July 26, 1960 S. R. CROCKETT 2,946,261

PERIPHERAL NOZZLE SPINNER ROCKET

Filed May 2, 1956 2 Sheets-Sheet 1

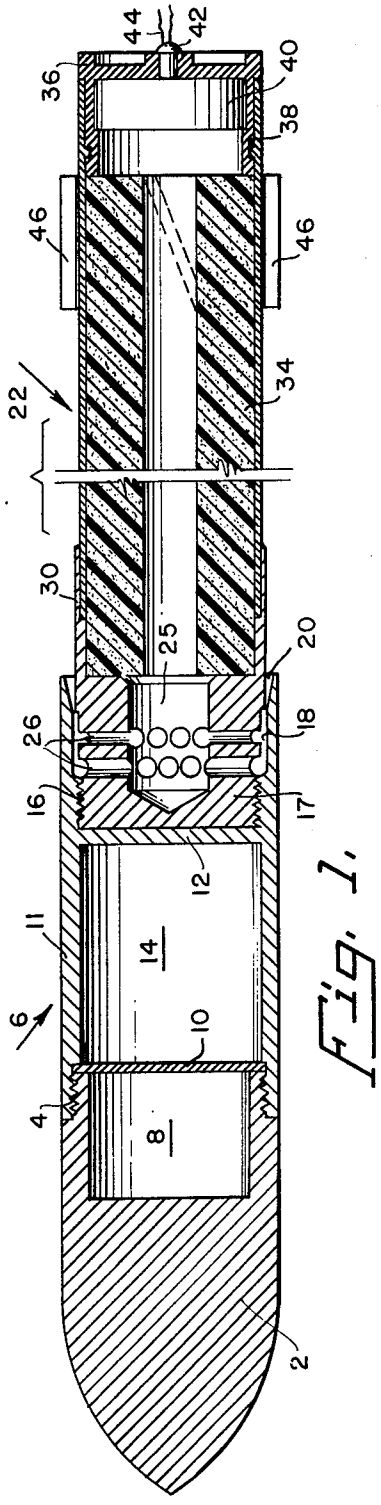


Fig. 1.

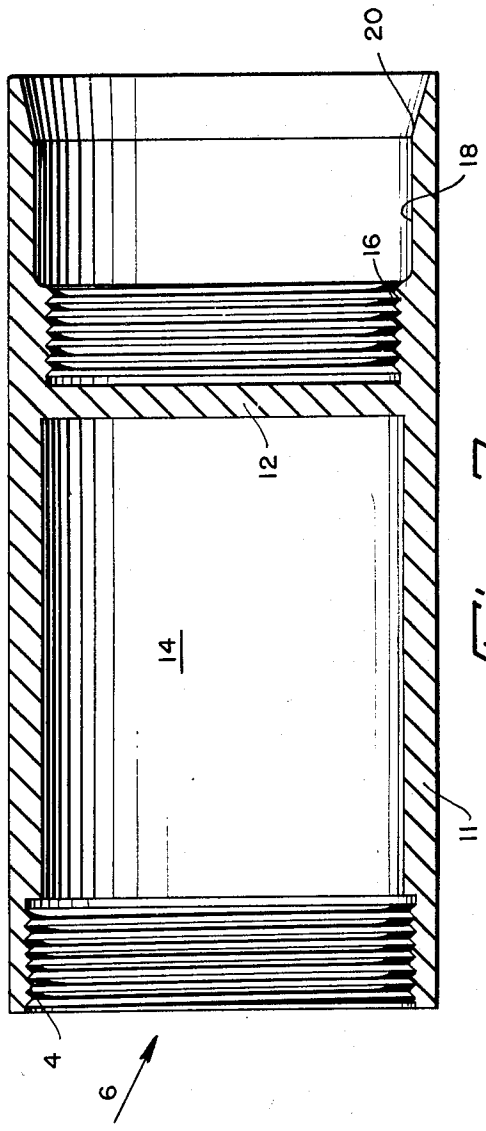


Fig. 2.

