

Nov. 28, 1950

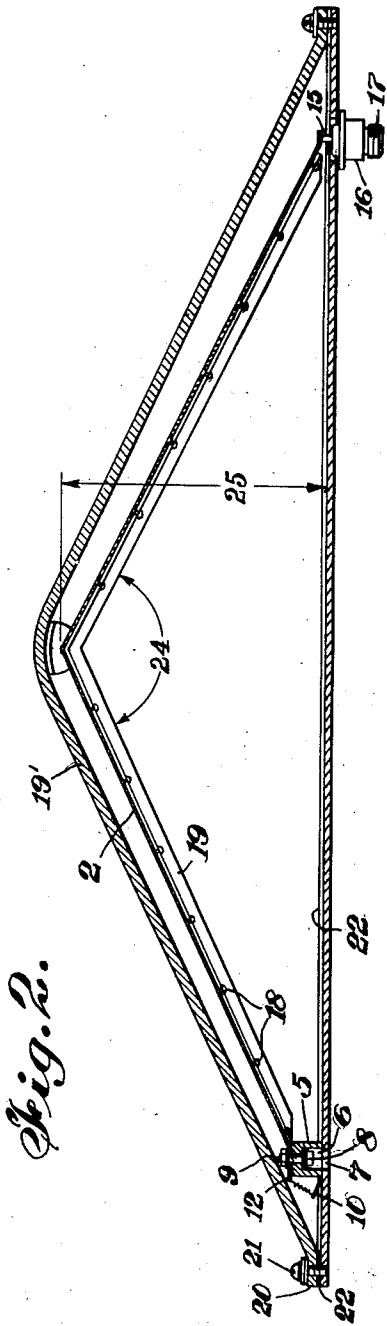
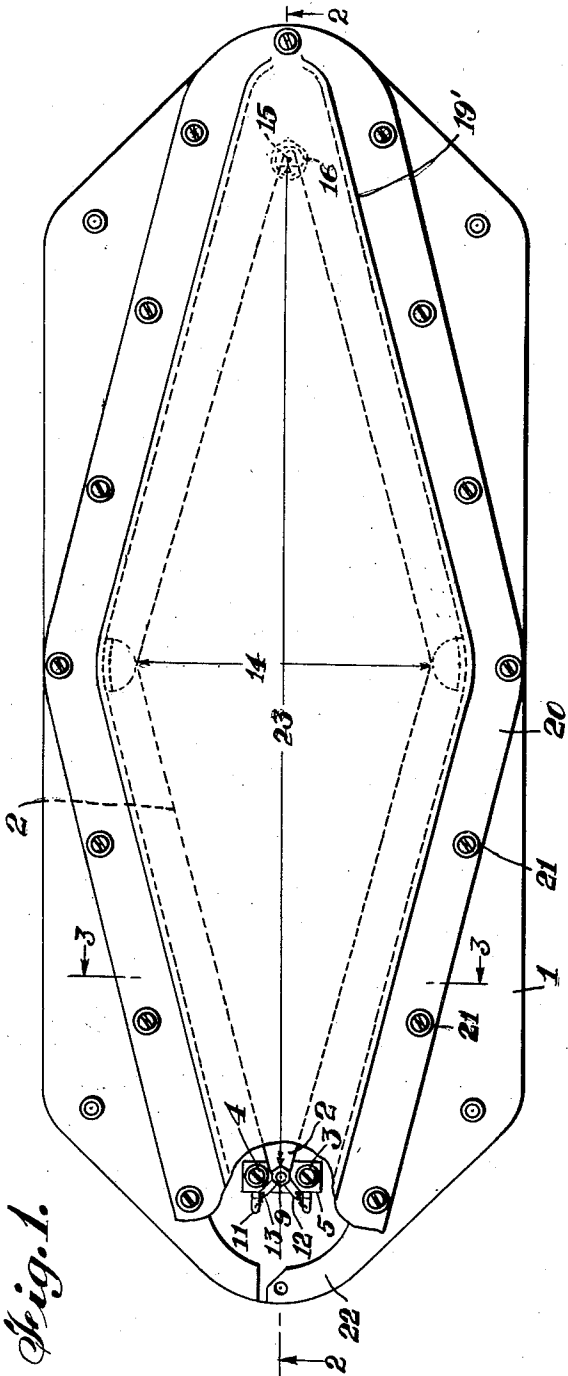
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2,531,432

BROAD BAND ANTENNA SYSTEM

Filed Oct. 1, 1948

3 Sheets-Sheet 1



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Fig. 5.

