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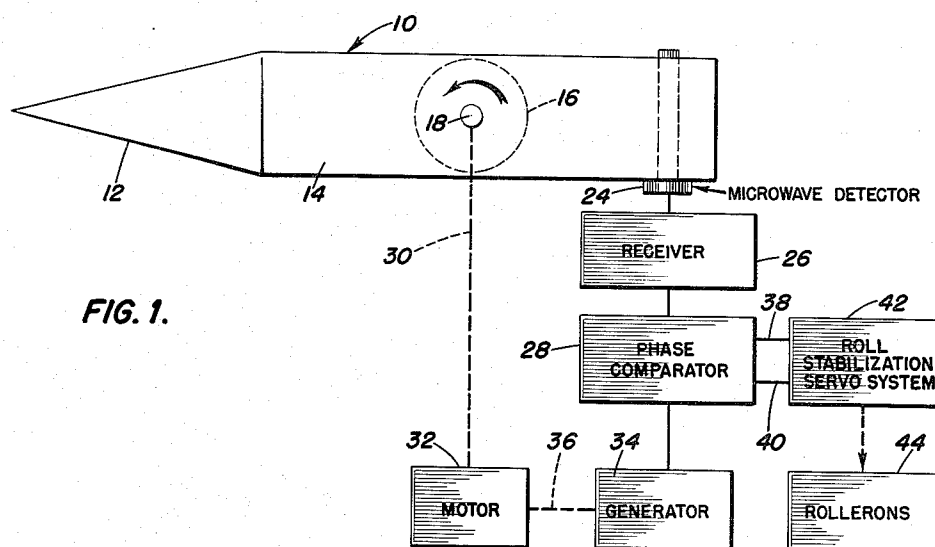
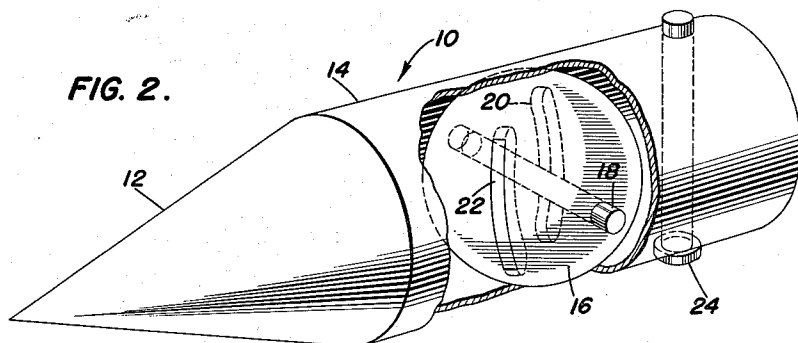
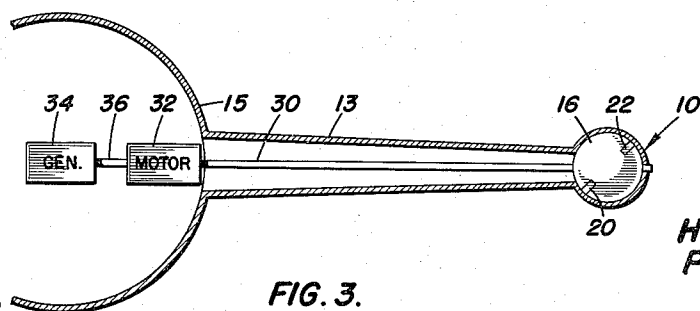
P. D. ULM ET AL

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ROLL STABILIZATION SYSTEM FOR GUIDED MISSILES UTILIZING
SIMPLIFIED MICROWAVE MODULATING ATTENUATOR.

