Dec. 18, 1962 | R. T. PATTERSON | 3,069,112

RADOME

Filed Aug. 20, 1956 | 2 Sheets-Sheet 1

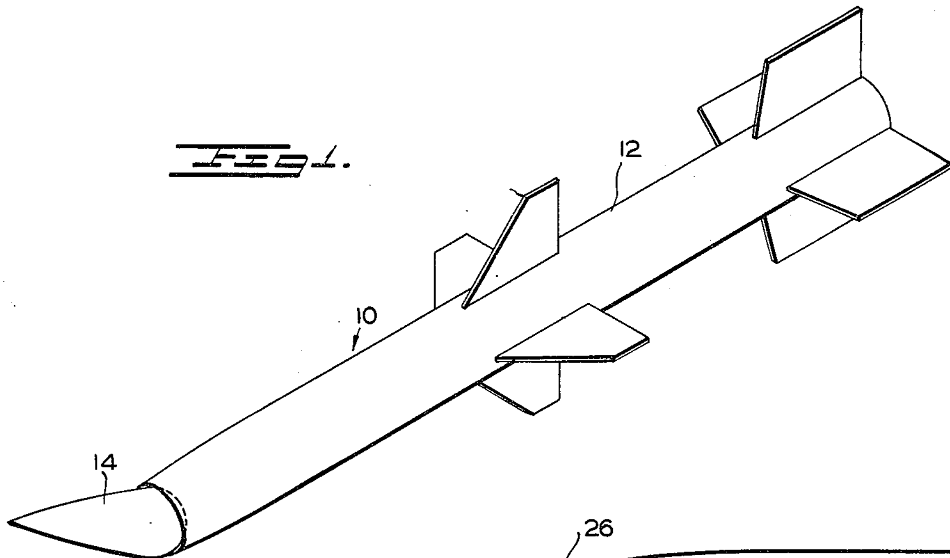

FIG. 1.

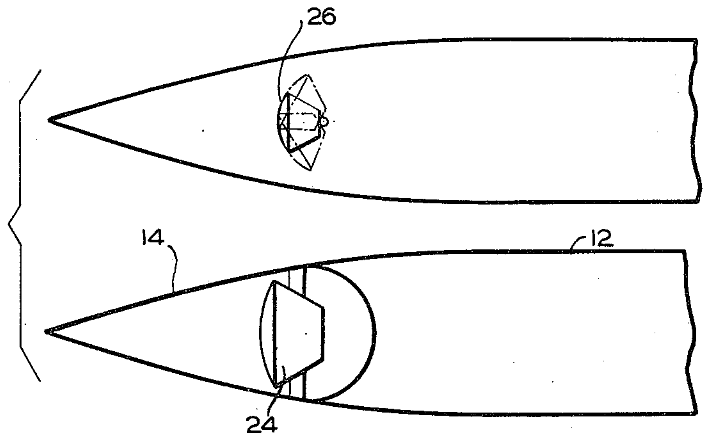

FIG. 2.

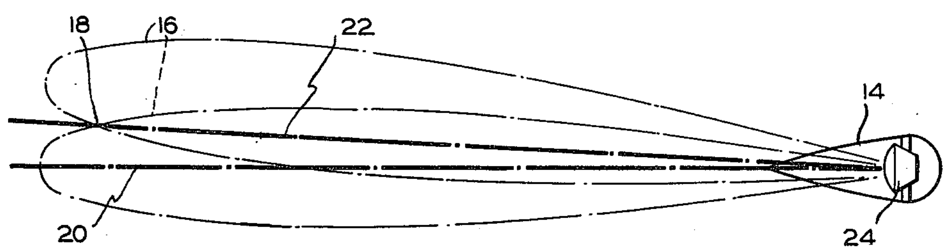

FIG. 3.

