July 7, 1959 L. HIMMEL ET AL 2,894,124

BROAD BAND OMNI-POLARIZED MULTIPLE ANTENNA SYSTEM WITH EACH ANTENNA HAVING INDIVIDUAL DETECTOR AND LOW FREQUENCY COUPLING NETWORK

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Fig. 1

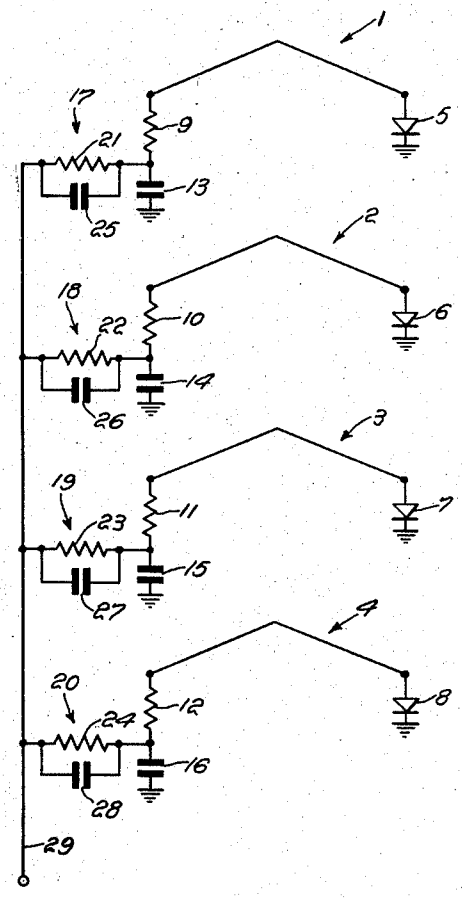


Fig. 4

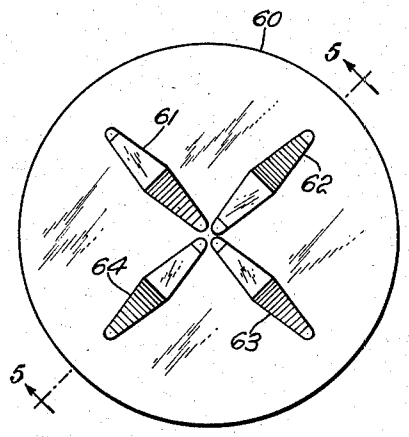
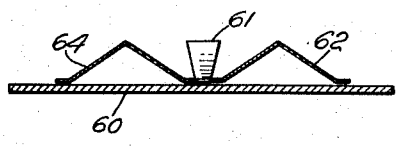


Fig. 5



INVENTORS
LEON HIMMEL
HENRY F. KURAS
BY Ernest Tanick
ATTORNEY

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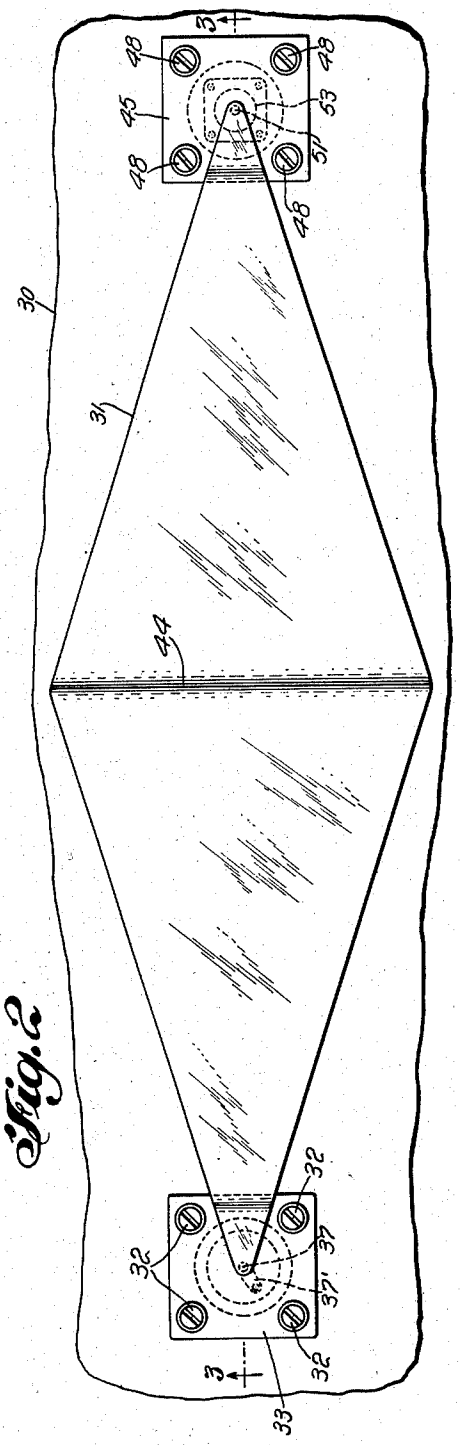