Filed Nov. 19, 1954

2 Sheets-Sheet 1



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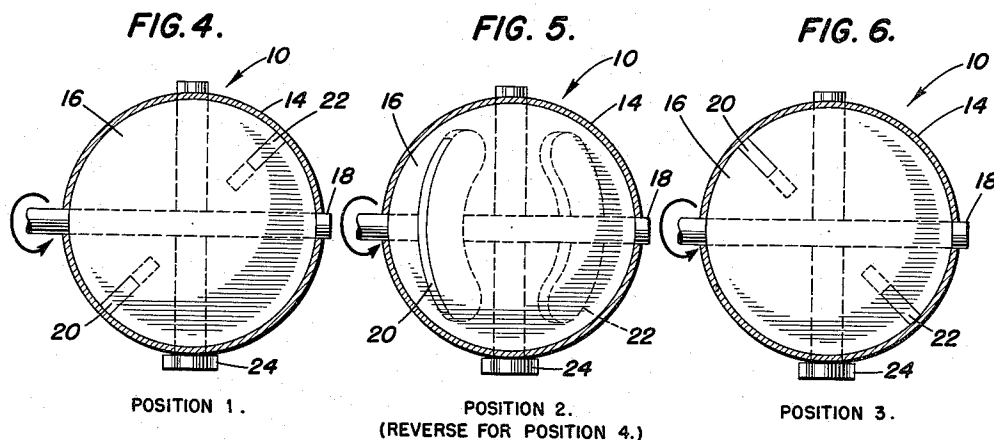
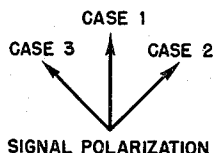


FIG. 7.



FIG. 8.



FIG. 9.



FIG. 10.

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ROLL STABILIZATION SYSTEM FOR GUIDED MISSILES UTILIZING SIMPLIFIED MICROWAVE MODULATING ATTENUATOR**Paul D. Ulm, Butler, Ind., and Henry H. George, Silver Spring, Md., assignors to the United States of America as represented by the Secretary of the Navy**

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8 Claims. (Cl. 244-14)

This invention pertains generally to stabilization systems, and in particular to an improved roll stabilization system utilizing microwave attenuator modulation of the signal received from a guidance beam for roll stabilizing an aerial missile.

One of the objects of this invention is to provide a roll stabilization system which utilizes microwave attenuator modulation of the signal received from a guidance beam of electromagnetic energy for roll stabilization of an aerial missile so that the control axes of the missile substantially coincides with axes of the guidance beam.

Another object of this invention is to provide an improved roll stabilization system from a standpoint of simplicity and efficiency for roll stabilizing a beam riding aerial missile.

Still another object of this invention is to provide a microwave attenuator modulation system for ascertaining polarization of radar and like equipment.

Even still another object of this invention is to provide a microwave attenuator modulation system which is compact and which can be located in the wing of an aerial missile. This has not been possible with prior roll stabilization systems.

Other objects and many of the additional advantages of this invention will be apparent by the following detailed description taken in conjunction with the accompanying drawings in which:

FIG. 1 is a schematic of a roll stabilization system for an aerial missile;

FIG. 2 is an enlargement of the microwave attenuator modulation system of FIG. 1 shown in greater detail;

FIG. 3 is a schematic of an aft portion of a missile showing a part of a roll stabilization system in position;

FIG. 4 is a schematic of the dielectric ball in one position;

FIG. 5 is a schematic of the dielectric ball in a second position;

FIG. 6 is a schematic of the dielectric ball in still another position;

FIG. 7 is a vectorial representation of the polarization of the received signal for the various cases illustrated in FIGS. 8, 9, and 10;

FIG. 8 is a graphical representation of the attenuation for vertical polarization of the received signal for various positions of the dielectric ball;

FIG. 9 is a graphical representation of the attenuation for 45° polarization of the received signal for various positions of a dielectric ball; and

FIG. 10 is a graphical representation of the attenuation for a -45° polarization of the received signal for various positions of the dielectric ball.