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RADOME

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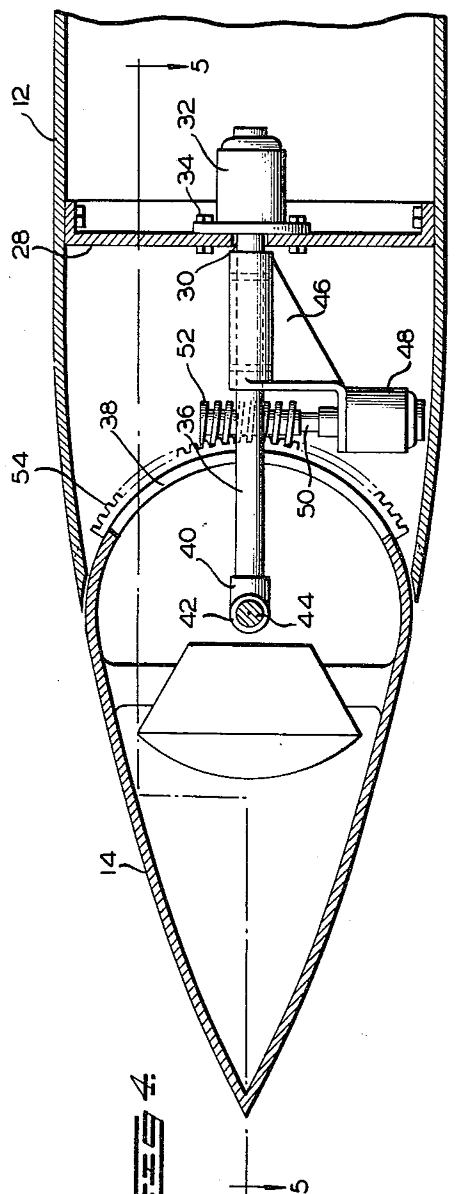

FIG. 4.

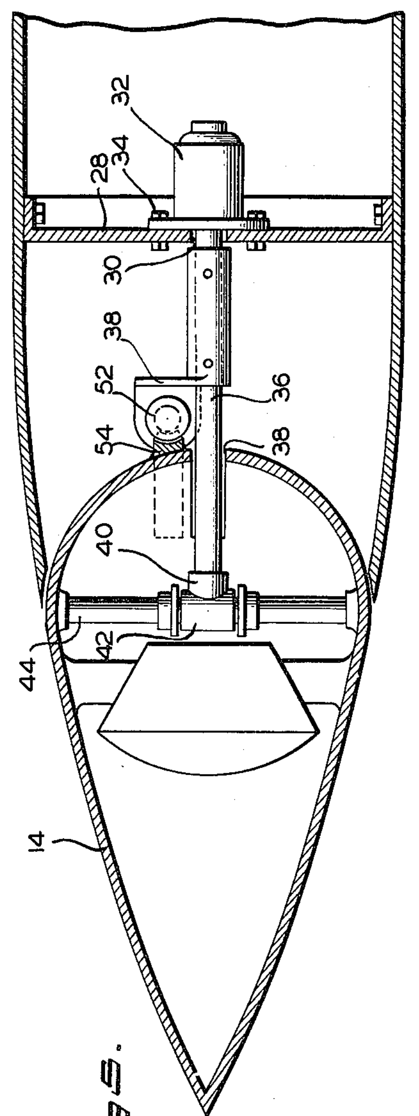

FIG. 5.

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3,069,112
RADOME

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Filed Aug. 20, 1956, Ser. No. 605,237
2 Claims. (Cl. 244—14)
(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 movable radome, and more particularly to a movable radome for use with a guided missile.

Prior art guided missiles conventionally include a radar-antenna horn located in the nose of the missile. The antenna horn is usually mounted on a gimbal or the like which allows universal movement of said horn. The missile also contains automatic mechanism for oscillating the antenna horn about the gimbal connection, for the purpose of bringing about conventional radar-antenna scanning action.

In operation, the radar-antenna born radiates electromagnetic energy which takes the form of overlapping radiation lobes, of the type hereinafter described. The outermost point on the line of intersection of two lobes is called the crossover point. Ideally, the radar mechanism functions, by scanning, to maintain the crossover point on a straight line between the antenna horn and the target, said line being known as the target-line. Any deviation of the crossover point from the target-line is called bore-sight shift, or beam-deflection error. The chief reason for bore-sight shift is a combination of reflection, refraction, diffraction, and absorption of the radar beam by the missile nose, or radome.

Ideally, the radome should be constructed of a uniformly thick, homogeneous material of unity dielectric, but these conditions have not been met to a satisfactory degree. Since aerodynamicists specify nose shapes which are ogival or conical, the scanning radar beam passes through varying thicknesses of this non-ideal material at various angles causing serious bore-sight shift. If this bore-sight shift varies as some reasonable function of scan angle, electronic compensating circuits in the missile can reduce the resulting tracking error to some extent. However, in general, this variation is irregular and the correction is not satisfactory to the degree required. This is the case even with spherical nose shapes.

