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ELECTROMAGNETIC HORN
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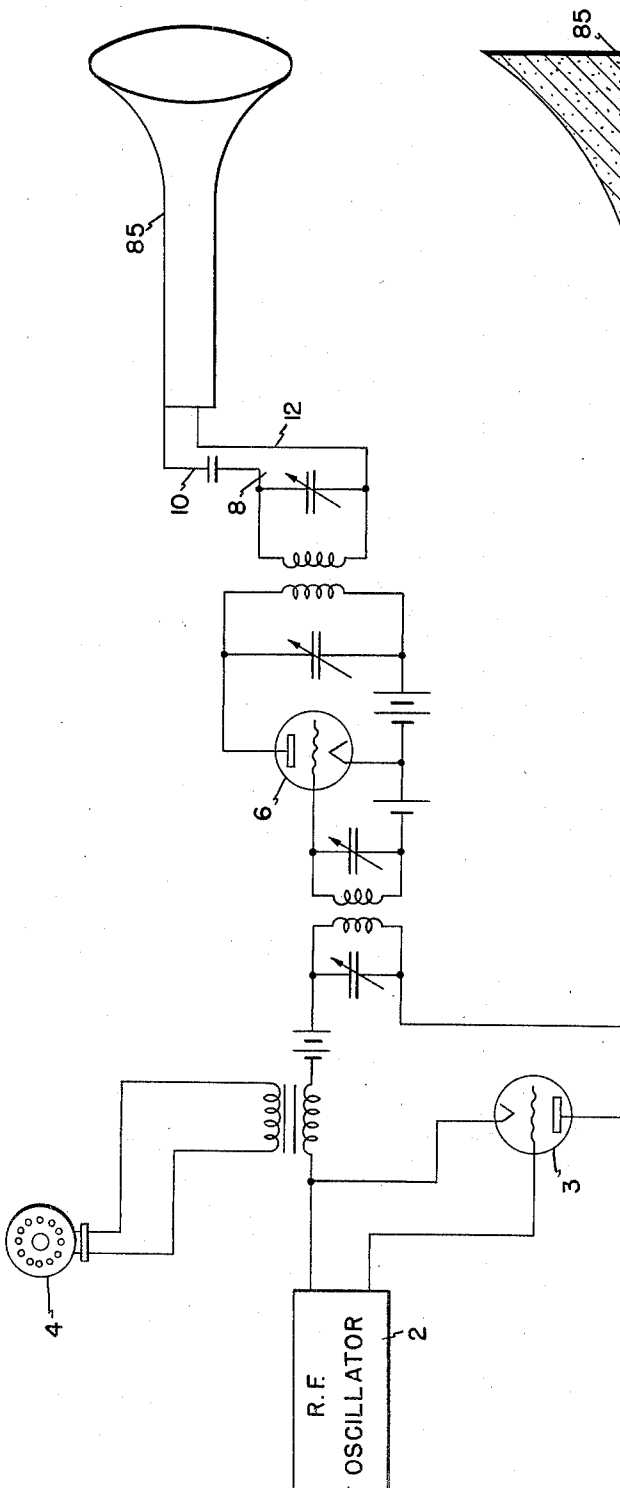


FIG. 1

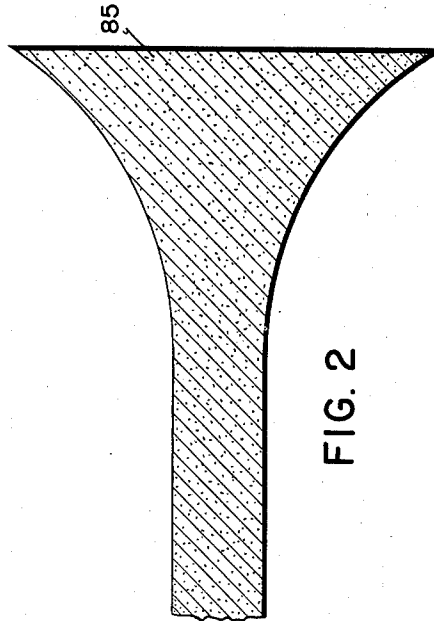


FIG. 2

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ELECTROMAGNETIC HORN

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The present invention relates to electromagnetic horns. The present application is a continuation-in-part of application, Serial No. 155,489, filed July 24, 1937, now Patent No. 2,425,716, granted August 19, 1947.

An object of the present invention is to provide a new and improved electromagnetic antenna suitable for radiating and absorbing at ultra-high frequencies and, more particularly, a horn comprising dielectric material.

Other and further objects will be explained hereinafter and will be particularly pointed out in the appended claims.

The invention will now be more fully described in connection with the accompanying drawings, in which Fig. 1 is a diagrammatic view of circuits and apparatus showing, in longitudinal section, an electromagnetic horn embodying the present invention connected to suitable sending equipment; and Fig. 2 is a perspective of the horn.

In Fig. 1 there is shown, for illustrative purposes, a transmitting system comprising an ultra-high-frequency oscillator 2, provided with a modulator 3, which may be modulated in any desired way, as by means of a microphone 4. The modulated output may be fed to a radio-frequency amplifier 5 that may be coupled to a circuit 6 having two-wire output-conductor connecting leads 10 and 12. The leads are shown connected to a wave-guide integral with the throat or small end of an electromagnetic horn 85. They may be replaced by coaxial or other lines or a hollow-pipe wave-guide transmission-line system.

The large end or mouth of the horn 85 intercommunicates with free space to permit the horn to receive electromagnetic waves from space or to radiate electromagnetic waves forward out into space at the large end. The transverse dimension of the small end or throat of the horn and of the wave-guide to which it is connected is substantially equal to or slightly greater than the critical transverse dimension for the lowest-order electromagnetic wave that will pass through a hollow pipe of the same cross-sectional shape as that of the small end of the horn. The principal axis of the horn extends between the small and the large ends of the horn.

