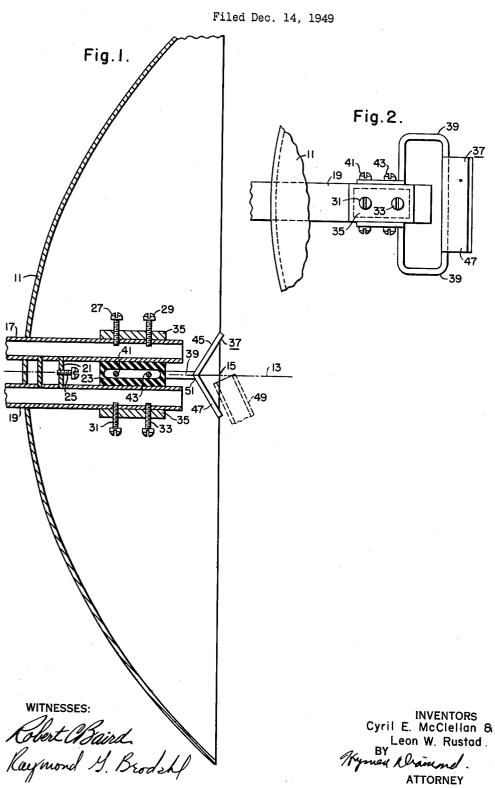
3,045,239



United States Patent Office

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3,045,239 Patented July 17, 1962

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3,045,239 PARABOLIC FEED SYSTEM Cyril E. McClellan, Glen Burnie, and Leon W. Rustad, Linthicum, Md., assignors to Westinghouse Electric Corporation, East Pittsburgh, Pa., a corporation of Pennsylvania

Filed Dec. 14, 1949, Ser. No. 132,918 9 Claims. (Cl. 343-776)

This invention relates to a radio beam system, and more 10 particularly it relates to a radar beam system using a single parabolic reflector.

In accordance with the prior art of which we are aware, it has generally been necessary to employ at least two separate reflector antennas. This has the disadvantage 15 of requiring additional space and there is the possibility of misalignment between the transmitting and receiving antennas to result in a reduced effective range.

Our invention teaches the use of a single paraboloidal reflector antenna for use with a continuous wave or Dop-20pler radar apparatus but is not limited to continuouswave apparatus alone. The energy is fed into the reflector through a wave guide which is placed parallel to the axis or center line of the paraboloidal reflector and is perpendicularly displaced from the axis a slight distance. 25 The energy which bounces off the target and is received by the reflector is taken from it through a second wave guide which is parallel to the first wave guide and is perpendicularly displaced from the parabolic axis opposite the first wave guide, as shown in FIG. 1 of the attached 30 drawing. Directly in front of each wave guide is a small plane reflector which is so located as to reflect the energy between its respective wave guide and the paraboloidal reflector. Said small plane reflector is so located as to reflect said energy as though that energy were directed from the focal point of said paraboloidal reflector toward it. In this way the open ends of the wave guides are effective as though they were physically located at the focal point of the paraboloidal reflector, whereas in fact the small plane reflector is so located as to cause 40 this effect. One of said wave guides is used for feeding the antenna and its energy is reflected to the paraboloidal reflector by the small reflector in such a manner that the energy seemingly comes from the focal point of the first reflector and is thereafter transmitted parallel to the axis 45 of said paraboloidal reflector. This energy, after it bounces off a target, returns to the same paraboloidal reflector and is channeled by means of the small plane reflector into the second of said wave guides. This second wave guide leads to the receiver apparatus. 50 This allows the use of the same paraboloidal reflector for both the transmission and the reception of the continuous wave of radio beam energy. When used for continuous-wave radar the two said wave guides may be interconnected in 55such a manner that some of the energy leaks there-between to give a heterodyne effect between the transmitted and received beam energy.

It is an object of our invention to provide an antenna apparatus for use with a continuous-wave radar apparatus in which only one paraboloidal reflector is necessary.

Another object of our invention is to adapt a single paraboloidal reflector antenna for both transmission and reception of radio energy in a continuous wave or Doppler type radar.

