular projection to receive the permanently deformed portions of said annular projection caused by stresses due to said thermal expansion.

5. An insulating and strength-supplying annular liner adapted to support and locate an inner annular member subjected to high temperatures and to permit thermal expansion of said inner member relative to said liner comprising:

- (a) a body portion of insulating and strength-supplying material having a low modulus of elasticity relative to said inner member,
- (b) a plurality of integral, spaced apart, rib-like and crushable projections on said body portion for supportingly engaging the inner member and crushed and spread by the thermal expansion of said inner member relative thereto when said inner member is subjected to high temperatures, and
- (c) an annular groove formed in said liner adjacent each side of each said rib-like projection to receive the portions of each said projection spread by said crushing.

6. In the gas discharge nozzle assembly of a reaction motor, a high temperature insulating and strength-supplying assembly comprising:

- (a) an inner refractory nozzle member subjected to high temperatures and expanded thereby,
- (b) an outer sleeve-like strength-supplying and insulating member expanded less by said high temperatures than said nozzle member,
- (c) projections on said supporting member supportingly engaging and locating said nozzle member, at least said projection portions of said supporting member having a materially lower modulus of elasticity than said nozzle member to be crushed and spread by the thermal expansion of said nozzle member, and
- (d) spaces between said projections to receive said spread portions and insulatingly minimizing heat conduction from said nozzle member to said insulating and supporting member.

7. The combination of claim 6 wherein said supporting member has an axial end portion tapered inwardly with certain of said projections thereon and the corresponding axial end portion of said refractory nozzle member is correspondingly tapered and wherein said projections are rib-like rings around the inner surface of said supporting member and said spaces therebetween are ring-like grooves.

8. The method of permitting the differential thermal expansion of a high temperature insulating supporting and locating assembly including an outer supporting insulating locating member and an inner supported member subjected to high temperatures expanded thereby more than said supporting member comprising:

- (a) supportingly engaging the inner supported member and locating it relative to the supporting member by low modulus of elasticity, crushable projections extending from the surface of the supporting member,

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- (b) subjecting the inner supported member to high temperatures to heat and expand it more than the thermal expansion of the supporting member, and
(c) thereby permanently deforming and spreading the crushable projections into recesses formed in the surface of the supporting member adjacent said projections.

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