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VECTORIZING NOZZLE HEAT DAM

Filed Nov. 30, 1960

2 Sheets-Sheet 1

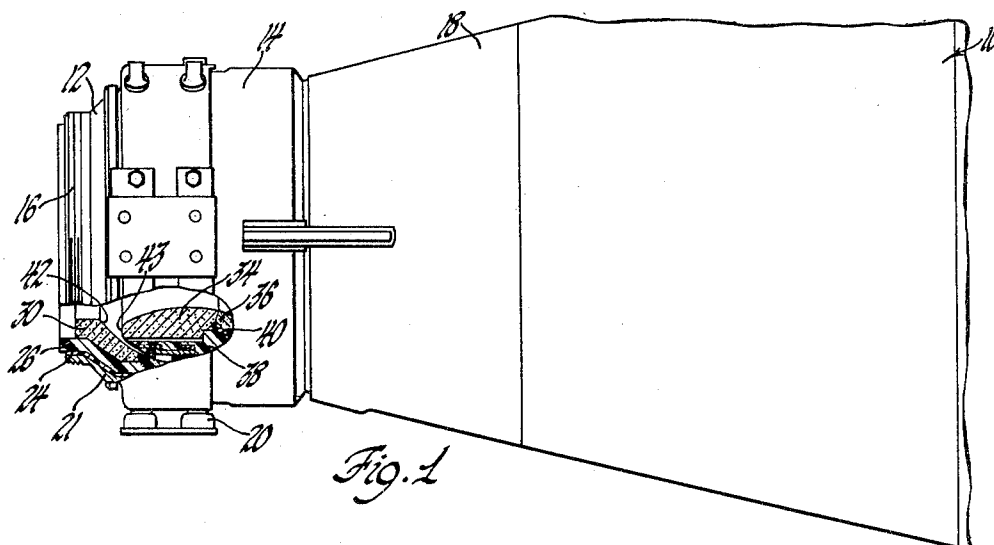


Fig. 1

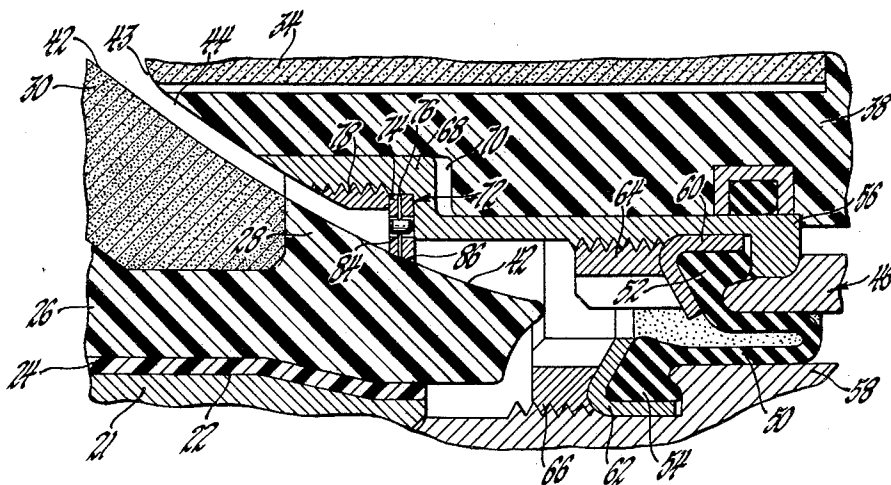


Fig. 2

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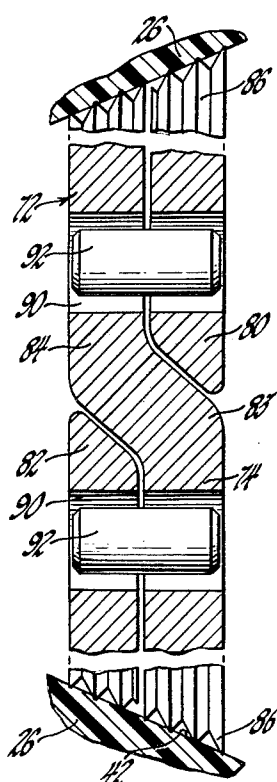