A further object of our invention is to overcome the 65 disadvantage in prior art continuous-wave radar systems, where more than one paraboloidal antenna is required, of misalignment between those antennas.

A still further object is to provide a continuous-wave radar antenna system which requires less physical space 70 than the prior art systems.

An additional object is to transmit simultaneously a

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continuous wave and receive a continuous wave with the same paraboloidal antenna and without appreciable interference therebetween.

These and other objects are effected by our invention as will be apparent from the following description and claims taken in accordance with the accompanying drawings forming a part of this application, in which:

FIGURE 1 is a sectional view of the reflector apparatus; and

FIG. 2 is a side view of the wave guide and small plane reflector mechanism showing the manner of mounting the said plane reflector.

The apparatus shown in FIG. 1 comprises a paraboloidal reflector member 11 having an axis 13 and a focal point 15. A first wave guide 17 and a second wave guide 19 physically extend through the base of said reflector 11 into its interior. Said wave guides 17 and 19 are parallel to each other and are rigidly so fixed by spacing members 21 and 23. The first of said spacing members 21 interconnects the two wave guides 17 and 19 and has the same interior dimensions as each of said wave guides. An adjusting screw 25 protrudes through the wall of this spacing member 21 parallel to the "E" vector within it. This adjusting screw 25 is used to control the amount of energy fed to the receiving wave guide 19 from the transmitting wave guide 17 as a heterodyning system. The other spacing member 23 may, for example, be made of some insulating material. Tuning screws 27 and 29 are provided in the transmitting wave guide 17, and similar screws 31 and 33 are provided in the receiving wave guide 19. A piece of material 35 may be used to add strength to the side of each wave guide to help support the tuning screws. An angular reflector member 37, located in front of the two wave guide outlet ends, is slidably mounted on one of the spacing members 23 by means of a yoke 39 held by screws 41 and 43, or bolts which fasten it to the spacing member 23. The angular reflector 37 comprises two plane reflecting surfaces 45 and 47 so positioned as to reflect the beam energy between the respective wave guides 17 and 19 and the paraboloidal reflector 11. The plane reflecting surfaces 45 and 47 are so oriented that effectively the electrical images (the image of wave guide 17 is sketched as 49) of the ends of the wave guides 17 and 19 are in line with the focal point 15 of the paraboloidal antenna 11. This angle which each plane reflecting surface 45 or 47 makes with respect to the end of the wave guide 17 or 19 respectively to direct the reflected energy to the large paraboloidal reflector 11 is relatively critical. Also the size of the reflecting plane surface 45 or 47 is critical. The most desirable size would reflect all useful energy from the guides 17 or 19 to the paraboloidal dish reflector 11 and still be small enough to prevent blocking of the transmitted and received beam signal from said dish reflector 11 to and from the target. For our purposes, all energy less than 20 decibels and down is considered as useful energy.

The angle which the small plane surface 45 or 47 makes with respect to the axis 13 of the paraboloidal dish 11 and its respective wave guide 17 or 19 may be de-60 termined in the following manner. The distance which the wave guide 17 or 19 protrudes forward from the paraboloidal dish face should be measured. In general this is a function of the focal length of the paraboloidal dish 11 since the small plane reflector 45 or 47 must be placed inside said focal length. The plane reflector 45 or 47 also must not be too closely physically to its wave guide 17 or 19 respectively, since too much of the reflected energy could not pass it and would thus be blocked off. The image 49 of the wave guide 17 should illuminate, as uniformly as possible, one half of the paraboloid 11. This is determined experimentally by covering half of the antenna reflector 11 and placing a wave guide energy source

at the focus 15, directed toward the uncovered half, and orienting it until the optimum radiation pattern is obtained. This will be roughly pointing at the center of the reflecting half. Because of its finite size, the wave guide may be found to operate best when it is slightly displaced 5 from the true focal point 15. The location and position so determined specify the image position.

There are an infinite number of source and reflector combinations which can produce any given image; however, a number of practical considerations govern the 10 final choice. For convenience, the wave guide will probably be parallel to the axis 13. The reflector 37 must be large enough to intercept most of the energy radiated from the wave guide 17 without excessive blocking of the aperture of the paraboloid 11.

