July 25, 1950 R. McG. ROBERTSON 2,516,530

ANTENNA

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FIG. 2

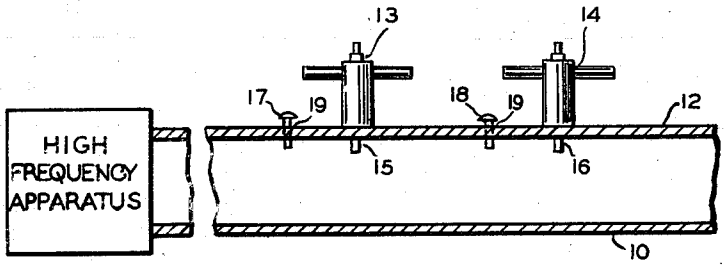


FIG. 1

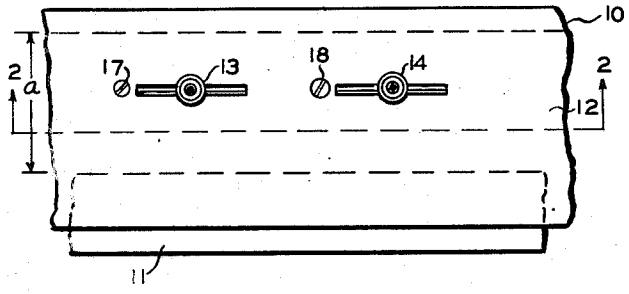
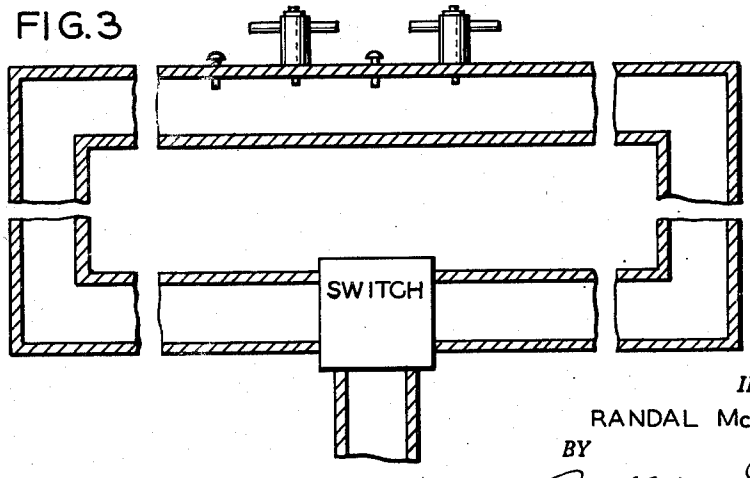


FIG. 3



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5 Claims. (Cl. 250—33.63)

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This invention relates to antennas for high frequency communication systems and more particularly to means for reducing the standing wave amplitude in scanning antennas of the linear array type, such as those disclosed in the copending applications of Luis W. Alvarez, Serial No. 542,287, filed June 27, 1944, now Patent No. 2,480,208, issued August 30, 1949, and Serial No. 509,790, filed November 10, 1943.

Scanning antennas of the above kind generally comprise a long wave guide for feeding electromagnetic waves of energy to a plurality of aligned spaced radiating elements such as dipoles or slots disposed along the length of the wave guide. In linear array antennas, standing waves of considerable amplitude are likely to build up in the wave guide whenever the spacing between the radiating elements approximates 180 electrical degrees, i. e., corresponding to the radiation of a beam which is substantially normal to the longitudinal axis of the wave guide.

