

[54] **HOMING MISSILE**

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Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 602,453, Dec. 13,
1966, abandoned.

[52] U.S. Cl. **244/3.16, 244/3.15**

[51] Int. Cl. .. **F42b 15/16, F42b 15/00, F42b 15/02**

[58] Field of Search..... **244/3.16; 250/204;
350/274; 343/112, 117**

[56] **References Cited**

UNITED STATES PATENTS

2,560,265	7/1951	Adler, Jr.	343/112
3,024,079	3/1962	Salvatori et al.	350/274

3,482,103	12/1969	Martinsen	250/204
3,042,917	7/1962	Elhoff	343/117

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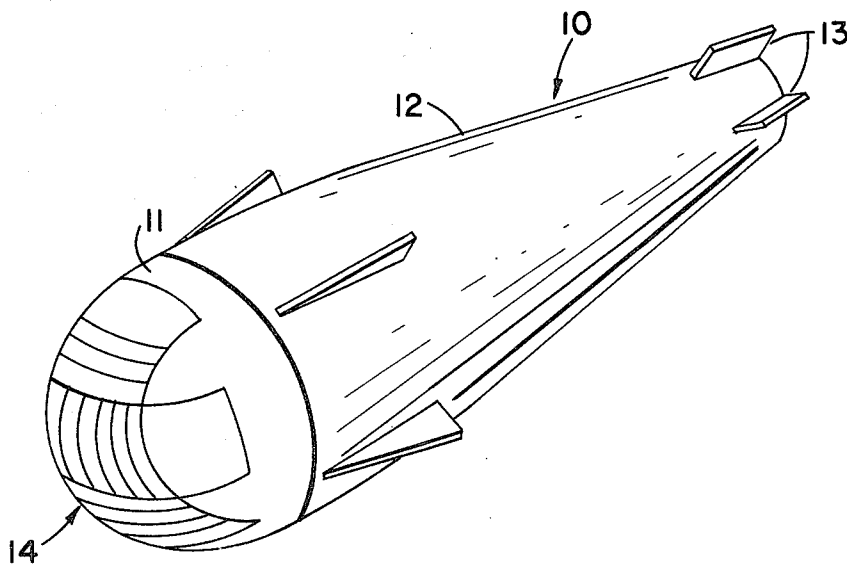
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[57] **ABSTRACT**

A uniform array of quasi-optical horn shaped baffles are carried on the hemispherical nose of a missile. The horns are so made that each one has a field-of-view of a discrete portion of the space around the missile nose. Each horn is generally a hollow wedge with its point on the longitudinal axis of the missile, its open base on the nose of the missile, and with a photocell inside near its point. A discrete horn provides an output from its photocell for a particular point-source target. Each output causes a unique output from a digital-to-analog converter. The output of the converter is the input to a controller for the steering fins of the missile.

