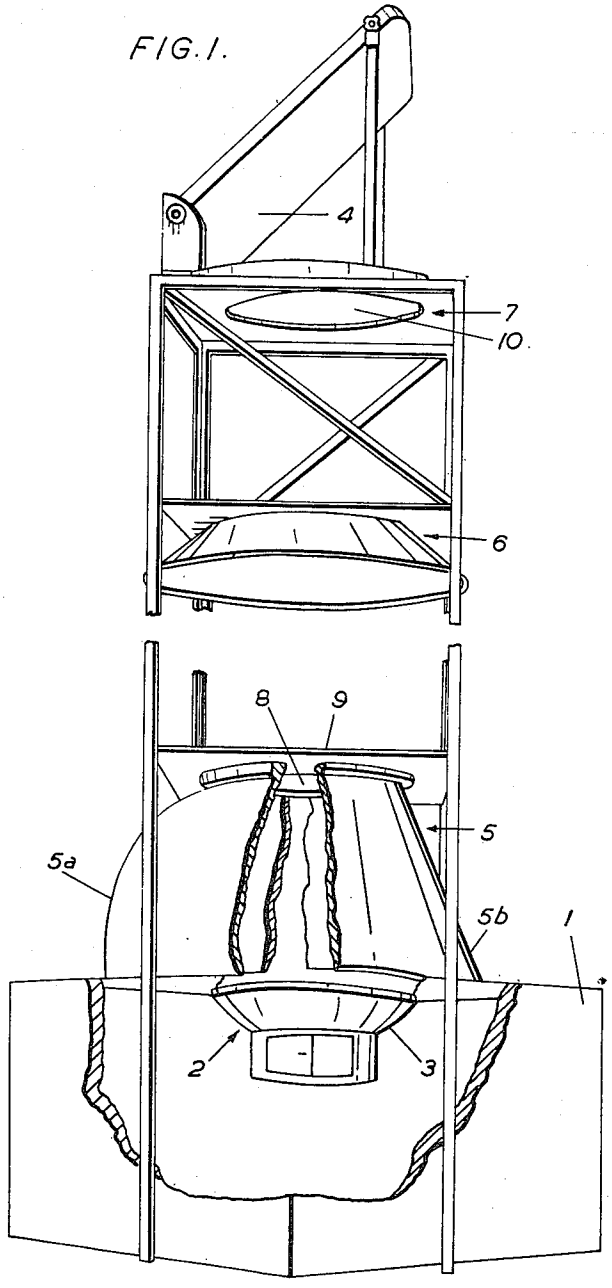
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RADIO BEAM ANTENNA ARRANGEMENTS

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FIG. 1.



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FIG. 2.

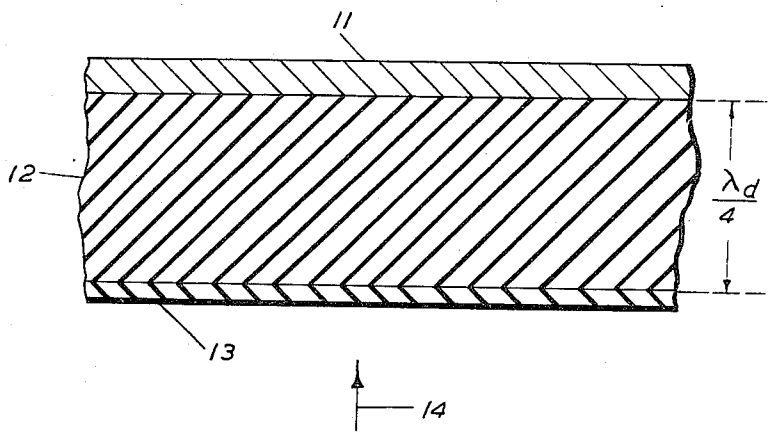
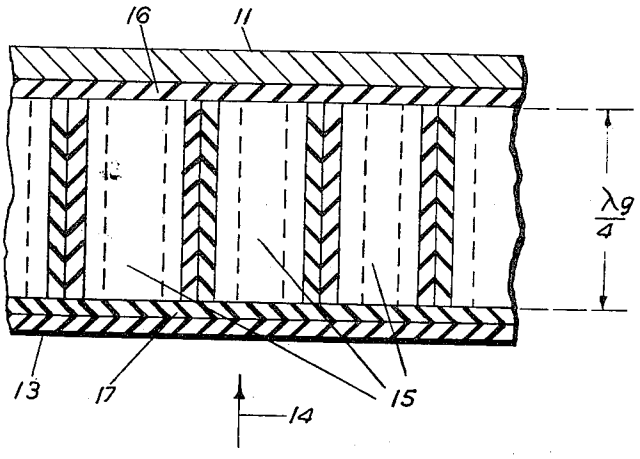


FIG. 3.



