

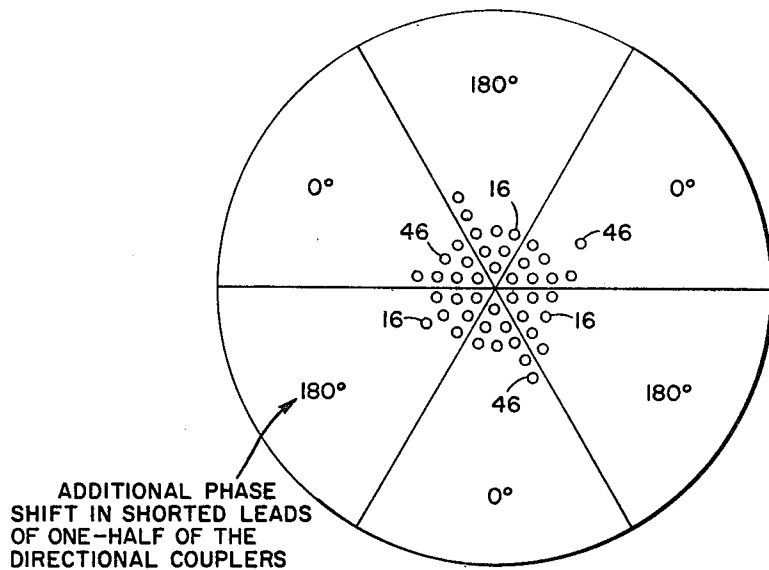
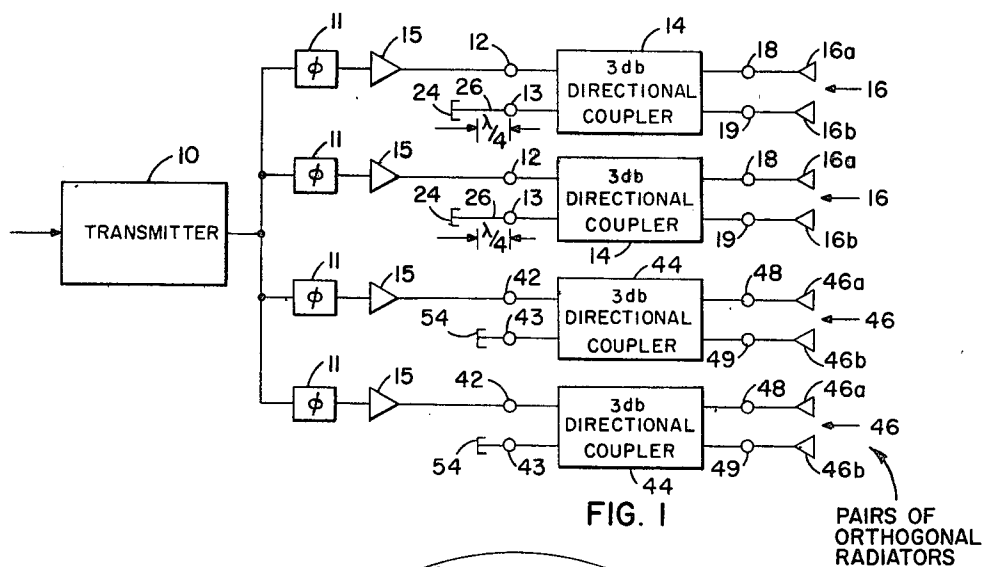
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PHASED ARRAY ANTENNA SYSTEM

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1

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PHASED ARRAY ANTENNA SYSTEM

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4 Claims

ABSTRACT OF THE DISCLOSURE

A system for controlling the reradiation of the reflected cross polarized mode in phased array radar antennas wherein two orthogonally polarized waves can be transmitted. This reradiation is controlled by transmitting the cross polarized reflected power of a number of elements 180° out of phase with the reflected power of a like number of elements.

Background of the invention

This invention relates to the defocusing of orthogonal-mode radiation in a phased array radar transmitter antenna.

Many phased array radar antennas are designed to transmit two orthogonally polarized waves, for example, two circularly polarized waves. This may be accomplished by connecting the two output terminals of a 3 db directional coupler to two linearly polarized probes in an antenna element which are in space quadrature. One input terminal of the coupler is excited while the second one, in general, is terminated in order to absorb the opposite sense of polarization and thus preserve polarization purity and reduce system degradation.