2 Claims, 6 Drawing Figures



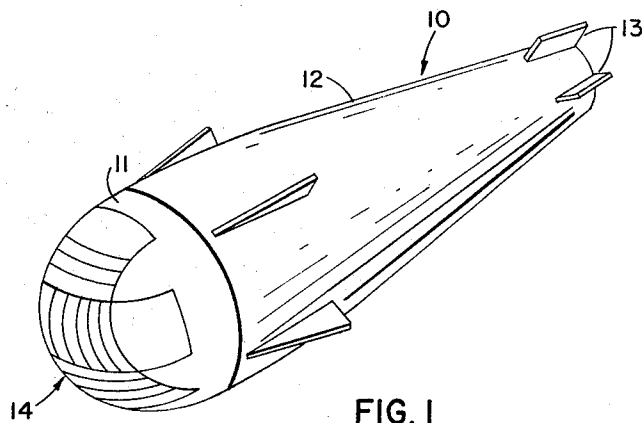


FIG. 1

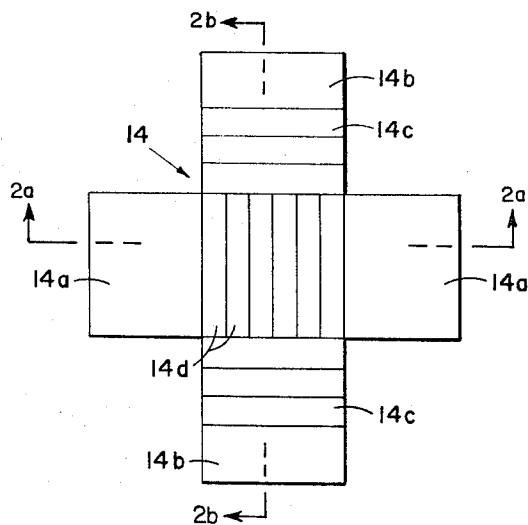


FIG. 2

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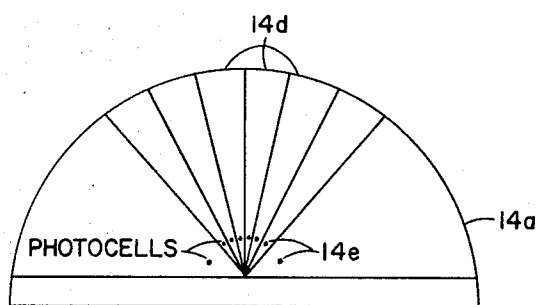


FIG. 2a

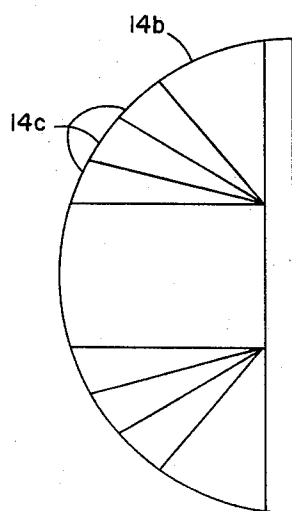


FIG. 2b

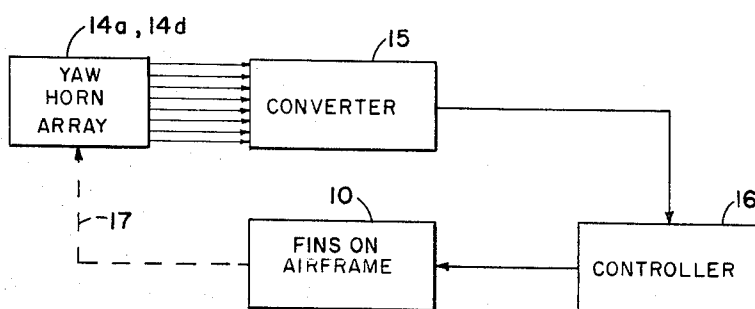


FIG. 3

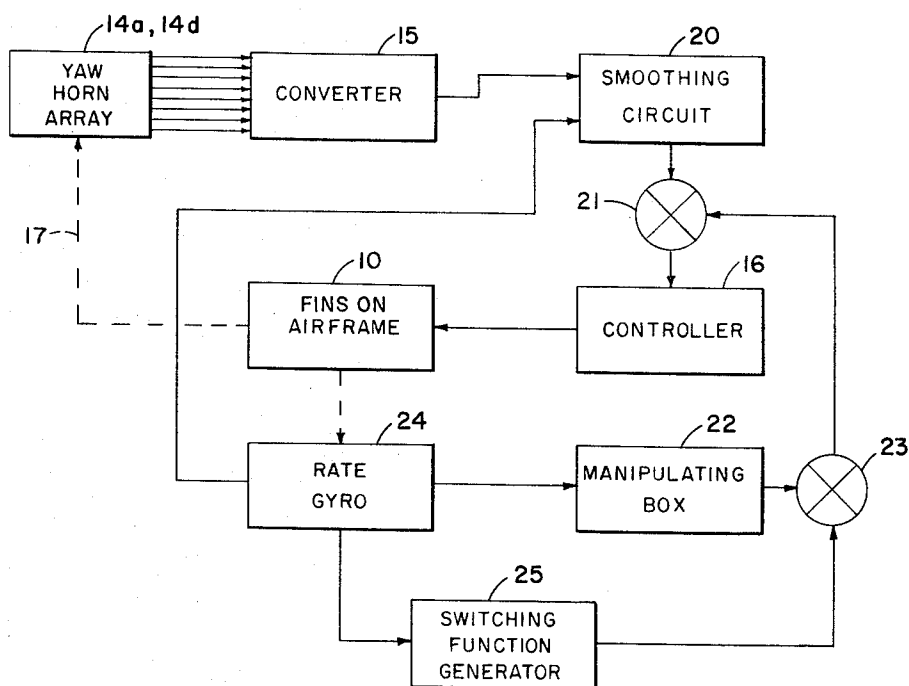


FIG. 4

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HOMING MISSILE

CROSS REFERENCE TO RELATED APPLICATION

This is a continuation-in-part of our earlier filed application Ser. No. 602,453, filed Dec. 13, 1966 and now abandoned.