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RADIO BEAM ANTENNA ARRANGEMENTS

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Claims priority, application Great Britain August 3, 1951

1 Claim. (Cl. 250—33)

This invention relates to radio beam antennae arrangements. More particularly, it relates to antenna arrangements such as are used at microwave frequencies to produce a highly directive radiation beam such as is required for radio link or radar purpose.

When such highly directive antenna arrangements are used the radiation polar diagram takes the form of a main lobe which constitutes the desired beam, usually accompanied by side lobes which are well defined and of significant power, and which represent energy transmitted in directions other than that desired. The radiation of these side lobes can produce confusion and cause incorrect information to be supplied to the operator, thereby affecting his judgment. Moreover, reflections of these side lobes from various objects tend to confuse the primary data required for the radio system, when the latter is used for radar purposes. In the case of a radio link used to convey secret information from one point to another the presence of side lobes might enable the intelligence to be put at the disposal of other than the intended recipient.

It is therefore of considerable advantage that in such arrangements means should be provided for absorbing all radiation outside that which is required for the particular usage of the antenna system.

According to the most general aspect of the present invention a directive antenna arrangement comprises an antenna system such that when energised it would radiate energy in both wanted and unwanted directions simultaneously and an associated iris (i. e. apertured plate) system, said iris system including energy absorbing means and being so formed and located as to pass freely energy radiated by said antenna system in desired directions and to absorb energy radiated by said antenna system in undesired directions.

In embodiments of the invention an antenna system, which by itself may or may not be directive, has associated with it an iris system comprising one or more energy absorbent iris plates or diaphragms located in the radiation field of the antenna, having apertures so dimensioned and placed as to pass freely the main beam, or a sufficient part of the main beam, all other incident energy radiated by the antenna being intercepted by the plates and dissipated in the energy absorbing surfaces of the plates without reflection therefrom. The underside surfaces of the iris plates, i. e. the surfaces facing the antenna, may be coated with an energy absorbing layer of high-loss dielectric material such as colloidal graphite; alternatively, the coating may comprise an "absorbent trap" layer consisting of a honeycomb arrangement of closely spaced "lossy" wave guide tubes the axes of which are parallel to the direction of propagation of the incident energy, with the two surfaces of the honeycomb structure formed by the tubes each closed by a thin covering layer of energy absorbing material such as already mentioned. In either case the exposed surface of the absorbing layer may be protected by a weather-resistant varnish.

The aperture in such an iris plate may be of any suitable shape, determined primarily by the primary radiator i. e. elliptical, rectangular, circular, etc. While it should normally be possible to obtain the desired suppression with one single iris plate of suitable dimensions, it may in some cases be more economic to use two or more iris plates in series. The external shape of the iris plate is of course determined by the radiation to be suppressed, and should preferably be such that this radiation impinges on the absorbing surface with normal incidence.

It will be observed that since the iris plates absorb energy instead of reflecting it, there is no reaction on the radiating antenna, and the location of an iris plate is not critically dependent on the operating wavelength. The arrangement is therefore well adapted to wide-band operation.

It will also be observed that the efficient suppression of side lobes in the manner described has the advantage that a transmitter so equipped will not interfere with other systems working on the same frequency and in close proximity.

It will also be understood that while the invention has been described in terms of a transmitting antenna arrangement it is equally applicable and advantageous in highly directive receiving antenna arrangements.

A better understanding of the invention will be obtained from the following description of a particular embodiment of the invention, illustrated by the accompanying drawings in which:

Fig. 1 shows in perspective side view a radio link directive antenna system in accordance with the invention;

Fig. 2 illustrates in section one type of energy-absorbing construction suitable for use in the iris plates illustrated in Fig. 1.

Fig. 3 illustrates a type of energy-absorbing construction alternative to that illustrated in Fig. 2.

Referring to Fig. 1, there is indicated at **1** a box or building for containing a radio transmitter (not shown) which energizes an antenna system **2** of the type comprising a concave mirror **3** having at its focal point an energising radiator (not shown) such as a dipole radiator or a horn. The radiation axis of concave mirror **3** is directed vertically upward, so that the main beam hits a plane reflector **4** making an angle of 45° with the horizontal, and is reflected therefrom in a horizontal direction towards a predetermined location. Reflector **4** is carried on a metal-work lattice tower or similar structure. Before the energy radiated from mirror **3** can reach reflector **4** it has to pass in succession through the gaps of three iris plates indicated at **5**, **6** and **7** respectively, the inner surface of each iris plate, i. e. the surface facing the antenna system, being coated with an energy-absorbing layer as hereinafter described. The lowermost iris plate **5** is of generally hemi-spherical shape, as indicated at *5a*, or even of conical shape, as indicated in the alternative form shown at *5b*; whatever its form its base is of such diameter and is so located with respect to the aperture plane of mirror **3** as to embrace the whole of the radiation emitted therefrom, only that portion of the radiation which is directed to the iris aperture **8** being passed on for further limitation by iris plates **6** and **7**. Iris plate **5** is mounted by any convenient means on a platform **9** which in turn is supported by the lattice structure, and is of course apertured to correspond with iris aperture **8**. The "frame" of the iris plate, i. e. the sheet-like main member, may be of any material, such as metal or plywood, of sufficient rigidity to carry the absorbing surface material or absorption trap. (In the case of a receiving antenna arrangement system it is advantageous to make the frame of metal so as to serve as a screen against energy coming from an undesired direction, the inner coating of energy absorbing material then serving

to prevent reaction from the screening metal affecting the antenna impedance.)

