

April 3, 1962

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3,028,119

MISSILE GUIDANCE SYSTEM

Filed April 24, 1956

2 Sheets-Sheet 1

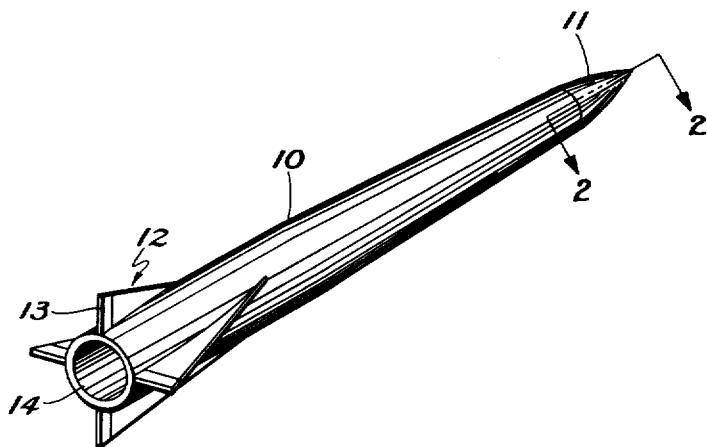


FIG 1

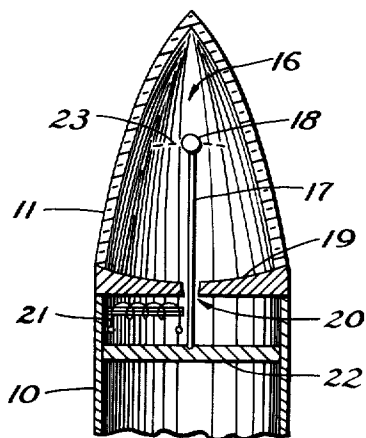


FIG 2

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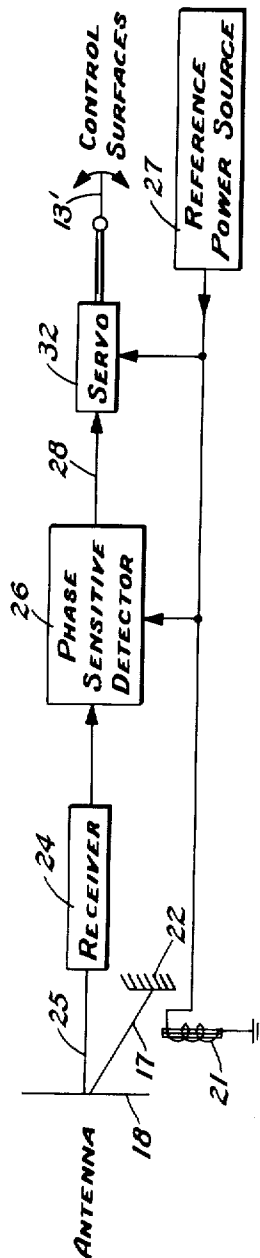
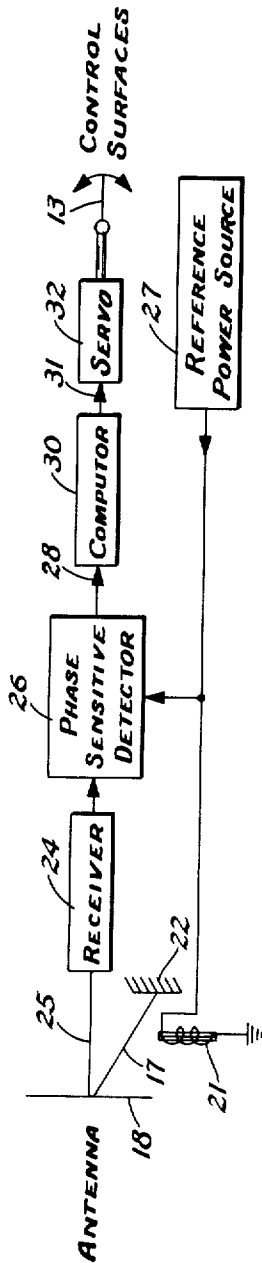
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MISSILE GUIDANCE SYSTEM

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2 Claims. (Cl. 244-14)

This invention relates to missile systems and more particularly to passive target-seeking missile control systems.

Prior art seeking-missile systems have involved unduly complicated arrangements for sensing radiation and controlling the control surfaces therefrom. The usual form of antenna has been some type of nutating or rotating antenna or radiation receiving means. This has involved an excessively complicated control derivation system to translate the information received by the nutating antenna into simple, Cartesian coordinate signals useable on control surfaces. Furthermore, these prior art systems have been unduly heavy as a result of their complication with a result that the missile payload has been reduced.

