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EJECTION APPARATUS

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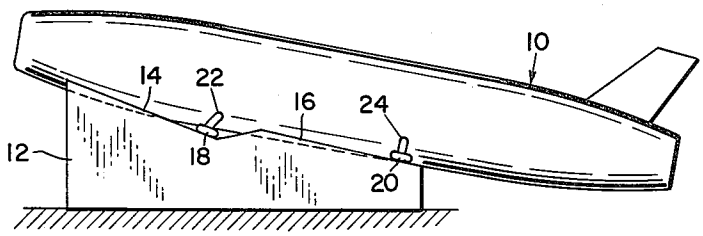


Fig. 1

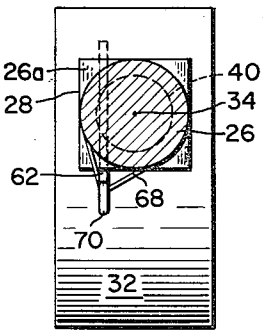


Fig. 3

Fig. 2

Fig. 4

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EJECTION APPARATUS

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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.

The present invention relates to apparatus operating subsequent to the surface launching of a missile for ensuring the complete ejection of components which, if retained during flight, would have an adverse effect on missile performance.

Data obtained during the testing and evaluation of surface-launched guided missiles indicates that a considerable improvement in speed and/or range could in many cases be achieved by reducing the drag which results from failure of the missile to rid itself of certain outwardly-projecting structural components utilized only during the launching operation.

One presently-employed launching technique incorporates a plurality of guide rails upon which a booster-aided surface-to-surface missile is positioned for firing. To provide for slidable engagement between the missile and this supporting structure, a number of rail-engaging adaptors, commonly referred to as "slippers," are respectively connected to the missile body by means of an equal number of detachable outwardly-extending supports. These slippers and their associated supports remain with the missile until after the latter leaves the launching pad.

At the time of booster burnout, the expended booster chambers are ejected from the missile. In many designs, this booster chamber ejection causes a valve to open and admit a fluid under pressure to cylinders respectively associated with the slipper supports. This compressed fluid exerts a force against a piston forming an integral part of each support, thereby resulting in an ejection of the supports from the missile.

Experience has shown the percentage of failures of this slipper-ejection apparatus to be higher than warranted by operational conditions. Intensive study of the cause of the failures points clearly to a low velocity of ejection as the prime contributing factor.

The principal objective of the present invention, therefore, is to provide means for increasing the ejection velocity of a missile slipper support over that obtained by methods heretofore employed.

Another object of the present invention is to provide a structure through which the pressure behind a missile slipper may build up to a point where high-speed ejection of such support may take place, the latter being securely retained in position throughout the period of pressure build-up.

A further object of the invention is to provide means for raising the pressure level at which slipper support ejection actually begins, and for maintaining at least a portion of this ejection pressure until such time as complete ejection of the slipper support has been effected.

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 partly schematic view of a missile positioned on a launching platform by a plurality of slippers

and supports of a type with which the present invention may be utilized;

FIG. 2 is a partly sectional view of a single missile slipper support incorporating a preferred embodiment of the present invention, also showing that portion of the missile body with which such support is associated:

FIG. 3 is a sectional view of FIG. 2 taken along the line III—III; and

FIG. 4 is a view of a portion of FIG. 2 showing a modified form of a mechanical restraining device for the slipper support.

In FIG. 1 of the drawings is illustrated a missile 10 (which may be of the surface-to-surface type) supported in firing position upon a more or less conventional launching platform or pad generally identified by the reference number 12. The launching platform 12 includes a pair of forward parallel guide rails 14 as well as a pair of rearward parallel guide rails 16, only one rail of each pair being visible in the drawing. It will be understood, however, that each such pair of guide rails 14, 16, as well as the general missile assembly to be hereinafter set forth, is of symmetrical design, and hence it is believed that a detailed description of the components illustrated in FIG. 1 will provide a complete understanding of the environment in which applicant's invention is to be utilized.

During the initial portion of its movement the missile 10 "rides" along the rails 14 and 16, actual contact being through a pair of forward "slippers" 18 and a pair of rearward "slippers" 20, all of which members are of course configured to engage the surface of the guide rails along which they travel as the missile 10 is caused to move following ignition of its booster rockets (not shown). Two pairs of arm-like supports 22 and 24 respectively connect the two pairs of slippers 18 and 20 to the body of missile 10.