Referring now to FIGS. 1 and 3 of the drawings, there is illustrated an antenna 10 having a conical lens portion 12 and a cylindrical hollow waveguide portion 14. This antenna 10 is generally mounted on the tail surface 13 of an aerial vehicle 15, as shown in FIG. 3, for receiving electromagnetic energy from a polarized source, such as a search or tracking radar unit located on the grounds, aboard an aircraft, or a ship.

This polarized electromagnetic energy is transmitted down the waveguide portion 14 to a spherical dielectric ball 16, which is mounted for pivotal movement in wave-

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guide portion 14 by means of a shaft 18 arranged transverse to the longitudinal axis of the waveguide portion 14 and which passes through the ball 16. This shaft 18 is journaled in the cylindrical wall of waveguide portion 14.

The ball 16 has two slots provided therein for receiving two strips 20 and 22 of attenuator material, such as graphite, so that the attenuation of the electromagnetic waves is dependent only upon the angular position of the ball 16 with respect to the vertical component of the electromagnetic wave.

The signal that is not absorbed by the ball 16 then progresses to a microwave detector 24 where it is rectified and then transmitted to a receiver 26. The signal output of receiver 26 is then passed to a phase comparator 28.

Shaft 18, of ball 16, is mechanically connected by suitable means as indicated by reference numeral 30, to either an A.C. or D.C. motor 32. This motor 32, in turn, is mechanically connected to a sine wave generator 34, such as indicated by numeral 36. The output signal from generator 34 is fed to the phase comparator 28.

The phase comparator 28 compares the signal output of the receiver 26 due to the modulation introduced by the ball 16 with the signal output of the generator 34 to produce a D.C. voltage signal. The magnitude and polarity of this D.C. voltage signal depends upon the phase relationship of the signal received from the receiver 26 and the signal received from the generator 34. This signal is then fed, by connections 38 and 40, to a roll stabilization servo system 42. This servo system 42 is mechanically connected to the rollerons 44 of the aerial vehicle.

Referring now to FIG. 2, the microwave attenuator modulation system is shown in greater detail. As previously indicated, the ball 16 is provided with two slots located 45° to the longitudinal axis of the waveguide portion 14 and the strips 20 and 22 are placed in these slots on opposite sides of the ball 16 as shown. Referring now to FIGS. 4, 5, and 6, the dielectric ball 16 is shown in various positions. The ball is rotated by the motor 32 which drives the generator 34.

For the purposes of simplification in this discussion, the polarization of the input signal is shown rotated in lieu of rotation of the aerial vehicle 15. This is shown in FIG. 7, which illustrates three cases where the polarization of the input signal is vertical, and 45° to either side of the vertical.

In Case I when the polarization of the input signal is vertical, the ball 16 is placed in the circular waveguide 14 with its rotational axis perpendicular to the polarization. In this case, there is no modulation since attenuator attenuates the same in any position of rotation, as illustrated in FIG. 8. The amount of attenuating material effective in the waveguide 14 is the same no matter what position of rotation the ball 16 is in.

In Case II of FIG. 7, when the polarization is not perpendicular to the axis of rotation the ball 16, as illustrated in FIGS. 4, 5, and 6, attenuates more in position 1 than in position 3, as shown in FIG. 9. The attenuation of the wave down the waveguide 14 is then a function of the rotation of the ball 16.

In Case III, the polarization of the received signal is 180° from that shown by Case II, with the result that the attenuation in FIG. 10 is 180° from that shown in FIG. 9.

In operation, a polarized electromagnetic signal is picked up by antenna 10, and it is modulated if the polarization is not perpendicular to axis of rotation of the ball 16, with a phase dependent on direction of polarization. The phase of the output modulation signal is then compared with the phase of the output signal from the motor driven generator 34 giving the correct sense of polarization of

the received input signal. The polarity of the output signal is determined by the polarization direction, and its amplitude is proportional to angle between axis of ball rotation and polarization vector with the magnitude being zero for Case I, and maximum for Cases II and III.