It has been found that a good working system can be achieved when the end of the guide 17 is on the order of one wavelength from the axis 13 and two or three wavelengths from the focal point 15. The reflecting plate 45 is located along the perpendicular bisector of a line 20going through the end of the guide 17 and its image 49. The reflecting plate 45 should cover about all the area within which the radiated field from the guide 17 is not less than 20 decibels down. This is true for the plane re-47 before the receiving wave guide 19.

There will be a slight interference between the transmitting and the receiving halves of the paraboloidal dish 11 with respect to received beam energy. However, it does not interfere with the operation of the apparatus.

The plane reflector surfaces 45 and 47 are connected together at their intersection 51 with the paraboloidal dish They are secured to the nearest wave guide axis 13. spacer 23 by two goose-neck shaped sliders 39 or yoke members which are set in a groove on said spacer 23. Adjustment is made possible by two set screws 41 and 43 which fasten the sliders 39 in the said groove.

Conventional tuning screws 27, 29, 31 and 33 are placed on both the transmitting and the receiving wave guides to match the paraboloidal reflector 11 to the wave guides 17 and 19.

The apparatus shown in FIG. 2 is shown in a side view of the two wave guides 17 and 19 and the goose neck mounting 39 for the plane surface reflectors 45 and 47. The tuning screws 31 and 33 for the receiving wave guide 19 are shown. The set screws 41 and 43 and the goose neck yoke 39 supporting the plane surface reflectors 45 and 47 which allow adjustment of their relative positions are shown.

The apparatus shown in FIG. 1 operates to allow a singe paraboloidal dish reflector 11 to be used with a continuous-wave radar beam system by effectively providing the equivalent of two reflectors in the one reflector 11. The radar beam to be transmitted is fed to the paraboloidal dish 11 through a first wave guide 17. The energy leaves the output end of said first wave guide 17 to reflect against a plane reflecting surface 45 located in such a manner that the beam energy is reflected toward the paraboloidal dish 11 as though it originated at the focal point 15 of said dish 11. The energy then leaves the paraboloidal dish 11 toward some target (not shown) and bounces back toward said dish 11. The returned beam energy from the taget strikes the paraboloidal dish 11 at a lower energy level than that which it had when going toward the target, and is reflected toward the focal point 15 of the paraboloidal dish reflector 11. However, in line with the focal point 15 is a second plane reflecting surface 47 which causes a portion of the received energy to enter a second wave guide 19. Actually the returned energy is reflected by both plane reflecting surfaces 45 and 47 into both of the wave guides 17 and 19 respectively. However, the energy level difference between the received radar beam and the transmitted radar beam is of such an amount that the returned beam energy entering the transmitting wave guide 17 is of no appreciable conse-

The receiving wave guide 19 then carries the quence. returned beam energy away from the paraboloidal dish reflector 11 to some receiving apparatus not shown.

As shown in FIG. 2 and in FIG. 1, the relative position of the plane reflecting surfaces 45 and 47 can be adjusted to that of the most efficient operation merely by changing the set screws 41 and 43 and moving the supporting yoke 39 relative to the spacing member 23 fixed between the two wave guides 17 and 19.

While we have shown and described our invention in one form only, it will be obvious to those skilled in the art that it is not so limited but is susceptible of various changes and modifications without departing from the spirit thereof, and we desire, therefore, that only such limitations shall be placed thereupon as are specifically set 15 forth in the appended claims.

We claim as our invention:

1. In a system for transmission and reception of high frequency wave energy, the combination of a symmetrical main wave reflector, a pair of wave energy conducting elements having their translating portions symmetrically disposed about and spaced from the axis of symmetry of said main wave reflector, and a symmetrical auxiliary wave reflector having a pair of non-coplanar flector 45 before the wave guide 17 as well as the reflector 25 plane reflecting surfaces located with respect to said conducting elements so that their line of intersection lies

inside the focal point of said main wave reflector. 2. In a system for transmission and reception of high frequency wave energy utilizing a single antenna, the 30 combination of a main paraboloidal wave reflector, a

pair of waveguides having end portions symmetrically disposed about and spaced from the axis of symmetry of said main reflector, and a symmetrical auxiliary wave reflector having a pair of non-coplanar reflecting plane surfaces located with respect to said end portions so that 35

their line of intersection lies inside the focal point of said main wave reflector.