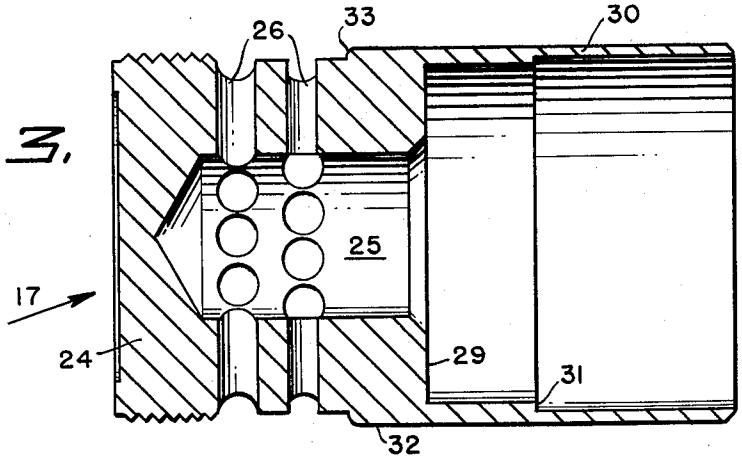
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Fig. 3.



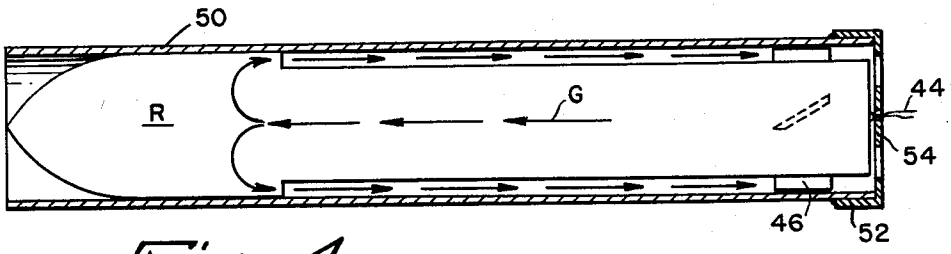


Fig. 4.

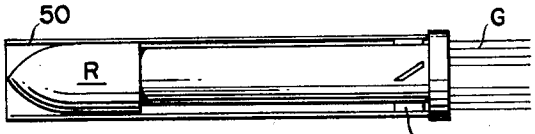


Fig. 6.

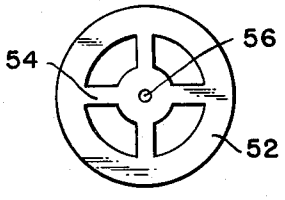
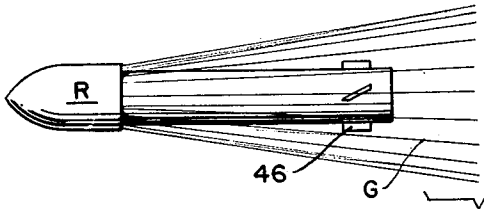


Fig. 5.



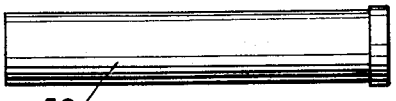


Fig. 7.



Fig. 8.

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PERIPHERAL NOZZLE SPINNER ROCKET

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2 Claims. (Cl. 89—1.7)

(Granted under Title 35, U.S. Code (1952), sec. 266)

The invention described herein 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 improvements in jet propelled rockets, and more particularly to improvements involving spin stabilization of such rockets in the launching thereof, and in flight.

It has long been recognized that projectiles in flight require stabilization means of some kind. In general, two types of stabilization have been utilized, namely fin stabilization and spin stabilization. Fin stabilization is generally accomplished by fins attached to a projectile in the contemplated direction of flow of the airstream (generally parallel to the longitudinal axis of the projectile) and serve to resist movement out of said direction of flow, and such stabilizers are generally not satisfactorily operable in conditions of cross-wind flight or launching. Spin stabilization is effected in various ways, as by gun-barrel rifling in the case of gun-fired projectiles or by the use of canted fins or vanes or other torque producing means. In the field of jet-propelled rockets, with which the present invention is particularly concerned, spin stabilization is accomplished by disposing either the jet propulsion nozzles or spin vanes in a direction at an angle to, or canted relative to, the direction of flight of the rocket, and such types of spin stabilization are effective to increase the trueness of flight of the rockets. Spin stabilization of rockets is generally more effective than fin stabilization to decrease the dispersion rates of the rocket designs to which it is applied.

