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SWIVEL NOZZLE

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FIG.1.

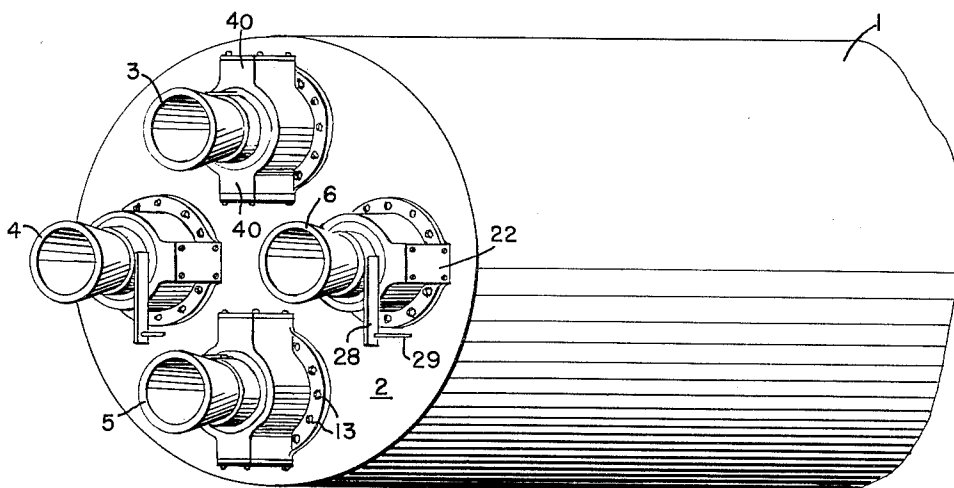
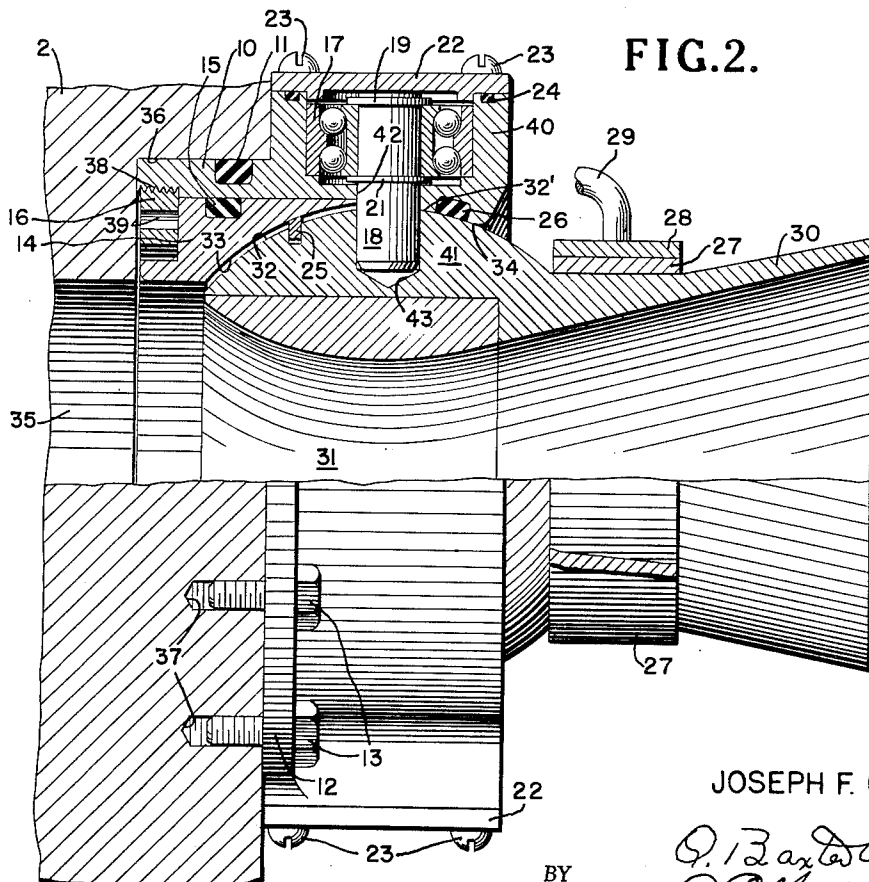


FIG.2.