Fig. 2

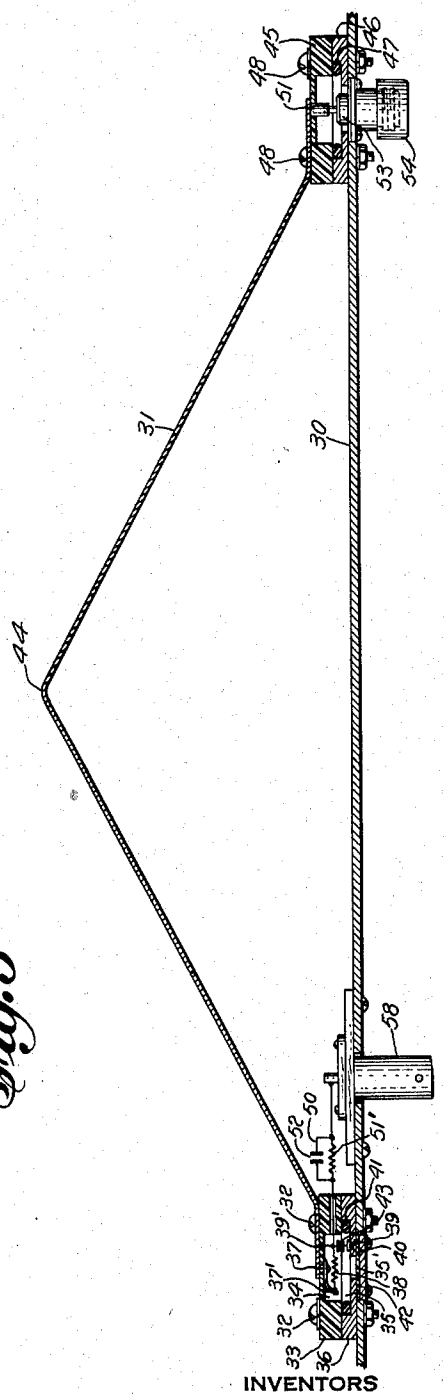


Fig. 3

INVENTORS
LEON HIMMEL
HENRY F. KURAS
BY Ernest Tanimura
ATTORNEY

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Fig. 6

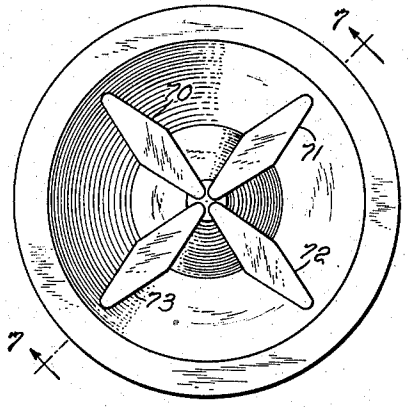


Fig. 7

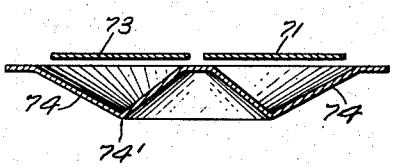


Fig. 8

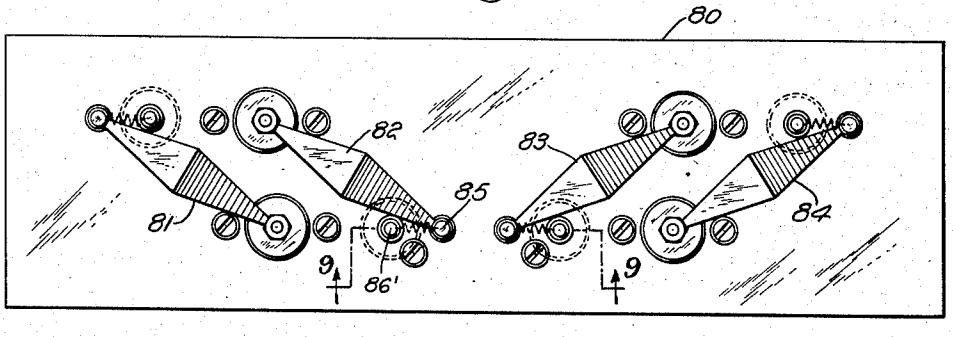
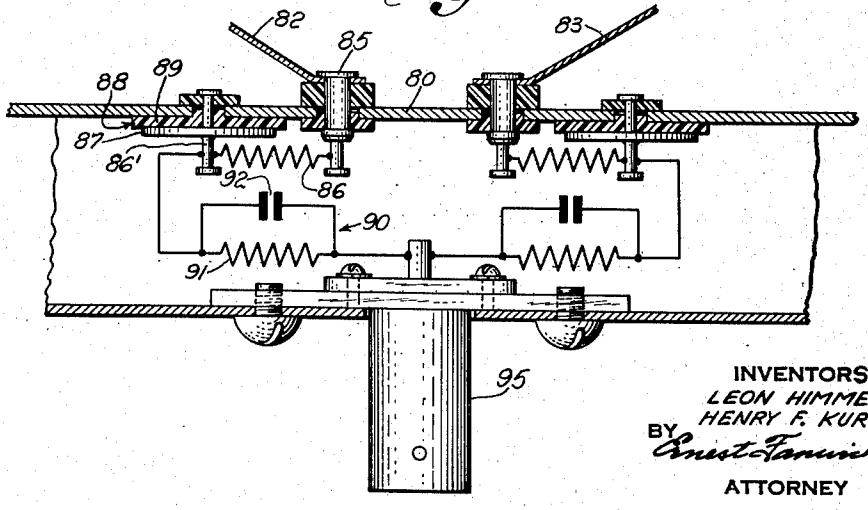


Fig. 9



INVENTORS
LEON HIMMEL
HENRY F. KURAS
BY Ernest Tannick
ATTORNEY

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BROAD BAND OMNI-POLARIZED MULTIPLE ANTENNA SYSTEM WITH EACH ANTENNA HAVING INDIVIDUAL DETECTOR AND LOW FREQUENCY COUPLING NETWORK

Leon Himmel, Cedar Grove, and Henry F. Kuras, Fairlawn, N.J., assignors to International Telephone and Telegraph Corporation, Nutley, N.J., a corporation of Maryland

Application January 7, 1954, Serial No. 402,672

3 Claims. (Cl. 250—20)

This invention relates to antenna structures and more particularly to an antenna system for use at very high frequencies, having broad band frequency response characteristics and capable of receiving signals of any polarization characteristic.

In many installations the provision of a broad band omni-polarized antenna system is desirable. For the portable direction finders for use in aircraft, for example, it is desirable that such antenna systems be of rigid construction and be capable of being mounted in such a manner that it does not interfere with the aerodynamic characteristics of the aircraft. It is desirable that such an antenna system be able to receive transmissions within a broad frequency range of unknown polarization and over a wide azimuth angle since the operators at the receiving equipment may have no apriori knowledge of the transmission characteristics of the signals to be detected.