In the application of spin stabilization to rockets a good deal has been learned of the performance requirements of spin-stabilized rockets, and of the effects of different and ideal spin rates at different phases of the flight of rockets. Thus, it is now known that one critical phase of flight is the launching phase and that a relatively high rate of spin at this point is effective to prevent undue dispersion of rockets. Secondly, it is known that the rate of spin should be proportional to the rate of speed for ideal effectiveness in controlling dispersion. Thus, the ideal situation would be to provide a rocket having means effective to develop high rates of torque for providing relatively high rates of spin at the launching phase of flight and for providing relatively lower torques proportional to the speed of flight of the rocket in the accelerating stage occurring during burning of the fuel of the rocket.

The use of angularly disposed or canted jet nozzles has proven incapable of producing the ideal arrangement discussed hereinabove because any attempt to arrange such nozzles to give high launching spin results in increasingly excessive spin rates as propellant burnining causes continued acceleration, with possible resultant motor failure caused by breakdown of metallic and other parts.

Similarly, angularly disposed or canted vane-type spin producing means, as used prior to this invention, were not adaptable to providing good conditions for both the launching and the flight phases. Thus, in conventional rockets with the jet nozzles positioned aft of the spin producing fin structure, comparatively large fin means are required to provide spin in flight because spin is imparted by ambient air forces only, and such structures do not lend themselves to high initial spin in launching because of the low initial speed of the rocket and the difficulty or impossibility of providing artificial air streams over such outwardly extending surfaces in launching.

Forwardly disposed nozzles are, per se, not new and are disclosed, for example, in United States Patent No. 2,412,134 issued on December 3, 1946 to C. L. Eksergian, and in United States Patent No. 2,500,117 issued on March 7, 1950 to E. F. Chandler. However, prior to the present invention no means was known to utilize such forwardly disposed nozzles to effect a beneficially variable spin. Thus, the Eksergian patent does not envisage spin stabilization at all and the Chandler patent utilizes a forwardly disposed auxiliary nozzle to impart a progressively increasing spin rate by forcing substantially all of the gas produced through canted spin vanes, there being no provision for varying the effectiveness of the gases on the spin vanes.

This invention is predicated upon the discovery that the combination of forwardly disposed nozzles and of rearwardly disposed canted spin fins of limited extent make it possible to provide a rocket motor which has a high torque development characteristic during launching (when used with appropriate launching means) and which has the inherent capability of reducing the torque producing force upon emergence of the rocket motor from the launching means and of then increasing said force proportionately as the speed of the rocket increases. Thus, ideally, if propulsion jets are arranged in the area of the center of gravity of an assembled rocket, so as to cause an envelope of high pressure gases to strike spin vanes fixed to the after end of the rocket body, an advantageous character of spin variations is developed as an inherent quality of the arrangement.

It is not intended to limit the broad discovery described in the preceding paragraph to the illustrative example depicted in the drawings. However, said example points out auxiliary advantages of great importance which are inherent in the reduction to practice of the basic premises of the present invention. Thus, the gas generating section of a rocket according to the principles of this invention may be transported separately from the warhead and assembled at a point of use. By virtue of the radial nature of the gas outlets the gas generator is non-propulsive while so transported, which is a safety feature of great importance. Moreover, such separate handling of components make possible a selective assembly with various types of head components, and even a selection of variable jet outlet sizes, since the degree of insertion of the gas generating portion into the nose portion controls the effective size of the jet outlet in each case.

It is, therefore, an object of this invention to provide novel spin-stabilized rocket motor means wherein the effectiveness of the spin producing forces are variable to provide optimum spin conditions for the various phases of rocket flight.

A further object of this invention is to provide novel rocket means wherein the forces tending to produce spin in flight are proportional to the velocity of the rocket, subsequent to the launching of such rocket means.

A still further object of this invention is to provide novel rocket and launcher means wherein the full volume of combustion gas is utilized in the launcher tube to provide high prelaunching, spin-producing torques.

Another object of this invention is to provide a novel rocket construction wherein spin stabilization is effected entirely by the reaction of combustion air on spin vanes, ambient air having no direct spin-producing effect until after burn-out.