Sending or receiving apparatus may be connected to the two-wire connecting leads 10 and 12. As before stated, Fig. 1 illustrates a sending system. The corresponding connections for receiving will be understood by persons skilled in the art without further illustration.

In transmission, modulated ultra-high-frequency

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electromagnetic energy may be taken by the conductors 10 and 12 from the sending apparatus and delivered to the wave-guide and, through the wave-guide, to the throat of the horn 85. The modulated electromagnetic energy will then be propagated through the interior of the horn to the large end or mouth thereof. Upon arrival at the mouth of the horn, the electromagnetic waves become readily disattached from the horn, continuing thereafter to travel beyond this large end for radiation forward out into free space, as ordinary modulated radio waves. The horn thus constitutes a directive electromagnetic radiator.

Similar but reverse operation will take place during reception of such waves. The modulated electromagnetic waves will be received at the large end of the horn and, after traveling through the interior of the horn, to the throat thereof, and through the wave-guide connected thereto, will be communicated to the conductors 10 and 12 by which they will be conducted to a receiving system (not shown), where the signals comprising the intelligence will be demodulated.

The horn may thus be connected to sending or receiving apparatus, at its throat or small end, and to free space, at its large end or for purposes of either radiating radio waves into, or absorbing them from, space. If the horn is used for the transmission or the reception of ultra-high-frequency waves of wave-lengths below ten meters, its dimensions may be kept reasonably small.

In accordance with the present invention, the horn 85 may be constituted throughout, between its large and small ends, of solid dielectric material. The material may have a dielectric constant greater than unity. The wave-guide to which the horn 85 is joined, at its throat end, indeed, may be integrally constituted, with the horn 85, of the same dielectric material. The horn and the wave-guide may thus be constituted of a dielectric wave-guide wire, the surface of which is flared at one end into the shape of the wave-guide horn with the small end or throat of the horn 85 integral with the wave-guide wire at the junction of the horn 85 with the dielectric wire. A construction of this kind has great advantages, because a flared dielectric wire is capable of transferring more energy from the energy source 2 into the horn 85 for radiating purposes. The unflared part of the dielectric wire serves as a wave-guide for transmitting electromagnetic waves to the horn 85 or receiving them from the horn. The invention finds utility, how-

ever, even though the horn 85 be connected directly, at its small end or throat, to the leads 10 and 12 or their equivalent. If the dielectric-wire wave-guide is thus dispensed with, moreover, a separate exciting or absorbing antenna may be embodied in the dielectric of the horn 85.

The horn 85 may be conical, pyramidal, sectoral, or of any other desired shape, depending upon the application. It is shown approximately conical, but curved somewhat away from the true cone shape, in order that it may flaringly expand more rapidly than linearly, thus to enhance the directivity of radiation and increase the frequency response.

The solid-dielectric electromagnetic horn 85, in either event, is provided with a flaring guiding surface or flaring guiding walls between its small end or throat and its large or mouth end. The horn thus operates to guide the electromagnetic waves traveling through the solid dielectric thereof tangentially along its surface in the longitudinal direction, more or less parallel to its principal axis, smoothly, continuously, and without interruption. In reception, the electromagnetic waves received from space at the mouth of the horn are thus guided to the throat end of the horn. In transmission, the electromagnetic waves generated at the small end of the horn are guided to the mouth thereof, for propagation forward out into free outer space. The horn provides a guiding surface of progressively greater cross-sectional area toward the mouth of the horn, causing the wave energy to spread over a relatively large area at the mouth for directive transmission, and the configuration of the waves is reasonably maintained during their outward progression. The waves are partly guided along the horn surface, although a part of the field is outside of the solid dielectric in the surrounding space. A similar operation takes place during reception.

The waves travel through the solid dielectric of the horn with a phase velocity substantially different from that of light in the solid dielectric. Near the small end of the horn, the phase velocity may be greater than the velocity of light. The phase velocity decreases as the large end or mouth of the horn is reached.

Further modifications will occur to those skilled in the art, and all such are considered to fall within the spirit and scope of the invention, as defined in the appended claims.

What is claimed is:

1. An electromagnetic wave-guide antenna having a small end and a large end and consti-

tuted throughout solely of a solid dielectric between the large end and the small end, the large end electromagnetically intercommunicating with space to permit the antenna to receive electromagnetic waves from space or to radiate electromagnetic waves forward out into space, and absorbing or exciting translating means connected with the antenna, the antenna having flaring guide walls between the large end and the small end for guiding the waves received from space at the large end through the solid dielectric to the translating means with a phase velocity substantially different from that of light.

2. A wave-guide antenna comprising a solid-dielectric wire the surface of one end of which is flared into the shape of a wave-guide horn and said antenna being integrally constituted throughout of the solid dielectric, the transverse dimension of the wave-guide corresponding to a critical wave-frequency equal to or less than the frequency of the waves transmitted through the wave-guide.

3. A radiator for electromagnetic energy comprising solely a solid dielectric structure having a horn-like shape, and translating means operatively connected to the smaller end of said horn-like structure.

4. A dielectric wave guide, and an antenna constituted throughout of solid dielectric having a flaring shape, said antenna having its smaller end operatively connected to said dielectric wave guide.

5. A dielectric radiator for electromagnetic energy constituted throughout of solid dielectric one portion of which comprises a rod-like configuration which is dimensioned so as to function as a wave guide and a second portion integrally connected with said wave guide portion, said second portion having a gradually widening cross-section and being at least one wavelength in length at the operating frequency.

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