BACKGROUND OF THE INVENTION

The tracking and interception of targets with terminal homing or homing—all—the-way missiles is well known in the guided missile art. The missiles may home on reflections from radar illumination (active or semi-active homing), or on target radiations, such as heat (infrared), or light (using television trackers or photocell detectors). In each of the known systems, the various target detectors on the missiles must be initially guided into a position where its own radar antenna can receive target reflections. Ordinarily, the missile-borne radar antennas do not have wide angle response patterns, and are, consequently, unable to detect targets more than slightly off-axis of the missile. Some missiles, in an attempt to overcome this limitation, have employed gimbaled radar antennas. These antennas may operate in a search mode to acquire a target. Obviously, in terms of target acquisition time and ruggedness, a gimbaled radar antenna leaves much to be desired. Some passive target detection systems, such as those employing infrared detectors, suffer from the same problems as radar. In order to have a wide angle response or detection pattern, it is necessary to have some form of rotating apparatus. U. S. Pat. No. 2,997,594, issued Aug. 22, 1961, is a case in point. This patent employs a rotating scanning drum, whereby off-axis targets cause the generation of different frequencies by detectors spaced around the axis of the patent missile. The present invention is able to avoid the above discrepancies, because of its novel arrangement.

SUMMARY OF THE INVENTION

A plurality of quasi-optical horn shaped baffles for sensors or antennas (called "horns" hereafter), are arranged on the nose of the missile, around its longitudinal axis. Each of the horns covers a portion of a hemisphere forward of the body of the missile. "Quasi-optical" is intended to denote those frequencies in or below the visible portion of the electromagnetic spectrum. These frequencies are amenable to treatment by optical techniques, and include visible light, infrared, and very short wave-length microwave. A point-source or equivalent target appearing in the above-mentioned hemisphere will cause an output from one (and only one) of the said horns. This output is applied to a means for converting the output into a control signal for guiding the missile. The means for converting could be a digital—to—analogue converter, wherein the inputs to the converter are from the individual horns. Depending on which horn is providing an output, the converter will provide a corresponding analog output, which analog output may be used to guide the missile. A separate plurality of horns would be necessary for control of pitch and yaw of the missile. The missile must be stabilized from rolling, in order to decouple pitch and yaw controls.

An object of the invention is to provide a homing missile using strapped-down target detectors.

Another object is to provide a homing missile in which the target detectors require no search mode.

Yet another object is to provide a homing missile having target detectors with a very wide field—of—view.

Still another object is to provide a homing missile capable of use in a large variety of target engagement problems.

And, a further object is to provide a homing missile in which time-optimal controls may be employed.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a perspective view of a missile employing the invention.

FIG. 2 shows a view of the arrangement of the horns on the nose of the FIG. 1 missile, but with the horn arrangement rolled flat.

FIG. 2a shows a sectional view taken through the nose of the missile in direction 2a—2a as indicated on FIG. 2.

FIG. 2b shows another sectional view taken through the nose of the missile, taken in direction 2b—2b on FIG. 2.

FIG. 3 shows a block diagram of the basic circuit of the invention.

FIG. 4 shows another block diagram of the inventive circuit with refinements added.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIG. 1, there is shown a missile 10 having a nose portion 11, a body portion 12, and steering fins 13. In nose portion 11, there are a plurality of generally wedge shaped quasi-optical horns in an arrangement 14.

FIG. 2 shows how the outlines of the horns in arrangement 14 would appear if rolled out flat. As can be seen from FIG. 2, there are large horn openings 14a and 14b, and smaller horn openings 14c and 14d. Openings 14a and 14d form an array which provides information for yaw steering toward a target, and openings 14b and 14c form an array which provides pitch information.

FIG. 2a is a sectional view of nose portion 11, in the direction as shown by the line 2a—2a in FIG. 2. As can be seen, various horns 14a and 14d are wedges having common side walls with the points of the wedges pointing toward the center of the nose. Each horn has within a respective photocell 14e near its point.

FIG. 2b is a sectional view of nose portion 11, in the direction as shown by the line 2b—2b in FIG. 2. As can be seen, various horns 14b and 14c are wedges having common side walls. As in FIG. 2a, each horn would include within (not shown) a photocell near its point.

Referring now to FIG. 3, the yaw horn array, comprised of horns 14a and 14d, has each of its horns connected to a converter 15. It should be understood that the photocells of the horns are what is actually connected to converter 15. The converter converts the information from the horns into a signal which activates a controller 16, which controller 16 in turn activates the yaw fins of the missile, and the airframe of missile 10 is headed in the proper direction. Dotted line 17 is to show that the angular position of the yaw horn array is dependent upon the angular position of the airframe.