Yet another object of this invention is to provide novel rocket motor constructions wherein the gas generating component may be stored and transported separately from the head component and in a relatively safe non-propulsive condition.

A still further object of this invention is to provide novel and improved rocket motor constructions wherein the gas generating and head components are separable and wherein variation in jet nozzle outlet size may be effected by the mode or degree of connection of the said components.

Still another object of this invention is to provide novel rocket motor launching and flight methods leading to simplified and improved variable spin-stabilization characteristics in such rocket motors.

Yet another object of this invention is to provide novel rocket means wherein forwardly situated nozzles are utilized for propulsion and wherein the combustion gases released therethrough envelopes the rocket to improve its stability, said envelope of gases serving also, in varying degree, to impart spin producing torque to said rocket.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings, wherein:

Fig. 1 is a vertical sectional view through a spin-stabilized rocket according to the present invention;

Fig. 2 is a vertical sectional view through the propulsion nozzle element of the rocket motor of Fig. 1, it being notable that said element, as illustrated, may be used as a warhead, since space for explosive payload is provided as well as adapter threads for coupling to an ogival nose piece;

Fig. 3 is a vertical sectional view through the gas outlet nozzle element of the rocket motor of Fig. 1;

Fig. 4 is a vertical sectional view of rocket launching means for use with the rocket motor of Fig. 1, the rocket being shown schematically and the gas flow in the rocket and in the launcher being diagrammatically indicated by arrows;

Fig. 5 is an elevational view taken from the right side of the launcher shown in Fig. 4, illustrating the open gas-emitting end construction of the launcher tube; and

Figs. 6, 7 and 8 are schematic views of phases of rocket motor flight illustrating the launching phase, the initial slow free flight phase, and the accelerated flight phase respectively.

Attention is now directed to the drawings, in which like numerals have been appended to like parts throughout. Fig. 1 is illustrative of one embodiment of a rocket motor according to the present invention, and comprises an ogival nose piece **2**, having a screw threaded extension for engagement, as at **4**, with a jet propulsion nozzle section **6**. Nose piece **2** may be arranged with a chamber **8** adapted to be closed by a disc **10** clamped between the nose piece and the propulsion nozzle section, as shown, and this chamber is adapted to hold fuze means, if desired. Propulsion nozzle section is shown in enlarged detail in Fig. 2 and is of hollow cylindrical configuration, having an outer wall **11** extending forwardly into screw threads **4** for connection to the ogival nose piece **2**, as previously described, and a generally medially positioned transverse wall **12**, defining a chamber **14** which may be loaded with an explosive charge if the performance of a warhead function is desired, or may be used to contain instrumentation for test purposes. The cylindrical wall **11** extends rearwardly of the transverse wall **12**, as shown, and is screw threaded internally for connection, as at **16**, with the gas outlet nozzle element **17** of the rocket motor assembly. The wall **11** is externally cylindrical, as shown, but the rearwardly extending portion is formed or cut away to a slightly greater internal diameter to provide an annular passage **18** for propulsion gases, the passage **18** flaring at its outlet end into an annular propulsion nozzle **20**, as shown, the passage being formed between said cut-away portion and gas outlet nozzle **17**.

Gas outlet nozzle **17**, shown in detail in Fig. 3, serves the dual functions of forming one side of passages **18**, **20** and of directing gas generated in motor tube **22** to said passages. For these purposes the nozzle **17** is of external dimensions related to the internal dimensions of the after portion of the propulsion nozzle **6**. Thus, the forward portion **24** of nozzle **17** is of screw threaded external diameter and length to engage the internal screw threads of the wall **11**, as at **16**, and to abut the transverse wall **12**. The forward portion **24** of nozzle **17** is of generally solid metallic construction, having a closed forward portion and is tapped to provide a rearwardly opening chamber **25** and connecting radial outlet passages **26**. Nozzle **17** has a shoulder **29** formed by the rearward extremity of thickened forward portion **24** and by a rearwardly extending skirt **30** forming an integral part of said nozzle and serving as a means for attachment to motor tube **22**. The external diameter of nozzle **17** is constant from its forward end to a point aft of the outlet passages **26**, and the parts are so proportioned that said passages **26** open into the annular passage **18** formed in propulsion nozzle section **6**. In the area in which the passage **18** is flared to form jet nozzle **20**, the external diameter of the gas outlet nozzle **17** may be increased as at **32**, if desired, to provide a more efficient restricted flow path to the jet nozzle **20**, and more efficient flow may be further effected, if desired by rounding the shoulder formed at the line of increasing diameter, as at **33**.

