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2,848,716

COMPARTMENTAL ANTENNA WITH HYBRID FEED

Filed May 3, 1957

2 Sheets-Sheet 1

FIG. 1A

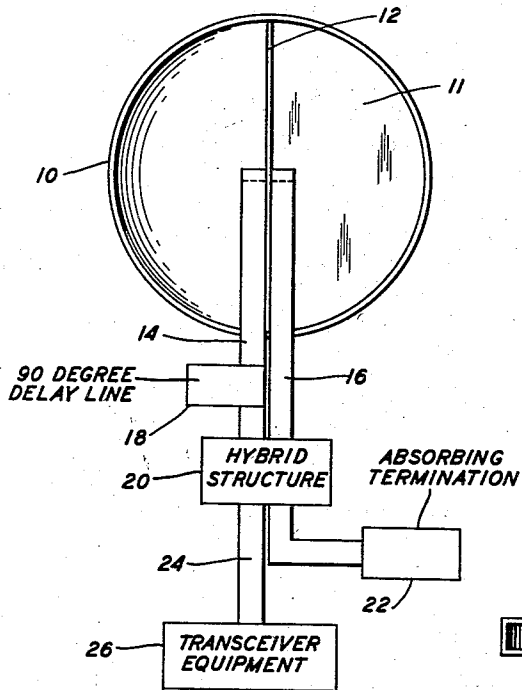


FIG. 1B

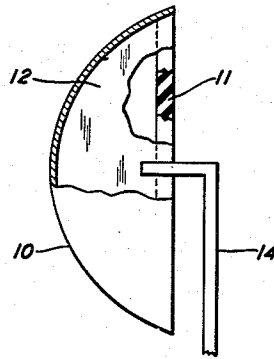


FIG. 2A

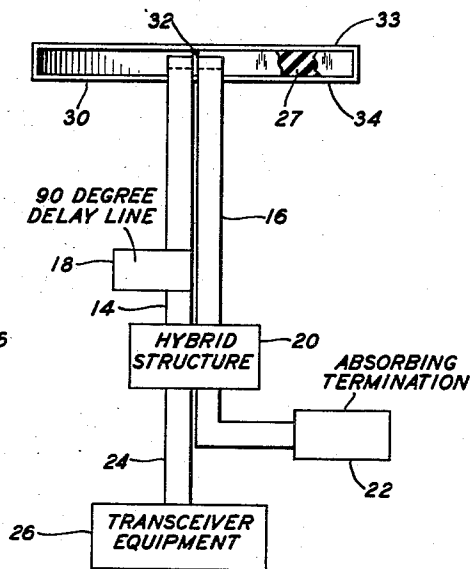
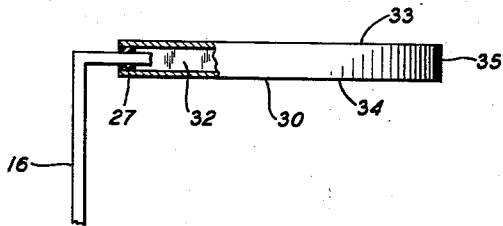


