Aug. 27, 1963 J. R. MOREAU ETAL 3,102,265

NEW AERIAL SYSTEM RADIATING SEVERAL BEAMS

Filed Jan. 4, 1960 3 Sheets-Sheet 1

FIG. 1.

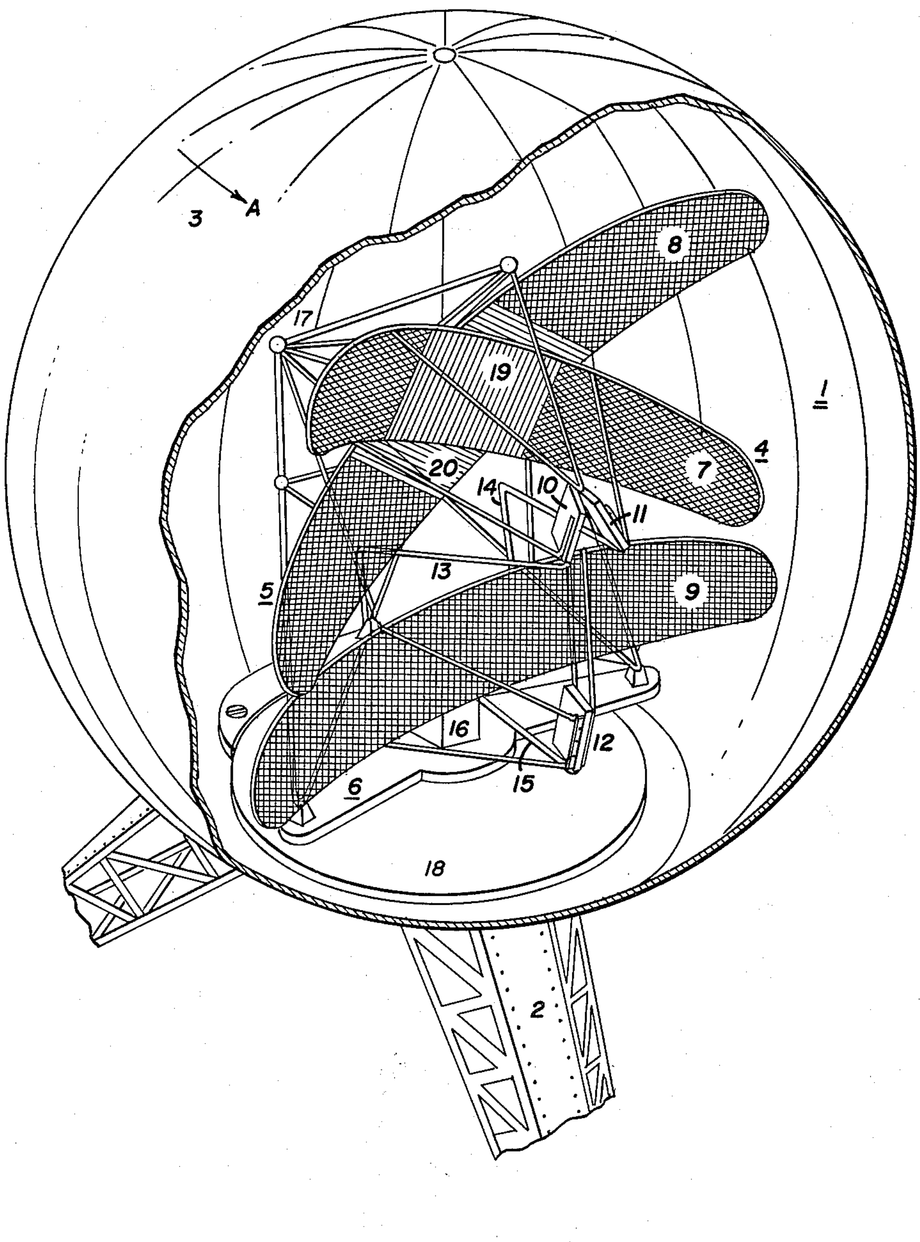

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FIG.2.