Converter 15 is a digital—to—analogue converter. Since only one of the horns 14a and 14d can "see" a point-source target at any one time, only one of the plural lines into converter 15 will be energized at any one

time. The output of converter 15 is a stepped analog voltage. The digital-to-analog converter can take the form as shown on page 238 of the book, "Logical Design of Digital Computers," by Montgomery Phister, Jr., and published in 1961 by John Wiley and Sons, Incorporated, Library of Congress Catalog Card No. 58-6082.

Controller 16 includes an amplifier for the output of converter 15, and a servo system for positioning the yaw fins of the missile airframe 10. The FIG. 3 circuit is, in effect, a closed servo loop. A circuit identical to that of FIG. 3 would be used for pitch control of the missile, but would use the pitch horn-array as an input.

FIG. 4 shows a refined version of the FIG. 3 circuit. Connected to the output of converter 15 is a smoothing circuit 20. This smoothing circuit may take the form of an electronic integrator, and provides a ramp output for the stepped analog input from converter 15. The output of smoothing circuit 20 feeds a mixer 21. A rate gyro 24, strapped to the missile airframe, gives an output in response to maneuvers of the missile. The output of the rate gyro is used to control the integrating factor of smoothing circuit 20, and also feeds a manipulating box 22 and a switching function generator 25. Switching function generator 25 provides a time-optimal function, to make the system self-adapting and manipulating box 22 is a shift function generator for the missile. Each of 22 and 25 is known, as shown by sections 4.7 and 15.2-15.6, respectively, of the book, "Engineering Cybernetics" by H. S. Tsien, published in 1954 by the McGraw-Hill Book Company, Incorporated, and having Library of Congress Catalog Card No. 54-8098.

The circuit arrangement of FIG. 4, with the use of a combination of wide angle and narrow angle horns, allows for quasi-time-optimal switching in the servo loop, with minimum number of horns.

The invention has been described with a point-source target assumed. This can be obtained in practice by using an illuminator with a very narrow beam, which would appear as a point-source on a target. For other than a point-source, it would be necessary to have some means in converter 15 to select the output of only one horn. This could be done by including a circuit in converter 15 such as that shown in U. S. Pat. No. 2,974,286, issued Mar. 7, 1961.

Obviously, the missile could have some form of initial guidance to bring it in target viewing position. If the illuminator and target were not visible from the missile launching site, the missile could be command guided (radar or radio), or inertially guided by the well-known techniques until it was in position to home on the target. The laser illuminator could be C-W or pulsed, as desired, and could be visible, if desired. The pulsing rate of reflected target illumination could be monitored in the missile as a CCM.

With a target providing its own radiation, homing could be passive, by the well-known techniques.

Targets engaged by the inventive missile may be airborne or water-borne, or land vehicles, or emplacements, or personnel.

The illuminator for the instant invention may be man-carried or transported by any desired vehicle, or may be at an emplacement.

While the instant missile has been shown and described as being guided by fins, obviously, other type of control may be used, such as thrust deflection, or vernier jets.

Another type of angular rate sensor may be used in place of rate gyro 24, if desired.

There are several advantages over the prior art homing missile which are realized by the present inventive missile. These are:

1. All target detecting components of the missile are strapped down (immoveable with the respect to the missile frame).
2. No target search mode is required.
3. The target sensors may have a very wide angle field-of-view.
4. Great flexibility is obtained because of the wide angle of view.
5. Time-optimal controls (bang-bang) may be employed.

The particular missile of the invention is designed for use on targets illuminated from some source external to the target. The illuminator may be near the launcher for the missile, or separated from it, as required. A particular illuminator which may be used is an infrared laser. Desired targets are illuminated by the laser, and the missile, when launched, homes on the reflected illumination from the target.

We claim:

1. A target homing missile including a body with a nose and with steering means on said body; a plurality of target sensors arranged in a cruciform on said nose, each sensor being a horn antenna with a detector for quasi-optical radiation in the throat thereof, each horn subtending angles sufficient to cover a discrete portion of space around said nose, a digital-to-analog converter means connected to said sensors, whereby said converter means provides an analog signal dependent on which sensor detects a target; and missile guiding means connected to said converting means for controlling said steering means.

2. The missile as set forth in claim 1 wherein said horns are generally wedge shaped and are arranged in two perpendicular groups, wherein the horns of one group have common side walls, and the horns of the other group are arranged in two subgroups with the horns of the subgroups having common side walls.

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