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F. O. CHESUS ET AL

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ANTENNA SYSTEM

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Fig. 1.

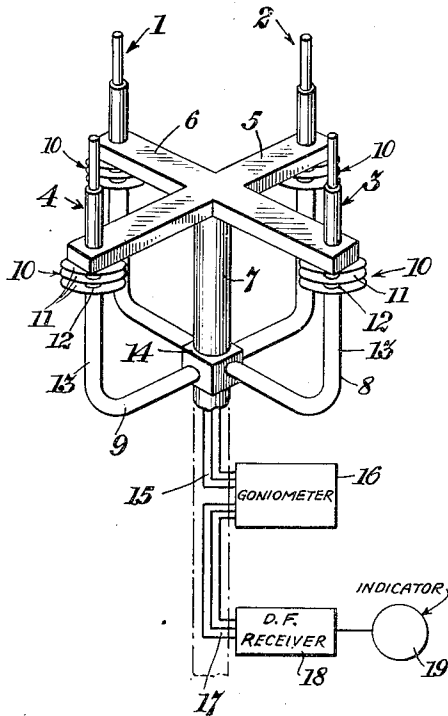
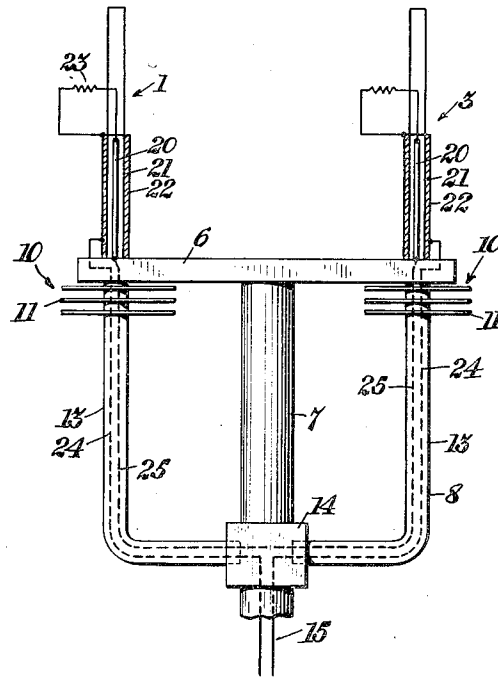


Fig. 2.



INVENTORS.
FRANK O. CHESUS
FRANK G. THOMAS
BY *Lucy P. Lentz*
ATTORNEY

UNITED STATES PATENT OFFICE

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ANTENNA SYSTEM

Frank O. Chesus, Jackson Heights, and Frank G. Thomas, Islip, N. Y., assignors to Federal Telephone and Radio Corporation, New York, N. Y., a corporation of Delaware

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8 Claims. (Cl. 250—33.59)

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This invention relates to antenna systems and particularly to directional arrays which may be used in direction finders and the like.

In many antenna systems, particularly directional systems, it is desired that the field pattern of the antennas be unaffected by radiation or fields emanating from the lead-ins, or connecting transmission lines, as well as from the supporting structure. For example, in the attempt to eliminate polarization errors from direction finders using antenna arrays, the transmission lines connecting the spaced antennas have been enclosed in metallic sheaths to thereby shield the lines and isolate said lines from the antennas. However, horizontally polarized waves induce voltages in the horizontally disposed sheaths which voltages have fields with vertical components, which vertical components affect the antennas and produce polarization errors.

An object of the present invention is the provision of an antenna system in which the antenna is substantially isolated from its transmission line, that is, from reradiation or a field emanating from said transmission line.

Another object of the present invention is the provision of an antenna array of the Adcock type having spaced apart antennas which are cross-connected by a transmission line cased in a metallic sheath and in which the field emanating from voltages induced in such sheath by horizontally polarized waves, will not substantially affect the vertical antennas, thus minimizing polarization errors.

