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W. RUNGE ET AL

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ANTENNA SYSTEM

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Fig. 1

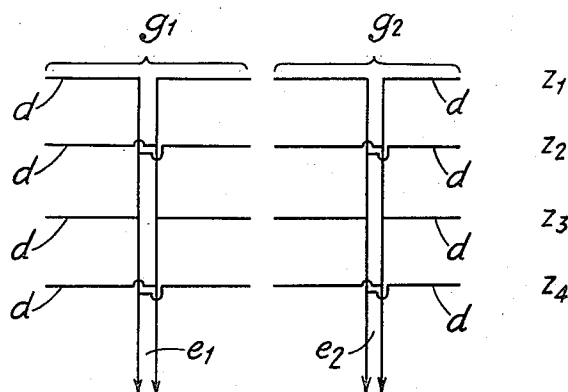


Fig. 3

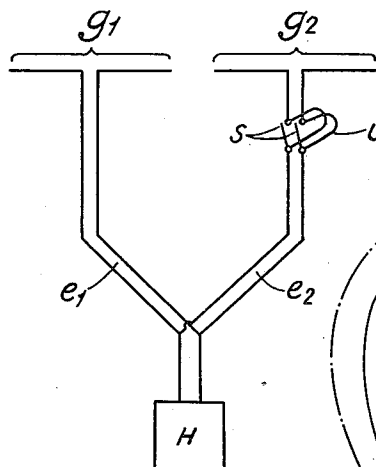
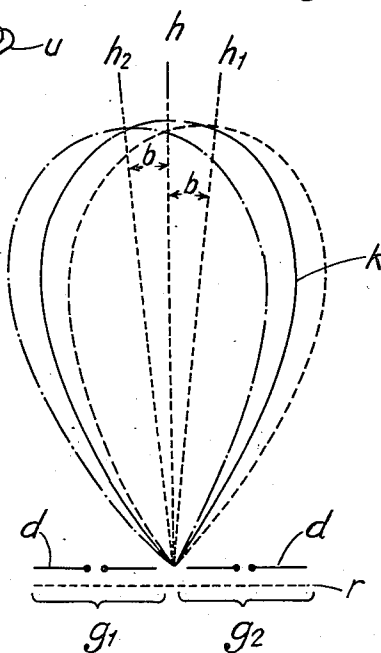


Fig. 2



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ANTENNA SYSTEM

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3 Claims. (Cl. 250—11)

The invention concerns methods and means to produce guide rays or equi-signal zones or lines.

In order to mark a course of travel or the lateral boundaries of a lane of travel by means of electro-magnetic waves, recourse has been had to so-called guide rays using beams. These are marked by two partially over-lapping electromagnetic fields resulting in an equal signal zone. For the production of guide rays recourse is mostly had to two directive antennae the main radiations of which enclose a certain angle. The two antennae either are connected alternately with an R. F. oscillator or else they permanently radiate dissimilarly modulated waves. For reasons of energy economy it is preferable to provide the two antennae with reflectors so that they will radiate only in one direction. Attempts have been made to reduce the amount of required equipment by employing for both antennae a joint reflector or for one antenna two different reflectors, the relative position between the antennae and reflectors being so chosen that the two controlling main radiations enclose an angle between each other. However, in either case either two antennae or two reflectors are required. Because of the great depth of parabolic reflectors, sheet antennae consisting of radiator units are generally preferred, and these sheet antennae are equipped with planar reflectors. The arrangement of two such planar antennae insuring comparatively sharp focusing, however, is attended with appreciable space requirements either in the direction of width or of height. The object of the present invention, on the one hand, is a saving in material and equipment, and, on the other hand, a reduction in space requirements for an antenna arrangement adapted to the production of beams.

According to the invention, a single antenna comprising a plurality of radiator units is used such that parts thereof are fed with different phases, and that the phase position of the radio frequency currents fed to the various radiators is rhythmically altered.

Fig. 1 shows an antenna which may be used with the invention;

Fig. 2 shows curves explanatory of the invention; and

Fig. 3 illustrates a system in accordance with the invention.

Sheet antenna known in the prior art have been built in a manner so that the different radiator units were disposed in one plane. As a general rule, the feeding of adjacent radiator units is in phase, with the result that the fields

issuing therefrom become added and that a sharply concentrated radiation characteristic is obtained. It has been suggested in the earlier art to insure a change in sharpness of concentration or focusing of beam by dividing the sheet antenna into several radiator groups which are fed with currents of different phase in such a way that the phase shifts come to be placed symmetrically in reference to the median axis of the antenna system. For instance, the antenna has been divided into three groups, to the outer groups being imparted like phase displacement of the radio frequency feeder current so far as absolute value is concerned. By varying the magnitude of the phase shift of the feeder current supplied to the outer radiator groups compared to the feed of the middle group, it is possible to alter the sharpness of concentration.