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SWIVEL NOZZLE

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3 Claims. (Cl. 60—35.55)

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This invention may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

This invention relates to the control of missiles; more particularly it relates to a movable nozzle for the control of missiles by deflecting the exhaust gases from the reaction engines thereof.

Such control has been achieved in the past with the use of moveable external control surfaces and by deflecting the exhaust gases with jet vanes, jetevators, and gimbaled nozzles. Such methods possess disadvantages however in certain applications.

External control surfaces, besides being bulky, do not allow precise control in the initial stages of flight since the velocity of the missile is low and the amount of control attainable from such surfaces is a function of missile velocity. The use of jet vanes results in lessened thrust of the engine due to the losses associated with the drag of the vanes in the exhaust and the turbulence in the exhaust flow created by the vanes; the use of jetevators also results in lessened thrust of the engine due to the losses associated with the underexpansion of and the turbulence in the exhaust. Additionally, the use of both jet vanes and jetevators has control limitations.

Gimbaled nozzles have the ability to deflect the exhaust gases in an infinite number of planes and so control the pitch and yaw of the missile but the roll of the missile must be controlled by other means.

Moveable nozzles present problems in achieving gas tight seals between the moveable and stationary parts to prevent leakage. Such seals have been achieved in the past, with varying degrees of success, by maintaining extremely close clearances between the moving parts or by the use of flexible diaphragms. The former expedient requires extensive machining and the parts are quite susceptible to binding due to unequal thermal expansions or to the build-up of combustion products on the two adjacent surfaces; the latter requires materials which will not break down when subjected to the flexure, temperature, and pressure encountered in such an application.

It is therefore a general object of the present invention to provide a variable position nozzle arrangement wherein undesired leakage of the exhaust gases is prevented to an exceptionally high degree, while at the same time, allowing for unequal thermal expansion of various portions of the assembly, thereby preventing seizure of the relatively movable parts of the system.

It is also an object of this invention to provide a new and improved moveable nozzle with which the direction of the thrust of a reaction motor can be controlled.

Another object is to provide new and improved means whereby a jet propelled missile can be completely controlled in roll, pitch, and yaw, at all velocities.

A further object is to provide improved sealing means

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between the moveable and the stationary parts of the nozzle so as to prevent gas leakage therebetween.

The invention will be best understood from a consideration of the following detailed description taken in connection with the accompanying drawing, with the understanding, however, that the invention is not confined to a strict conformity with the showing of the drawing but may be changed or modified so long as such changes or modifications mark no material departure from the salient features of the invention as expressed in the appended claims.

FIG. 1 is a perspective view of the rear portion of a rocket motor having four nozzles of the instant type; and

FIG. 2 is an elevational view, partly in section and broken away, of one of the nozzles of FIG. 1.

Referring now to the drawing wherein like reference characters designate like or corresponding parts throughout the several views, FIG. 1 illustrates a rocket motor having an outer casing 1, an end closure 2, and nozzles 3, 4, 5, and 6 mounted therein with the weight distribution thereof being symmetrical with respect to the axis of the motor.

Referring now to FIG. 2, there is shown a portion of closure 2 containing nozzle 5 which is identical to each of the other nozzles 3, 4 and 6. Closure 2 is shown to be provided with an exhaust port 35 which opens into an annular recess 36 in which is inserted a main bearing housing 10 having O ring 11 forming a seal between closure 2 and main bearing housing 10. Closure 2 is further provided with a plurality of tapped bores 37 which are arranged in a pattern around recess 36. Housing 10 is provided with a flange 12 which abuts the outer surface of end closure 2 when housing 10 is positioned in recess 36. Flange 12 has a plurality of apertures corresponding to and in alignment with said tapped bores 37 in end closure 2 and threaded bolts 13 pass through the apertures in the flange and engage the threads in tapped bores 37 thus securing housing 10 to end closure 2.