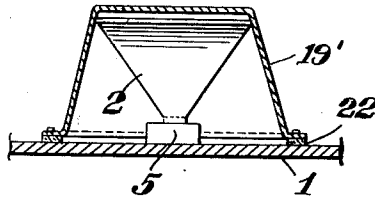


Fig. 6.

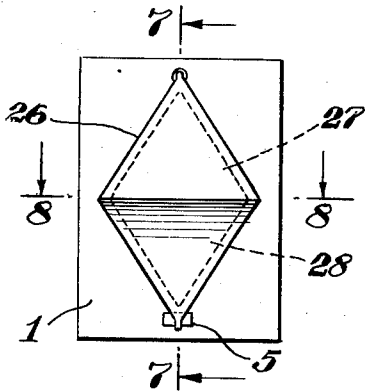


Fig. 7.

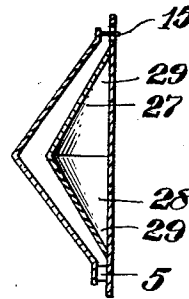


Fig. 8.

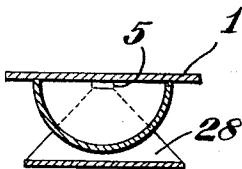
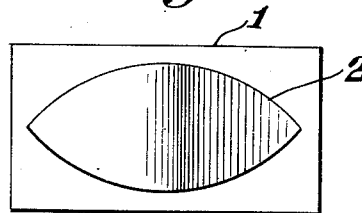


Fig. 9.



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Fig. 4.

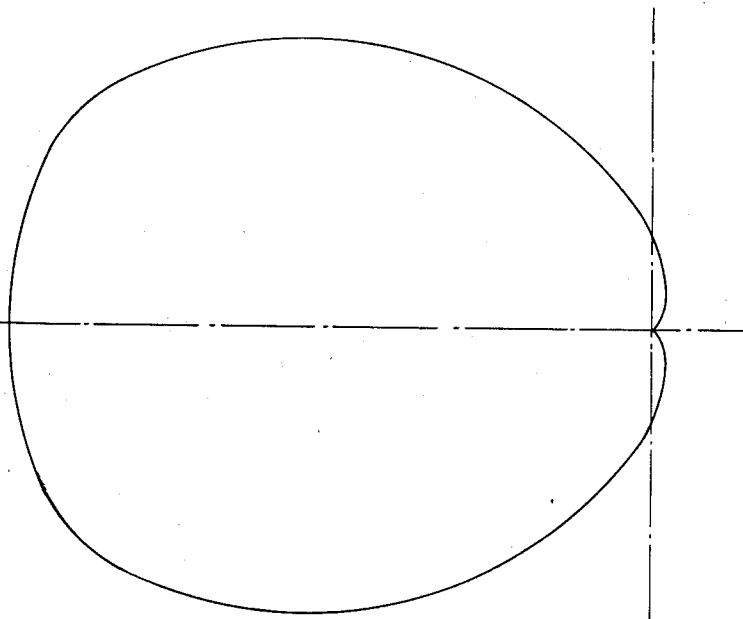
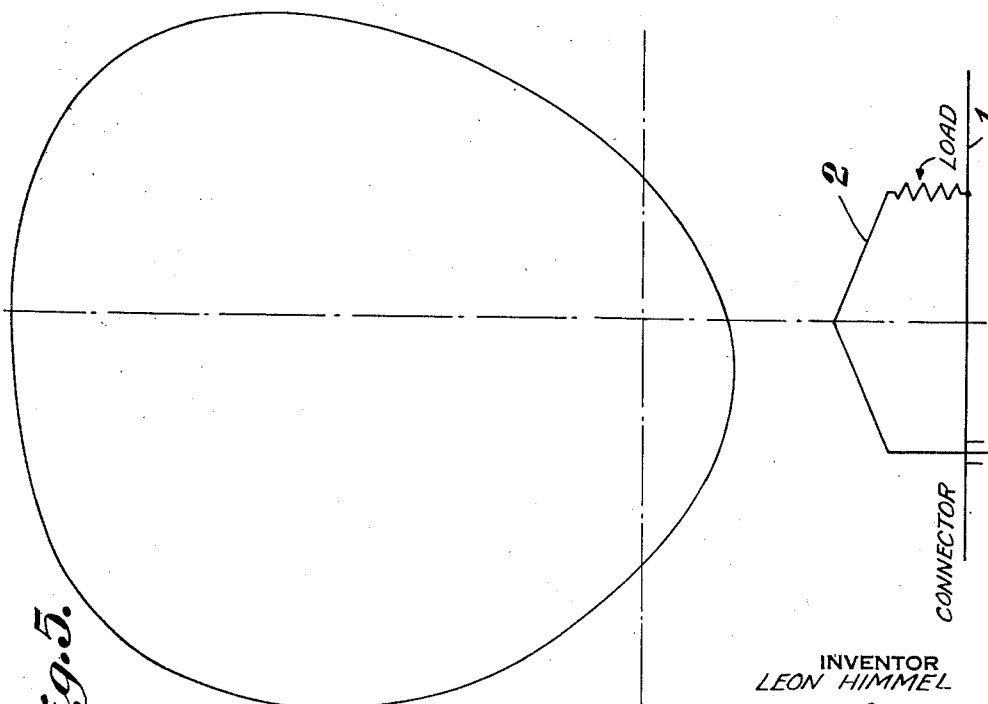