It might be mentioned that the body of missile 10 is cradled between the two guide rails of each pair, and that the slope of the forward pair is somewhat greater than that of the rearward rails in order to impart an induced pitch to the missile as it leaves the launching area. Although not shown, a plurality of booster rockets are customarily attached to the missile 10 to aid it in reaching a speed where its jet propulsion unit becomes effective. Such an expedient is standard practice, however, and is referred to only because the present invention may in one embodiment employ an ejection of the expended chambers of these booster rockets to initiate a series of events which leads to a similar ejection of the slipper support members after they, like the booster rockets, have served their purpose successfully launching the missile.

FIG. 2 of the drawings illustrates a preferred construction for the slipper supports 22, 24 of FIG. 1, all of these supports being identical in design and hence capable of being covered by the single description which follows. The principal component of each slipper support is an S-shaped arm 26 which is of essentially circular cross-section throughout its length, except for a portion 26*a* that is of generally square outline in that region where the arm enters a matching opening 28 formed in a fitting 30 which constitutes part of the missile body. The surface covering or "skin" 32 of the missile is apertured in front of this opening 28 to admit the arm 26, as illustrated. The reason for making the arm portion 26*a* (as well as the opening 28) of noncircular cross-section is to preclude a rotation of the arm within the fitting 30. Such a relative movement between these members would prevent a correct positioning of the missile 10 on the platform 12 and hence reduce the chances for a successful launching operation.

Both the slipper support arm portion 26*a* and the opening 28 in the fitting 30 are symmetrical about an axis 34 which lies in a horizontal plane. The opposite

end of arm 26, which carries one of the slippers 18, 20 (positioned within the boundaries indicated by the broken line 36) has an axis 38 which also lies in a horizontal plane. The slipper carried by this arm portion is thus maintained in position to slidably engage one of the guide rails 14, 16 of the launching platform 12.

The slipper arm portion 26*a* (which as stated is of square outline) has a cylindrical extension 40 receivable in a corresponding opening 42 formed in fitting 30, the openings 28 and 42 having the common axis 34 as illustrated. A shoulder 44 between arm portions 26*a* and 40 abuts a surface discontinuity 46 between openings 28 and 42 to limit the inward progress of the slipper support and thereby create a chamber 48 between the end of the cylindrical extension 40 and a face plate 50 which is secured to the rear surface 52 of the slipper fitting 30. A conduit 54 leads to an opening 56 in the face plate 50, this opening being concentric with opening 42. Fluid (such as gas) is admitted through opening 56 to chamber 48 from a pressurized source in the missile (not shown). When the pressure of this fluid in chamber 48 reaches a point where it is able to overcome the resistance offered by the frictional engagement between the surface of the slipper support arm portions 26*a* and 40, on one hand, and the inner surface of the openings 28 and 42 in the fitting 30, on the other, the slipper support is ejected from the missile. The extension 40 thus acts as a piston, and a compression ring 58 receivable in an annular recess 60 in the surface of the piston provides a substantially fluid-tight seal between such member and the wall of opening 42.

Even though the pressure of the fluid in chamber 48 is sufficient to overcome initial frictional resistance, the slipper support arm 26 does not always attain sufficient outward momentum to completely clear the fitting 30. It should be noted that support arm portion 26*a* and extension 40 for structural reasons are of substantial length, and that the volume of chamber 48 increases accordingly as the arm is being ejected. This is due in part to losses in the conduit 54 which lengthen the period required for chamber pressure build-up. The result of such a relatively slow pressure increase is that the slipper support is moved outwardly in gradual fashion rather than abruptly. In fact, if the pressure mounts at less than a critical rate, the slipper support will be moved to a position where the piston 40 may clear the cylinder opening 42, but portion 26*a* will still be in frictional engagement with the walls of opening 28. At this point, a sequence valve (not shown) will close to cut off the supply of fluid, and no further pressure will be imparted to the support arm 26. Hence, the latter will not clear the missile if its velocity is insufficient at the time this valve closure occurs.

An additional factor bearing on the above is that lateral acceleration of the missile during the boost phase of its flight may cause the slipper supports 22, 24 to move outwardly. If a particular support moves out far enough to clear the sequence-valve contact button (not shown), that valve will close and thus isolate the cylinder from the pressure source. If the support moves some distance outward, but not far enough to clear the sequence valve, ejection failure may still result because the shorter-than-normal engagement of the piston with the cylinder may result in lower ejection velocity.