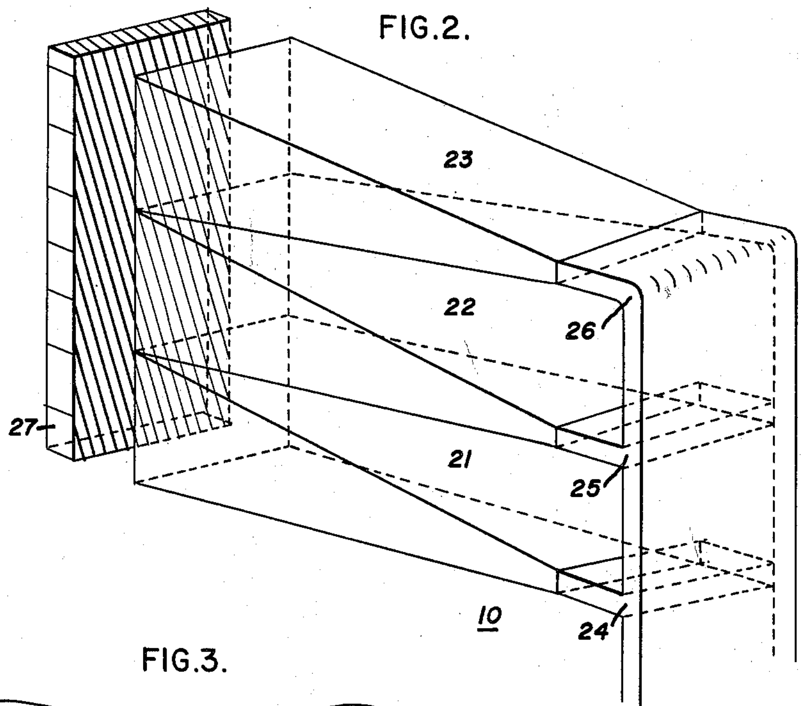

FIG.3.

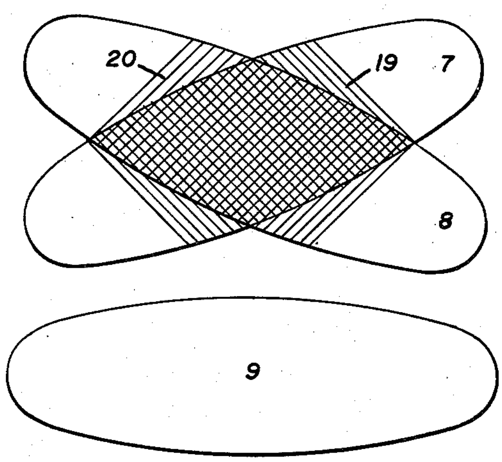

FIG.4.

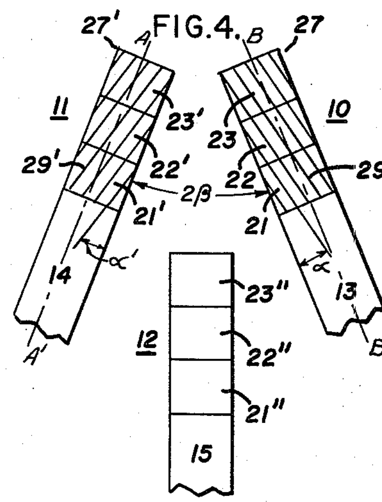

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FIG.5.

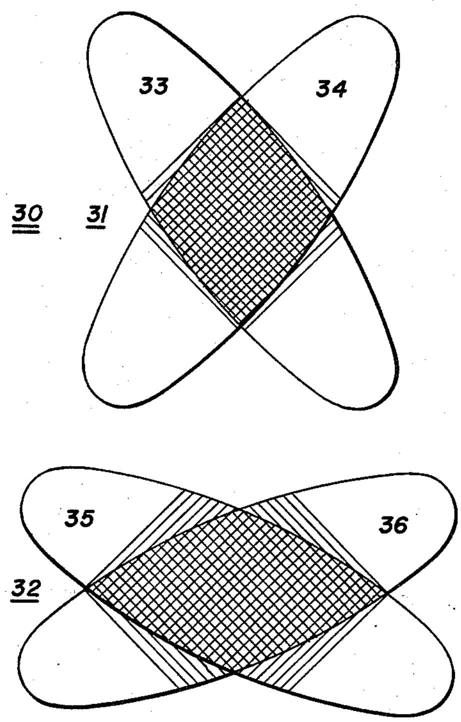
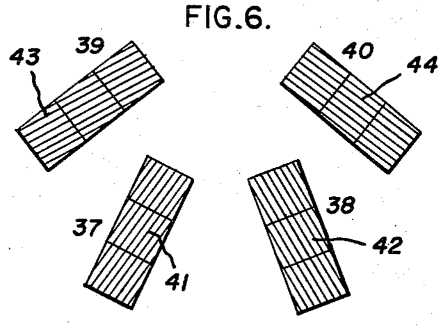


