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LAUNCHING CONTROL DEVICE

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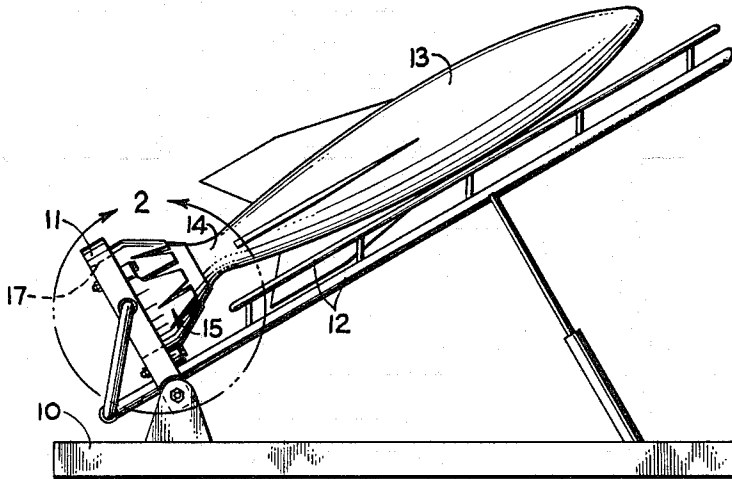


Fig. 1

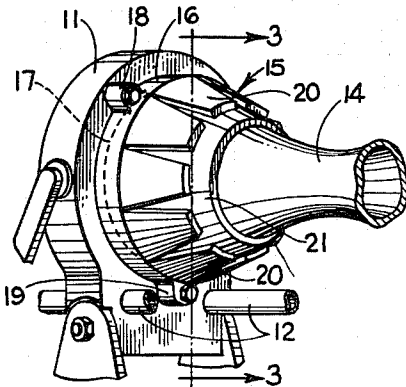


Fig. 2

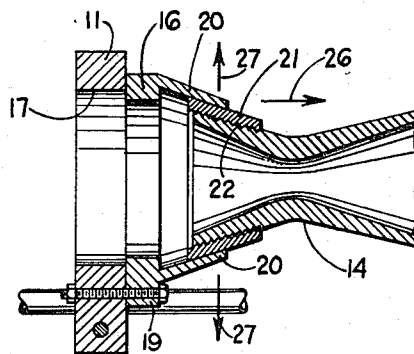


Fig. 3

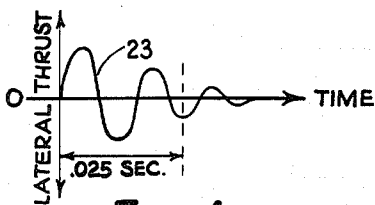


Fig. 4

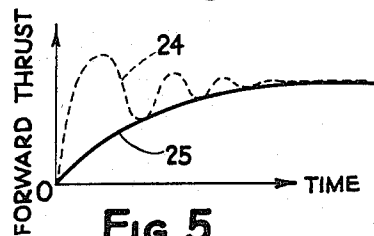


Fig. 5

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1 Claim. (Cl. 89—1.7)

This invention relates generally to launching apparatus for missiles and more particularly, to launching devices for controlling the initial forward movements of rocket propelled missiles.

Missiles or rockets that are unguided in flight, are conventionally launched from frame structures including elongated guide rails or tubes for directing the missile during its initial acceleration in the desired direction of travel. The guide rails are of a length determined by both the characteristics of the propellant and the dispersion and miss-distance that can be tolerated. In the case of missiles employing a solid propellant fuel, there are usually relatively large thrust eccentricities during the initial burning period as a result of non-uniform burning about the surface of the propellant grain. These eccentricities are most pronounced during the initial transient burning of the fuel and therefore can result in large miss distances unless the launcher guide rails hold the missile on course for a sufficient period of time to permit the transient burning periods and their effects to pass and a normal steady state thrust to develop. Usually the initial thrust eccentricities resulting in lateral thrust components diminish to a negligible value within two or three hundredths of a second.

A further problem in launching unguided missiles insofar as minimizing miss distance is concerned, arises from the relatively large initial thrust developed while the missile is still on the launcher frame. This initial thrust impact and resulting high acceleration reacts on both the launcher and the missile setting up elastic waves in the frame which in turn react on the guiding rails for the missile, thereby resulting in possible angular deviations from the desired course.