A principal object of this invention is to provide a simple and structurally rigid broad band omni-polarized antenna-detector system for use at very high frequencies.

Another object is to provide an improved antenna system employing a plurality of substantially diamond shaped or modified rhombic metal antenna elements to receive omni-polarized radiations.

A further object is to provide an improved antenna system for use with an airborne transmission intercept system which is adaptable for mounting in an aircraft.

A feature of this invention relates to an antenna system utilizing a plurality of terminated modified rhombic antenna elements of substantially diamond shape in a prearranged spaced relation above a coextensive image plane. One end of the major axis of each antenna element is coupled to one end of a crystal detector which has its other end grounded and each antenna element is terminated at the other end of its major axis by a resistive load which is grounded for R-F (radio-frequency) by an R-F bypass condenser coupled to ground. In series with each antenna unit is an equalizing network comprising a resistor and capacitor in parallel to neutralize variations in the D.-C. (direct-current) resistance of the individual crystal detectors for crystal biasing purposes. The antenna units are coupled in parallel to form the antenna system of this invention which can be utilized to feed a positive detected signal to a video receiver.

The above-mentioned and other features and objects of this invention will become more apparent by reference to the following description taken in conjunction with the accompanying drawings, in which:

Fig. 1 is a schematic circuit diagram of the antenna system of this invention;

Fig. 2 is a plan view of one embodiment of an antenna unit for use in the antenna system of this invention;

Fig. 3 is a longitudinal sectional view taken along the lines 3—3 of Fig. 2;

Fig. 4 is a plan view of an alternate embodiment of the antenna system of this invention;

Fig. 5 is a view in elevation taken along the lines 5—5 of Fig. 4;

Fig. 6 is a plan view of a flush mounted embodiment of the antenna system of this invention;

Fig. 7 is a view in cross-section taken along the lines 7—7 of Fig. 6;

Fig. 8 is a top plan view of still another embodiment of the antenna system of this invention utilizing a rectangular image plane; and,

Fig. 9 is a cross-sectional view of the antenna system taken along 9—9 of Fig. 8.

Referring to Fig. 1 of the drawing a schematic circuit diagram of a broad band omni-polarized antenna system in accordance with the principles of this invention is shown therein to comprise a plurality of antenna units 1, 2, 3, and 4. Each antenna unit 1, 2, 3 and 4 comprises a terminated modified rhombic antenna having one end connected to one end of a crystal detector 5, 6, 7 and 8, respectively. Each crystal detector 5–8 has its other end grounded. The opposite end of each antenna element 1–4 is terminated by a resistive load 9, 10, 11, and 12, respectively. Each resistor 9–12 is grounded by the R-F (radio-frequency) bypass capacitors 13, 14, 15, and 16 respectively. The bypass capacitors 13—16 function effectively as an open circuit for any detected video frequencies. In series with each of the four crystal detector-antenna element combination is an equalizing network 17, 18, 19, and 20 comprising a resistor 21, 22, 23, and 24 in parallel with a capacitor 25, 26, 27, and 28, respectively. The networks 17–20 compensate for the non-uniformity of crystals 5–8 and variations in the D.-C. (direct-current) resistance of the crystals. The capacitors 25–28 provide a low impedance path for the detected signals. The four antenna units 1–4 of the antenna system of this invention are connected in parallel to feed a positive detected signal to appropriate video amplifier over line 29.

