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TWO FREQUENCY ELECTROMAGNETIC HORN RADIATOR

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Fig. 1.

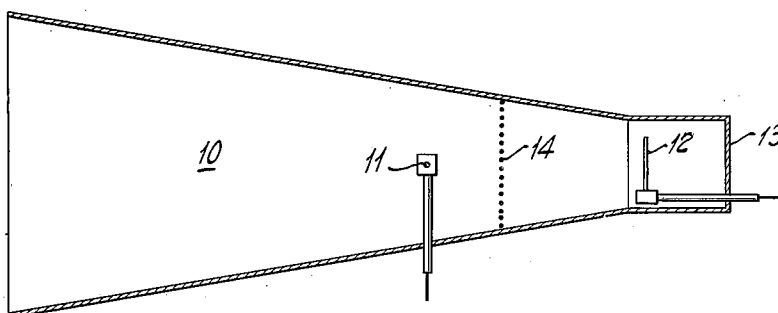
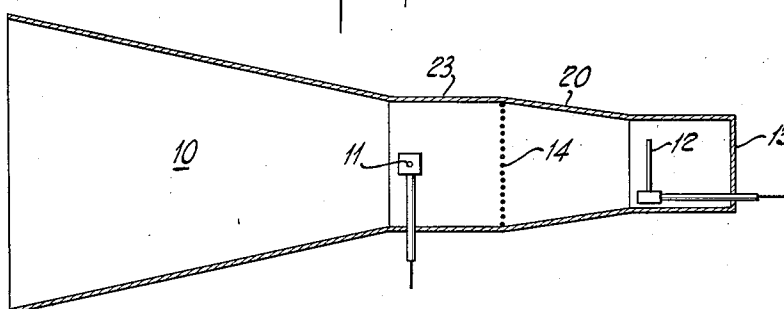


Fig. 2.



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TWO FREQUENCY ELECTROMAGNETIC HORN RADIATOR

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Original application December 12, 1940, Serial
No. 369,826. Divided and this application
August 4, 1943, Serial No. 497,348

6 Claims. (Cl. 250-11)

The present application is a division of my prior application #369,826, filed December 12, 1940, now Patent 2,362,561, granted Nov. 14, 1944.

The present invention involves ultra-short wave horn radiators and, more particularly, is directed toward means for operating a single radiator of this type to simultaneously radiate or receive signals at a plurality of different frequencies.

An object of the present invention is to provide a single horn radiator for the simultaneous or selective transmission and/or reception of separate intelligence bearing signals at different frequencies.

Another object of the present invention is the provision of means for simultaneous energization of a wave guide structure with two separate signals at different frequencies without interaction therebetween.

Still a further object of the present invention is the provision of a horn radiator, as aforesaid, in which the two signals may be spaced only moderately in the frequency spectrum or in which the frequencies may differ by a factor of two or more.

In general, in employing the present invention a rectangular tapered wave guide section is used as a horn to simultaneously, or selectively, receive or transmit a pair of signals at different frequencies. The energizing antennas, or pick-up means, depending upon whether the horn is used for transmission or reception, are located at the small end of the tapered wave guide section. The two signals of different frequencies are radiated or received with their polarizations crossed in order to eliminate interaction. In the case of transmission, in order to provide linearly polarized radiated waves, the electromagnetic horn or tapered wave guide may be fed with $H_{0,1}$ and $H_{1,0}$ waves of different frequencies, that is, one wave will have a vertical polarization of the electric field intensity and the other, a horizontal polarization of the electric field intensity. Both waves will, of course, have a component of magnetic force in the direction of propagation.

In the above used notation the first subscript denotes the number of half sine waves in the distribution of electric field intensity in the direction parallel to the vertical axis and at right angles to the direction of propagation, while the second subscript indicates the number of half sine waves in the distribution of field intensity in the direction parallel to the horizontal axis and at right angles to the direction of propagation. The subscript 0 denotes that the field in-

tensity for that wave is independent of the corresponding direction.