Fig. 3

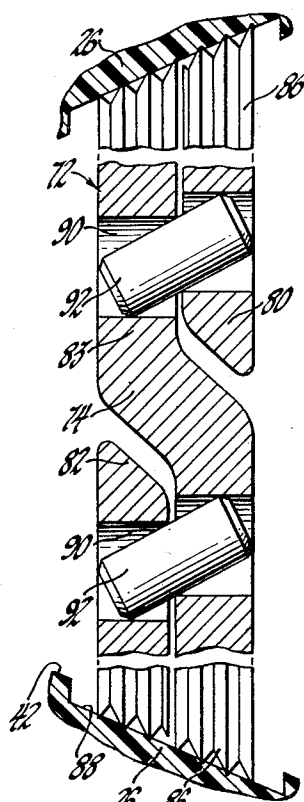


Fig. 4

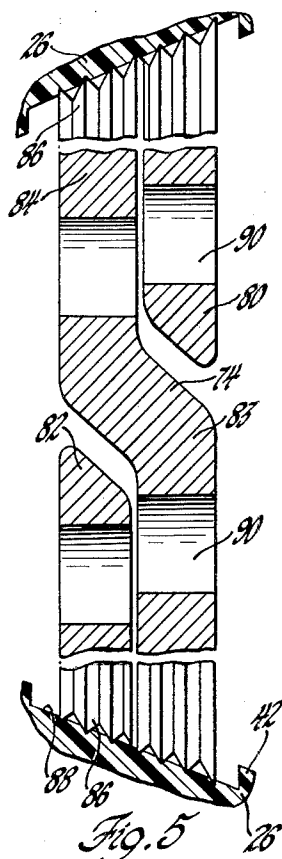


Fig. 5

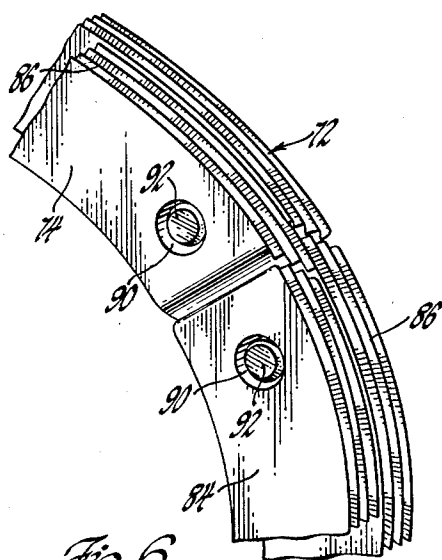


Fig. 6

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VECTORIZING NOZZLE HEAT DAM

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6 Claims. (Cl. 60—35.55)

This invention relates to a heat dam and gas seal. More particularly, it relates to means to prevent a burn-out of a vectoring nozzle gas seal.

In vectoring or swivel type nozzles, the running clearance between the stationary and vectoring nozzle portions provides a passage through which gas can escape from the nozzle. This not only causes a loss in efficiency and thrust, but also immediately subjects the gimbal or trunnion mounts and other parts to the intense heat of the exhaust gases resulting in an eventual burn-out of these parts and failure of the nozzle to vector properly. A gas seal is therefore generally provided in this area to positively prevent this leak of gas. However, known seal materials can withstand such intense heat for only a short period, and it therefore becomes necessary to provide a heat dam upstream from the seal to insulate the seal from the exhaust gas heat for as long as possible. It is a heat dam and gas seal with which the present invention is concerned.

Therefore, it is an object of this invention to provide a heat dam and fluid seal for a vectoring type exhaust nozzle to insulate the nozzle seal against the exhaust gas heat.

It is a further object of the invention to provide a heat dam and fluid seal for a vectoring type nozzle consisting of a spiral ring circumferentially compressed between nozzle portions so as to be loaded into sealing contact with the portions.

It is a still further object of the invention to provide a nozzle heat dam and gas seal of the ring type described above, wherein further fusible means limits the full expansion of the ring until the passage of exhaust gases through the nozzle.