Referring to Figs. 2 and 3 of the drawing, one embodiment of an antenna unit for use in an antenna system of this invention is shown therein to comprise an elongated flat metal plate 30 on which is supported the antenna element 31. Plate 30 has fastened thereto by nuts and bolts 32 adjacent one end an insulator block 33 which has a central undercut portion or recess 34 in registry with the corresponding opening 35 in seal plate 36 and opening 35′ in plate 30 to permit the insertion of a fastening stud 37. Stud 37 connects the antenna element 31 to the insulating block 33. Fastened to stud 37 is a connector lug 37′. A suitable terminating resistive load 38 is connected between lug 37 and a capacitor 43. The capacitor 43 is connected to the terminal 39 which is mounted on seal plate 36. A cover assembly plate 40 covers the opening in seal plate 36 and plate 30. Gaskets 41 and 42 are provided to effect a weather tight closing. A bypass capacitor 43 is coupled between terminal 39′ and the grounded image plane 30 providing a ground path for the R-F while presenting an effective open circuit to the detected video frequencies. Thus, an R-F grounded dummy load termination is provided for the left hand end of an-

tenna element **31**. In one embodiment the antenna element **31** is formed from a substantially diamond or rhombic shaped metal plate which is bent along its minor axis **44** at an angle, for example, 130°. Consequently, the antenna plate **31** is supported at one end of its major axis by the block **33** in insulated relation with respect to the image plane **30**. The opposite end of the major axis of antenna element **31** is supported in a similar manner by insulating block **45**, seal plate **46**, gasket **47** and nuts and bolts **48**. The antenna element **31** is electrically connected via stud **51** to one end of the crystal detector mounted in crystal holder **53**. The other end of the crystal detector is directly coupled to ground through holder **53**. A crystal holder cap **54** is provided to protect the crystal proper. Referring again to the circuitry connected at the left end of antenna unit **31** an equalizing circuit **50** is connected to terminal **39'** providing an electrical contact between the resistive load **38** and bypass capacitor **43**. The equalizing circuit **50** comprises a resistive element **51'** and capacitor **52** connected in parallel. The output of the equalizing circuit is connected to the inner conductor of coaxial output connector **58** whose outer conductor is grounded to image plane **30**.

Referring to Figs. 4 and 5 of the drawing, a broad band omni-polarized antenna system utilizing a flat image plane in accordance with the principles of this invention is shown comprising a flat circular metallic plane **60** on which is mounted four terminated modified rhombic antenna units **61–64**. Each unit is mounted on plane **60** as explained heretofore with respect to Figs. 2 and 3. Each antenna unit **61–64** is mounted at an angle with respect to the vertical and thus the polarization vector of each element can be resolved into a vertical and horizontal component. It is thus obvious that antenna units **61–64** are sensitive to both vertically and horizontally polarized waves. As will be understood by those familiar with the art, diagonally opposite antenna elements may employ the same type of crystal holder enabling two types of crystal holders to be utilized in order to obtain high antenna efficiency over a wide frequency range. The entire assembly may be enclosed within a weather-proof dome shaped plastic case which can be fastened to the image plane **60**. It will be understood, of course, that the material for any cover for the antenna system shown must be transparent to the electromagnetic waves to be received by the antenna system.

Referring to Figs. 6 and 7 of the drawing, a broad band omni-polarized antenna system adapted for flush mounting in accordance with the principles of this invention is shown comprising a plurality of terminated modified rhombic antenna units **70–73**. Each antenna unit comprises a flat substantially diamond shaped metallic element mounted in a manner as explained heretofore with respect to Figs. 2 and 3. A shaped metallic image plane **74** is provided. The shaping of the image plane **74** is arranged to compensate for the flat configuration of each antenna unit **70–73**. The sunken apex **74'** of the image plane **74** rearward of each antenna element has an angle which can be compared to the angle of the antenna unit shown in Fig. 3. The curvature of the image plane **74** is designed to maintain a substantially constant impedance between the ends of the major axis of the antenna units **70–73**. Due to the flat characteristic of the antenna units **70–73** a weather-proof flat plastic cover can be fastened over the antenna system for protection. Since the outer configuration of the antenna unit is flat the antenna system may be mounted flush with its surrounding surface.

