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ELECTROMAGNETIC HORN ANTENNA

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Fig. 1

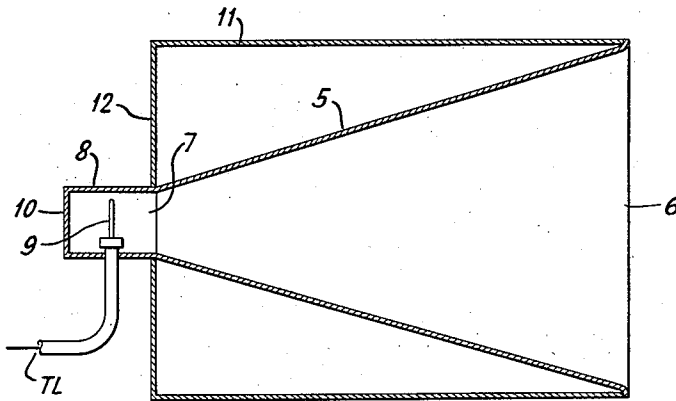
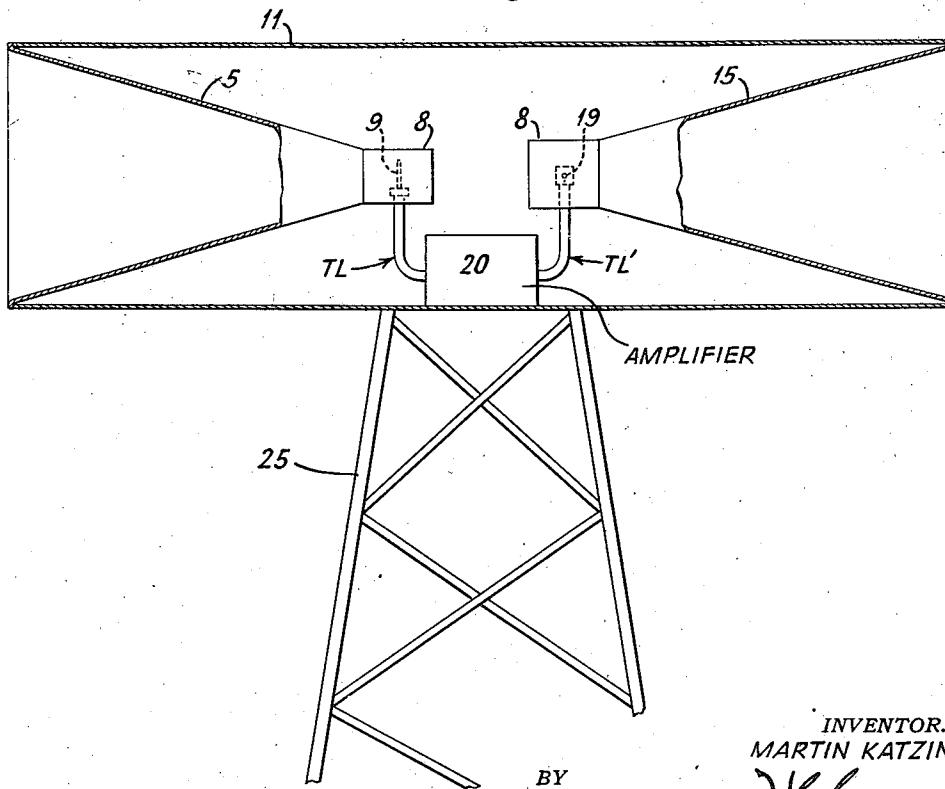


Fig. 2



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ELECTROMAGNETIC HORN ANTENNA

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10 Claims. (Cl. 250—11)

The present invention relates to directive horn radiators and more particularly to horn antennae structures utilizing cross polarization for discrimination between signals.

Simultaneous operation at the same general location of a pair of radio receivers and/or transmitters on the same frequency or closely adjacent frequencies has heretofore been accomplished with some degree of success by utilizing directive antennae so directed that low interference between the different signals is obtained. Also, interference has been reduced by utilizing polarization discrimination. Thus one transmitter or receiver operates with a signal wave of one polarization and the other with a signal wave polarized at 90 degrees to the first. In ultra short wave radio relay systems where each intermediate station consists basically of a receiving antenna, a radio frequency amplifier and a transmitting antenna, both of the above-mentioned expedients have been used to reduce coupling or feedback between the receiving and transmitting antennae.