Fig. 5.



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UNITED STATES PATENT OFFICE

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BROAD BAND ANTENNA SYSTEM

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7 Claims. (Cl. 250—33.51)

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This invention relates to antenna structures, and more particularly it relates to an antenna for use at very high frequencies and having broad band frequency response characteristics.

In many installations the provision of wide band response antennas is desirable. In portable direction finders, for example, it is desirable that such wide band antennas be rigid in construction and have stable directional characteristics.

A principal object of the invention is to provide an improved directional antenna for use at very high frequencies and terminated in a dummy resistance load.

Another object is to provide a simplified and structurally rigid antenna assembly employing a substantially diamond-shaped metal antenna plate which is bent along its minor axis at a predetermined angle.

A further object is to provide an improved antenna of the generic rhombic type.

A feature of the invention relates to the combination of a substantially diamond-shaped metal antenna plate which is bent along a minor axis, in conjunction with a specially designed reflector for controlling the directionalized field pattern of the antenna as a whole.

Another feature relates to a compact directionalized broad frequency band antenna for use at very high frequencies, in the form of a substantially diamond-shaped antenna plate which is supported in spaced relation to a coextensive ground plate. The antenna plate is bent along a minor axis and one apex of the major axis is connected to a feed or transmission line, and the other major apex is terminated in a dummy resistance load. The angle of the said bend and the length of the major axis are correlated to provide a predetermined directivity characteristic in the plane of the major axis.

A further feature relates to an antenna in the form of a diamond or rhombic antenna plate which is bent along its minor axis to a predetermined angle, for example 130° , in conjunction with a specially designed conical reflector in nested relation to the antenna plate to provide a uniform impedance relation along the length of the antenna plate and to provide an impedance match to a feed or transmission line connected to one apex of the antenna plate.

The above-mentioned and other features and objects of this invention and the manner of attaining them will become more apparent and the invention itself will be best understood, by reference to the following description of an embodiment of the invention taken in conjunction with the accompanying drawings, wherein:

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Fig. 1 is a top plan view, partly sectional, of an antenna assembly according to the invention.

Fig. 2 is a longitudinal sectional view of Fig. 1, taken along the line 2—2 thereof.

Fig. 3 is a transverse sectional view of Fig. 1, taken along the line 3—3 thereof.

Fig. 4 is a horizontal field pattern diagram of the antenna.

Fig. 5 is a vertical field pattern diagram of the antenna.

Fig. 6 is a top plan view of a modification of the antenna of Figs. 1 to 3.

Fig. 7 is a sectional view of Fig. 6, taken along the line 7—7 thereof.

Fig. 8 is a sectional view of Fig. 6, taken along the line 8—8 thereof.

Fig. 9 is a further modification of the antenna according to the invention.