FIG.6.



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NEW AERIAL SYSTEM RADIATING SEVERAL BEAMS

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3 Claims. (Cl. 343—100)

The invention relates to wave radiating systems employing several antennas, each radiating a beam of energy of different polarization.

In the electrical arts, the solution of certain technical problems involves the use of radiating systems with more than two antennas, each serving distinct functions. For example, in obstacle detection systems a rotary aerial system radiating more than two flat beams is used.

Heretofore, antennas have made use of a source associated with an elongated, preferably elliptical, reflector where the ratio between length and cross dimensions is comparatively great.

It would be possible to build a radiating system with more than two antennas, each radiating a flat beam, by superposition of simple antennas with source and reflector as described above. Such a radiating system would be bulky, particularly if the flat beams to be radiated cannot be parallel.

The object of the invention is to design a system radiating more than two flat beams, which is not too bulky.

A further object is to provide at least one pair of orthogonally polarized waves from reflectors which are fed with waves that are not orthogonally polarized.

It is a further object of this invention to provide a plurality of waves of desired relative polarization from waves available from sources where the available waves have a different relative polarization.

It is a further object of this invention to provide an improved wave processing arrangement.

Briefly, in accordance with one embodiment of the invention reflectors of an antenna array produce two waves respectively, whose polarization planes are perpendicular although the polarization planes of the waves emitted by the sources associated with such reflectors are not perpendicular angle 2β (FIG. 4). In front of at least one of the sources a polarization shift network is provided to make the polarization planes of the waves reaching the reflectors perpendicular. It is known that the polarization plane of the waves emitted by such a polarization shift network is different from the polarization plane of the incident waves entering the polarization shift network from the source. If the angle between the slope of the parallel elements of the polarization shift network and the polarization plane of the incident waves is α, the rotation angle of the polarization plane of these waves is 2α. The angle formed between the polarization planes of the waves received by the reflectors is thus $2\alpha+2\beta$. In order that this angle have the desired value, the condition $\alpha+\beta=45°$ must prevail. In case a polarization shift network is provided in front of each source, α and α' being the angles formed by the elements of the polarization shift network with the polarization planes of the emitted waves, the condition changes to $\alpha+\alpha'+\beta=45°$.

If the radiating system covered by this invention has only two antennas, that is to say in the simplest case, the second antenna can be identical with the first; it can also consist of a source and a reflector.

If several other antennas are combined with the duel antenna, they can be identical or different, provided that they are of one of the two types already mentioned, namely, dual antenna or simple antenna.

While the novel and distinctive features of the invention are particularly pointed out in the appended claims, a more expository treatment of the invention, in principle and in detail, together with additional objects and advantages thereof, is afforded by the following description and accompanying drawings in which:

FIG. 1 is a view in perspective of an aerial system with a dual antenna and a simple antenna for a radio detection system with three beams. The aerial is protected against weather influences by an inflatable radome shown in partial cutaway representation,

FIG. 2 is a view in larger scale of one of the sources of the dual antenna used according to the invention,

FIG. 3 is a schematic rear view of the reflectors of the radiating system shown in FIG. 1, as seen by an observer looking in the direction of arrow A (FIG. 1),

FIG. 4 is a schematic front view at a different scale of the sources provided in front of the reflectors.