Bearing the above in mind, a primary object of the present invention is to provide a launching control device in the form of a gradual release mechanism arranged to retard a missile so that it will not leave the launcher guide rails until substantially all lateral components of thrust have passed and the steady state thrust has been established, whereby dispersion and miss-distances are considerably reduced.

Another object is to provide a launching control device which will enable a launcher frame and associated guide rails or tube to be of considerably less length than heretofore employed, and yet properly guide the missile in the desired direction.

Still another object of this invention is to provide a launching control device in which the initial impacts from high transient thrust may be controlled whereby the acceleration of the missile may be programed.

Briefly, these and other objects and advantages of the present invention are attained by providing a hollow frusto-conical member having tapered slot means cut radially along its surface to define a plurality of fingers. This frusto-conical member is rigidly secured to a launching frame. The plurality of fingers are biased to circumferentially grip a peripheral portion of a body or missile to be launched, preferably, the rocket nozzle por-

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tion. The nozzle itself is of a generally similar frusto-conical shape whereby movement of the missile away from the annular frusto-conical member will radially expand the end portions of the fingers so that the missile is gradually released.

The retarding action on the missile by the spring fingers may be controlled by the degree of taper defining the sides of the fingers, the elasticity of the material used, and the angular relationship of the fingers with respect to the axis of the conical members. In some instances it may be desirable to control this angular relationship by employing an adapter having a predetermined exterior frusto-conical surface angle for cooperation with the frusto-conical member and associated spring fingers. This adapter would then be threaded on the rocket nozzle or conceivably another portion of the missile in alignment with the center of gravity of the missile.

A better understanding of the invention will be had by referring to a preferred embodiment thereof as shown in the accompanying drawings in which:

Figure 1 is a schematic elevational view of a rocket launching control device in accordance with the present invention;

Figure 2 is an enlarged perspective view of that portion enclosed in the circular arrow 2 of Figure 1;

Figure 3 is a cross-section taken in the direction of the arrows 3—3 of Figure 2;

Figure 4 is a graph illustrating lateral thrusts; and, Figure 5 illustrates forward thrust characteristics useful in explaining the operation of the present invention.

Referring to Figure 1, there is shown a launching frame base 10 supporting a launcher frame 11 and suitable guide rails 12 for a missile or rocket 13. In accordance with the invention, a peripheral portion of the rocket 13, such as the nozzle portion 14 is held by a gradual release mechanism, designated generally by the numeral 15, rigidly secured to the launching frame 11.

Referring to Figures 2 and 3, the gradual release mechanism comprises an annular member 16 adapted to be secured about the peripheral edges of a central opening 17 in the launcher frame 11, by three bolt lugs circumferentially spaced 120° apart about the opening 17. Two of these lugs 18 and 19 are shown in Figure 2.

The annular member 16 includes a plurality of slots defining tapered fingers 20 extending away from the plane of the annular member 16, generally in the direction of the axis of the rocket 13. Preferably, the annular member 16 and fingers 20 form a frusto-conically shaped body, the fingers 20 being adapted to circumferentially surround a similarly shaped frusto-conical adapter member 21 threaded to the end of the nozzle 14 as at 22, as best shown in Figure 3. Since the fingers 20 integrally extend from the annular member 16, they act as cantilevered springs biased radially inwardly whereby the fingers securely grip the adapter 21. In the event that the nozzle 14 or any other peripheral portion on the missile or rocket body in alignment with its center of gravity were of the proper frusto-conical shape to cooperate with these spring fingers 20, the adapter 21 could be omitted.

Referring to Figure 4 there is shown a curve 23 representing the initial lateral thrust components developed in a solid propellant rocket as a function of time. As shown, the greatest lateral thrusts occur during the first .025 second of burning and are responsible for the greatest dispersion or miss distances in the launching of unguided missiles.

In Figure 5 there is shown in dotted lines a curve 24 representing the variations in the forward thrust components of the rocket with time. Because of the initial un-uniform burning of the propellant grain resulting in

the lateral thrust components illustrated by 23 of Figure 4, the forward thrust components will vary also.

