June 30, 1970 J. A. KUECKEN 3,518,692

ORTHOGONAL ANTENNA SYSTEM WITH MULTIPLE-CHANNELS

Filed Aug. 25, 1967

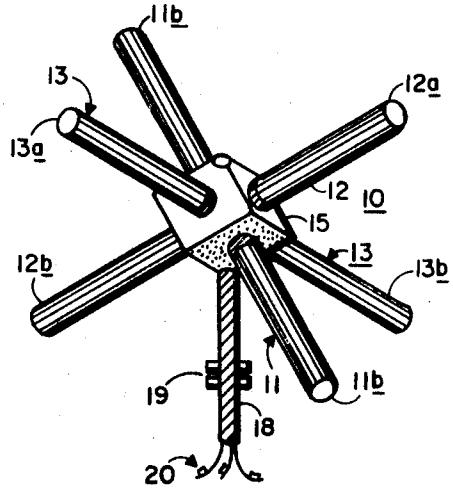


Fig. 1

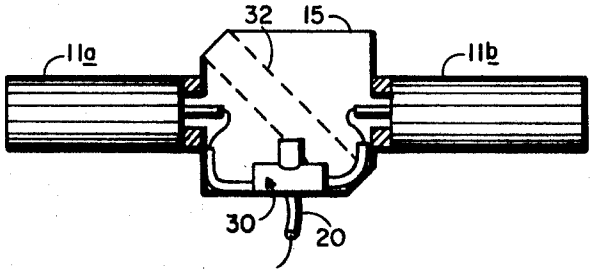


Fig. 2

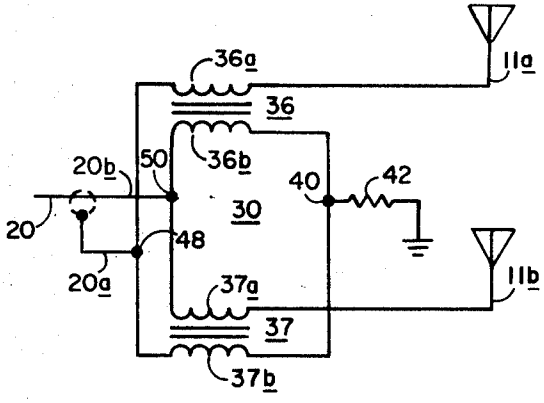


Fig. 3

INVENTOR.
JOHN A. KUECKEN

Raymond L Owens
attny

BY

United States Patent Office 3,518,692
Patented June 30, 1970

3,518,692

ORTHOGONAL ANTENNA SYSTEM WITH MULTIPLE-CHANNELS

John A. Kuecken, Pittsford, N.Y., assignor to General Dynamics Corporation, a corporation of Delaware

Filed Aug. 25, 1967, Ser. No. 663,396
Int. Cl. H01q 21/26
U.S. Cl. 343—797 6 Claims

ABSTRACT OF THE DISCLOSURE

An orthogonal antenna system is described comprised of three orthogonally disposed center-fed dipole radiators, each of which intersects a horizontal plane at an equal angle. Because of this symmetry, the system provides for a high degree of mutual isolation between the radiators. Each radiator may also be coupled to its signal source by means of a hybrid device which also aids in radiator isolation.

The present invention relates to receiving and transmitting antenna systems, and more particularly the invention relates to antenna systems having a plurality of independent (decoupled) radiators.

There has long been a need for antenna systems which provide, in a unitary structure, a system which simultaneously broadcasts or receives radio waves in the same frequency range, without interference. In other words, the radiators provide a high degree of mutual isolation between each other.

In view of the foregoing it is an object of the present invention to provide an improved multi-channel antenna system in which the radiators are electrically isolated from each other.

A further object of the present invention is to provide a multi-channel antenna system which may be mounted in a limited space and which is substantially maintenance free.

Briefly described, an antenna system in accordance with the invention employs three mutually orthogonal dipole radiators decoupled from each other but mounted in close proximity in a feed box. Each radiator intersects a horizontal plane with the same angle. By means of this symmetrical relationship, any radiator will tend to induce cancelling currents in the other radiators, thereby providing high mutual isolation.

Preferably, the radiators are dipoles having two separate radiating elements. Moreover, each radiator is coupled to its source by means of a hybrid device which has a feature of enhancing mutual isolation between the radiators.

The invention itself, both as to its organization and method of operation, as well as additional objects and advantages thereof will become more readily apparent from a reading of the following description taken in conjunction with the accompanying drawings in which:

FIG. 1 is a diagrammatic, perspective illustration of an antenna system in accordance with the present invention;

FIG. 2 is a detailed view of one of the radiators shown in FIG. 1; and

FIG. 3 is a schematic illustration of the hybrid feed device shown in FIG. 2.

Turning first to FIG. 1, an antenna system **10** is shown comprising three mutually orthogonal dipole radiators **11**, **12** and **13** which are electrically decoupled from each other but mounted in the same di-electric feed box **15**. The box **15** holds each radiator so that its axis intersects a horizontal plane with the same or equal angle. The

feed box **15** is supported by a di-electric mast **18** about which a choke structure **19** is employed to isolate and break up RF currents on a plurality of coaxial feed cables **20** (one coaxial cable for each radiator).

By means of this arrangement each radiator provides an omni-directional coverage and, because of the symmetry of it in relation to the other radiator, tends to induce cancelling currents in them, thereby providing high mutual isolation between radiators.

