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LAUNCHING STABILIZER FOR MISSILES

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2 Sheets-Sheet 1

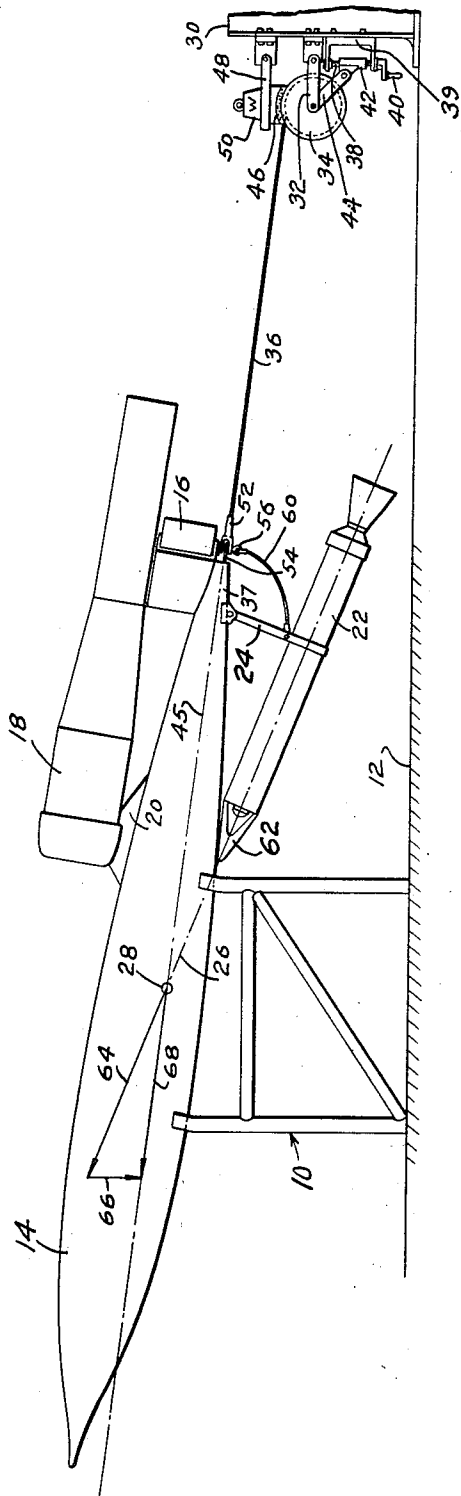


Fig. 1.

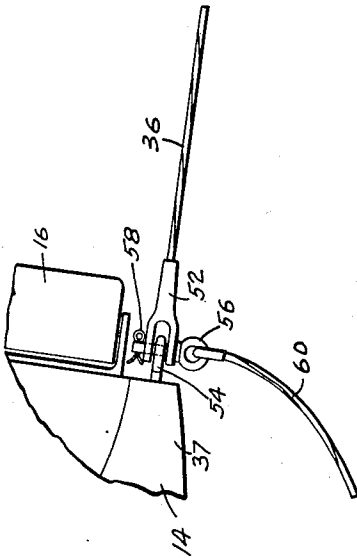


Fig. 2.

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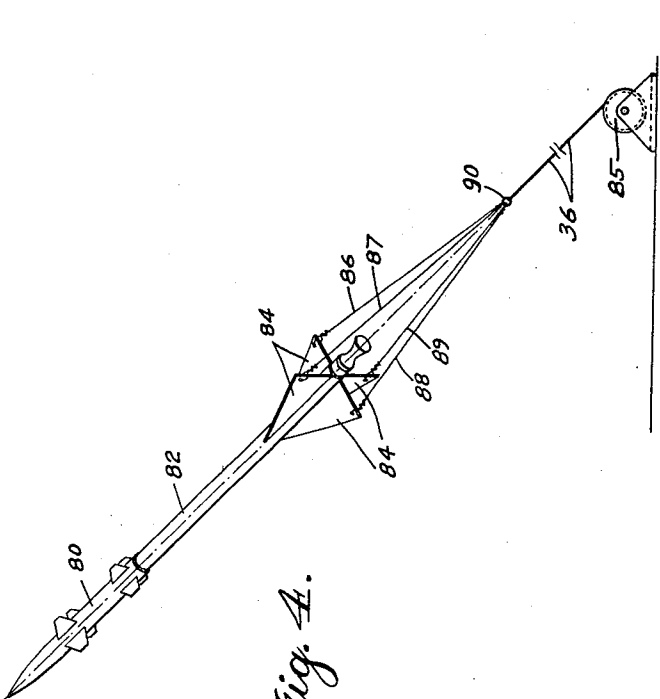
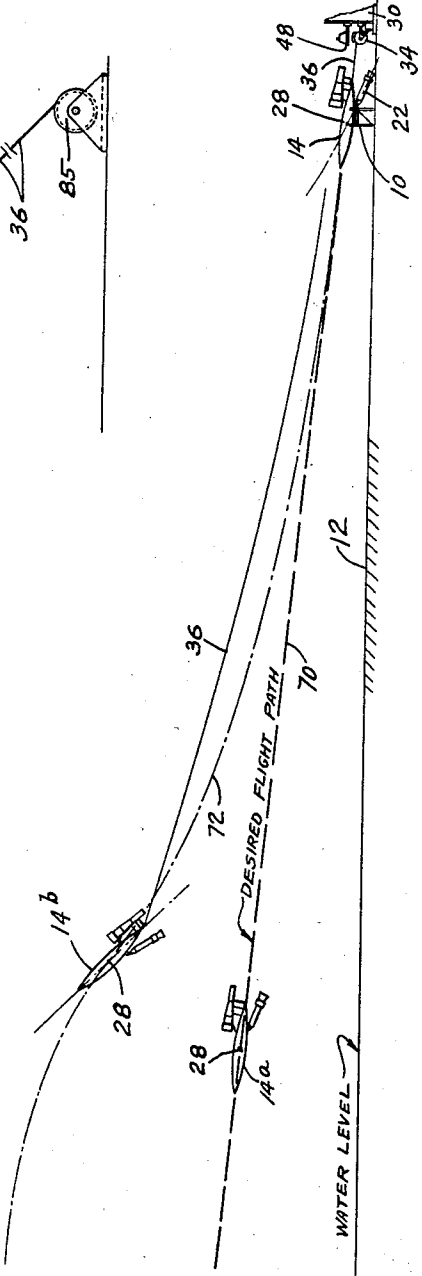