FIG. 2B



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FIG. 3A

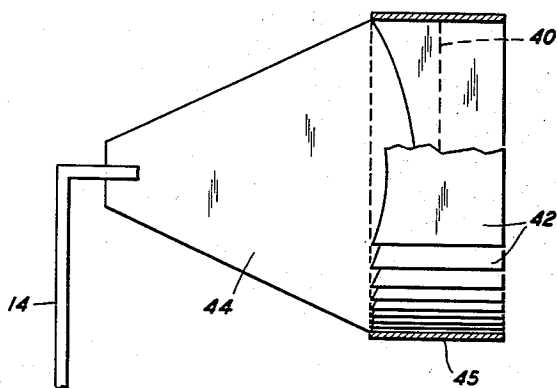


FIG. 3B

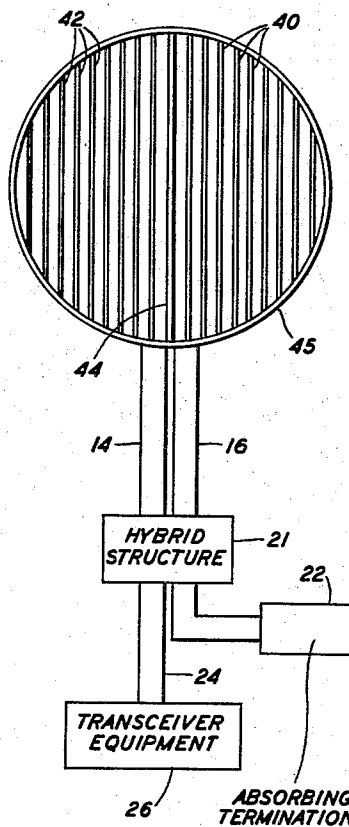
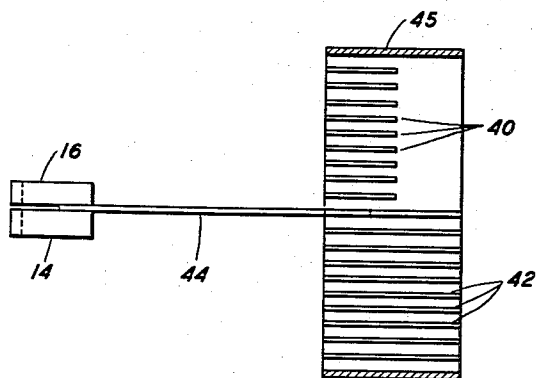


FIG. 3C



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## COMPARTMENTAL ANTENNA WITH HYBRID FEED

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11 Claims. (Cl. 343—782)

This invention relates to directive transmission systems employing primary and secondary directive antennas. More particularly it relates to directive systems employing antennas of the type in which relatively large secondary antennas are energized or "illuminated" by smaller "feeding" or primary antennas. In such arrangements the "feeding" line or horns are referred to as "primary" or "active" antennas and highly directive large reflector or lens antennas fed by the primary antennas are referred to as "secondary" or "passive" antennas.

When either a reflector or a lens is energized or illuminated by a feeding source or line, usually simply referred to as a "feed," an appreciable amount of energy is normally reflected from the reflector or the lens back into the feeding source or line, giving rise to impedance mismatches in the output circuit of the energy source or transmitter, which are difficult to eliminate over any appreciable width or range of operating frequencies by any of the numerous and varied expedients disclosed in the prior art. This seriously limits the range of frequencies over which the system can operate satisfactorily.

Accordingly, a principal object of the present invention is to eliminate impedance irregularities in the output circuit of the transmitter resulting from the reflection of energy from a passive antenna into its associated primary or active antenna structure.

Other and further objects, features and advantages of the invention will become apparent during the course of the following detailed description of illustrative embodiments and from the appended claims.

In the drawings:

Figs. 1A and 1B illustrate an application of the principles of the invention to a system employing as a secondary antenna a parabolic dish reflector;

Figs. 2A and 2B illustrate an application of the principles of the invention to a system employing as a secondary antenna a pill-box reflector; and

Figs. 3A, 3B, and 3C illustrate an application of the principles of the invention to a system employing as a secondary antenna a parallel plate lens.

In the various figures of the drawings, like components are given the same respective designation numbers in all figures in which they appear.

In more detail, in Fig. 1A and partial side view Fig. 1B, the parabolic dish reflector 10 is divided into two equal and substantially identical parts by a metal septum or partition 12 which may be, for example, a plane sheet of copper. Wave guide feed lines 14 and 16 have their orifices directed toward reflector 10 from centrally located points on opposite sides of septum or partition 12, as shown, so that each feed line energizes or illuminates its respective half of the parabolic dish reflector 10.

Feed lines 14 and 16 extend downwardly to hybrid structure 20, Fig. 1A. Structure 20 may be a magic-T, a hybrid ring, or one of the directional-coupler-like structures, numerous forms and varieties of each of which are well known and extensively used by those skilled in the art.

Assuming structure 20 to be of conventional magic-T type, the lines 14, 16 are connected, respectively, to a pair of its arms which are conjugately related and one of the lines 14 includes a delay line 18 providing substantially a ninety degree delay.