Summary of the invention

In low power radars, there is no particular problem associated with the practice of terminating the orthogonal port. However, at elevated power levels the problems of dissipating the heat produced in these terminations results in a more complex and expensive element design, antenna support structure, as well as more stringent cooling requirements. Therefore, the reradiation of the orthogonal port power is a much more practical solution. When the orthogonal ports of the antenna elements are terminated by a short (or open) circuit at identical locations the reradiated power would be scattered coherently and thus affect the main beam. To avoid affecting the main beam the antenna system according to the present invention reradiates the orthogonal power of one-half of the elements 180° out of phase with the rest of the elements. The elements are arranged in circular sectors such that one-half of the elements, disposed in alternate sectors, reradiate the energy coupled into the orthogonal port 180° out of phase with respect to the remaining elements.

Brief description of the drawings

FIGURE 1 is a block diagram illustration of a system for radiating two orthogonally polarized waves according to the present invention; and

FIGURE 2 is an illustration of a circular aperture with sector arrangement of orthogonal port shorts.

Description of the preferred embodiment

In FIGURE 1, a radar transmitter 10 provides excitation for input terminals 12 and 42 of groups of 3 db directional couplers 14 and 44. Transmitter 10 is connected to each of the input terminals 12 through a phase shifter 11 and a high power amplifier 15. Each coupler 14 has an antenna element 16 comprising probes 16a and 16b connected respectively to output terminals 18 and 19. The

2

remaining input terminal 13 is connected to a short-circuit-stub 24 through a quarter-wavelength of transmission line 26. Each coupler 44 is connected to an antenna element 46 having probes 46a and 46b at output terminals 48 and 49. The only difference in the connections for coupler 44 is that the short-circuiting stubs 54 are connected directly to input terminals 43, without the quarter-wavelength of transmission line.

The system of FIGURE 1 will not only radiate two orthogonal waves but will also radiate the orthogonal mode reflected wave. If all of the antenna elements 16 and 46 were made identical, this orthogonal mode would radiate a pattern identical to the desired mode pattern which would severely degrade the polarization quality in the main beam. However, the transmission line lengths 26 inserted between stubs 24 and couplers 14 cause probes 16a and 16b to radiate the energy from the orthogonal port 180° out of phase with respect to that radiated by 46a and 46b. To obtain maximum benefit from the radiation of the reflected power, it is necessary that the radiating elements 16 equal the elements 46. Further, the elements are arranged in circular sectors, as shown in FIGURE 2, wherein elements 16 and 46 are evenly divided between alternate sectors. Although the most effective arrangement is for an odd number of paired sectors (a paired sector being two adjacent sectors of 0° and 180° shorts) the circular array is not limited to any given number of sectors. The significant aspect of this arrangement is that the reradiated energy constitutes a beam that is somewhat analogous to a degenerate difference pattern whose main response is in the far sidelobe region. As a result, the main beam characteristics are basically unaffected by this technique and the two-way (combined transmitter and receiver) sidelobe levels of the desired polarization are only slightly affected.

Another desirable property of the radiation of the reflected power is that the main beam characteristics and the two-way sidelobe performance are only slightly affected during the other modes of radar operation, where phase spoiling (defocusing) is employed. This is a result of the orthogonality between the beam defocusing function and the sector phasing of the reradiated energy.

An alternative method of defocusing the orthogonal-mode radiation is to distribute the locations of the orthogonal port short in a random fashion. This technique might be useful for extremely large arrays.

In summary this invention provides for the control of the reradiated power of the cross polarized mode in phased array radar transmitters utilizing only two short positions (0° and 180° at midband) for all elements. All elements are arranged in segments of a circular array with elements with 0° short positions placed in one-half of the sectors and the 180° short positions are placed in its remaining sectors.

Although the invention has been described with reference to a preferred embodiment thereof, it will be apparent that various modifications will occur to those skilled in the art, within the scope of the invention as set forth in the appended claims.

What is claimed is:

1. A phased array antenna system comprising: a plurality of pairs of antenna probes arranged in a circular array; a plurality of 3 db directional couplers, each having output terminals connected to a pair of said antenna probes; means energizing a first input terminal of each of said couplers; and means short-circuiting a second input terminal of each of said couplers so that one-half of said antenna probes radiates the orthogonal-mode reflected power of associated couplers 180° out of phase with respect to that of the other half of said probes.

2. The combination of claim 1 wherein said short-circuiting means comprises first short-circuit stubs having

3

a given length connected to each of said second input terminals of one-half of said couplers; and second short-circuit stubs having a length differing by one-quarter wavelength from the length of said first short-circuit stubs connected to each of said second input terminals of the other one-half of said couplers.

3. The combination of claim 1 wherein said circular array is divided into a plurality of pairs of circular sectors; said one-half of said antenna probes being disposed in alternate ones of one-half of said sectors of said circular array and said other half of said probes being disposed in the remaining sectors of said circular array.

4. The combination of claim 3 wherein the number of pairs of sectors is an odd number.

4

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10

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