Fig. 4.

Fig. 3.



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LAUNCHING STABILIZER FOR MISSILES

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3 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 a device for stabilizing a missile during the period while it is being launched by rocket power or the like. The missile may be a guided missile, and may be launched from a submarine or other floating platform by booster rockets, but the invention is capable of application to diverse other types of situations.

The launching of a missile from a water-borne craft such as a submarine presents the usual launching problems in more acute form than is the case where a stationary platform is used. The length of the launching ramp is limited by the dimensions of the craft, and the rolling and pitching of the craft; together with possible misalignment of the rockets, produce in the missile adverse moments which, during the launching phase, tend to cause it to deviate in pitch and yaw and consequently from the desired flight path. Such deviation beyond a certain amount cannot be corrected by the autopilot of a guided missile because the speed is so low that the effective air pressure upon the control surfaces of the missile is too low.

The present invention increases the safety of the launching operation by applying a retarding force to the rear end of the missile fuselage during launching, thus producing a stabilizing moment around the center of gravity of the missile counteracting undesired deviations of the missile in pitch and yaw. The stabilizing force is applied by a flexible cable or wire which is payed out from a drum mounted on the ship or the ground.

An object of the invention is to provide improved apparatus of the type above mentioned for stabilizing a missile during launching.

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 description.

Fig. 1 is a view in side elevation of a missile provided with apparatus embodying the present invention;

Fig. 2 is an enlarged detail of the release mechanism;

Fig. 3 is a diagrammatic view illustrating some of the principles involved in the operation of the device; and

Fig. 4 is a perspective view of a missile of different type provided with a modified form of the invention.

Referring to Fig. 1, there is shown a launching stand or "zero length ramp" 10 mounted upon a platform such as a submarine deck 12. Upon the stand is mounted a missile comprising a body 14, a rudder 16, and an engine 18 secured by means such as a bracket 20 to the body of the missile. The missile may also comprise wings, elevators, and other known elements, not shown. A booster rocket 22 of the JATO type is releasably secured to the body 14 by means of a frangible bracket member 24, and is so aligned that its line of thrust, indicated at 26, passes through the center of gravity of the combined

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missile and booster rocket, indicated at 28. The missile is provided with an autopilot, not shown, designed to control its flight after the launching stage is completed. The structure thus far described is old.

Mounted on the platform 12 is a support 30 to which is pivotally connected an arm 32 which supports a reel 34. Upon the reel is wound a flexible cable 36 the outer end of which is secured to the tail 37 of the missile as described hereinafter. The inner end of the cable may be unsecured to the reel, or may be secured by any suitable type of frangible fastening, not shown; in either case, when the cable is unwound from the reel its rear end leaves the reel and trails after the missile. A threaded rod 38 is rotatably mounted in a frame 39 secured to support 30, and may be rotated by means of a crank 40 to move upwardly or downwardly an internally threaded sleeve 42. A link 44 has one end pivotally connected to the sleeve and its other end pivotally connected to arm 32, so that rotation of crank 40 will move the reel upwardly or downwardly to align the cable 36 with a line 45 extending from the tail 37 through the center of gravity 28.

The brake shown schematically in Fig. 1 comprises a shoe 46 carried by an arm 48 pivotally connected to the support 30 and adjustable by any suitable means such as a weight 50.