Annular insert housing 14 is closely fitted within main housing 10 and is secured therein by means of threaded lock ring 16 which engages threads 38 of main housing 10. Suitable bores 39 may be provided in lock ring 16 to receive a torque tool (not shown) whereby ring 16 may be securely tightened in position. In addition to its locking function, it will be noted that lock ring 14 also serves to provide a tortuous path for any exhaust gas which attempts to pass between insert housing 14 and main housing 10 and, in addition, annular seal ring 15 may be provided to increase sealing between the two housing portions. It will be apparent that internal surface 33 of insert housing 14 and internal surface 34 of main housing 10 together form a portion of a sphere, the purpose of which will hereinafter be made more clearly apparent.

Main housing 10 is further provided with two diametrically disposed enlarged portions 40 which act as journal boxes for bearings 17 and diametrically disposed shafts 18, the latter of which have a common axis normal to the axis of housing 10. Shafts 18 are radially secured in bearings 17 by rings 19 and 21 which are positioned in annular grooves in the outer ends of shafts 18. Caps 22 form closures for journal boxes 40 and may be conveniently secured thereto by means of screws 23 and sealed by O rings 24 set in suitable sealing grooves.

Shafts 18 extend radially inwardly from main housing 10 through suitable apertures 42 and are secured to spherical portion 41 of nozzle 30, as for example, by force fitting in blind bores 43. In this manner, nozzle 30 is pivotally supported within main housing 10 by means of shafts 18 and bearings 17, and spherical portion 41 of nozzle 30 is free to oscillate within the spherical cavity provided by surfaces 33 and 34. It should also be noted that relatively greater clearance is provided between surfaces 32 and 33 than is provided between surfaces 32' and 34. This unequal clearance is provided in order to allow for unequal thermal expansion of surfaces 32, 33 relative to surfaces 32', 34 which occurs due to the closer proximity of surfaces 32, 33 to the hot gas flow than that of surfaces 32', 34 which are relatively farther removed therefrom. In addition, it will also be apparent that surfaces 32', 34 are much closer to the external surfaces of housing 40 and spherical portion 41 which are in contact with the much cooler ambient atmosphere, and also, annular split metal ring seal 25 serves to greatly reduce the amount of hot gas which reaches surfaces 32', 34. Furthermore, O ring seal 26 substantially eliminates the residual leakage through seal 25 from passing any farther which thus builds up a back pressure to the left of O ring 26 as viewed in FIG. 2 which, in turn, substantially reduces further leakage through seal 25.

It will therefore be apparent that the disclosed nozzle assembly achieves maximum temperature compensation for each of the relatively movable surface portions and thereby solves the problem of excessive frictional engagement between all movable surfaces, while at the same time, solving the problem of exhaust leakage between the movable surfaces. Even more importantly, the subject invention greatly reduces the heretofore required machining tolerances of surfaces 32, 32', 33 and 34 since nozzle 30 is supported by shafts 18 journaled in externally located bearings 17 which is entirely different from the bearing design heretofore employed in so-called "gimbal mounted" nozzles.

Nozzle piece 30 is shaped cylindrically externally for a short distance behind the spherical end portion and collar 27 fits about the nozzle thereat, gripping it tightly. Arm 28 is attached to said collar tangentially and extends outwardly.

Rod 29 is attached normally to arm 28 near the outward end thereof, the other end of rod 29 being attached to conventional power and sensing means, not shown.

Insert 31 is an annular member which is cylindrically shaped externally and fits within a corresponding indentation in nozzle piece 30.

It is also apparent that a considerable thickness of material lies between the inner surface of nozzle piece 30 and O ring 26. This thickness of material is designed to act as a heat sink so as to minimize the heating of O ring 26 as well as surfaces 32, 34 and bearings 17.