Referring to the embodiment of Figs. 1-3, the antenna assembly comprises an elongated flat metal plate 1 on which is supported the antenna plate 2. Plate 1 has fastened thereto by screws 3, 4, adjacent one end, an insulator block 5, which has a central undercut portion or recess 6 in registry with a corresponding opening 7 in plate 1 to permit the insertion of a fastening screw 8. Screw 8 passes through an opening in the end of antenna plate 2 and is fastened by a suitable nut 9. Fastened between the block 5 and plate 1 are two connector lugs 10, 11 and likewise fastened between the nut 9 and the end of antenna plate 2 are a pair of connector lugs 12, 13. A suitable dummy load resistance is connected between the lug 10 and the lug 12, and a similar dummy load resistance is connected between the lug 11 and the lug 13, thus providing a grounded dummy load termination for the left-hand end of the antenna plate. The antenna is formed from a substantially diamond or rhombic-shaped metal plate which is bent along its minor axis 14 at an angle, for example of 130° . Consequently, the antenna plate is supported at one end of its major axis by the block 5 in insulated relation with respect to plate 1. The opposite end of this major axis of the antenna plate can be soldered to a rigid central metal conductor 15 of any well-known type of coaxial fitting or plug 16 such as is customarily used for connection of coaxial lines to antennas and the like. This fitting or plug comprises the outer threaded metal conductor 17. This plug or connector can be rigidly fastened in any suitable manner to plate 1, it being understood, of course, that the center conductor 15 is electrically insulated from the outer conductor 17. By this arrangement, the antenna can be fed from any well-known coaxial feed or

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transmission line and it is supported in the proper spaced relation above the ground plate 1. Preferably, the antenna plate 2 is attached by small rivets 18 to a correspondingly bent diamond-shaped rigid metal frame 19, so as to preserve the rigidity and bent shape of the antenna plate. Preferably, the entire assembly is enclosed within a weather-proof plastic cover 19' which has a peripheral flange 20 that is fastened to the ground plate 1 by a series of screws 21, with an intervening and correspondingly shaped moisture-proof rubber or similar gasket 22. It will be understood, of course, that the material for the cover 19 is transparent to the electromagnetic waves to be transmitted from or to the antenna plate 2.

Fig. 4 shows the average horizontal field pattern of the antenna when operating at a frequency of between 225 and 390 megacycles, the antenna being mounted so that the long or major axis 23 is vertical. Fig. 5 shows the average vertical field pattern of the antenna when so mounted.

As the frequency at which the antenna is to operate, is reduced, the vertical field pattern maintains about the same shape as that shown in Fig. 5, the field lobe shifting approximately 20° towards the feed end of the antenna. It has been found that with such an arrangement the standing wave ratio on a 50-ohm line feeding the antenna, increases from a minimum of 1.1/1 at 225 megacycles to a maximum of 2.5/1 at 325 megacycles and then decreases to 2.1/1 at 390 megacycles.

It has been found that the angle 24 of the bend of the antenna plate 2 and the length of its major axis 23, determine the directionalized characteristics of the antenna, when considered in a plane passing through the major axis of the antenna plate. The shorter the said major axis, the more the lobe of the field pattern points towards the feed end of the antenna. The greater the angle of the bend 24, the broader becomes the field pattern lobe. However, with too sharp an angle of bend, minor lobes tend to appear in the vertical pattern. It has been found that the optimum results are obtained when the angle of bend is approximately 130°, and at that angle of bend there is produced the sharpest field pattern which is free from minor lobes.

To a certain extent the impedance of the antenna can be controlled by choosing the length of the minor axis 14. If the feed line is a 50-ohm line, this minor axis of the antenna plate can be chosen of a length so as to provide an impedance between the antenna and ground plate which is effectively 50 ohms throughout the length of the antenna plate. In that case, the dummy load resistance termination may be a 50-ohm resistor. However, it has been found that the value of this dummy load resistor may vary as much as 20% with little change in input impedance to the antenna.

While it is preferred to bend the antenna plate at an angle of approximately 130°, the invention is not necessarily limited thereto. For example, in certain applications it may be desirable to provide an antenna with a greater spacing 25 between the apex of the bend and the ground plate 1, in which case it may be necessary to have the width of the antenna plate at the minor axis 14 much wider. The necessity of making the antenna very wide at the minor axis may then be offset by inserting a built-up ground section behind the antenna

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plate, rather than employing a flat ground plate 1. Thus as shown in Fig. 6, the antenna plate 26 which is substantially diamond-shaped, may be bent at an angle of approximately 90°. The manner of attaching this antenna plate to the ground plate 1 can be the same as that disclosed in connection with Figs. 1 to 3, and also the manner of feeding one end of the antenna from a coaxial line and terminating the opposite end of the antenna in a dummy load resistance may be the same as that already described. Located between the ground plate 1 and the antenna plate 26, are two half-conical metal plates 27, 28, which are soldered or otherwise fastened along their edges to the plate 1 so that the bases of the semi-cones are in abutting relation, and the straight edges of the semi-cones are in close contact with the plate 1. The members 27 and 28 may be formed from a single metal cone which is split in half along its altitude. The apex angle 29 of each half-conical built-up section is so chosen with respect to the width of the minor axis 14 of the antenna plate 2, so as to provide a uniform impedance along the length of the antenna and so as to provide the necessary impedance match to the coaxial input or feed line.