A motor tube **22** is appropriately secured to the skirt **30** as by soldering, and shoulder means **31** may be provided on gas outlet nozzle **17** for positioning and supporting the motor tube. Motor tube **22** serves to retain propellant gas producing means and to support spin vanes, as shown. Thus, in the illustrative example given herein, a hollow grain **34** of solid propellent material is retained within said tube, with the hollow center thereof in communication with the chamber **25** of nozzle **17**. The after end of motor tube **22** is sealed by a closure cap **36** fitted internally into the end of the tube and secured in this position by any suitable means, as for example by swaging as at **38**. The length of grain **34**, motor tube **22**, skirt **30** of nozzle **17** and the inner skirt of closure cap **36** are such that the grain is clamped against longitudinal movement between said inner skirt and shoulder **29** of the nozzle **17**. If desired, suitable flexible shock absorbing means may be included between the grain and the metallic pieces, although such details are not illustrated since they are not necessary to the description of the present invention. Igniting means are required for initiating burning of the propellent grain, and one type of such means is illustrated in Fig. 1, wherein an igniter **40**, comprising a plastic body member containing suitable squib and black powder components is supported within the cap member **36** by means of a post insulatingly passing through and attached to cap **36** (as by a riveting technique). The post **42** also serves as a pass-through for insulated lead wires **44** adapted to be attached to a suitable firing circuit.

It should be noted that the external configuration of the rocket thus far described is such that an ogival nose piece rounds into a cylindrical portion of given diameter

(the diameter of jet nozzle section 6) and that aft of the jet nozzle 20 the diameter is somewhat reduced. It is an important feature of this invention that the spin vane stabilizing means be of no greater outer diameter than the larger forward diameter of the rocket so that the rocket may be fired from an open-breech cylindrical launching tube of such inner diameter as to closely accommodate the rocket, thus obviating any substantial loss of gases forwardly of the jet nozzle 20 such as would occur if an oversize or open arrangement were necessary to accommodate larger fins. Spin vanes 46, accordingly, are of a radial extent substantially equal to the difference in diameter between jet nozzle section 6 and motor tube 22. A plurality of such vanes 46 are suitable attached, as by welding, to the after end of motor tube 22. Vanes 46 are spaced about the periphery of the motor tube and similarly angularly disposed relative to the longitudinal axis of the rocket whereby gas currents striking the vanes will exert forces tending to impart spin to the rocket. As a cooperating feature of significant importance, the jet nozzle outlet 20 is ideally situated substantially at the plane of the center of gravity of the rocket motor, as shown best in Fig. 1.

In actual use, the gas generating section of the described rocket motor (comprising gas outlet nozzle 17, motor tube 22 with spin vanes 46, closure cap 36 and igniter 40) will be stored and/or transported separately from the head or heads with which it is intended to be used and that, since passages 26 are radial, the unit will not be propulsive if accidentally ignited. Moreover, this feature of separability between the gas generating section and the rearwardly extending skirt of the head portion makes it possible to vary the effective size of the jet nozzle 20 since variation of the degree of insertion of nozzle 17 into said skirt changes the size of said nozzle and such variation may be readily achieved in various ways, as by shims, or provision of variously designed screw thread lengths, etc.

The rocket described hereinabove, as best shown in Fig. 1 is fired by impressing a voltage across wires 44 to cause igniter 40 to be operated to produce hot gases and flame to initiate burning of propellant grain 34 with the resultant generation of propulsion gases. Such gases are emitted through chamber 25, radial passages 26, annular passage 18, and jet nozzle 20 to cause propulsion of the motor. The propulsion gases, emitted from the forward portion of the motor in this manner are effective to form a rearwardly outwardly flaring envelope of gases around the after portion of the rocket as shown by G in Figs. 6 to 8. These gases strike the angular vanes 46 to create spin creating torque, this effect varying as the gaseous envelope is varied in its concentration in the vane area, as will be more thoroughly explained hereinafter.