When utilizing horn antennae a very high order of polarization discrimination has been obtained when working in the forward direction—that is, in the direction of the opening of the directive horns. However, a much lower order of polarization discrimination is usually obtained to the rear of the directive horns. Thus, in prior practice, the major reduction in feedback between receiving and transmitting antennae in relay stations has been due to the directivity of the antennae. I have discovered that the failure of discrimination between signals in the direction toward the rear of the horns is caused by currents flowing in the outer surfaces of the horns, these currents being induced by the radiated field diffracting around the mouth of the horn. Since the sides of the horn are tapered, these currents in turn, produce field components in both vertical and horizontal planes of polarization. Thus, even though in a relay station a receiving antenna is designed to operate on vertically polarized waves, due to the currents induced in the exterior surfaces of the horns by the field diffracted around the mouth of the horn, the field radiated by the transmitting antenna produces vertically polarized waves to the rear of the transmitting horn. These vertically polarized components are picked up by the receiving antenna and produce an overall feedback at the relay station which may result in "singing." This feedback disables the relay station for its intended function of repeating the received signals and forwarding them to a more

remote receiving location. Also, where duplex operation is carried out on a single frequency by a cross polarization of the signals, both the receiving and transmitting antennae being located within the same directive horn structure, there is the same possibility of currents induced by the field diffracting around the mouth of the horn causing interference between the two operating channels.

An object, therefore, of the present invention is the improvement of ultra short wave radio relay systems.

Another object of the present invention is the provision of a horn radiating structure having improved discrimination between horizontally and vertically polarized waves in the direction to the rear of the horn.

Still a further object of the invention is to reduce feedback between the transmitting and receiving antennae in ultra short wave relay stations.

In order to accomplish the above-mentioned objects and other objects which may hereafter appear in accordance with the present invention, I propose to provide an outer conducting shell or box over the electromagnetic horn radiating structure. The shell covers the horn back from the large end or mouth and extends back over the horn far enough to prevent the flow of currents on the tapered sides of the horn. This may be only a short distance, or as far back as the throat or small end of the horn. It is contemplated that this outer shell may be electrically connected to the mouth or large end of the horn and may either be left open at the throat or small end of the horn.

Alternatively, the outer shell may be entirely closed at the end away from the mouth of the horn or extended far enough to accommodate another horn facing in the opposite direction. The outer shell which I have described is preferably of uniform rectangular cross-section to avoid the introduction of any sloping surfaces which might produce a partial shift of the plane of polarization of energy flowing thereover.

The present invention will be more completely understood by reference to the following detailed description which is accompanied by a drawing in which Figure 1 illustrates one embodiment of the present invention and Figure 2 illustrates a modification thereof particularly usable in radio relaying stations.

Figure 1 shows in vertical cross section a tapered horn radiator 5 which has a rectangular mouth opening 6 and a smaller rectangular