It will be seen, therefore, the the $H_{0,1}$ wave results in a vertically polarized radiation while the $H_{1,0}$ wave results in a horizontally polarized radiation. For the $H_{1,0}$ wave which results in a horizontally polarized radiation the vertical dimension of the resonant chamber which surrounds the energizing means for this wave must be larger than the critical dimension, which is determined by the operating frequency of that wave. That is, the vertical dimension of the resonant chamber must be greater than a half wavelength at the operating frequency. The horizontal dimension of the resonant chamber may be arbitrarily chosen as far as the $H_{1,0}$ wave is concerned. Similarly, the $H_{0,1}$ wave, which results in a vertically polarized radiation, requires that the horizontal dimension of the resonant chamber which surrounds the energizing means for this wave must be larger than the critical dimension. As before, this horizontal dimension is a half wavelength at the operating frequency for the vertically polarized wave. The vertical dimension of the resonating chamber may be arbitrarily chosen.

In the case of a receiving horn structure a rectangular horn is coupled to a rectangular resonating chamber containing the receiving antenna and both horizontal and vertical polarizations are received by the horn simultaneously. Then the feed chamber will contain both $H_{0,1}$ and $H_{1,0}$ waves. If the resonating chamber is tapered down in the horizontal dimension to a value less than the critical dimensions for the propagation of $H_{0,1}$ waves then these waves will be suppressed beyond that point and only $H_{1,0}$ waves will continue on past the taper. Similarly, a tapering of the chamber in the vertical dimension down to a value below the critical dimension for the propagation of $H_{1,0}$ waves will allow only $H_{0,1}$ waves to pass. If desired, a further discrimination between the two waves may be provided by the insertion of a grid of parallel wires or bars at the place where the critical dimension for the propagation of the undesired wave is attained.

Further objects, features and advantages of the present invention will be more clearly understood by reference to the following detailed description, which is accompanied by a drawing in which Figure 1 illustrates in horizontal section an embodiment of the present invention and Figure 2 illustrates a modification of the form of the invention shown in Figure 1.

Figure 1 of the drawing shows an arrangement which is suitable for cases where the two fre-

quencies to be transmitted or received differ relatively widely. Here the horn structure 10 is shown as being of uniform taper throughout. The antenna 11 for the lower frequency is placed nearer the mouth of the horn where the cross-sectional dimensions are greater than the feed antenna 12 for the higher frequency. It is preferably located a suitable distance in front of a grid of wires 14 which lie parallel to the low frequency feed antenna. The distance between the antenna 11 and the grid 14 is determined by considerations of impedance matching of the transmission line (not shown), by means of which the antenna 11 is energized or by means of which the receiver is energized. The wire grid 14 is placed at a point in the horn where the dimension of the horn at right angles to antenna 11 is a half wavelength, or more, of the operating frequency for antenna 11. The small end of the horn is terminated in a throat connected to a suitably dimensioned resonant chamber 13 for the higher frequency. The dimension of chamber 13 in a direction at right angles to the sectioning plane is at least a half wavelength of the operating frequency of antenna 12. The space between antenna 12 and the closed end of chamber 13 is determined by the same considerations as determine the space between antenna 11 and grid 14.

Figure 2 shows a modification of Figure 1 which is suitable for any separation of the two desired frequencies of operation. As in the case of Figure 1, the radiating horn structure 10 is shown of uniform taper throughout. To the small end of horn 10 is connected a feed chamber 23 having therein an energizing antenna 11. The dimension of chamber 23 at right angles to the antenna 11 is at least a half wavelength at the operating frequency of antenna 11. The end of feed chamber 23, remote from its connection to horn 10 is closed as far as radiation from antenna 11 is concerned by a grid 14 of wires parallel to the antenna 11. As in the case of Figure 1, the spacing between the antenna 11 to the grid 14 is determined by considerations of impedance matching. At the rear end of the low frequency feed chamber 23 is placed a further tapered section 20 and to the throat of this section is connected the resonant chamber 13 containing therein the second energizing antenna 12. The construction of this portion of the figure is the same as in the case of Figure 1 and will not, therefore, be further described.

In all of the embodiments heretofore described the rate of taper of the horn need not be uniform throughout but may vary as described in my prior copending application #354,954, filed August 31, 1940. In the case of Figure 2 wherein a separate tapered horn connects the high frequency feed chamber to the main horn 10, the separate portion may advantageously have a steeper rate of taper since the aperture in which it terminates is relatively small. Furthermore, the interior of horn 10 may be treated as shown in my prior copending application #363,248, now Patent No. 2,317,464, granted April 27, 1943, in order to assure that the horn may provide equal gain for both waves.