Attention is directed to Figs. 4 to 8, which illustrate launching tube means used with the rocket of the present invention and depict the nature of the spin producing gaseous envelope G for different flight phases of the rocket G. Any open-ended tube 50 having an internal cylindrical bore slightly larger than the outer diameter of the forward section of rocket R and of the vanes 46 may be used as a launching tube, and, if desired, the after end of tube 50 may be capped by a vented closure 52, with a transverse wall 54 providing gas venting openings as shown in Fig. 5 and a central opening 56 through which lead wires 44 may be threade, if desired. The arrows G in Fig. 4 show the path of the gases formed in the rocket upon firing in the launcher. The gases formed in the motor tube move forwardly along the only possible egress path and are diverted radially by passages 26 (see Fig. 1) and longitudinally rearwardly by passage 18 and jet 20 to cause rocket motion by virtue of reaction to the gas emission. All of the rearwardly directed gases are compelled to pass through the vanes in moving to the vents in the cap 52 for release, because there is no other possible avenue of escape. Therefore, the rocket R is subject to the maximum amount of torque-producing force which can possibly be acquired from the force of the propulsive combustion gases, since said gases are compelled to form an envelope tightly surrounding the rocket body. Accordingly, a maximum, high degree of initial spin is developed in the prelaunching and launching period, and this condition is shown in Fig. 6.

When the rocket is emitted from the launching tube the gaseous envelope spreads out, as shown in Fig. 7, and since the speed is relatively slow the spreading is substantial before the vanes are affected thereby, and the spin torque is decreased to an estimated one-sixth of the launching spin-torque. When this occurs the axial thrust is increased and axial velocity increases more rapidly, because less of the forces are being utilized to create spin.

As the rocket thus increases its axial velocity, the gaseous envelope is forced inwardly toward spin vanes 46 by the increasing pressure of the ambient air (see Fig. 8) thus increasing the rate of spin. This is desirable, since optimum stability requires increased rate of spin with an increase in axial velocity.

From the above it may be seen that the present invention provides new and improved rocket motor constructions wherein ideally variable spin rates are achieved. Moreover, the present invention provides novel rocket launching and flight techniques leading to improved automatically variable spin-stabilization in the launching of rockets and in the free flight thereof.

Only a single structural example illustrative of the principles of this invention has been specifically described in this specification. 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 the scope of the invention is to be restricted only by the scope and limitations of the appended claims and not by the details of the said specifically described exemplary modification.

What is claimed is:

1. A spin stabilized rocket adapted to be launched from a launching tube having a cylindrical bore open at opposite ends thereof, said rocket comprising a nose portion having a maximum diameter slightly less than the diameter of said bore and a portion disposed rearwardly of the nose portion of a diameter to provide an annular space between its outer surface and the bore, a plurality of angularly spaced outwardly extending vanes on said second portion disposed angularly to the longitudinal axis of the rocket, the outer peripheries of the vanes being substantially the same diameter as the maximum diameter of said nose portion, whereby the nose portion and vanes provide guide means for the rocket to rotate about and translate along the axis of said bore, and an annular outwardly and rearwardly flaring nozzle disposed forwardly of said vanes adapted to discharge an envelope of gases rearwardly and through said space for impingement against said vanes to impart relatively high initial spin to the rocket while it is in the tube, said nozzle being constructed and arranged relative to said vanes such that after the rocket leaves the tube the envelope spreads outwardly from the vanes but still partially impinges same, thereby decreasing the spin torque and increasing the effective longitudinal thrust to thereby increase the velocity of the rocket, the envelope being forced inwardly by surrounding ambient air as the rocket further increases in speed to thereby effect impingement of an increased portion of said envelope on said vanes and produce increased spin torque until the envelope ceases, said vanes serving thereafter to continue spin of the rocket by action of ambient air thereon.

2. A rocket in accordance with claim 1 constructed and arranged to permit adjustment of the size of the throat of said nozzle upon relative longitudinal adjustment of said nose portion and the rearwardly disposed portion, where-

by the velocity of the gases in the envelope, and orientation of the envelope relative to the vanes may be varied.

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