It will be noticed that in FIGS. 1 and 2, the respective orientations of the two reflectors and two sources of the dual antenna differ from those shown in FIGS. 3 and 4, due to the fact that the former are related to a front view whereas the latter relate to a rear view.

FIG. 5 is a schematic rear view of an aerial system with four antennas, and

FIG. 6 is a schematic front view at different scale of the sources provided in front of the reflectors.

The aerial system **1** of FIG. 1 is supported by a pedestal **2** with three legs and protected against weather influences, for example by means of an inflatable radome **3**. It consists essentially of three antennas **4**, **5** and **6**. These are formed by three reflectors **7**, **8** and **9**, connected respectively to the three feeds or waveguide horns **10**, **11** and **12**, fed by guides **13**, **14**, **15**, one end of which ends at the distributor **16**. The assembly of reflectors **7**, **8** and **9** is supported by a jointed structure **17** attached to turntable **18**.

The surfaces of the three reflectors **7**, **8**, **9** (FIGS. 1 and 2) are parts of paraboloids of revolution with elliptic boundary lines. The long transverse axes of reflectors **7** and **8** form an X; they are slightly inclined in relation to a horizontal line and between themselves form an angle 2β which is also the angle of the short transverse axes. The parts of the reflectors which overlap are formed by an array (**19** or **20**) of parallel elements (wire, rods or strips). The elements of array **19** of reflector **7** are parallel to a direction which is inclined against the vertical at an angle of 45°; they are furthermore perpendicular to the elements of array **20**. These evidently are also inclined 45° to the vertical. The third reflector **9**, of which the long axis is horizontal, is of the classic type.

FIG. 2 shows the horn or waveguide feed **10** connected with reflector **7**. Assuming that the metal cover has been lifted, it will be noted that this wave guide feed is identical with source **11**, connected with reflector **8**. Essentially, this source is formed by three flat flares **21**, **22**, **23** where the small parallel sides are trapezoidal, whereas the large sides are rectangular. The flares are connected with the feed guide **13** by means of two T's, **24** and **25**, and an elbow **26**. The three flares radiate waves whose polarization planes are parallel to the small cross axis of reflector **7**. A half-wave network **27**, commonly referred to as a polarization changer, is arranged in front of the flares to rotate the polarization plane of the waves reaching reflector **7** so that it is parallel with the elements of array **19**. If a wave is incident at an angle α to the plates of the network, the exit wave occurs at an angle 2α relative to the input polarization.

It will be noticed that the FIGS. 3 and 4 relate to a rear view of the antenna and particularly that the sources of FIG. 4 are shown as they would be seen by an observer standing between them and the reflectors. These sources can be of a different type than shown in FIG. 2.

The flares of each source emit waves whose polarization planes are parallel to the long transverse axes AA' and BB' of the spouts of the feeds (FIG. 4); these axes form an angle 2β. In FIG. 4 are seen the elements **29** and **29'** of the half-wave networks **27** and **27'**, arranged before sources **10** and **11** respectively. As already stated, these networks make it possible to impart the desired polarization to the waves received by the reflectors. As can be seen in FIG. 4, the planes of the elements of the network and the polarization plane of the received waves form an angle α. Feed **12** connected with reflector **9** is arranged below feeds **10** and **11**, its symmetrical plane being vertical. This feed **12** is analogous to feeds **10** and **11**, but has no polarization shift network. An antenna such as just described can be used in a radio detection system of the type employed to detect and measure the angular position of remote objects with respect to the antenna.

FIGS. 5 and 6 relate to an aerial system having four antennas; they correspond to views similar to those shown in FIGS. 3 and 4. It shows that this aerial system **30** has two dual antennas **31** and **32**. Each of these antennas is analogous to the dual antenna of FIG. 3. Reflectors **33**, **34** of aerial system **31**, and the reflectors **35**, **36** of aerial system **32**, consist in part of an array. The parallel wave reflecting elements of each of them are inclined by 45° to the vertical. With the reflectors **33—34** and **35—36** are connected feeds **38—39** and **40—41**, identical, for example, with that shown in FIG. 2. Before each feed is arranged a polarization shift network **41**, **42**, **43** or **44**, with characteristics determined according to the principles shown above.