Accordingly, it is an object of this invention to provide a simple yet effective antenna system and a direct-acting control system for actuation of the control surfaces of a passive target-seeking missile.

It is a further object to provide a simplified control signal deriving system.

It is a feature of this device that the antenna is effectively moved only in one direction transverse to the axis of the missile relying on a reflecting surface behind it and the rotation of the missile to provide a full scan of the possible paths of the missile.

It is a further feature of this device that the antenna system is relatively simple and compact.

It is a further feature of this invention that the control signal deriving system has relatively few components and is inherently stable.

Further objects, features, and advantages of the invention will become apparent from the following description and claims when read in conjunction with the drawings, in which:

FIGURE 1 shows a perspective view of a self-rotating missile,

FIGURE 2 shows a section of the nose along the line 2-2 showing more clearly the antenna arrangement,

FIGURE 3 shows a control system for a four control-vane system on the tail surfaces of the missile and,

FIGURE 4 shows a simplified version adaptable to a missile having only a pair of opposed control vanes.

FIGURE 1 shows a perspective view of the missile going away from the observer. As a typical of the self-propelled types, it has a long, slender substantially cylindrical body 10. A nose section 11 is transparent to electromagnetic radiation at the frequency to which the receiving system is tuned. Tail fins 12 are cocked relative to the axis of the body 10 to provide rotation of the body on its axis. On the trailing edge of each tail fin is rudder or vane 13 which is hinged on a pivot transverse to the axis of the cylindrical body. The missile has an exhaust port 14. This missile is self-propelled but it is obvious that other missiles may have this control system installed therein.

FIGURE 2 shows a cross section of the nose section. Here the body 10 terminates in the nose section 11 which is streamlined in accord with aerodynamic principles. The interior of the nose section is hollowed, 16, at least to the extent of providing a clearance for a vibrating mounting member 17 and a radiation sensitive device 18 carried on the tip of said mounting means thereof. The end of the body portion adjacent said nose is terminated in a reflecting surface 19 which is concave towards said nose and arranged to focus radiation received through

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the transparency of nose 11 onto the sensing means 18. Reflector 19 has a slot 20 cut through the central portion to provide clearance for said mounting member 17. An electromagnet 21 is shown schematically to illustrate the manner in which mounting bar 17 and the sensing means 18 is cyclicly moved or vibrated transversely to the axis of the missile. The motion is great enough, in cooperation with the reflector to cause a relatively small fan of response to sweep transversely of the forwardly looking volume into which the missile enters. Rotation of the missile then causes a scan of the entire volume forwardly of the missile. Circuit connections, not shown, connect radiation sensing means 18 through to the bulkhead 22.

Where it is desired to have no moving parts in the scanning system, a plurality of dipoles are disposed in successive positions along the path 23 seen in FIGURE 2 which the single sensing means 18 has as it scans. This alternative form of scanning then occurs by a cyclic switching of the plurality of sensing means so positioned. The switching will take place in a manner similar to the actual physical scanning occurring with the movable antenna. This means that a single antenna will be connected at any one time to the input of the receiver 24 as seen in FIGURES 3 and 4.

Where the radiation utilized is visible light, nose section 11 will be optically transparent and reflector 19 will be an optical reflecting surface. Sensing means 18 will then be a photocell capable of withstanding the high acceleration involved. Similarly, use of infrared radiation will require transparency of the nose section and sensitivity of the sensing means to infrared frequencies. The preferred form, however, is that sensitive to radar frequencies where the nose section 11 is transparent to at least the radar frequency received. Reflection means 19 is merely metallic and sensing means 18 is a dipole cut to the length of the radar radiation used. A typical radar frequency would be three thousand megacycles per second.

The source of radiation to which the guided missile is sensitive originates on the ground or on some aircraft flying within sight of the target. The radar radiation reflecting from the target to this missile is sensed by the radiation sensing means 18 utilized in deriving a control signal for the control of the missile. While operative with visible radiation, the device is preferably operated in a frequency range in which clouds, haze, dust, etc. do not block the radiation, making the missile independent of weather conditions.

FIGURE 3 shows a control system applicable to the missile shown in FIGURE 1. Here antenna 18 receives the radiation. Receiver 24 is connected to antenna 18 by a transmission line 25. Transmission line 25 is flexible and adapted to be a part of the lever which mounts antenna 18. Lever 17 and bulkhead 22 are shown schematically to illustrate the mounting of the antenna. Electromagnet 21 is placed adjacent lever 17 to move it and the antenna. Receiver 24 is tuned to make the most of the output of the sensing means 18. Receiver 24 has sufficient gain to excite the phase detector properly, taking into account the signal level input from 18.