Relay line 18 can conveniently be merely a loop of wave guide of the proper length to have the desired delay.

Wave guide 24 and absorbing termination 22 are connected, respectively, to the other pair of conjugately related arms of the hybrid structure 20.

A transceiver, i. e. a transmitting and receiving equipment, 26 is connected to the other end of wave guide 24.

Energy from the transmitter of equipment 26 will then, upon reaching hybrid structure 20, divide equally and be in phase in the two conjugately related arms to which feed lines 14 and 16 are connected. The two halves of the reflector 10 will consequently be fed equal energies but that of the left side through guide 14 will be delayed ninety degrees by delay line 18. To compensate for this the aperture of the right side of reflector 10 includes a layer of dielectric 11 of sufficient thickness to delay the energy emerging from that half by ninety degrees to bring it back into phase with the energy emerging from the aperture of the other half. As taught in Patent 2,577,619, granted December 4, 1951, to W. E. Kock, the dielectric may be "loaded" with small metallic elements which will greatly increase its dielectric constant and correspondingly reduce the thickness required to provide a given delay. This layer of dielectric 11 is placed behind the orifice of feed lines 14, 16, as shown more clearly in the side view of Fig. 1B, so that energy from or to line 16 is not affected by it. Alternatively, a phase-advance element could be placed in the aperture of the other half of the reflector to appropriately advance the phase of energy emitted by that half and thus bring the energies from the two halves into phase coincidence again. This alternative in a somewhat modified structure is illustrated in Fig. 3.

In view of the substantially symmetrical arrangement of the feeds 14, 16 and their respective halves of the reflector 10, and the isolation between these halves afforded by conductive septum or partition 12, substantially equal amounts of the respective energies directed to strike reflector 10 will be reflected back into the two feed lines 14, 16 and return to hybrid structure 20. The reflected energy returning through feed line 14 will again pass through delay line 18 and consequently will arrive at hybrid structure 20, one hundred and eighty degrees out of phase with the reflected energy returning to structure 20 through feed line 16. Accordingly, the reflected energies will combine in the fourth arm of the hybrid structure connected to absorbing termination 22 and will be absorbed in termination 22. Conversely, no appreciable amount of reflected energy will return to wave guide 24 to disturb the impedance of guide 24 and the transmitter is therefore effectively isolated from the disturbing effects of reflected energy.

In passing, it may be noted that with certain of the hybrid structures, such, for example, as the "short-slot hybrid junction" described by H. J. Riblet in the Proceedings of the Institute of Radio Engineers, volume 40, February 1952, starting at page 180, the delay line 18 can be eliminated. This results from the fact that an appropriate ninety degree phase difference between the two conjugately related arms (connecting to feed lines 14, 16) of the hybrid structure is inherent in the structure and consequently need not be inserted by external circuitry. Such an arrangement is indicated diagrammatically in Fig. 3B, as will be described in detail below.

In Fig. 2A, and partial side view Fig. 2B, the well known "pill-box" type of antenna 30 is represented and comprises upper and lower parallel plane conductive sheets 33,

34 and a back edge 35 (Fig. 2B) of parabolic curvature, the front of the pill-box 30 being open except for the layer of dielectric 27 in the right half of its aperture, as shown. The pill-box is divided into two equal portions (halves) by a thin conductive septum or partition 32, which may, for example, be of sheet copper. Feeds 14 and 16 are centrally located on opposite sides of septum or partition 32, as shown, and serve to energize or illuminate their respective halves of the parabolic edge 35 of the pill-box 30.

The remaining components of Fig. 2A are identical with the correspondingly designated components of Fig. 1A and the overall operation of the structure of Fig. 2A is substantially the same as for that of Fig. 1A, described in detail above, as will be immediately apparent to those skilled in the art.