It is an object of this invention to overcome the disadvantages of the prior art radar scanning devices.

It is a further object of this invention to provide a combination radar-antenna horn and radome wherein the effects of bore-sight shift of the radar energy radiations is minimized.

It is another object of this invention to provide a means whereby a radar-antenna horn and radome enclosing the same are movable together, as a unit.

It is still a further object of this invention to increase the signal-to-noise ratio of a radome and radar-antenna assembly.

It is still another object of this invention to provide a means whereby the explosive and/or fuel carrying capacity of a guided missile may be increased.

In accordance with this invention a guided missile, of otherwise conventional design, is modified so as to provide the same with a movable nose portion. The movable nose portion serves as a radome or radar-antenna horn enclosure. The radar-antenna horn is fixedly mounted within the movable nose portion of the missile, and means is provided for moving said radome, thereby causing scanning action by said antenna horn. It is pointed out that there is no relative movement between the radar-antenna horn and the radome within which it is enclosed and fixedly mounted.

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Additional 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 detailed description when considered in connection with the accompanying drawings wherein:

FIG. 1 is a perspective view of a guided missile made in accordance with this invention;

FIG. 2 is a schematic diagram showing a comparison between a preferred embodiment of the invention and the prior art device;

FIG. 3 is a diagram of a radar transmission pattern;

FIG. 4 is a longitudinal sectional view of the structure shown in FIG. 1; and

FIG. 5 is a sectional view on line **5—5** of FIG. 4.

Referring now to the drawings, wherein like reference characters designate like or corresponding parts throughout the several views, there is shown in FIG. 1 a perspective view of a guided missile **10** made in accordance with this invention. The missile **10** comprises a tubular body portion **12**, and a movable nose portion **14**, that serves as a radome.

Attention is directed to FIG. 3 wherein is shown a diagram of a radar transmission pattern comprising two lobes **16**. The outermost point **18** on the line of intersection of the two lobes **16** is called the crossover point. The radar mechanism functions, by scanning, to maintain the crossover point **18** on a straight line between the antenna horn and the target. If, in the example shown in FIG. 3, the radar-antenna horn were open to the surrounding atmosphere, the crossover point would be on line **20**; however, due to the fact that the radar energy emanations must first pass through an enclosing radome, there is a deviation of the crossover point **18** from the normal target line **20**, said deviation being shown as being on a line **22** extending between the shifted point **18** and the antenna horn. The deviation of line **22** from the target line **20** is called bore-sight shift, or beam-deflection error. The chief reason for bore-sight shift, as pointed out above, is a combination of reflection, refraction, diffraction, and absorption of the radar beam by the missile nose or radome **14**. It is pointed out that bore-sight shift varies as the relative angle between radar-antenna emanations and the surrounding radome varies, that is, as the antenna horn goes through its scanning movements. It is further pointed out that a conventional, oscillatably mounted antenna horn **26** is shown in FIG. 2; this antenna horn arrangement will give rise to the problem of variable bore-sight shift described above, since the angle between the horn radiations and the walls of the radome varies constantly.

In accordance with this invention, a radar-antenna horn **24** is fixedly mounted within a movable radome **14** mounted at the forward end of a guided missile **10** or the like, said radome **14** being adapted to be moved, in a manner hereinafter described, by suitable mechanism within the missile **10**. While it is true that fixedly mounting the radar-antenna horn within the radome in the manner described above, does not completely eliminate the problem of bore-sight shift, it does simplify the problem of electronically correcting for the same, since the bore-sight shift will remain constant, due to the fact that there is no change in the relative angle between the radar emanations and the surrounding radome.

One example of apparatus designed to move the radome 14, in a desired manner, is shown in FIGS. 4 and 5. The body portion **12** of the missile has a bracket **28** fixedly mounted therein and extending transversely thereof. The bracket **28** has a hole **30** extending through the center thereof. A motor 32 is fixedly mounted on the bracket 28 by bolts 34 or the like, and has a shaft 36, driven by said motor, extending forwardly therefrom, longitudinally of the missile. The shaft 36 extends forwardly through a slot 38 provided in the rear portion of the radome 14 and has a T-shaped member 40 fixedly mounted at the forward end thereof for rotation therewith. The cross portion 42 of the T-shaped member 40 is a hollow bearing member 42, and has a cross-shaft 44 rotatably carried therein, the opposite ends of said shaft 42 being fixed to the interior of the radome 14.