The internal configuration of the nozzle is dictated by conventional design criteria, and the materials employed in its construction are conventional and well known in the art.

Ball bearings are preferred but other types may be used. The amount of angular movement in the joint is a function of the size of the ball and socket.

Ring 25 and O ring 26 may be located at any convenient place, provided only that ring 25 be placed ahead of the O ring and that a considerable thickness of material be present between the inner surface of the nozzle and the said O ring.

To completely control the roll, pitch, and yaw of a missile, it is necessary to utilize four of the instant nozzles. Each pair of oppositely disposed nozzles must rotate in the same direction, simultaneously or separately, as the case may be. For example, nozzles 3 and 5 would rotate in a horizontal plane about vertical axes and nozzles 4 and 6 would rotate in a vertical plane about horizontal axes, as viewed in FIG. 1. When the four nozzles are

arranged in a missile as aforesaid, and rod 29 of each nozzle is connected to suitable power and sensing means, it is possible to vary the direction of the thrust of each nozzle in such a fashion that complete control of the roll, pitch, and yaw of the missile is obtained.

From the foregoing it will be apparent that a swivel nozzle structure has been provided which is suitable for use in the complete control of the flight of jet propelled missiles. The sealing means herein provided is an improvement over previous sealing means in that a ring similar to a conventional piston ring is interposed between the exhaust gases and the O ring which forms the primary seal, and in that the O ring is further protected by the use of a heat sink to reduce the amount of heat conducted to the ring through the walls of the nozzle.

While the preferred embodiment of the invention has been shown, it will be obvious to those skilled in the art that the invention is not so limited but is susceptible of various other changes and modifications without departing from the spirit thereof.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. A high temperature, high pressure, variable position nozzle assembly for directing the flow of high temperature and high pressure fluids comprising; annular bearing housing means having an internal surface defining a spherical cavity, a discharge nozzle having a partly spherical external surface portion positioned within said spherical cavity, bearing means positioned in said bearing housing means externally of said nozzle, supporting shaft means journaled at one end in said bearing means and connected at the other end to said nozzle whereby said nozzle is supported for pivotal oscillation in one plane, means for compensating for unequal thermal growth of said surfaces comprising a thermal expansion gap positioned between said spherical surfaces on one side of said supporting shaft means to absorb the unequal thermal expansion of said surfaces, a first seal means located within said gap and partially sealing said surfaces against high temperature and high pressure fluid leakage, a second seal means located between the mating spherical surfaces on the other side of said supporting shaft means, whereby the first and second seal means cooperate to form an effective seal to all high temperature and high pressure fluids.

2. The nozzle assembly as claimed in claim 1 wherein said first seal means comprises a metallic, piston-type seal ring and the second seal means comprises a non-metallic O ring type seal.

3. A variable position nozzle assembly comprising; an annular bearing housing having an internal surface which defines a first portion of a spherical cavity, an annular insert ring positioned within said annular housing and having an internal surface defining a second portion of a spherical cavity, a lock ring securing said insert ring within said annular housing, bearings located within said annular housing external of said spherical cavity, two diametrically disposed apertures providing openings between said bearings and said spherical cavity, a convergent-divergent nozzle having a spherical external surface portion at one end, said spherical surface portion being positioned centrally of said spherical cavity, a pair of support shafts journaled in said bearings and extending radially inwardly through said apertures and connected to said nozzle at said spherical surface portion, the diameter of the spherical surface portion provided by said insert ring being greater than that provided by said housing whereby unequal expansion of the various spherical surfaces is accommodated, and a pair of ring seals, one of which is positioned between said spherical surface of said nozzle and the larger diametered portion of said cavity, and the other of said seals being positioned between said spherical surface of said nozzle and the smaller diametered portion of said cavity, whereby leakage of fluid between said spherical surfaces is effectively eliminated.

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