While I have particularly shown and described several modifications of my invention, it is to be distinctly understood that my invention is not limited thereto but that improvements within the scope of the invention may be made.

I claim:

1. Means for coupling a pair of independent

transducer means to a tapered horn antenna comprising a pair of elongated resonant chambers adjacent one another, an elongated antenna within each of said chambers, each of said antennae being mounted at right angles to the longitudinal axis of its associated resonant chamber and mutually at right angles with respect to one another, said antennae being adapted to operate at substantially different frequencies, the dimensions of each of said chambers transverse to the antenna therewithin being at least half of the operating wavelength of said antenna and the dimension of at least one of said chambers along the length of the antenna therewithin being less than one-half of the operating wavelength of the other of said antennae, and means for coupling said chambers to the small end of said horn, and a grid interposed between at least one of said antennae and said coupling means, said grid being conductive only in a direction normal to the antennae behind it, said coupling means being so constructed as to prevent reflection of high frequency energy passing between said horn and said antennae.

2. In combination with an elongated tapered wave guide, a pair of linear antennae adapted to operate at different frequencies, each of said antennae being mounted in said tapered wave guide at such position that the transverse dimension of said guide normal to said antennae is at least a half of the operating wavelength of said antennae, each of said antennae being mounted at right angles to the axis of said guide at their respective locations and mutually at right angles with respect to one another, the dimensions of said guide along the axis of at least one of said antennae being less than one-half of the operating wavelength of the other of said antennae, and a grid interposed before one of said antennae and conductive only in a direction perpendicular to said one antenna.

3. In combination with an elongated wave guide having portions of different transverse dimensions, a pair of linear antennae adapted to operate at different frequencies, said antennae being mounted at right angles to the longitudinal axis of said guide and mutually at right angles with respect to one another, each of said antennae being mounted along said wave guide at such position that the transverse dimension of said guide normal to said antennae is at least a half of the operating wavelength of said antennae and means interposed between said antennae for preventing interaction therebetween, the dimension of said guide along the axis of the higher frequency antennae being less than a half of the operating wavelength of the other of said antennae whereby energy at the lower of said frequencies is prevented from reaching said high frequency antenna.

4. In combination with a tapered wave guide, a pair of linear antennae adapted to operate at different frequencies, said antennae being mounted at right angles to the axis of said guide and mutually at right angles with respect to one another, the one of said antennae adapted to be operated at the lower frequency being located at such position along said guide that the transverse dimension thereof transverse to said antenna is at least a half wavelength at said frequency and the other of said antennae being located in a narrower portion of said guide where the transverse dimension thereof transverse to said second antenna is of the order of a half wavelength at its operating frequency, and means in

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the path within said guide between said antennae for preventing interaction therebetween.

5. In combination with a tapered wave guide, a pair of linear antennae adapted to operate at different frequencies, said antennae being mounted at right angles to the axis of said guide and mutually at right angles with respect to one another, the one of said antennae adapted to be operated at the lower frequency being located at such position along said guide that the transverse dimension thereof transverse to said antenna is at least a half wavelength at said frequency and the other of said antennae being located in a narrower portion of said guide where the transverse dimension thereof transverse to said second antenna is of the order of a half wavelength at its operating frequency, and means in the path within said guide between said antennae for preventing interaction therebetween, said means comprising a grid of parallel wires conductive only in a direction parallel to the one of said antennae adapted to operate at the lower frequency.

6. In combination with a tapered wave guide, a pair of linear antennae adapted to operate at different frequencies, said antennae being mounted at right angles to the axis of said guide and mutually at right angles with respect to one another, the one of said antennae adapted to be operated at the lower frequency being located at such position along said guide that the transverse dimension thereof transverse to said antenna is at least a half wavelength at said frequency and the other of said antennae being located in a narrower portion of said guide where the transverse dimension thereof transverse to said second antenna is of the order of a half wavelength at its operating frequency, and means in the path within said guide between said antennae for preventing interaction therebetween, said means comprising a grid conductive only in a direction parallel to the one of said antennae adapted to operate at the lower frequency.

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