Other objects, features and advantages will become apparent upon reference to the succeeding detailed description of the invention and to the drawings illustrating the preferred embodiment thereof; wherein,

FIGURE 1 is a side elevational view with parts broken away and in section of a vectoring nozzle embodying the invention;

FIGURE 2 is an enlarged view of details of FIG. 1;

FIGURES 3, 4 and 5 are enlarged views of a detail of FIG. 2 in different operative positions; and,

FIGURE 6 is a perspective view of the detail of FIGS. 3 to 5.

In general, the invention is concerned with providing a vectoring type nozzle with heat dam and gas seal means to insulate the main nozzle gas seal from the extreme heat of the exhaust gases for the length of time vectoring is required. This means consists of a spiral ring compressed between nozzle portions in the clearance passage between so as to be expanded into sealing contact with the portions and thereby block the passage of gas and heat through the passage. The ring carries a number of fusible alloy pins to limit its expansion beyond a predetermined amount during cold vectoring of the nozzle, the pins being melted by the heat of the exhaust gases after engine fire-up to permit the continued expansion of the ring into sealing contact.

FIGURE 1 shows a vectoring or swivel nozzle 10 having a stationary portion 12 and a vectoring portion 14. The stationary portion is adapted in this case to be se-

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cured to the converging conical end of a rocket case (not shown) by the screw threads 16 to form a rocket motor. It will be clear, however, that the nozzle would have use in many installations other than a rocket. The vectoring nozzle portion 14 is formed with a diverging conical exit portion 18 and is pivotally connected to the stationary portion by a gimbal ring type mount indicated generally at 20. The gimbal mount permits a full 360° positioning of the vectoring portion. The vectoring and stationary portions together define a convergent-divergent gas passage through the nozzle with a throat section between.

FIG. 2 shows the details of the throat section more clearly. The stationary nozzle portion 12 has an annular case 21, the inner surface 22 of which is sprayed with a thin coat of heat resistant insulation 24, such as Haveg or Durez. To this is cemented a thicker coat of similar insulation 26. Insulation 26 has a retaining flange 28 adapted to abut a graphite ring 30 secured in the insulation and forming the nozzle throat inlet portion. The throat of the nozzle vectoring portion 14 likewise comprises a contoured carbon ring 34 cemented to and abutted by a conically diverging throat exit portion 36 (FIG. 1). Both the ring 34 and exit portion 36 are secured within an annular plastic liner 38 of Haveg or the like, the exit portion being separated from liner 38 by other insulation 40. Although the details are not shown, liner 38 is pivotally supported upon the stationary nozzle portion 12 by the gimbal mount 20.

As best seen in FIG. 1, the contours of the stationary and vectoring nozzle portions are such as to provide the desired convergent-divergent gas passage with smooth and streamlined walls to diminish the heat and friction losses. The contours are also such as to provide a non-interfering close sliding fit between the portions. To these ends, the inner surfaces of both the ring 30 and insulation 26 are smoothly contoured to form a spherical socket-like surface 42 for cooperation with the smoothly rounded inlet end 43 of the vectoring nozzle portion.

This construction provides the necessary running clearance between the stationary and vectoring portions, but it also, however, provides a passage 44 permitting the leakage of exhaust gases out of the nozzle. A bag type seal 46 therefore is used to bridge the gap between nozzle portions to prevent this.

Briefly, seal 46 comprises an annular rolling fabric seal member 50 having beaded ends 52 and 54. The ends are secured separately to stationary and movable nozzle retaining members 56 and 58 by lip flanges 60 and 62 and spanner nuts 64 and 66. The retaining members are suitably secured to the liner 38 and case 21, respectively. The forward end 68 of retainer 56 fits in a recess 70 in the liner 38 and is arcuately curved to conform to the outer streamlined surface of the liner.