Referring to Figs. 8 and 9 of the drawing, a broad band omni-polarized antenna system in accordance with the principles of this invention is shown comprising a substantially rectangular image plane **80** on which is mounted four terminated modified rhombic antenna units **81–84**. Each antenna unit **81–84** is mounted at an angle to the vertical axis of the system so that the polarization vector of each element can be resolved into a vertical and horizontal component making the antenna system sensitive to both vertical and horizontal polarized waves. Shown in Fig. 9 each antenna element **81–84** has one end terminated by a metallic stud **85** insulated from the image plane **80**. The resistor **86** is coupled from metallic stud **85** to a metallic stud **86'** which is connected to one plate **87** of a capacitor **88**. The other plate of capacitor **88** is formed by the image plane **80** spaced from plate **87** by a dielectric layer **89**. Coupled from post **86'** is the equalizing network **90** comprising resistor **91** and capacitor **92** in parallel. The outputs from the equalizing network of each of the antenna units **81–84** are coupled to the inner conductor of a coaxial output connector **95**. The other end of each of the antenna units **81–84** is coupled to a crystal held within a crystal holder. The cathode of each crystal holder is grounded as hereinbefore explained.

While we have described above the principles of our 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 our invention as set forth in the objects thereof and in the accompanying claims.

We claim:

1. A broad band omni-polarized antenna system comprising a plurality of substantially rhomboidal shaped metal sheet antennas each having the termination points of its major axis lying in a given plane, said antennas being angularly disposed with respect to each other so that an extension of their major axis intersect, means providing a reflective ground plane surface in adjacent spaced relation to each of said antennas, the reflective surface being located on one side of said plane, the spacing between said reflective surface and the metal sheet forming each antenna being varied between the terminals of the antenna to introduce vertical and horizontal polarization radiation characteristics, a plurality of detectors each coupled between one end of the major axis of each of said antennas and said ground plane, means to terminate each of said antennas in a resistive load at the other end of said major axis, means to couple a capacitive impedance between said resistive load and said ground plane, a plurality of equalizing networks, each having one end coupled to a point between said resistive load and said capacitive impedance and means to couple in parallel the other end of each of said equalizing networks.

2. A broad band omni-polarized antenna system comprising four substantially rhomboidal shaped metal sheet antennas each having a major axis disposed at right angles to the adjacent antennas and each having the termination points of its major axis lying in a given plane, means providing a reflector surface in adjacent spaced relation to each of said antennas providing a ground reflector surface for said antenna system, the spacing between said reflector surface and the metal sheet forming each antenna being varied between the terminals of the antenna to introduce vertical and horizontal polarization radiation characteristics, a plurality of detectors each coupled between one end of the major axis of one of said antennas and said reflector means, means to terminate each of said antennas in a resistive load at the other end of said major axis, means to couple a capacitive impedance between said resistive load and said reflector means, a plurality of equalizing networks, each having one end coupled to a point between said resistive load and said capacitive impedance and means to couple in parallel the other end of each of said equalizing networks.

3. A broad band omni-polarized antenna system comprising a plurality of angularly disposed rhomboidal shaped metal sheet antennas, a metal reflector member in spaced relation to said plurality of antennas, the spacing between said reflector member and the metal sheet forming each antenna being varied between the terminals of the antenna to introduce vertical and horizontal polarization radiation characteristics, a plurality of crystal detector means each coupled to one end of each of said antennas,

means to terminate each of said antennas in a resistive load at the opposite end of each of said antennas, an equalizing network in series with each of said antennas, each of said equalizing networks comprising a resistor and capacitor in parallel, said network being coupled to one end of said resistive load, a capacitor and means to couple said capacitor between ground and the junction of said equalizing network and said resistive load, and means coupling the outputs of said antennas in parallel.

References Cited in the file of this patent

UNITED STATES PATENTS

2,217,623	Peterson	Oct. 8, 1940
2,519,209	Wheeler	Aug. 15, 1950
2,531,432	Himmel	Nov. 28, 1950
2,541,021	Baum	Feb. 13, 1951
2,543,085	Willoughby	Feb. 27, 1951
2,664,507	Mural	Dec. 29, 1953