The chief disadvantage of the suddenly increased standing-wave ratio which accompanies the production of a beam normal to the axis of the array is the possibility that the change in the load offered by the antenna resulting from the standing waves may cause the transmitting tube to shift its frequency of operation. Also the frequency-sensitivity of the antenna is increased by the existence of standing waves in the feed line connecting the transmitting apparatus to the antenna. This is of little practical consequence for standing-wave ratios of the order of magnitude encountered in arrays of 50 wavelengths or longer, so far as radio-echo detection apparatus of ordinary types is concerned, but it is of considerable importance in the case of specialized equipment of very high accuracy such as equipment employed for directing anti-aircraft fire. The effect of the variation in standing-wave ratio in the neighborhood of the normal beam position of the scanner may be greatly reduced by employing means for varying the length of the wave guide between the feed wave guide of the antenna and the transmitting tube. Such means may be a section of wave guide of variable width, as disclosed in the aforementioned copending application Serial No. 509,790. The variable portion of wave guide has the function of adjusting the electrical length of the wave guide so that the standing waves are presented to the transmitter tube in the most favorable phase. However, it has been found that this variation of the width of the wave guide does not sufficiently reduce the effect of the standing waves on the transmitting

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apparatus under certain special conditions such as under conditions of normal beam particularly when the scanning antenna is used for such special purposes as for directing gun fire.

Accordingly it is the principal object of this invention to provide means for reducing the standing wave amplitude in linear array type antennas.

Other objects and advantages of this invention will become apparent as the description proceeds with reference to the accompanying drawing in which:

Fig. 1 is front elevational view of a portion of a wave guide linear array antenna including two radiating dipoles and showing an embodiment of the present invention; and

Fig. 2 is a sectional side view along the line 2—2 of Fig. 1.

Fig. 3 is a wave guide adapted to be fed from alternate ends.

By way of example and for simplicity of illustration and description the invention will be described with reference to a linear array antenna of the kind disclosed in the aforementioned application Serial No. 509,790. While the present invention is particularly directed to, and the following description relates to, such an antenna, it will be understood that the invention is not limited to this particular structure but may be adaptable to any form of linear array having a hollow pipe or coaxial wave guide for feeding energy to a series of aligned and spaced radiating elements.

A portion of a variable width wave guide antenna array is illustrated in the drawings. In practice the entire structure may have a considerable length and may be mounted in an aircraft or on a mobile or fixed mounting structure on the ground or on a ship. Accordingly there is shown a portion of a wave guide 10 having a movable wall 11 of narrow dimension whereby the wide dimension a of the wave guide may be varied in the manner described in the aforementioned application, Serial No. 509,790. Along one of the walls 12 of wide dimension of wave guide 10 are arranged a plurality of aligned and spaced radiating elements here shown as two dipoles 13 and 14 of any conventional structure. Dipoles 13 and 14 are excited by probes 15 and 16 projecting through wall 12 into wave guide 10 in a well-known manner.

The means for reducing the standing wave ratio in a wave guide such as wave guide 10 comprises the provision of additional or auxiliary projections into wave guide 10. Such projections may be in any desired shape and size. For example

they may be in the form of rods, bars, pins or screws extending through a suitable aperture in wave guide wall 12 and firmly secured or adjustably movable relative thereto. Hence such projections may be screws 17 and 18 in adjustable threaded engagement through threaded apertures 19 in wall 12. Screws 17 and 18 are preferably arranged in alignment with dipoles 13 and 14 and are suitably spaced therefrom as more clearly described hereinafter.

The purpose of projections such as screws 17 and 18 is to "match out" the standing waves set up in wave guide 10 under normal beam conditions. This matching effect is achieved by the insertion of screws 17 and 18 a sufficient distance into wave guide 10 to set up independent standing waves. By proper choice of the position and depth of penetration of screws 17 and 18 at least a partial cancellation effect will occur between the standing waves set up by the screws and the standing waves set up in the guide due to the impedance imposed by probes 15 and 16.

The extent of penetration and the position of the screws into the wave guide is coordinated with the distance of penetration into the wave guide of an adjacent probe which excites its associated antenna element. It has been found that a desirable degree of reduction of the standing-wave ratio for conditions of normal beam is obtained when the penetration of the screws 17 and 18 into the wave guide is substantially half of the penetration of the probes 15 and 16 into the wave guide and when the spacing between the screws and the respective nearest probes is equal to substantially one-fifth of the wavelength in the wave guide for conditions of normal beam. It will be understood, however, that this distance is for the type of dipole and feed as illustrated in the drawings and that such spacing may be varied for different types and sizes of dipoles and probes, the exact spacing being determined by experimentation and calculation according to the impedance of the particular radiating elements used. The screws should be located on that side of the probes from which they are respectively spaced by 0.2 λ_G or other determined distance in the direction towards the connection of the feed wave guide to the transmitting and receiving apparatus. As shown in the drawings, the screws are disposed on the left of dipoles 13 and 14 assuming that the connection of wave guide 10 to the transmitting and receiving apparatus is at the left hand end of the figures.