In operation, when a rocket propelled missile having the above described initial thrust characteristics is launched by means of the launching control device of the present invention, the rocket body is held on the launcher rails by the spring fingers 20 until the initial transient lateral thrust characteristics have diminished to a negligible magnitude. Holding the rocket for .025 second is usually sufficient.

Referring to Figure 3, the rocket body is shown in a position shortly after the rocket fuel has been ignited wherein it is moving away from the launcher frame 11 as indicated by the arrow 26. It will be apparent that movement of the body in this direction will radially expand the spring fingers 20 as indicated by the arrows 27, resulting in a gradual releasing of the body.

As the nozzle 14 moves toward the end of the spring fingers, the radial expansion thereof increases because of the angle of the conical surface, and thus an increasing force is required to move the fingers. On the other hand, movement of the nozzle 14 toward the end of the spring fingers enables the radial expansion of the fingers to be effected more easily inasmuch as the fingers are cantilevered and a longer lever arm is provided. The retarding or resisting force to movement of the missile may thus be accurately controlled by the conical angles of the adapter and fingers and by the elastic constant of the cantilevered fingers 20 which in turn is controlled by the degree of taper in the fingers. The design is such, however, as to insure that the relative movement of the fingers are well within the elastic limit of the material used.

In practice, the design of the spring fingers is such that it will hold the rocket propelled missile on the launcher for at least .025 second in order that the transient thrust eccentricities will have become negligible in magnitude before the missile is actually released.

In many instances, however, it may be desirable to retard the missile for an even longer period of time in order to program the initial acceleration and thus the initial force reactions on the launching frame. Referring again to Figure 5, the curve 25 illustrates an example of how the forward thrust may be programed wherein it will be noted that the effective rocket thrust in a forward direction gradually builds up to operating value as the missile is gradually released by the spring fingers. By a gradual and smooth programing of the acceleration of the missile, reaction forces resulting in elastic waves in both the launching frame and missile are substantially eliminated and dispersion or a large miss distance as a result of launching frame reaction on the missile itself is inconsequential. Programing the initial thrust or acceleration is also important in applications where sensitive instruments are carried by the missile in that the acceleration can be kept below values which may result in damage to such instruments.

In the actual design of the spring fingers for programing the launching of the rocket, the fingers themselves need not be of a great length. For example, assume that the programing or gradual releasing of the missile is to

extend over a period of .04 second after the rocket has reached a steady state thrust, that is after all transients have become negligible. The spring fingers are designed to exert sufficient force on the rocket nozzle of the missile to prevent any movement of the missile until this operating or steady state thrust has been attained. Assume that the operating or steady state thrust is then sufficient to radially expand the fingers and further assume that the average acceleration of the missile while moving past the length of the fingers is 10 g's. If S equals the length of the fingers, then, $S = \frac{1}{2} at^2$ where a is equal to 10 g and t is equal to the programing time. For .04 second and an acceleration of 10 g's, $\frac{1}{2} (10) (32) (.04)^2 = .256$ ft. or $S = \text{about } 3''$. Thus a comparatively short finger length is all that is required to stabilize the missile before release. Since the force is normal to the fingers as the result of forward movement of the missile and many times greater than any thrust eccentricities, the rocket may be launched with extreme accuracy with the device of this invention.

It should also be noted that by means of the present invention long guide rails or tubes are unnecessary and therefore conventional launching frames may be made considerably shorter than heretofore thought necessary for attaining the same accuracy.

Modifications within the scope and spirit of this invention will occur to those skilled in the art. The invention is therefore not to be thought of as limited to the particular apparatus chosen for illustrative purposes.

What is claimed is:

An apparatus for gradually releasing a rocket propelled missile comprising in combination: a launching frame; a hollow frusto-conical member having tapered slot means cut laterally along its surface to define a plurality of fingers; means rigidly securing said frusto-conical member to said launching frame; a frusto-conical adapter member adapted to be secured to a portion of said missile in alignment with the center of gravity thereof, said adapter having a surface angle with respect to the axis of said frusto-conical member for cooperation with said plurality of fingers, said fingers circumferentially gripping said adapter member, said surface angle and the taper of said slot means being such that relative movement of said adapter and missile with respect to said frusto-conical member and launching frame is retarded by the radially directed spring force of said fingers for a period greater than the period during which initial transient thrust eccentricities exist.

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