

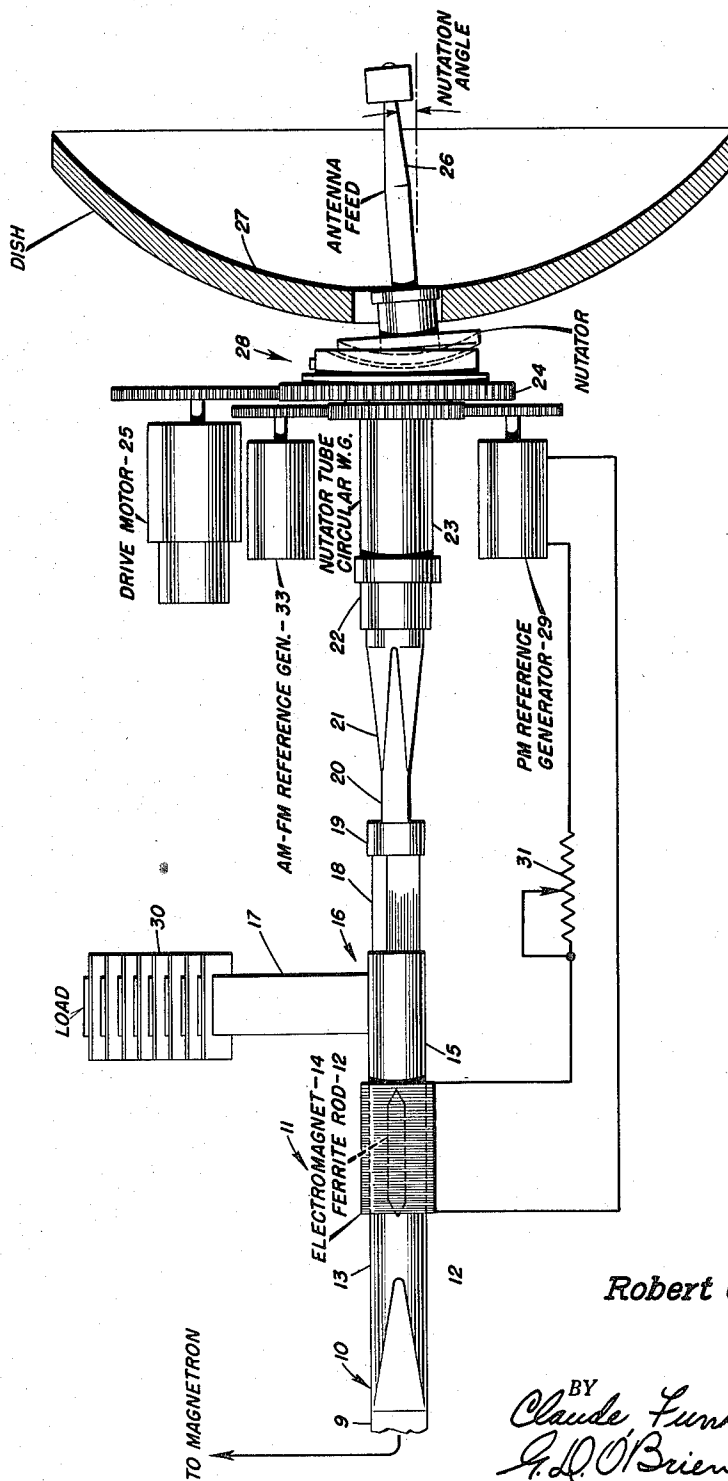
Nov. 22, 1960

R. C. GIPE

2,961,656

POWER MODULATOR FOR CONICALLY SCANNING CAPTURE RADAR

Filed Sept. 11, 1958



Robert C. Gipe
INVENTOR.

BY
Claude Funkhouser
J. D. O'Brien ATTORNEYS

1

2,961,656

POWER MODULATOR FOR CONICALLY SCANNING CAPTURE RADAR

Robert C. Gipe, Cheverly, Md., assignor to the United States of America as represented by the Secretary of the Navy

Filed Sept. 11, 1958, Ser. No. 760,525

4 Claims. (Cl. 343—100)

The present invention relates to power modulators for radars. More specifically, it relates to an improved power modulator of the type disclosed in United States patent application Serial No. 556,370, filed December 29, 1955 by William L. Vann for Power Modulator.