Now, according to this invention the feeding of the various radiator groups is effected in such a manner that the direction of the chief ray or vector is changed. In order to explain the situation then arising, reference is made to Fig. 1. What is shown in this figure is a sheet antenna comprising eight di-pole radiators d . These radiators are superposed in four rows $z1$ to $z4$ placed above one another. Such radiators as are thus superposed form a group so that the antenna comprises two groups $g1, g2$. If the two groups are fed in phase there results a radiation diagram which is shown in Figure 2 by a curve of equal signal strength k , the main vector h being at right angles to the plane laid through the antenna. By using a planar reflector r posteriorly of the antenna wall and suitably spaced apart therefrom, conditions as well known in the art are obtained so that uni-directional radiation will be brought about. The planar reflector r could consist also of a plurality of di-poles, or else of an unbroken metallic surface, that is, a solid sheet, or metal gauze. If the two radiator groups $g1, g2$ are fed in such a way that the feed currents supplied by way of leads $e1, e2$ present a relative phase displacement, there will be occasioned a shift in the radiation diagram in such a way that the new major vector $h1$ or $h2$ comes to form with the original chief ray direction h an angle b . Whether the shift of the major vector will be towards the right or left hand side depends upon which of the two groups is fed with a leading phase. According to this invention, the conditions hereinbefore described are utilized for the purpose of producing an equi-signal zone with a single antenna or reflector arrangement by rhythmically changing the phase shift be-

tween the feed currents supplied to the different radiator groups, and for this purpose a number of embodiments are conceivable.

The introduction of a phase shift is particularly easy by the insertion of a by-pass in one of the two feeder leads $e1$ or $e2$.

In Fig. 3 is shown again an antenna system comprising two groups fed from a radio frequency generator H. In order that in-phase feed of the two antenna groups may be insured it is necessary that the two energy feeder leads $e1$, $e2$ should have exactly the same length. If a shift in phases is to be caused, then an extension piece u could be inserted in one of the said two leads, say, in $e2$. By the proper choice of the length of u any desired size of phase shift may be obtained for a given wave-length. In order that changes in the phase angle may be accomplishable, it is preferable to make the by-pass or lengthening piece trombone-fashion or telescope-fashion in order that the length of the by-pass may be variable by pulling the U-shaped part more or less far out. The rhythmic change is effected, for instance, by that the by-pass u is short-circuited by the agency of two switches s . This switch may be subject to mechanical drive in such a way that it will be opened or closed at a definite signal rhythm.

A particularly efficient way of shifting the major vector is obtained by that in both feeder leads $e1$ and $e2$ by-passes are provided which are cut in and short-circuited in phase opposition or push-pull fashion. The energy supplied from the radio frequency generator H could be modulated, e. g., with a constant audio frequency sound or note. At the receiving end the equi-signal line is ascertainable as known in the prior art by receiving a permanent note of constant volume. The cutting in and out of the by-passes is most suitably effected in a complementary signal rhythmically (for instance, $e-t$, $a-n$) so that from a predominance of one signal also the lateral deviation is determinable. The short-cir-

cutting switches s inserted in the two energy feeder leads $e1$, $e2$ are preferably inter-coupled or locked in a positively acting manner, the drive being from a single mechanism.

It will be understood that the antenna could be sub-divided also into a greater number of groups, and it is then, of course, necessary to so dimension the phase shifts for these various groups that two neighboring groups will always differ by the same phase angle.

What we claim is:

1. An antenna system comprising a first antenna and a second antenna, high frequency apparatus, individual feed lines of substantially equal length from said first and second antennas to said high frequency apparatus, one of said lines being of fixed length, and means for physically lengthening the path of the other of said feed lines.

2. A transmitting antenna system comprising a first antenna and a second antenna both in the same plane, transmitting apparatus, an energy feed line from each of said first and second antennas to said transmitting apparatus, and a switch in one of said feed lines operative in one position to lengthen the path of energy flow in said line, and in the other position to short circuit a portion of said line, said feed lines being of substantially equal length to the flow of energy from said transmitting apparatus when said switch is positioned to short circuit a portion of its associated line.

3. An antenna system comprising a first antenna and a second antenna, high frequency apparatus, individual feed lines of substantially equal length from said first and second antennas to said high frequency apparatus, one of said lines being of fixed length, and means for physically changing the length of the path of the other of said feed lines.

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