It will be understood, of course, that the built-up reflector sections need not necessarily be of half-cone formation, providing they are symmetrical and provide the necessary impedance relations with respect to ground along the entire length of the antenna. Furthermore, it is not necessary that the antenna plate 2 be exactly in the form of a straight edged diamond, for example the longitudinal edges of the bent plate can be curved as illustrated in Fig. 9. However, the diamond-shaped form is preferred because of its simplicity of manufacture and construction. By way of example, if the antenna is to be operated in the frequency band between 200 and 400 megacycles, the major axis of the antenna plate 2 may be approximately 17 inches and the minor axis 14 may be approximately 10 inches. If the angle 24 of bend of the antenna plate is approximately 90°, then each of the half-cones 27, 28, may be cut from a single cone having a base diameter of approximately 8 inches and a cone altitude of approximately 7½ inches.

While in the foregoing, reference has been made to the antenna plate as being diamond-shaped, it will be understood that this term is used in a rather broad sense to include any shape similar to that of a diamond such as a lozenge shape, rhombic shape, etc., the important thing being that the antenna plate has a substantial difference between its major and minor axis lengths and that the antenna comes to a substantial point at the ends of its major axis.

While I have described above the principles of my invention in connection with specific apparatus, it is to be clearly understood that this description is made only by way of example and not as a limitation to the scope of my invention.

What is claimed is:

1. A directionalized antenna for broad frequency band operation at very high frequencies, comprising a rhomboidal-shaped metal sheet antenna bent along a minor axis, and a metal reflector member in spaced and substantially nested relation with said antenna sheet, means to feed said antenna sheet at one end of its major axis, and means to terminate said antenna sheet

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in a dummy resistance load at the opposite end of said major axis.

2. A directionalized antenna according to claim 1 in which said reflector member comprises substantially half-conical sections with their apices facing in opposite directions and located substantially adjacent the opposite ends of the major axis of said antenna sheet.

3. A directionalized antenna for broad frequency band operation at very high frequencies, comprising a substantially diamond-shaped metal sheet bent along its minor axis to a predetermined angle, metal means defining a ground plane substantially coextensive with said antenna, the last-mentioned means comprising a pair of half-cones joined together at their circular edges and with their apices pointing in opposite directions, a wave transmission line connected between one end of the major axis of the antenna and the corresponding apex of one of said half cones, and a dissipation load element connected between the opposite end of the major axis of the antenna and the corresponding apex of the other of said half-cones.

4. An antenna assembly according to claim 3 in which said diamond-shaped metal sheet and said half-conical reflector members are supported from a flat metal base, said half-cones being directly attached at their straight edges to said base, and said diamond-shaped metal sheet being insulatingly supported at opposite ends of its major axis from said base.

5. An antenna assembly, comprising a flat metal base forming an antenna ground plane, a rigid and substantially diamond-shaped metal frame bent along a minor axis to a predetermined angle, a substantially flat diamond-shaped metal sheet attached to said frame, means insulatingly supporting said sheet at one end of its major axis from said base, a coaxial line coupling unit having the outer member anchored to said base, means to support said sheet at the opposite end of the major axis from the

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center member of said coupling unit, and a resistance dissipation load connected between the first-mentioned end of said sheet and said metal base.

6. An antenna assembly according to claim 5 in which a weather-proof housing encloses said antenna, said housing being transparent to ultra-high-frequency waves, and a weather-proof gasket is fastened between the marginal periphery of said housing and said base.

7. An antenna for broad frequency band coverage at ultra-high-frequencies, comprising a pair of symmetrical half-antenna sections each substantially in the form of a half-diamond shaped metal plate with the apices of the sections facing in opposite directions, said sections converging towards each other and joining each other with an included angle less than 180 degrees, a metal base forming a ground plane for said antenna, means for insulatingly supporting said apices from said metal base, a curved reflector member located between said antenna and said base, means to feed said antenna at one apex, and means to terminate said antenna in a dummy dissipation load at the opposite apex, said reflector having its curvature proportioned to maintain a substantially constant antenna impedance between said apices.

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