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MISSILE GUIDANCE SYSTEM

Filed March 5, 1956

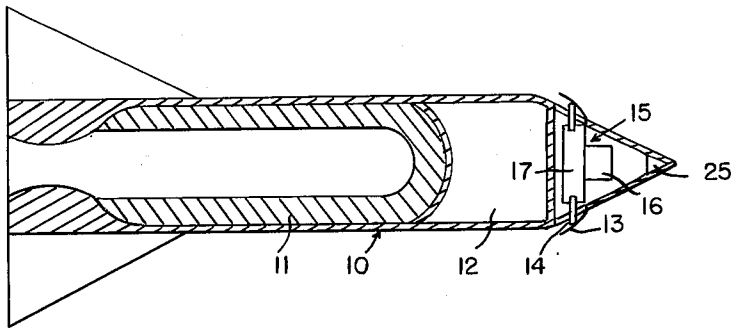


FIG. 1.

FIG. 2.

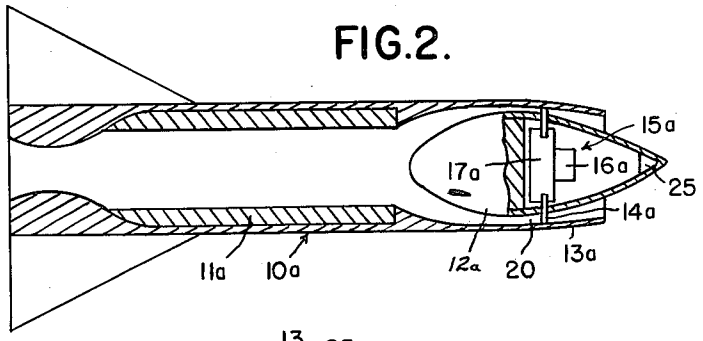
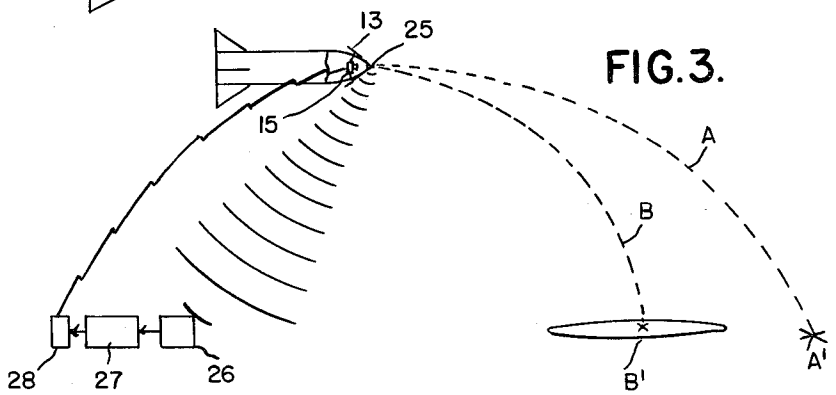


FIG. 3.



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MISSILE GUIDANCE SYSTEM

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4 Claims. (Cl. 244—14)

The invention relates to ballistic missiles and particularly to a ballistic missile guidance system for attaining increased accuracy of trajectory control. As the range of missiles increases, the problem of accuracy in striking the designated target has become more critical. It is recognized that the lateral accuracy of the missile, or deviation from the target in a line perpendicular to the trajectory path, is not too great a problem for an aerodynamically stable missile, particularly if it is rotated during flight. However, due to possible variations in the initial velocity of fixed and rocket boosted missiles and in the engine performance of self-propelled missiles, especially solid fuel rockets and ram jets, the longitudinal accuracy of the missiles, or deviation from the target along the trajectory path, is a problem which this invention proposes to solve.

Many powered or self-propelled ballistic missiles are designed so that the fuel burns for only a portion of the trajectory, after which time the missile follows a normal unpowered ballistic trajectory. By determining the altitude, velocity, and position of the missile at any point in the trajectory path after fuel exhaustion, and by knowing the weight and drag coefficient of the missile, the point of subsequent impact may be computed in a manner that lends itself readily to computation on an analog computer. Thus the precise deviation from a theoretical trajectory path which will make point-of-impact coincide with a specified target position may be determined. The present invention is based on these facts.

A particular object of the present invention is to improve the accuracy of ballistic missiles by providing a simplified means of selectively altering the trajectory of the missile so as to bring it onto the target with a high degree of accuracy.

Another object of the invention is to provide a means for altering the trajectory of a ballistic missile by constructing a drag changing device operated in response to electronic remote control signals.

A more complete understanding of the invention may be had by reference to the accompanying drawing illustrating preferred embodiments of the invention in which like characters refer to like parts throughout the several views and in which—

Fig. 1 is a cross-sectional view of a representative ballistic missile incorporating a preferred embodiment of the invention.

Fig. 2 is a cross sectional view of another type of ballistic missile incorporating another preferred embodiment of the invention, and

Fig. 3 is a diagrammatic view illustrating a possible guidance control system utilizing the invention.