While the principles of the invention have now been made clear, there will be immediately obvious to those skilled in the art many modifications in structure, arrangement, proportions, the elements and components used in the practice of the invention, and otherwise, which are particularly adapted for specific environments and operating requirements without departing from those principles. The appended claims are therefore intended to cover and embrace any such modifications within the limits of the true spirit and scope of the invention.

What we claim and desire to secure by Letters Patent of the United States is:

1. An arrangement for communicating electromagnetic waves with a first and second polarization separated 90° from one another comprising a first and second electromagnetic wave reflector, each of said reflectors having a major and a minor axis, means for mounting said reflectors in a cross position such that their major axes make a given angle with respect to one another, each of said reflectors having a plurality of parallel electromagnetic wave reflecting elements at least where the reflectors overlap one another, the elements of one reflector being perpendicular to the elements of the other reflector, a first waveguide horn associated with said first reflector, a second waveguide horn associated with said second reflector, each of said horns having major and minor horn axes, said major axis of each horn being positioned parallel to the minor axis of the associated reflector, said given angle being different from 90° such that electromagnetic waves communicated between one horn and its associated reflector are not perpendicular to the electromagnetic waves communicated between the other horn and its associated reflector, means for rotating the polarization of electromagnetic waves associated with said first horn such that the resulting electromagnetic waves are polarized parallel to the elements of said first reflector, means for rotating the polarization of electromagnetic waves associated with said second horn such that the resulting electromagnetic waves are parallel to the elements of said second reflector, a third electromagnetic wave reflector having a major and minor axis, a third horn associated with said third reflector and having a major and minor horn axis, said major axis of said third horn being parallel to the minor axis of said third reflector, said major axis of said third reflector positioned to be parallel to the line bisecting the major axes of said first and second electromagnetic wave reflectors, and means for angularly rotating said feeds and associated reflectors about a common axis.

2. An arrangement for providing electromagnetic waves with a first and second polarization separated 90° from one another comprising a first, second, third, and fourth electromagnetic wave reflector, each of said reflectors having a major and a minor axis, means for mounting said reflectors in pairs such that their major axes make different given angles with respect to one another and with respect to said desired angle, each of said reflectors having a plurality of parallel electromagnetic wave reflecting elements at least where they overlap the other reflector in said pair, the elements of each reflector in each pair being perpendicular to the elements of the other reflector in such pair, first, second, third and fourth waveguide horns associated with said first, second, third and fourth electromagnetic wave reflectors respectively, each of said horns having major and minor feed axes, said major axis of each horn being positioned parallel to the minor axis of the associated reflector, individual means associated with each of said first, second, third and fourth horns for rotating the polarization of electromagnetic waves associated with such horns such that the resulting waves are polarized parallel to the elements of the reflectors associated with each of said horns.

3. An arrangement for transmitting electromagnetic waves with a first and second polarization separated 90° from one another comprising a first and second electromagnetic wave reflector, each of said reflectors having a major and a minor axis, means for mounting said reflectors in a cross position to form an X configuration, each of said reflectors having a plurality of parallel electromagnetic wave reflecting elements at least in the overlapping sections of said configuration, the elements of one reflector being perpendicular to the elements of the other reflector, a first electromagnetic wave feed associated with said first reflector, a second electromagnetic wave feed associated with said second reflector, each of said feeds having major and minor feed axes, said major axis of each feed being positioned parallel to the minor axis of the associated reflector, means for rotating the polarization of electromagnetic waves emanating from said first feed such that the resulting electromagnetic waves are polarized parallel to the elements of said first reflector, means for rotating the polarization of electromagnetic waves emanating from said second electromagnetic waves such that the resulting electromagnetic waves are parallel to the elements of said second reflector, a third electromagnetic wave reflector having a major and minor axis, a third feed associated with said third reflector and having a major and minor feed axis, said major axis of said third feed being parallel to the minor axis of said associated third reflector, said major axis of said third reflector positioned to be parallel to the line bisecting the major axes of said first and second electromagnetic wave reflectors, and means for angularly rotating said feeds and associated reflectors about a common axis.

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