The signal output from the phase comparator is then utilized to control the servo system 42, and the latter, through the mechanical linkage, controls the position of the rollerons 44 to roll stabilize the missile.

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. In a microwave receiving system having a cylindrical antenna for receiving polarized electromagnetic energy, an attenuator comprising a sphere of dielectric material rotatably mounted in said antenna, and a pair of attenuating elements carried by said sphere, said sphere in one position effecting an attenuation of the energy received by the antenna in one plane and in another position effecting an attenuation of the energy received by said antenna in another plane.

2. In a microwave receiving system having a cylindrical antenna for receiving polarized electromagnetic energy, an attenuator comprising a sphere of dielectric material rotatably mounted in the antenna, and a pair of strips of conducting material embedded in the surface of said sphere at diametrically opposite locations on said sphere, said strips defining attenuating elements.

3. In a microwave receiving system having an antenna for receiving polarized electromagnetic energy, attenuator means comprising a sphere of dielectric material rotatably mounted in said antenna, and a pair of attenuating elements carried by said sphere, said sphere in one position effecting an attenuation of the energy received by said antenna in one plane and in another position effecting an attenuation of the energy received by said antenna in another plane.

4. In a microwave receiving system having an antenna for receiving polarized electromagnetic energy, an attenuator comprising means including a sphere composed of dielectric material rotatably mounted in said antenna, and a pair of strips of conducting material embedded in the surface of said sphere at diametrically opposite locations on said sphere, said strips defining attenuating elements.

5. In a microwave receiving system having a non-polarized antenna for receiving electromagnetic energy, means including a sphere of dielectric material rotatably mounted in said antenna, and a pair of attenuating elements carried by said sphere, said sphere in one position effecting an attenuation of the energy received by said antenna in one plane and in another position effecting an attenuation of the energy received by said antenna in another plane.

6. In a microwave receiving system having a non-

polarized antenna, means including a sphere of dielectric material rotatably mounted in said antenna, and a pair of strips of conducting material embedded in the surface of said sphere at diametrically opposite locations on said sphere, said strips defining attenuating elements.

7. In a roll stabilization system for an aerial missile having a control surface, a microwave system including an antenna for receiving a polarized electromagnetic signal, attenuator means including a sphere of dielectric material rotatably mounted in said antenna, a pair of attenuating elements carried by said sphere, said sphere in one position attenuating the signal received by said antenna and in another position attenuating the signal received by said antenna, means for rectifying said attenuated signal, a receiver for said signal, means mechanically coupled to said sphere for generating a signal, means for comparing the signal output of said receiver due to the modulation introduced by said attenuating elements in said sphere with the signal output of said generating means to produce a D.C. voltage signal, the magnitude and polarization of said D.C. voltage signal being dependent upon the phase relationship of the signal received from said receiver and the signal from said generating means, servo motor means for receiving the D.C. voltage signal of said comparing means, said control surface being connected mechanically to said servo motor means and being adjustable in accordance with the D.C. voltage signal supplied to said servo system.

8. In a roll stabilization system for an aerial missile having a control surface, a microwave system including a cylindrical antenna for receiving a polarized electromagnetic signal, attenuator means including a sphere of dielectric material rotatably mounted in said antenna, a pair of elements of conducting material embedded in the surface of said sphere at diametrically opposite locations on said sphere, said elements defining attenuating elements, means for rectifying said attenuated signal, a receiver for said signal, means mechanically coupled to said sphere for generating a signal indicative of the position of said attenuator means, means for comparing the signal output of said receiver due to the modulation introduced by said attenuating elements in said sphere with the signal output of said generating means to produce a D.C. voltage signal, the magnitude and polarization of said D.C. voltage signal being dependent upon the phase relationship of the signal received from said receiver and the signal from said generating means, servo motor means for receiving the D.C. voltage signal of said comparing means, said control surface being connected mechanically to said servo motor means and being adjustable in accordance with the D.C. voltage signal supplied to said servo system.

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