In Figs. 3A, 3B, and 3C, an arrangement having much in common with those of Figs. 1A and 2A is illustrated. The arrangement illustrated by Figs. 3A, 3B, and 3C differs from those of the prior figures principally in that a phase-advance, parallel plate lens (secondary) antenna 45 is used in place of a reflecting secondary antenna. Antenna 15 comprises a nonconducting cylindrical frame holding a plurality of shaped parallel conducting plates 40 and 42. Such lens antennas are, for example, shown, described in detail, and claimed in Patent 2,736,894, granted February 28, 1956, to W. E. Kock. The arrangement of Figs. 3A, 3B, and 3C further differs from those of the prior figures in that a phase-advance section is employed for one-half of the secondary antenna instead of a dielectric phase delay section and in that the hybrid structure 21 is, in this instance, assumed to be a "short-slot hybrid junction" of the type described by H. J. Riblet, mentioned hereinabove.

In more detail in Fig. 3B and the partial side and top views Figs. 3A and 3C, respectively, the secondary or passive antenna 45 is a phase-advance, parallel plate lens of the type illustrated in Fig. 8 (bearing the designation number 55) of the above-mentioned patent to Kock, except that the plates 42 of one-half of the lens have rectangular extensions providing a phase advance of ninety degrees to the energy passing through this half of the structure.

As for the arrangements of the prior figures, in Fig. 3B energy from the transmitter section of transceiver 26 passes through wave guide 24 to hybrid structure 21. Structure 21 is, as mentioned above, a "short-slot hybrid junction" and divides the energy equally between the two feed lines 14, 16 but with a ninety degree phase difference between the energy in the two lines, for example, the energy in line 16 will be assumed to be delayed ninety degrees with respect to that in line 14.

A thin conductive septum or partition 44 passes through the focal point of lens 45 and lies in the median plane of the lens. The orifices of feed lines 14 and 16 are disposed adjacent the focal point on opposite sides of septum or partition 44, respectively, and directed to energize or illuminate their respective halves of lens 45.

To bring the energy of the two halves of the lens back into phase, the plates of the half in which the energy is delayed are extended a sufficient distance to form a phase-advance section advancing the phase ninety degrees. The principles of phase-advance structures of this type are of course the same as for the phase-advance lenses of the above-mentioned Kock patent except that since no focussing effect is desired the portions of the plates which constitute the phase-advance section are of identical breadth (front to rear) and of rectangular contour.

As for the arrangements of the prior figures, energy reflected by the halves of the parallel plate lens into their respective feed lines 14, 16 will arrive back at hybrid structure 21 precisely in phase opposition and will consequently be directed to energy absorber 22, no reflected energy reaching wave guide 24 to disturb the transmitter circuit impedances.

Numerous and varied other arrangements and modifica-

tions clearly within the spirit and scope of the present invention and embodying its principles will readily occur to those skilled in the art. No attempt to exhaustively illustrate all possible such arrangements and modifications has here been made.

What is claimed is:

1. A directive transmitting system comprising, a secondary antenna section, separate means for illuminating each half of said antenna section, means for shielding each half of said antenna section from energy intended for the other half and each illuminating means from reflections from the half which it does not illuminate, means for connecting both said illuminating means to a single source of energy, said connecting means equally dividing the energy of said source between said illuminating means, said portions of energy being in phase, means for introducing an additional phase delay of ninety degrees in the energy to one of said illuminating means, means for introducing a compensating phase delay in the energy emanating from the aperture of the half of said secondary antenna section the energy to which did not encounter said additional delay, an energy absorbing means connected to said connecting means, said connecting means including means for combining the energy reflected from each half of said secondary antenna section to its associated illuminating means and directing said combined energy to said energy absorbing means, whereby substantially no reflected energy is returned to said source of energy and impedance irregularities are not introduced in the circuit of said source.