It will be understood that under conditions other than those appropriate for normal-beam radiation the spacing between the screws and the respective probes will no longer be one-fifth of the wavelength in the wave guide, as the wavelength in the wave guide is varied from normal-beam conditions. This is not important, however, since reduction of standing waves is principally a problem in the neighborhood of normal beam conditions, as is more fully pointed out hereinabove. Since the dimension of the spacing between the screws and the nearest probe depends upon the wavelength in the guide under normal-beam conditions and since under normal-beam conditions successive probes are spaced by one-half of the wavelength in the guide, the recommended dimension can be restated as being about two-fifths of the spacing between successive probes. As indicated hereinabove this spacing may vary slightly depending on the impedance of the particular dipole used.

It will be understood that this arrangement will be most effective to reduce the standing waves for normal-beam conditions when the connection of the antenna array with the transmitting and receiving apparatus is at one end of the array.

It has also been found that partial matching may be obtained for a wave guide which is fed from alternate ends of the array such as in the manner disclosed in the aforementioned Patent No. 2,480,208. In such an arrangement the screws 17 and 18 are placed substantially halfway between dipoles 15 and 16 and the depth of penetration of screws 17 and 18 is determined to obtain the minimum standing wave ratio.

While preferred embodiments of this invention have been particularly described and illustrated, it will be understood that various other modifications and improvements may be made without departing from the spirit of the invention. Therefore it is not desired that the invention be limited to the precise details set forth.

What is claimed is:

1. An antenna for high frequency communication systems comprising, a rectangular feed wave guide to be connected at one end to high frequency apparatus, a plurality of aligned spaced radiating dipoles positioned along the length of said wave guide and having probes extending into said wave guide adapted to be excited by energy in said wave guide, said dipoles being spaced apart by a distance equal to one half of the wavelength of the energy in said wave guide under conditions in which the beam of energy radiated by said dipoles is normal to the axis of said wave guide, and an adjustable screw spaced from each of said dipoles in the direction towards that end of said wave guide at which the high frequency apparatus is connected, said screws being in substantial alignment with said dipoles, the spacing of each of said screws from its corresponding dipole being two-fifths of the distance between successive dipoles, said screws projecting into said wave guide for half the distance of penetration of said probes, said screws being effective to reduce the standing wave ratio of said energy in said wave guide.

2. An antenna for high frequency communication systems comprising a wave guide transmission line, a plurality of radiating elements disposed in aligned spaced relation along said line, each of said elements having a probe projecting into said wave guide and coupling each of said elements to said line whereby each of said elements are adapted to be excited by energy in said line, the space between probes of adjacent elements being substantially one half the wave length of said energy under conditions when the energy beam radiated by said elements is perpendicular to the axis of said line, and a member projecting into said line adjacent to and spaced from each said dipole, said members being in substantial alignment with said elements, each of said members being spaced from its adjacent elements by a distance of approximately one-fifth of the wavelength of the energy in said line.

3. In a linear array type antenna for high frequency communication systems having a plurality of aligned spaced radiating elements disposed along the length of a wave guide and adapted to be excited by probes extending into said wave guide when energy is fed through said

wave guide, means for reducing the amplitude of the standing waves set up in said wave guide when the axis of a beam of energy radiated by said elements is perpendicular to the axis of said wave guide, said means comprising a series of spaced projections extending into said wave guide for a distance not substantially more than the distance of penetration of said probes.

4. An antenna as claimed in claim 3 wherein each one of the projections is spaced from its adjacent radiating element by a distance approximately equal to two-fifths of the distance between successive elements.

5. An antenna as claimed in 3 wherein each of the projections are disposed substantially equidistant between successive dipoles when the wave guide is adapted to be fed from alternate ends thereof.

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REFERENCES CITED

The following references are of record in the file of this patent:

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Number	Name	Date
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