The output of the receiver 24 is applied to a phase sensitive detector 26. A reference source of alternating current 27 is applied to phase sensitive detector 26 and to coil 21. The phase sensitive detector uses the reference source to discern the position of the signal detected by the antenna relative to the axis of the missile, knowing the positions of the antenna caused by the energization of coil 21 by the reference source. The antenna, being vibrated transversely, is right-left positioned. By the use of phase sensitive detector 26 a signal appears at its output 28 which, by polarity, is right-left indicative of radiation coming from the target sought. The amplitude

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of the error signal developed by 26 increases as a function of the deviation from the axis of the missile.

The rest of the system is control system. A computer 30 takes error signals and modifies them in view of the missile's structure. The computer thus derives signals as its output, at 31, which are consistent with the geometry of the missile. Then the servos set the control surfaces intermittently in a direction transverse to the error direction, by a servo such as 32 which each rotate or deflect vane surfaces such as 13. The computer establishes the amount of deflection required for each of the four surfaces 13 with relation to the sensed signal so that the control surfaces are moved or not, depending on whether they will be effective in deflecting the missile toward the target.

FIGURE 4 shows a simplified version with an improvement in the servo portion.

In FIGURE 4 the system is similar to that in FIGURE 3 up to the output 28, yielding an error signal showing right or left orientation of the target relative to the axis of the missile at an instant. This right-left voltage is applied to one input of the servo system with voltage from reference source 27 applied to a sensitivity control input of the servo system. The sensitivity of the servo system is modified by this reference voltage, the sensitivity to the input signal being greater as the deviation is greater. This sensitivity variation is readily related to the deflection of the sensing means as indicated by the currents in coil 21, a phase correcting network being used where necessary to ensure the proper phase relationship.

Servos such as 32 each position one of a pair of opposed control surfaces, 13'. The reference numeral 13' is used to emphasize the fact that only two surfaces, similar to those of FIGURES 1 and 3, are used. These two surfaces are on opposite sides of the missile at the rear and pivoted on a transverse axis which is perpendicular to the path of motion of the radiation sensing means 18. It is readily seen that the substantially instantaneous deflection of control surfaces 13' in response to a right-left sensing by the antenna means directs the missile toward the target. On-target stability is further enhanced by use of the reference voltage controlling the sensitivity of the servo system.

In use, the target is located by ground or air-borne radar of some predetermined frequency. At the instant desired, the missile is launched towards the target. Once air-borne, the radiation sensing means 18 becomes operative and senses the reflected radiation returning from the target. As the missile progresses along its path the vanes 12 rotate the missile. This rotation plus the transverse vibration of the radiation sensing means 18 permits a full scanning of the volume of space in front of the missile. Reception of a signal by the antenna 18 operates through the system to give a right-left signal at the output 28 of the phase sensitive detector which then actuates the servo to move the control surfaces. The servo is so sensed relative to the right-left signal and the equations of motion established by the control surfaces, to move the control surfaces so as to deflect the missile toward the target. As the missile path comes onto the

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target in an intersecting course, the error reduces to zero; whenever the course of the missile develops an error, this shows up and the system repeats the reduction of error so that the missile path stays on target.

Other applications of the missile controlled by this system are readily discernible such as use of infrared sensitive sensing means directed by the sender of the missile towards the exhaust or other point source of energy located on or near the target. Passive missiles of this type actually fly into the exhaust port of the engine of a jet aircraft. The utility of the device arises from the operational fact of it being passive and receptive to a radiation characteristic of the target regardless of the origin of the radiation such as ground based radar or accidental emanation from the target itself.

Although this invention has been described with respect to particular embodiments thereof, it is not to be so limited as changes and modifications may be made therein which are within the full intended scope of the invention as defined in the appended claims.

I claim:

1. A guided missile radiation sensing means for a rotating missile comprising radiation sensing means, means continuously movable transversely to the axis of the missile in a single plane relative to the axis of the missile, said sensing means being mounted on said movable means, said movable means being mounted on a forward portion of said missile, cover means enclosing said radiation sensing means and completing the forward portion of said missile, said cover means being transparent to the radiation to which the sensing means responds, and reflector means intermediate said sensing means and said forward portion of said missile body.

2. A missile control system for a rotating missile comprising a radiation sensing means having means continuously movable transversely to the axis of the missile in a single plane relative to the axis of the missile, said sensing means being mounted on said movable means, said movable means being mounted on a forward portion of said missile, cover means enclosing said radiation means, said cover means being transparent to the radiation to which the sensing means responds, receiver means connected to said radiation sensing means, phase sensitive detection means for converting the output of said receiver into a control signal in accord with the position of sensed radiation relative to the axis of said missile, servo means, and means connecting said servo means to said phase sensitive output whereby the mechanical position output of said servo is a function of the deviation of a source of radiation from the axis as sensed by said system.

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