2. A directive transmitting system comprising, a secondary antenna section having a focal point, a pair of primary antenna sections, a four-terminal hybrid junction, a wave guide ninety degree phase delay means, a free space ninety degree phase changing means, an energy absorbing termination, a plane energy shielding means, and a source of energy to be transmitted, said source being connected to a first terminal of said hybrid junction, said absorbing termination being connected to a second terminal of said hybrid junction, said second terminal being conjugately related to said first terminal, said pair of primary antenna sections being connected to the third and fourth terminals of said hybrid junction respectively, said wave guide ninety degree phase delay means being included in the connection to one of said primary antenna sections, said pair of primary antenna sections being located on opposite sides respectively of a plane including the focal point and a line bisecting said secondary antenna section, one of said pair of primary antenna sections being directed to illuminate the half of said secondary antenna section on its side of said bisecting plane, the other of said pair of primary antenna sections being directed to illuminate the other half of said secondary antenna section, said shielding means being interposed in said bisecting plane between said primary antenna sections and extending to the common boundary of said halves of said secondary antenna section to isolate each half from radiation from the primary antenna section on the opposite side of said bisecting plane, said free space ninety degree phase changing means being disposed in the aperture of one-half of said secondary antenna section, whereby when energy is radiated from said secondary antenna section the energy portions from its two halves will be in phase and energy reflected from the two halves of said secondary antenna section into their respective associated primary antenna sections will return to said hybrid junction with a relative phase change of one hundred eighty degrees and be directed to and absorbed by the energy absorbing means connected to said second terminal and substantially no impedance irregularities will be established in the transmitter circuit.

3. A directive transmission system for microwaves comprising in combination, a parabolic reflector, a plane conductive septum extending from the focal point of said reflector to said reflector and bisecting said reflector, a

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pair of wave guide sections constituting feeds having orifices directed toward said reflector, the orifices of said feeds being positioned immediately adjacent to the said focal point and on opposite sides of said septum, each feed being directed to illuminate the respective half of said reflector on its side of said septum, a wave guide hybrid junction, the input ends of said wave guide feed sections being connected respectively to a conjugately related pair of the arms of said hybrid junction, one of said wave guide sections having a phase shift exceeding that of the other by ninety degrees, and an energy absorbing termination connected to a third arm of said hybrid junction whereby when microwave energy is introduced into the fourth arm of said hybrid junction it will divide equally in like phase between said wave guide feed sections, the two equal portions of said energy will be directed by said feeds to illuminate the two halves of said reflector respectively, portions of said energy reflected from the two halves of said reflector back into their respective two feed wave guide sections will return to said hybrid junction with a relative phase displacement of one hundred and eighty degrees, and the total reflected energy returning to said hybrid junction will therefore be directed into said third arm of said hybrid junction and will be absorbed in said termination.

4. The combination of claim 3 and a ninety degree phase changing element positioned in the radiating aperture of one-half only of said reflector.

5. The combination of claim 4 in which said element is a phase-advance element and is interposed in the radiating aperture of the half of the reflector the feed to which introduces an additional delay of ninety degrees.

6. The combination of claim 4 in which said element is a phase delay element and is interposed in the radiating aperture of the half of the reflector the feed to which introduces no additional delay.

7. Apparatus including an antenna system, said antenna system comprising a symmetrical passive antenna, a plane conductive septum bisecting an aperture of said passive antenna and passing through a focal point of said anten-

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na, a pair of like primary feed antennas placed adjacent said focal point on opposite sides of said septum, each feed antenna being directed to illuminate the half of said passive antenna on its side of said septum, said apparatus further including means electrically connecting said pair of primary feed antennas to a single input line, said means equally dividing energy from said single input line between said pair of feed antennas, means introducing a ninety degree phase difference between the energy reaching said feed antennas, and a further ninety degree phase difference in the same direction for energy components reflected back from said passive antenna into said feed antennas respectively, said electrical connecting means including an arm terminated in an energy absorbing member, and means for directing said reflected energy components into said energy absorbing arm, said antenna system further including means in the aperture of one-half of said passive antenna for bringing the phase of energy radiated from that half of said passive antenna into phase with the energy radiated from the other half of said passive antenna, whereby components reflected by said passive antenna into said primary antennas, respectively, will not introduce impedance irregularities at the input arm of said electrical connecting means, and energy radiated by the two halves of said passive antenna will emerge in phase coincidence.

8. Apparatus as defined in claim 7 in which said passive antenna is a lens.

9. Apparatus as defined in claim 7 in which said passive antenna is a parabolic reflecting surface.

10. Apparatus as defined in claim 7 in which said electrical connecting means is a wave guide hybrid junction.

11. Apparatus as defined in claim 7 in which said electrical connecting means is a short-slot hybrid junction which also constitutes the means introducing a ninety degree phase difference between the energy reaching said feed antennas respectively.

No references cited.