The cable 36 is secured to the missile by means of a clevis 52 held in engagement with an eye-bolt 54 on the missile by a release bolt 56 which passes through the clevis and is held in place by a frangible cotter key 58.

A release cable 60 connects the release bolt 56 to the bracket 24 adjacent the booster rocket 22. The forward end of the booster rocket is connected to the body of the missile by a socket member indicated at 62, from which the booster rocket separates automatically by its weight and drag when the thrust ceases. The bracket 24 will also separate automatically at the same time because of the backward motion of the booster relative to the missile. It will be seen that the jettisoning of the rocket will put release cable 60 under sufficient tension to shear the cotter key 58, thereby releasing and jettisoning the stabilization cable 36.

The forces acting on the missile are shown diagrammatically in Fig. 1, and comprise a vector of rocket thrust 64, a gravity vector 66, and a resultant vector 68 which represents the flight path line through the center of gravity 28. It is an essential principle of the invention that the cable 36 be adjusted to the missile in such manner that the cable line coincides with the flight path line as determined by the vector triangle.

The operation of the device is indicated in Fig. 3, wherein the desired pitch attitude of the missile is indicated at 14a and the desired flight path at 70. 14b shows the missile in the undesired "nose-up" pitch attitude, which may be caused by a nose-up misalignment of the booster. The undesired flight path line resulting from this nose-up pitch attitude is indicated at 72. In the position and attitude of the missile indicated at 14b in Fig. 3, it will be seen that the tension of the cable applied to the rear end of the missile will exert a turning moment about the center of gravity thereof, tending powerfully to cause it to nose down. An opposite corrective moment will be applied if the missile deviates downwardly from the desired flight path, and in fact a corrective moment will be applied whenever the attitude of the missile deviates in pitch or yaw from the proper attitude.

The length of cable 36 is preferably such that it is completely unreel well before the booster rockets have burned out. By the time the missile has attained sufficient velocity, say when one half the burning time of the rockets has elapsed, the autopilot will in most instances be able to prevent the missile from further increases of the angles of pitch and/or yaw.

Fig. 4 shows the invention applied to a missile 80 which is in process of being launched by means of a booster rocket 82 having four tail fins 84 for aerodynamic stabilization. The cable 36, shown as being unreeled from a reel 85, is connected to the booster rocket by means of a bridle comprising cable lengths 86, 87, 88, 89 which extend from a common junction 90 to the respective fins 84. At the end of the boost phase, the booster rocket is jettisoned by known means, not shown, and this action will also jettison the cable and bridle. It will be seen that the bridle will increase the lever arm of the force exerted by the stabilization cable and thus bring about more prompt rectification of the missile attitude or flight path. The tension in cable 36 may be controlled by suitable brake means such as those shown in Fig. 1. It will be clear that either pair of cable lengths 86, 88 or 87, 89 may be omitted if desired, at some sacrifice of the stabilizing leverage.

At the end of the stabilizing phase, where the apparatus of the present invention is used, the deviations of the missile in pitch and yaw, as well as in the flight path, will be relatively small. In particular, the angular momentum in pitch and yaw which the missile may have gained is only a small fraction of the momentum that would be gained without using the stabilizer. Consequently, the autopilot will then be capable of taking over.

An optimum stabilizing effect is achieved when the cable force and the cable length are so combined that the cable separates from the brake drum as soon as the angular deviation of the missile begins to reverse. This optimum combination can be determined for each missile type through calculation.

The retarding force to be applied to the missile for achieving an effective stabilization is small, generally not more than 2 to 6 percent of the thrust of the booster rocket. The best duration of its application is in the order of less than 50 percent of the entire boost time. Consequently, the impulse consumed by the stabilizer will be in the order of 1 to 3 percent of that of the rocket.

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.

What is claimed is:

1. For use with a missile having a propellant device designed to be jettisoned after the missile is launched, a cable, a connection securing the forward end of said cable

to said missile aft of its center of gravity, friction means for tensioning said cable during launching of the missile, and means operative upon jettisoning of said propellant device for breaking said connection, said last named means comprising a release cable connecting said propellant device to said connection, and frangible means in said connection designed to be broken by tension in said release cable.

2. For use with a missile having a propellant device operable to separate itself from the missile after the same is launched, a flexible tension member, a connection securing one end of said tension member to said missile aft of its center of gravity, and means operable upon separation of the propellant device from the missile for breaking said connection, said means comprising a release cable connecting said propellant device to said connection to cause the drag of the propellant device to exert tension upon the connection.

3. For use with a missile of the V-1 type having a booster unit connected thereto and operable to separate itself from the missile after the same is launched, a flexible tension member having one end secured to the missile aft of its center of gravity, means for frictionally paying out the tension member from a fixed point, and means operable upon separation of said booster unit from the missile to detach the tension member from the missile, said last mentioned means comprising a clevis and clevis pin connecting said tension member to the missile and held together by a frangible key, and a release cable connecting said booster unit to said clevis pin to cause the drag of the separated booster unit to break said key.

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