3. In a system for transmission and reception of high frequency wave energy, the combination of a symmetrical main wave reflector, a pair of wave energy conduct-

40 ing elements having their translating portions symmetrically disposed about and spaced from the axis of symmetry of said main wave reflector, and a symmetrical auxiliary wave reflector having a pair of dihedral reflecting surfaces located with respect to said conducting ele-45 ments so that their line of intersection lies inside the

focal point of said main wave reflector. 4. In a system for transmission and reception of high

frequency wave energy utilizing a single antenna, the combination of a main paraboloidal wave reflector, a 50pair of waveguides having end portions symmetrically disposed about and spaced from the axis of symmetry of said main reflector, and a symmetrical auxiliary wave reflector having a pair of dihedral reflecting surfaces located with respect to said conducting elements so that 55their line of intersection lies inside the focal point of said main wave reflector.

5. In a system for transmission and reception of high frequency wave energy, the combination of a paraboloidal main wave reflector, a pair of waveguides disposed 60 with respect to said main reflector so that the axes of the waveguides are on opposite sides of and in a common plane with the axis of said main reflector, and a symmetrical auxiliary wave reflector having a pair of plane non-coplanar reflecting surfaces located with respect to said conducting elements so that their line of intersection lies inside the focal point of said main wave reflector.

6. In a system for transmission and reception of high 70 frequency wave energy utilizing a single antenna, the combination of a paraboloidal main wave reflector, a pair of waveguides disposed equidistant from and on opposite sides of the axis of said main reflector, and an auxiliary reflector comprising a pair of plane reflecting 75 surfaces lying in different planes and disposed with respect to said waveguides and main reflector so that the line of intersection of said surfaces is inside the focal point of said main wave reflector.

7. In a system for transmission and reception of high frequency wave energy utilizing a single antenna, the 5 combination of a paraboloidal main wave reflector, a pair of hollow waveguides disposed equidistant from and on opposite sides of the axis of said main reflector, and an auxiliary reflector comprising a pair of plane conducting surfaces, lying in different planes and each one fac- 10 between its focal point and its surface and each said ing the open end of a respective waveguide and oriented and spaced so that the line of intersection of said surfaces is inside the focal point of said main wave reflector and the electrical image of the ends of the waveguides are at the focal point of said main reflector.

15 8. In a system for transmission and reception of high frequency wave energy utilizing a single antenna, the combination of a paraboloidal main wave reflector, a pair of hollow waveguides disposed two wave lengths apart and equidistant from and on opposite sides of the 20 axis of said main reflector, and an auxiliary reflector comprising a pair of plane conducting surfaces, lying in different planes and each one facing the open end of a respective waveguide and oriented and spaced so that the line of intersection of said surfaces is inside the focal 25 point of said main wave reflector and the electrical image of the ends of the waveguides are at the focal point of said main reflector.

9. In a system using a single antenna for transmission and reception of high frequency wave energy, the combination comprising a main paraboloidal wave reflector, a pair of waveguides having end portions symmetrically disposed about and spaced from the axis of symmetry of said main reflector, a pair of auxiliary reflectors each having a plane surface and being located so that planes passing through their surfaces will intersect at a point which is on the axis of symmetry of said main reflector auxiliary reflector lies in a plane which is perpendicular to a line drawn between the center line of a respective wave guide at its end and the focal point of said main reflector.

References Cited in the file of this patent UNITED STATES PATENTS

2,342,721	Boerner Feb. 29, 1944	
2,430.568	Hershibargan Nov. 11 1047	
	Hershberger Nov. 11, 1947	
2,441,574	Jaynes May 18, 1948	
2,455,286	Werner Nov. 30, 1948	
2,477,694	Gutton Aug. 2, 1949	
2,523,398	Southworth Sept. 26, 1950	
2,638,547	Keary May 12, 1953	

FOREIGN PATENTS

570,568

Great Britain _____ July 12, 1945