Power modulators are employed in conjunction with conical scan capture radars in the control of guided missiles of the beam riding type. As is more fully explained in the aforesaid Vann application, missiles launched against low flying targets ordinarily encounter guidance difficulties due to reflection of the guiding radar waves from the sea. By reducing or modulating the power of the radar beam during that portion of the conical scan in which the radar beam is directed toward the sea surface, the scan axis of the radar beam is depressed toward the sea and at the same time interference from sea reflections is reduced.

The basic power modulator mechanism as disclosed by Vann comprises a microwave oscillator and a shunt pair of transmission paths connected to the oscillator and terminating through a hybrid junction in an antenna and a load. By means of a phase shifter geared to the scanning mechanism, power is periodically diverted from the antenna to the load thereby providing the desired asymmetrical lobe structure in the antenna pattern. The Vann structure operates in a fully satisfactory manner, accomplishing its intended results accurately and reliably. It is, however, of somewhat more than necessary bulk, when compared with the simpler construction of the present invention. Moreover, the Vann apparatus requires initial trimming operations and adjustments which are time consuming and tedious.

The principal object of the present invention is, therefore, to provide a power modulator structure which affords the advantages of reduced bulk, simplified construction, and ready adjustability.

Other 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 drawing.

Briefly, the present invention employs a branched waveguide circuit terminating in an antenna and a power absorbing load. Energy is diverted from the waveguide and antenna to the power absorbing load by means of a ferrite polarization rotator, the diversion being accomplished in synchronism with the scan cycle.

The single figure of the drawing is an elevation view of the present invention with certain elements thereof being illustrated in section.

Referring now to the drawing, energy from the radar magnetron oscillator (not shown) is conveyed to the power modulator by a conventional rectangular waveguide transmission line 9, only a small portion of which is shown. The long dimension of the rectangular cross section of waveguide 9 lies in a vertical plane so that horizontally polarized waves are propagated there-through. Following waveguide 9, transition is made from

2

rectangular waveguide to circular waveguide in a transition section 10. The energy discharged from waveguide 9 continues to be plane polarized during its progress through the transition section 10. A polarization rotator 11 comprising a ferrite slug 12 inserted in a circular waveguide section 13 is joined to and provides a continuation of transition section 10. A solenoid 14 is wound around the exterior of the circular waveguide section 13 to provide a magnetic field for controlling the rotation of the plane of polarization of the waves in their travel past the ferrite slug 12.

The production of the Faraday Effect of rotation of the plane of polarization by the mechanism of a ferrite influenced by a magnetic field is well-known in the art. A device similar to the polarization rotator employed herein is described in U.S. Patent 2,644,940 to C. H. Luhrs et al., for "Microwave Polarization Rotating Device and Coupling Network."

The circular waveguide portion 15 of a circular waveguide magic T 16, which may suitably be of the type described by Smullen and Montgomery at page 369, of volume 14 "Microwave Duplexers," M.I.T. Radiation Laboratory Series, receives the output of polarization rotator 13 and apportions that energy between the rectangular waveguide arms 17 and 18 thereof. The planes containing the long cross section dimensions of arms 17 and 18 intersect each other perpendicularly, and at the same time are oppositely canted at 45° to the vertical. Thus horizontally polarized energy in waveguide 15 will divide equally between arms 17 and 18. Rectangular waveguide arm 17 is terminated in an absorptive load 30 while rectangular waveguide arm 18 discharges its energy through rotating portions of waveguide and an antenna, as will shortly be described. The energy from rectangular arm 18, by means of a fixed polarization rotator 19, is rotated an additional 45° and enters a rectangular waveguide section 20 having its long cross section dimension in a horizontal plane. A transition section 21 joins rectangular waveguide section 20 to a rotating joint 22 which may suitably be of the choke type. A portion 23 of circular waveguide extending from joint 22 is mounted for rotation and includes a ring gear 24 secured thereto so that the portion 23 may be rotated by means of a nutation drive motor 25.

Energy passes from waveguide 23 into an antenna feed 26 whence it is radiated towards a dish reflector 27 and focused into a beam. A nutator mechanism 28, converts the rotary motion of waveguide 23 into a nutating motion of antenna feed 26 thereby generating a conically scanning radar beam.