The bag seal is designed to positively prevent the leak of gases from the nozzle and is capable of withstanding high heat. However, the heat of the exhaust gases (5500°–6000° F., for example) and the concentration of these gases against the seal is so intense that the fabric member 50 will burn out if exposed to these hot gases for any length of time. Therefore, a heat dam 72 is provided upstream of the seal to protect it for as long a period as vectoring of the nozzle is required. Once the vectoring is terminated, it is immaterial whether or not the bag seal is burned out by the exhaust gases.

Heat dam 72 comprises a spiral wound ring seal 74 seated at its inner periphery in a recess 76 in the end 68 of liner 38 and held there by a spanner nut 78. The circumferentially spaced ends 80 and 82 of the ring axially overlap the body portion 83 as shown in FIGS. 3–6, and move circumferentially relative to each other in a

known manner to circumferentially expand or contract the ring 74. The ring extends across the passage 44 with the radially extending face portion 84 at right angles thereto forming a gas seal and heat dam as mentioned. The outer edges of the ring are canted and formed with a number of knife edges 86 in rubbing contact with surface 42 of the stationary nozzle portion to permit the ring to cut or abrade its own sealing surface upon vectoring of the nozzle. This reduces the surface finish and the concentricity requirements of the two adjacent surfaces.

The diameter of the ring and the radial distance between nozzle portions is such that the ring is initially compressed or preloaded by circumferentially shortening the relative distance between ends 80 and 82 for insertion into the recess 76. This assures that the knife edges 86 will be loaded into sealing contact with surface 42, i.e., after installation, a biasing force will continually urge the circumferential expansion of the ring in an attempt to separate the ends 80 and 82 and force the knife edges 86 into sealing contact with surface 42. Vectoring of the nozzle therefore causes the ring to rub along surface 42 to maintain the seal.

In an installation of this type, the nozzle must occasionally be vectored cold for test purposes, i.e., the swiveling action of the nozzle is tested without fire-up of the engine. During the test, however, the loading of the ring seal knife edges 86 grooves a new sealing surface 88 (FIG. 4) in the softer plastic insulation 26. Each subsequent test therefore tends to deepen the grooves to a point where the sealing ring would, if not limited, expand and cut or abrade surface 42 to the maximum limit. The knife edges would then merely drag across the surface instead of rubbing or cutting, and the seal would be substantially ineffective. Fire-up of the rocket would then cause exhaust gas to flow past the heat dam to the main gas seal.

To prevent this, as mentioned previously, the expansion of the ring is limited or controlled during cold vectoring, and restored after fire-up of the rocket. To this end, each of the overlapping portions of the ring 74 is bored at 90 adjacent the ends of the ring to loosely receive a fusible alloy pin 92. The pin has a substantially smaller diameter than the bores 90 to permit the ring to circumferentially expand from its original or initially installed position (FIG. 3) to successive positions cutting deeper grooves 88 into surface 42 upon successive cold vectoring of the nozzle. However, the bores and pin sizes are such that prior to the ring reaching its expansion limit, the pins become wedged (FIG. 4) in the adjacent bores to prevent any further expansion and therefore prevent further radial movement of the knife-like edges 86. The pins are however made of a material having a low melting temperature (150° F., for example). Therefore, immediately upon firing up of the rocket to which the nozzle is attached, the exhaust gases (at 5000°–6000° F.) passing through the nozzle and into passage 44 strike the pins and melt them. The ring 74 then is free to expand to the FIG. 5 position to again load the knife edges 86 into sealing engagement with surface 88. It is to be noted that the bores 90 are so located radially, as seen in FIG. 2, with respect to the ring and liner 38 that no gas can leak through the bores after the pins have melted even though the vectoring may not be sufficient to cause total misalignment of the holes.

After a predetermined time, the heat dam 72 will begin to char and volatilize and eventually expose the bag seal to the high gas temperature. However, by this time, the need for vectoring of the nozzle will be substantially over. Therefore, it is only necessary that the bag seal be able to withstand the intense heat for a short time, until vectoring is no longer required, which it does.

The operation is believed to be clear from the previous description, and therefore will not be repeated.