Other and further objects of the present invention will become apparent and the invention will be best understood from the following description of an embodiment thereof, reference being had to the drawings, in which:

Fig. 1 is a schematic perspective view of an antenna system embodying our invention, and a block diagram showing its relation to a direction finding receiver;

Fig. 2 is an enlarged schematic side elevational view of a pair of the antenna units and the connecting transmission line of Fig. 1.

Referring now to Fig. 1, four equally-spaced vertically-disposed antenna units 1-4 respectively are mounted on cross-arms 5 and 6 supported at their centers by a mast 7. The cross-arms 5 and 6 are preferably made of insulating material. Antenna units 1-4 form part of an Adcock array of the interconnecting vertical U type, with antenna units 1 and 3 forming one pair and antenna units 2 and 4 the other pair. Antenna units 1 and 3 are cross connected by a shielded transmis-

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sion line 8 and antenna units 2 and 4 are cross connected by a shielded transmission line 9, each of said lines 8 and 9 being substantially in the form of a U, the sides of which are substantially vertical and the bottom portion of which is substantially horizontal.

Adjacent each of the antenna units there is provided a set 10 of horizontally disposed circular plates or discs 11, each set consisting of a plurality of spaced, horizontal, parallel discs. Each of said discs 11 is provided with a central opening 12 through which the transmission line extends, the discs 11 of each set being electrically conductively connected adjacent the openings 12 to each other and to the outer shield 13 of the shielded transmission lines 8 or 9. Each set 10 of discs is mounted adjacent one end of one of the transmission lines 8 or 9 adjacent the antenna unit connected to said end.

The middles of the U-shaped shielded transmission lines 8 and 9 extend through a junction box 14 supported on mast 7, leads 15 from said junction box going to a goniometer 16 which in turn is connected through suitable leads 17 to a direction finding receiver 18 having in its output an indicator 19, which may be in the form of a cathode ray oscillograph or the like.

While the specific antenna units employed may be monopoles, or dipoles of known construction, we prefer to use the type of antenna unit described in our co-pending application, Serial No. 613,329, filed August 29, 1945, now Patent No. 2,454,774, issued November 30, 1948.

Referring now to Fig. 2, antenna unit 1 will now be described, it being understood that the other units are similar in construction. Antenna unit 1 consists of three cylindrical conductors coaxially arranged, the innermost one being 20, the intermediate one 21 and the outside conductor 22. The intermediate conductor 21 extends beyond conductors 20 and 22 and may be twice as long as they are. The top of the innermost conductor 20 is connected by a resistance 23 to the outer surface of the outside conductor 22. The value of resistance 23 is chosen in relation to the other parameters of the antenna system so that usual requirements, such as impedance matching, are satisfied. The radiating surfaces of this unit include the outer surface of outside conductor 22 and the exposed portion of intermediate conductor 21. This unit is characterized by small volume, light weight and operates satisfactorily over a relatively wide band of frequencies.

Transmission line 8 which has two inner con-

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ductors 24 and 25 surrounded by a metallic sheath 13 has one of these inner conductors 25 connected to the bottom of innermost conductor 20 of antenna unit 1 while the other inner conductor 24 of transmission line 8 is connected to the outer surface of the outside conductor 22 of antenna unit 1 adjacent the lower end thereof. At its other end inner conductor 25 of transmission line 8 is also connected to the innermost conductor 20 of antenna unit 3 while transmission line 24 is likewise connected to the outer surface of the outside conductor 22 of antenna unit 3.

The arrangement hereinabove described substantially minimizes polarization errors. In part this is due to the fact that the horizontal portion of transmission line 8 and transmission line 9 is disposed such a distance below the set 10 of discs that at said discs the field produced by voltages induced in said horizontal portion is almost at right angles to the discs. The sets of discs serve to shield the antennas from the effects of the horizontal polarization and from any currents along the sheaths of said transmission line. According to our present understanding of the effects of said discs, there are several different ways in which they serve to prevent the transfer of energy from the shield 13 of the transmission lines to the antenna units, in addition to their function as electrostatic shields. The discs may be considered as transmission lines shorted at their inner ends and offering a very high impedance to current passing from said sheath toward the antenna units. Since these transmission lines are substantially less than a quarter wavelength, (the distance between any two antenna units is a quarter wavelength or less and the discs have less diameter than this distance), these transmission lines look like an inductance and offer high impedance to said currents. The effect of the capacity between the lower end of the antenna units and the topmost disc of the sets 10 of discs, that is the amount of energy transferred across said capacity, depends upon the potentials present. Looking at the arrangement from this aspect, the effect of the discs is like that of a mass at the end of a point in reducing the potential of said point. There is also some type of transformer effect produced by said disc arrangement which so affects the potentials that there is very little transfer of energy from the sheaths 13 to the antenna units 1-4.