An alternating current generator 29 geared to waveguide section 23 supplies its output through a rheostat 31 to the solenoid 14 of polarization rotator 11. An AM-FM reference generator 33 is also geared to waveguide section 23 to provide reference signals enabling the missile to determine the direction of its error from the beam center.

As will be readily understood, horizontally polarized energy entering the waveguide 9 and passing into magic T 15 without change by polarization rotator 11 will divide equally between waveguide arms 17 and 18. If a positive current is now applied to solenoid 14, the plane of polarization of the waves in polarization rotator 11 will be rotated in the direction of one of the rectangular arms of magic T 16, say arm 18. The power entering arm 18 will then increase while the power entering arm 17 will decrease. If, in fact, sufficient current is applied to solenoid 14 to rotate the waves 45°, all the power entering magic T 16 will be discharged from arm 18 and none will enter load 30. Negative currents in solenoid 14 rotate the plane of polarization of the waves oppositely from positive currents, say in the direction of

arm 17, and consequently a negative current will cause the power flowing into load 30 to be increased above that entering for no rotation of the polarization plane. Thus the application to solenoid 14 of an alternating current which is synchronized with the scan cycle, say with the positive half cycle of current corresponding with motion of the antenna above the nutation axis and the negative half cycle of current corresponding with motion of the antenna below the nutation axis, more power will be radiated in the upper beam position than in the lower beam position. Since generator 29 is geared to the nutation mechanism absolute synchronism, having once been obtained by adjustment, will be maintained indefinitely. Rheostat 31 provides a convenient means for adjusting the modulation index which determines, as explained in the aforesaid Vann application, the amount by which the beam crossover is lowered due to power modulation.

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. A power modulator for a conically scanning radar, comprising, a transmission line for conveying plane polarized waves, a polarization rotator of the ferrite type connected to said transmission line, said polarization rotator including an electromagnet for controlling the degree of rotation of the plane of polarization of the waves passing therethrough, a circular waveguide magic T junction including a circular waveguide arm and a pair of intersecting rectangular waveguide arms, said circular waveguide arm being aligned with said polarization rotator and receiving energy therefrom, said rectangular arms being so oriented with respect to the unrotated plane of polarization of energy passing through said polarization rotator as to result in a power division therebetween, one of said rectangular arms being connected to the radar antenna, the other of said rectangular arms being connected to a power absorbing load, and an alternating current generator for supplying current to said electromagnet, said generator being synchronized with the radar scanning mechanism.

2. A power modulator for conically scanning radar, comprising, a first rectangular waveguide for transmitting plane polarized waves, a circular waveguide portion, a

transition section joining said first rectangular waveguide with said circular waveguide portion, a ferrite slug contained within said circular waveguide portion, a solenoid wound on said circular waveguide portion so as to impress a magnetic field on said ferrite slug upon energization of said solenoid, a circular waveguide magic T junction having a circular waveguide arm connected to said circular waveguide portion and a pair of rectangular waveguide arms, one of said rectangular waveguide arms being connected to said circular waveguide arm so as to form a collinear extension thereof, said one arm being canted so as to support waves having their plane of polarization inclined at 45 degrees to the plane of polarization of the waves transmitted by said first rectangular waveguide, said other arm intersecting said circular waveguide arm perpendicularly and being oriented so as to support waves whose plane of polarization is perpendicular to the plane of polarization of the waves supported by said one arm, a load terminating said other arm, means including a nutator mechanism for conducting waves from said one arm to the radar antenna, and an alternating current generator driven by said nutator mechanism and supplying output to said electromagnet.

3. In a radar including a high frequency oscillator, a transmission line for conveying plane polarized microwaves away from said oscillator, an antenna for radiating a beam of energy composed of microwaves received through said transmission line, and a nutator mechanism for generating a scanning motion of said beam; a power modulator comprising a polarization rotator of the ferrite type inserted in said transmission line, a circular waveguide magic T constituted by the intersection of a pair of rectangular waveguide arms with a circular waveguide, said circular waveguide being connected to said polarization rotator, one of said rectangular arms being connected to a power absorbing load and the other of said rectangular arms being connected to said antenna, and means synchronized with said nutator mechanism for controlling said polarization rotator to cyclically vary the plane of polarization of energy passing therethrough.

4. A power modulator as claimed in claim 3, wherein said last named means comprises an alternating current generator driven by said nutation mechanism and supplying an output having a fixed phase relationship with the scanning motion of said beam.

No references cited