From the foregoing, therefore, it will be seen that the invention provides a combination heat dam and gas seal

effectively insulating the vectoring nozzle main gas seal from the intense heat of the exhaust gases to permit vectoring of the nozzle for as long a time as is necessary. It will also be seen that the invention provides a heat dam and gas seal construction permitting numerous cold vectorings of the nozzle while still providing a highly effective seal during normal running operation of the nozzle.

While the invention has been illustrated in its preferred embodiment in connection with an exhaust gas jet nozzle, it will be clear to those skilled in the arts to which this invention pertains that many modifications may be made thereto without departing from the scope of the invention, and that it has use in many installations other than that illustrated.

I claim:

1. A vectoring fluid jet propulsion nozzle having vectoring and stationary portions and a fluid leakage passage therebetween, and expandable heat dam and fluid seal means in said passage biased into sealing and abrading contact with said portions to prevent the leakage of heat and fluid therepast, means to limit the expansion of said seal means to prevent abrasion of said portions, and means to render said last mentioned means inoperative.

2. A vectoring jet propulsion exhaust gas nozzle having vectoring and stationary portions and an exhaust gas leakage passage therebetween, and heat dam and gas seal means in said passage in sealing contact with both of said portions to prevent the passage of exhaust gas therepast, said dam means comprising an expandable member secured to one of said nozzle portions and expandable into sealing contact with the other nozzle portion, said member having means thereon to abrade the other portion contacted, said member being expandable upon abrasion of said other portion to maintain sealing contact therebetween, fusible means restricting the expansion of said member, said last mentioned means being fusible under the heat of the exhaust gases to permit said expansion.

3. A vectoring fluid jet propulsion exhaust nozzle having vectoring and stationary portions and a fluid leakage passage therebetween, and heat dam means in said passage in sealing contact with both of said portions to prevent the passage of fluid therepast, said means comprising an expandable member secured to one portion and being continuously biased into expanded position contact with the other portion, said member having means thereon to abrade the other portion contacted, said member being expandable upon abrasion of said other portion to maintain sealing contact therebetween, and means contacting said member to prevent the expansion thereof, said last mentioned means being rendered inoperative in response to the passage of fluid through said nozzle.

4. A vectoring jet propulsion exhaust gas nozzle having vectoring and stationary portions and a gas leakage passage therebetween, and heat dam means in said passage in contact with both of said portions to prevent the passage of gas therepast, said dam means comprising a spiral-wound circumferentially expandable ring secured to one of said nozzle portions and having parts biased into contact with the other of said portions, said ring parts having knife-like edges contacting the surface of said other portion adapted to abrade the said surface upon vectoring of said nozzle to provide a gas clearance between said edges and surface, the expansion of said ring eliminating said clearance, fusible stop means to limit said expansion, said stop means being fusible in response to the heat of the exhaust gases thereon to permit expansion of said ring into contact with the other portion surface to prevent gas leakage through said dam.

5. A vectoring jet propulsion fluid exhaust nozzle having vectoring and stationary portions and a fluid leakage passage therebetween, and heat dam and fluid seal means in said passage in contact with both of said portions to prevent the passage of fluid therepast, said dam means comprising an expandable spiral ring secured in one nozzle portion and having knife-like outer edges normally

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biased into sealing contact with the other said portion, said knife-like edges abrading the surface of said other portion, said ring expanding upon abrasion of said other portion to maintain sealing contact between said ring and other portion, temperature responsive means connected to said ring normally limiting the expansion thereof and the abrasion of said other portion and operable in response to a predetermined temperature to permit said expansion and abrasion.

6. A vectoring jet propulsion fluid exhaust nozzle having vectoring and stationary portions and a fluid leakage passage therebetween, and heat dam and fluid seal means in said passage in contact with both of said portions to prevent the passage of fluid therepast, said dam means comprising an expandable spiral ring secured in one nozzle portion and having knife-like outer edges normally biased into sealing contact with the other said portion, said knife-like edges abrading the surface of said other por-

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tion, said ring expanding upon abrasion of said other portion to maintain sealing contact between said ring and other portion, temperature responsive means connected to said member normally limiting the expansion thereof to a predetermined limit and operable in response to the attainment of a predetermined nozzle operating temperature to permit said expansion.

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