The effect of the plates or discs in reducing the horizontal polarization errors is not fully understood and the theoretical considerations outlined above may not be all borne out. However, in actual practice it has been found that two or more discs arranged as described do reduce polarization errors to a negligible value. Experience shows that three or four discs are sufficient to substantially eliminate the polarization errors and that additional discs above this number are not necessary. By use of our invention, performance of a portable direction finder is found to be substantially as good as one in which the vertical U interconnecting leads are buried three or more feet under a good conducting ground of extensive surface.

While we have described one embodiment of our invention it will be apparent to those versed in the art that numerous changes may be made therein without departing from the teachings of our invention. For example while the antenna arrangement described is intended to be stationary, it is obvious that it may be made ro-

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tatable. Different types of vertical antenna units may be employed instead of that type specifically here described. Accordingly, 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 on the scope of our invention as defined in the accompanying claims.

We claim:

1. An antenna system comprising an antenna unit, a transmission line including a pair of conductors coupled at one end to said unit, a shield about said line, means insulating said antenna unit from said shield, and a plurality of spaced metallic plates of non-resonant length at the system operating frequency each having an opening therein through which said line extends, said plates being positioned adjacent said antenna unit and conductively connected to said shield.

2. An antenna system according to claim 1 wherein said plates are parallel to each other and transverse to the portion of the transmission line which they surround.

3. An antenna system according to claim 1 wherein said metallic plates are in the form of circular discs each having a central opening and said discs are conductively connected to the shield of the line adjacent the opening and effectively prevent the transfer of radiant energy from said shield to said unit.

4. An antenna system according to claim 1 wherein said antenna unit is elongated and extends in a given direction, said plates extend in planes transverse to said given direction, and the portion of said transmission line surrounded by said plates extends substantially in a line with said given direction.

5. An antenna system according to claim 1 wherein said antenna unit is linear and extends vertically, said plates extend horizontally, and the portion of said line surrounded by said plates extends vertically.

6. An antenna system comprising a vertically elongated antenna unit, a transmission line comprising two inner conductors surrounded by a shield and having the inner conductors coupled at one end to said unit, means insulating said antenna unit from said shield, and a plurality of spaced, parallel non-resonant metallic plates each having an opening therein through which said line extends, said plates being substantially horizontal while the portion of said line surrounded by said plates is substantially vertical, said plates being positioned adjacent the unit and conductively connected to each other adjacent said openings and to the shield of the line, said line having a portion thereof substantially horizontally disposed at such a distance from said plates that at said plates the field produced by voltages in said horizontal portion will be approximately at right angles to the plates.

7. An antenna array comprising a pair of vertically-disposed elongated antenna units, a transmission line including a pair of inner conductors, a shield about said conductors, said transmission line coupling said units and having substantially the form of a vertically, disposed U, means coupling said inner conductors at the ends of said line to said units and the intermediate approximately-horizontal portion of said line spaced a given distance from said ends, means insulating said antenna units from said shield, and a pair of sets of spaced non-resonant me-

tallic plates, each set surrounding one end of said line, the plates of each set being connected to each other and to the shield of said line.

8. An antenna array according to claim 7 wherein said plates are parallel and extend horizontally, and said given distance is such that at said plates the field produced by voltages in said horizontal portion will be approximately at right angles to the plates.

FRANK O. CHESUS.
FRANK G. THOMAS.

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