As shown in the drawings, each radiator is effectively comprised of two individual radiating elements, for example, radiator **11** has elements **11***a* and **11***b*. The following discussion is given with respect to the radiator **11** but is equally applicable to the radiators **12** and **13**. Preferably, the elements **11***a* and **11***b* should be fed in phase opposition to provide an additive radiation field during broadcasting. To accomplish the function, a hybrid feed device **30** shown in FIG. 2 and in detail in FIG. 3 is provided. Turning briefly to FIG. 2, the hybrid **30** permits the center of the feed box to be vacant so that the other radiators may be inserted diagonally through holes (one of which is chosen by dotted lines and given number **32**) in the box **15** to facilitate radiator stacking or emplacement.

Turning now to FIG. 3, the hybrid device **30** includes two bi-filar wind coils **36** and **37** which may consist of a coaxial cable wound about a torroidal shaped metallic member. The coil **36** has a first winding **36***a* and a second winding **36***b*; similarly the coil **37** has a first winding **37***a* and a second winding **37***b*. The radiator **11***a* is serially connected to the winding **36***a* and the winding **37***b* which in turn is coupled at a junction **40** to a grounded resistive load **42**. In a like manner, the element **11***b* is connected in series to the winding **37***a* and the winding **36***b*, the latter of which is also connected at the junction **40**. The outer conductor **20***a* of the coaxial cable **20** is connected at the electrical junction **48** of the windings **26***a* and **37***b*, whereas the inner conductor **20***b* is connected at the electrical junction **50** of the windings **26***b* and **37***a*.

Accordingly, the cable **20** has two separate path connections to the junction **40**, one traced through the inner conductor **20***b* and the other through the outer conductor **20***a*. Moreover, the coaxial cable **20** is connected to the element **11***a* through its outer conductor **20***a*. By means of this arrangement, an impressed signal will excite the radiating elements **11***a* and **11***b* in phase opposition and if the loads presented by the elements **11***a* and **11***b* to the signal source are identical, no output will be produced at the junction **40**. Should a slight unbalance occur, by for example the element **12***a* exciting more current in the elements **11***a* and **11***b* than the cancelling current excited from the element **12***b*, an induced current would appear as a result of the in-phase excitation of the elements **11***a* and **11***b*. The hybrid circuit directly couples this induced current into the resistive load **42**.

Thus, with a signal impressed upon the cable **20**, the cable **20** is electrically coupled to the elements **11***a* and **11***b* but isolated from the resistor **42**; whereas any inequality of signals induced in the elements **11***a* and **11***b* from another radiator will be electrically coupled to the resistor **42** from the elements but the cable **20** will be partially isolated therefrom. The hybrid **30** greatly increases the isolation between the various elements and permits the attainment of effectively independent operation between the radiators when they are in operation.

The radiation pattern of the antenna being essentially that of a dipole is very nearly a cosine formation of the E plane. However, it has been determined that the E plane of each radiator is inclined at an angle to the vertical; and the maximum radiation of the E plane is above and below

the horizon in the plane of the antenna inclination. Although one would expect a variation in rated field strength around the horizon, quite unexpectedly in accordance with the invention, it has been found that the rotation of the pattern tends to be compensated by an equivalent rotation in the polarization pattern thereby restoring the omnidirectional character to the antenna pattern in the horizon plane.

While a single embodiment of the invention has been described, variations thereof and modifications therein within the spirit of the invention will undoubtedly suggest themselves to those skilled in the art. For example, although the illustrated hybrid device is preferred, other forms of series-parallel hybrids may also be employed in accordance with the invention. Accordingly, the foregoing description should be taken as illustrative and not in any limiting sense.

What is claimed is:

1. An antenna system comprising a plurality of electrically decoupled dipole radiators disposed adjacent to each other in mutual orthogonal relationship with each radiator intersecting a horizontal plane at an equal angle and having two radiating elements, means for feeding each of said plurality of dipole radiators, and separate means interconnecting the radiating elements of each radiator for dissipating energy induced therein from its adjacent radiators.

2. The invention as set forth in claim **1** wherein each radiator is a center-fed dipole.

3. The invention as set forth in claim **2** wherein there are three of said radiators, and said feeding means applies a different signal to each of said radiators.

4. The invention as set forth in claim **2** wherein said feeding means and interconnecting means are provided by a plurality of hybrid devices, one for each of said radiators coupled to each element of radiator in phase opposition and dissipates signals induced from the other radiators.

5. The invention as set forth in claim **4** wherein each of said hybrid devices includes a pair of hybrid transformers each coupled to a different radiating element of the radiator for which it is provided, for feeding said elements in phase opposition, a feed line coupled to input ports of said transformers, and a dissipative load connected to said transformers for dissipating said induced energy.

6. The invention as set forth in claim **5** wherein each hybrid device comprises a first and second bi-filar wound coil, each coil having first and second windings, with the first winding of the first and second coils being respectively connected to the first and second radiating elements, the second winding of each coil being connected to said dissipative load and the first winding of the other coil, and a two wire input line, the wires of which are separately connected to the first and second windings of different ones of said coils.

References Cited

UNITED STATES PATENTS

3,388,400	6/1968	Veldhuis	343—797
3,396,398	8/1968	Dunlavy	343—844
3,354,459	11/1967	Schwartz et al.	343—854

FOREIGN PATENTS

71,507	1/1953	Netherlands.

OTHER REFERENCES

RCA Technical Notes; RCA TN No. 226, Jan. 5, 1959; 343–797.

ELI LIEBERMAN, Primary Examiner

U.S. Cl. X.R.

343—816, 844