Referring to Fig. 1, a rocket type ballistic missile **10** is illustrated preferably having a solid fuel propellant **11** and a warhead **12**. Vanes or flaps **13** are adjustably secured to the missile by any convenient means and are connected by control rods **14** or other means to a servo mechanism **15**. The servo mechanism **15** comprises an

electronic signal receiver **16** of any conventional type required, and an actuator **17**. The servo mechanism **15** is operatively responsive to a controlled electronic signal and translates the received signal to the flaps **13**, which are accordingly moved into or out of the air stream passing the missile while in flight. The controlled electronic device may be remotely located with respect to the missile in flight or may, if desired, be incorporated or carried by the missile.

Fig. 2 illustrates a ram jet type ballistic missile **10*a***, preferably having a solid fuel propellant **11*a*** and a warhead **12*a***. An air passage **20** to the ram-jet propellant is provided, preferably near the nose of the missile as illustrated. Vanes or air passages gates **13*a*** are adjustably secured within the air passage **20** by any convenient means and are connected by control rods **14*a*** or other means to a servo mechanism **15*a***, comprising a receiver **16*a*** and an actuator **17*a*** of similar construction as that shown in Fig. 1.

In both Figs. 1 and 2, the effect achieved by adjusting the flaps **13** or gates **13*a*** respectively is to alter the drag coefficient of the entire missile a controlled degree in accordance with the signal received. This alteration plainly affects the trajectory or glide path of the missile. When the flaps or gates are retracted, the trajectory will be greater than when the flaps or gates are extended.

One method of utilizing the drag alteration factor is illustrated in Fig. 3. The missile at some point in flight may have a trajectory as represented by the dotted line A, which is partially a function of the missile drag coefficient. A signal emitter **25** in the missile transmits a signal which is received by any conventional reception means **26**, remotely located or carried by the missile, and indicates the missile velocity, altitude, and distance. This information is relayed to a computer **27**, which determines the theoretical point of impact A′ along the trajectory A, correlates this with the known target position B′ and missile drag coefficient, and computes in this case the amount of drag increase required to alter the trajectory or glide path to that represented by the dotted line B. The result is relayed to a transmitter **28** and translated into the required signal which is received by the servo mechanism **15** in the missile.

The flaps **30** are extended accordingly into the airstream, increasing the drag coefficient and altering the trajectory of the missile the desired degree.

It is to be noted that a radar tracking system could be utilized in place of the signal emitter. Also, trajectory A might be less than trajectory B, requiring that the drag coefficient be decreased, in which case the flaps **13** would be retracted the desired amount.

All of the required control equipment carried in the missile are items that may be commercially available and can be small enough to fit in a comparatively small volume. Also it should be pointed out that practically any type of ballistic missile, whether self-propelled as in the types illustrated, fired, or rocket boosted, will be adaptable to the simplified guidance system.

In addition, although the concept of altering trajectory in the manner described is illustrated in relation to air to ground and ground to ground type of missiles, it may be seen that the principle would be applicable to ground to air and air to air type of missile if desired.

Although we have described only a few embodiments of the invention, it will be apparent to one skilled in the art to which the invention pertains that various changes and modifications may be made therein without departing from the spirit of the invention or the scope of the appended claims.

We claim:

1. A ballistic missile having a predetermined drag co-

efficient and operable to travel a predetermined ballistic flight trajectory, a guidance system for said missile and comprising adjustable drag means carried by said missile and selectively variably increasing the drag coefficient of the missile symmetrically with respect to the axis thereof to variably alter the trajectory of said missile in the vertical plane only, and remote control actuating means selectively increasing and decreasing the drag effect of said drag means in flight to control within limits the trajectory of said missile.

2. A ballistic missile having a predetermined drag coefficient and operable to travel a predetermined ballistic flight trajectory, a guidance system for said missile and comprising adjustable drag means carried by said missile and selectively variably increasing the drag coefficient of the missile, symmetrically with respect to the axis thereof to variably alter the trajectory of said missile in the vertical plane only, and remote control actuating means selectively increasing and decreasing the drag effect of said drag means in flight to control within limits the trajectory of said missile, said actuating means comprising an actuator operatively connected to said drag means and operable in response to a controlled electronic signal to variably actuate said drag means, an electronic signal receiver, and means translating the signal to the actuator.

3. A ballistic missile having a predetermined drag coefficient and operable to travel a predetermined flight trajectory, a guidance system for said missile and comprising adjustable drag means carried by said missile and operable to selectively change the drag coefficient of the missile to alter the trajectory thereof, and remote control actuating means operable to adjust said drag means in flight, said actuating means comprising an actuator operatively connected to said drag means and operable in response to a controlled electronic signal, an electronic signal receiver, and means translating the signal to the actuator, said missile having an air passage therethrough, said adjustable drag means comprising a gate structure adjustably secured to said missile, and operable to be selectively positioned in the internal air stream passing through said missile air passage in flight.

4. A ballistic missile having a predetermined drag coefficient and operable to travel a predetermined flight trajectory, a guidance system for said missile and comprising adjustable drag means carried by said missile and only operable to selectively change the drag coefficient of the missile to alter the trajectory thereof in the vertical plane, and remote control actuating means operable to adjust said drag means in flight, said actuating means comprising an actuator operatively connected to said drag means and operable in response to a controlled electronic signal, an electronic signal receiver, and means translating the signal to the actuator, said adjustable drag means comprising a flap structure adjustably secured to said missile and operable to be selectively positioned symmetrically with respect to the axis of said missile in the external air stream passing said missile in flight.

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