A bracket 46 is fixedly mounted on the longitudinal shaft 36 between the motor 32 and the rear of the radome 14 for rotation with said longitudinal shaft. The bracket 46 has a motor 48 fixedly mounted thereon, with its shaft 50 extending at substantially right angles to the longitudinal shaft 36. The shaft 50 has a worm wheel 52 attached thereto, that is in driving connection with an arcuate rack member 54 affixed to the rear of the radome 14.

By means of suitable electronic control means, of a nature readily apparent to one skilled in the art, the motors referred to above may be caused to bring about both rotation of the radome 14 about an axis longitudinal of the missile 10, and oscillation thereof about an axis substantially at right angles to said longitudinal axis.

Rotation of motor 32 brings about rotation of shaft 36, and the bearing member 42 fixed to the forward end thereof. Rotation of bearing member 42 brings about rotation of the transverse shaft 44 in a plane extending transversely of the radome 14, which in turn causes radome 14 to rotate about the longitudinal axis of the missile, since the opposite ends of transverse shaft 44 are fixed to the interior of the radome.

Rotation of motor 48 brings about rotation of shaft 50 which in turn rotates the worm wheel 52. By virtue of the driving connection of worm wheel 52 with the rack 54 that is affixed to radome 14, said radome is caused to rotate about the axis of transverse shaft 44, since it is fixedly attached to the ends of said shaft which in turn is rotatably carried in bearing 42.

It is pointed out that various forms and amounts of scanning movement by the radome, and the radar-antenna horn mounted therein in fixed relation thereto, is possible by suitable sequential and/or simultaneous operation of the motors 32 and 48. The sequence and length of time of operation of motors 32 and 48 may of course be automatically controlled by suitable electronic means of a type readily apparent to one skilled in the art. Such electronic means can of course take the same form as that now utilized to control the scanning motion of a conventional, gimbal-mounted antenna horn carried within a non-moveable radome.

It is further pointed out, that with the applicant's structure as described above, no matter what the angle of scan is, each radar beam will always pass through

the radome in the same place; the ensuing, relatively small, non-variable bore-sight shift can be compensated for quite easily, and there is no need for elaborate equipment designed to compensate for numerous changes in bore-sight shift, as is the case with prior art radar devices of this class.

In addition, by virtue of the arrangement hereinabove described, the peripheral space in the nose normally required by the radar-antenna horn gimbal system is saved, making possible each of two alternate arrangements of a fixed radar-antenna horn, in the movable nose radome. First, the same size radar-antenna horn, as has been heretofore used, may be located further forward in the nose, causing lesser nose hinge moments and trimming moments, and also providing more space for either war head or propellent. On the other hand, if the antenna horn is placed at the same longitudinal station a larger radar-antenna horn can be accommodated, since the space needed for its movements, as shown in the upper portion of FIG. 2, is no longer necessary. The desirable effect of using a larger horn is that the signal-to-noise ratio of the system is improved, since said signal-to-noise ratio of radar systems is about proportional to the antenna horn diameter.

It should be understood, of course, that the foregoing disclosure relates to only a preferred embodiment of the invention and that it is intended to cover all changes and modifications of the invention herein shown for purposes of the disclosure, which do not constitute departures from the spirit or scope of the invention.

What is claimed is:

1. A guided missile comprising an elongated tubular body having an opening at its forward end, a movable nose portion having its rearward end pivotally mounted within said opening at the forward end of the missile body, said nose portion forming an aerodynamic extension of said missile body; a radar-antenna horn fixedly mounted within said nose portion and movable therewith; means within the body portion of the missile for simultaneously rotating said nose portion about a longitudinal axis of the missile and oscillating the same about an axis extending transversely to said longitudinal axis.

2. A guided missile, as set forth in claim 1, wherein said nose portion also serves as a radome, whereby scanning motion of said radar-antenna horn is brought about by the movement of said radome.

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