To overcome the above drawbacks, the present invention provides means for restraining the movement of the slipper support, such restraining means comprising in the preferred embodiment of FIGS. 2 and 3 a shear pin 62 receivable in two linearly-aligned openings 64 and 66 respectively formed in the slipper support portion 26*a* and in the fitting 30. The aligned openings 64 and 66 are disposed at an angle to the principal axis 34 of the assembly, as best shown in FIG. 2. To prevent an inadvertent withdrawal or loss of this shear pin, a safety wire 68 encircles the support arm 26 and passes through a loop 70 formed on the outer end of the shear pin.

A restraining device of the above type yields the following advantages:

(1) It prevents motion of the slipper support 26 until enough force has been developed on the piston 40 to cause release of the restraining device.

(2) It definitely prevents outboard motion of the slipper support 26 as a result of lateral acceleration of the missile 10.

Although the provision of such a mechanical restraining device does permit a slightly larger amount of compressed fluid to accumulate in the device chamber 48 prior to ejection of the slipper support, optimum ejection velocity can be attained only if a considerably larger quantity of fluid is made available for expansion. Such a marked increase in the volume of fluid stored would correspondingly increase the potential energy available to impart a higher ejection velocity to the slipper support. However, this larger volume of stored fluid should be located in close proximity to the cylinder 42 so as to minimize line losses, and, in an optimum design, should communicate directly therewith. The reason for this requirement is that the elapsed time between the initiation of piston movement and the ejection of the slipper support from the missile body is too short to permit any appreciable amount of fluid to flow through conduit 54 and thus act to sustain cylinder pressure. Consequently, maximum ejection velocity must be developed early in the ejection cycle.

In order to make a large quantity of compressed fluid available directly at the point of utilization, a so-called "accumulator," or fluid reservoir, is formed directly in the slipper support arm. This accumulator consists of an elongated cylindrical cavity 72 in the piston 40 which is preferably drilled so as to be coaxial not only with the outer surface of the piston but also with the opening 56 in the face plate 50. This cavity or chamber 72 has a volume considerably greater than that of chamber 48. In fact, optimum results are obtained when the fluid storage ratio (by weight) is approximately 6 to 1. The weight of this fluid, in turn, is a function of the pressure required to cause the restraining device (such as shear pin 62) to release.

Although it might be expected that the presence of cavity 72 would appreciably reduce the over-all strength of the slipper support, experiments do not confirm this view. When an opening 6 inches long and of $^{29}/_{32}$ inch diameter was drilled in a piston of 1.75 inch diameter, the margin of safety dropped only from 1.16 to 1.05. However, average ejection velocity of the slipper support increased from 10.6 feet per second to 21.7 feet per second, or a ratio of approximately 2.05 to 1. The size and/or composition of the shear pin 62 is not critical, and both $^{3}/_{16}$ inch diameter brazing rod and $^{1}/_{8}$ inch diameter music wire have been employed with satisfactory results.

In FIG. 4 is shown a form of mechanical restraining device which may be substituted for the shear pin 62 of FIGS. 2 and 3. This assembly includes a detent 74, a spring 76 urging the detent 74 into a depression 78 formed in the surface of the support arm portion 26*a*, and a set screw 80 accessible from the exterior of fitting 30. By rotation of screw 80, the tension of spring 76, and hence the amount of fluid pressure required to eject the slipper support, may be manually determined. Other arrangements may also be employed to prevent the slipper supports from moving in an outboard direction until a certain fluid ejection pressure has been attained. These may include, for example, a wire or cable placed under tension by the pressure of accumulated fluid, or a link assembly which will fail in tension when a predetermined loading pressure has been reached.

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 within

the scope of the appended claims the invention may be practiced otherwise than as specifically described.

I claim:

Slipper ejection apparatus for a missile comprising a source of fluid under pressure, a slipper support receivable in part within a cylindrical recess in the body of said missile, that portion of said slipper support receivable within the said cylindrical recess being in the form of a piston having an elongated cavity coaxially formed therein, means for admitting fluid under pressure from said source to said recess and thence to the cavity formed in said piston to fill the latter, means for restraining movement of said piston in said recess until after the fluid received by said cavity from said source has reached a predetermined pressure, the fluid filling said cavity becoming effective through expansion upon removal of the restraint imposed by said last-mentioned means to produce a sustained force on said piston during the initial phase of its movement and thereby ensure the complete ejection thereof from the body of said missile.

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