The radiation emergent from iris plate **5** at gap **8** impinges on the dish-shaped iris plate **6**, the aperture of which (not shown) allows only a part of this emergent radiation to proceed to the final iris plate **7**. The absorbing surface of this final iris plate is substantially flat, and the major portion of the emergent radiation from iris plate **6** passes through the aperture **10** in iris plate **7** to be reflected horizontally by reflector **4**. It will be obvious that the proportion of energy absorption decreases progressively as the radiation from antenna system **2** passes successively through the three differently shaped iris plates **5**, **6** and **7**.

As already mentioned, when the arrangement is used for reception there is some advantage in making the frame of iris **5** of metal, so that the iris has an "inner" absorbing surface and an "outer" reflecting. The same argument applies to irises **6** and **7**. Preferably, however, the outer surface of each iris plate should then be of energy absorbing nature in the immediate neighbourhood of the aperture, otherwise eddy currents set up in the metal by the emergent energy may modify the polar diagram unsuitably.

A section through the thickness of an iris plate as used in Fig. 1 is illustrated in Fig. 2. In this figure reference **11** indicates the frame or sheet-like main member of the iris plate, this frame being in the present example made of metal. On this frame is mounted by any convenient means (not shown) an energy-absorbing coating or layer of high-loss dielectric material such as colloidal graphite or carbon-loaded rubber, indicated at **12**. Preferably the thickness of this layer is substantially equal to an odd multiple one-quarter of a wavelength λd in the dielectric at the mean operating frequency. That surface of the layer **12** which is remote from the frame **11** is preferably protected against weather by means of a thin layer of protective varnish, such as that known as "seaplane varnish," as indicated at **13**. Whatever varnish is used, it should be substantially non-reflecting to radio energy. The iris plate as a whole should preferably be so shaped that the energy to be absorbed falls thereon with normal incidence as indicated by arrow **14**.

An alternative construction to that of Fig. 2 is illustrated in Fig. 3, the essential difference being the replacement of a simple layer of high-loss dielectric by a honeycomb of dissipative wave guides.

Referring to Fig. 3, the iris plate frame is indicated at **11**. Mounted on this frame is a honeycomb structure comprising a plurality of closely spaced wave guide tubes, three of which are indicated at **15**, both inner and outer surfaces of each tube being of high-loss dielectric material. In the present example each tube is constituted entirely of dielectric material, but if desired the main body of the tube may be made of metal or any other convenient material, so long as the surfaces are of dissipative material such as colloidal graphite. The tubes may be conveniently made of hexagonal cross-section, whereby they may be nested together in contiguous relationship. Each tube is made of length substantially equal to an odd multiple of one-quarter of the guide wavelength λg in the tube at the mean operating frequency. The ends of the tubes forming the honeycomb are sealed by two thin layers of high-loss dielectric material, one layer being indicated at **16**, separating the honeycomb from the frame **11**, the other layer being indicated at **17**. The external surface of the absorbent layer thus formed is, as in the structure illustrated in Fig. 2, protected against weather by a thin layer **13** of protective varnish.

While the principles of the invention have been described above in connection with a specific embodiment, 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 the invention. It will be obvious, for example, that while the invention has been described in connection with an embodiment in which use is made of a 90° reflection of the radiation emitted by the antenna system, such reflection does not constitute a feature of the invention, and that the invention can be applied to systems in which the antenna axis is itself directed towards the desired location. It will also be understood that the invention is not limited to stationary beams, and that an absorbing iris system may be used in association with a physically moving antenna system provided that the iris system is placed at such a distance from the main radiator elements as may be required for the efficient absorption of the unwanted radiation.

What I claim is:

A directive radio antenna arrangement having means for producing a highly directive radiation beam, said means comprising an iris plate having an aperture centrally located and positioned forward with respect to the direction of radiation of said beam producing means, the surface of said plate facing said antenna being coated with an energy absorbing material, said plate being shaped and positioned so that the aperture passes radiated energy in a given direction, and to intercept and absorb energy radiated by said antenna in all other directions; said energy absorbing layer being in the form of a honeycomb structure and comprising a plurality of wave guide tubes closely spaced side by side with their longitudinal axes normal to the plate, each said tube having all its surfaces coated with high-loss dielectric material and having a guidelength substantially corresponding to an odd multiple of one quarter wavelength at the mean operating frequency, each of the two honeycomb surfaces defined by the ends of said tubes being closed by a respective thin layer of high-loss dielectric material.

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