throat opening 7. The area of the mouth 6 and the over-all length of the horn are so related as to obtain a desired directivity in the forward direction—that is, out of the mouth of the horn. To the throat end of the horn 7 is connected a feed chamber 8 containing therewithin an energizing antenna 9. The antenna 9 is connected by a transmission line TL to a source of high frequency energy (not shown). A detailed exposition of the factors governing the dimensions of the horn structure 5 and the location of the energizing antenna 9 with respect to the closed rear wall 10 of the feed chamber 8 have been more fully set forth in my prior co-pending applications No. 354,954, filed August 31, 1940 and No. 354,955, filed August 31, 1940, to which reference may be had for a more complete description. However, these details are not believed to be essential to an understanding of the present invention. Around the outside of horn 5 is provided an outer shell 11 which is conductively connected to the edges of horn 5 at the mouth end 6. As shown in Figure 1 the outer shell 11 extends back over the horn surfaces at least as far as throat 7 and there is closed by a rear wall 12. In some cases the rear wall 12 may be found to be unnecessary and may therefore be omitted. Also, while I have shown the outer shell 11 as extending over the entire length of the horn 5, its length is not critical. It may be considerably shorter than the horn 5 or alternatively it may extend back over the feed chamber 8 and for some considerable distance therebeyond if desired. It may, as a matter of fact, extend for some considerable distance as shown in Figure 2 wherein it extends far enough to entirely enclose a second radiating horn 15 facing in the opposite direction to horn 5. This form of construction is particularly desirable in the case of ultra short wave relay systems at the intermediate stations wherein the energy from an immediately preceding relay station may be conducted by horn 5 to a receiving antenna 9 and thence through the intermediary of transmission line TL, applied to the input of an amplifier 20. There the signal is amplified as much as necessary preferably without a substantial change of frequency. The amplified signal is then applied by a transmission line TL' to a transmitting antenna 19 and directed toward the next station in the chain by means of horn 15. It will be noted that in the form of construction shown in Figure 2 considerable discrimination between the receiving input and output is obtained by utilizing crossed polarization as well as by having the horn structures directed in opposite directions. The receiving antenna 9 is responsive only to vertically polarized energy, while the transmitting antenna 19 radiates substantially only horizontally polarized energy. The surrounding outer shell 11 prevents any shifting of the polarization of the separate signals so that feedback between the transmitting and receiving antennae is minimized. In practice, amplifier 20 can be as shown, housed within the space enclosed by the outer shell 11. Thus the outer shell in addition to serving its purpose of preventing a shift in polarization also acts as a shield and weather protection for the amplifier 20. This is desirable since each complete intermediate relay station of a system is located in an exposed position and mounted on a tall supporting structure such as tower 25.

While I have particularly shown and described several modifications of the present invention,

it is to be distinctly understood that my invention is not limited to these particular embodiments but that modifications and alterations within the scope of the invention may be made.

I claim as my invention:

1. In combination, an antenna operative with radiant energy waves having a predetermined plane of polarization, structure associated with said antenna for confining the major part of the radiation from said antenna to a predetermined forward direction and means for preventing radiation in a rearward direction from experiencing a shift in the plane of polarization including a rectangular conductive shell surrounding said structure, the surfaces of said shell being perpendicular to and parallel to said plane of polarization.

2. In combination, an antenna operative with radiant energy waves having a predetermined plane of polarization, a wave directive structure associated with said antenna for directing radiation from said antenna to a predetermined forward direction and means for preventing radiation in planes of polarization other than said predetermined plane in a rearward direction including a rectangular conductive shell surrounding said structure, the surfaces of said shell being perpendicular to and parallel to said plane of polarization and said shell being of such length as to prevent the flow of energy over the exterior surface thereof.

3. In combination, an antenna operative with radiant energy waves having a predetermined plane of polarization, a conductive wave guide structure surrounding said antenna confining radiation from said antenna to a predetermined forward direction, and a rectangular conductive shell surrounding said wave guide structure and connected thereto at one end, the surfaces of said shell being perpendicular to and parallel to said plane of polarization, whereby energy flowing over the outer surface thereof and radiating in a rearward direction does not experience a shift in the plane of polarization.

4. In a radio relay system, a receiving antenna operative with radiant energy waves having one plane of polarization, a transmitting antenna operative with radiant energy waves having a plane of polarization perpendicular to said first wave, structure associated with each of said antennae for confining the major response of each of said antennae to opposite forward directions and a rectangular conductive enclosure surrounding and extending between said structures.

5. In combination, an antenna operative with radiant energy waves having a predetermined plane of polarization, a tapered conductive horn, said antenna being adapted to introduce radiant energy waves into the small end of said horn whereby the major portion of said energy is radiated in the direction of the large end of said horn, and a rectangular conductive shell surrounding said horn, said shell being connected to said horn at the large end thereof, the surfaces of said shell being perpendicular to and parallel to said plane of polarization, whereby energy flowing over the outer surface thereof and radiating in a rearward direction does not experience a shift in the plane of polarization.

6. In combination, an antenna operative with radiant energy waves having a predetermined plane of polarization, a tapered rectangular conductive horn, said antenna being adapted to introduce radiant energy waves into the small end of said horn whereby the major portion of said

energy is radiated in the direction of the large end of said horn, and a rectangular conductive shell surrounding said horn, said shell being connected to said horn at the large end thereof, said shell having substantially the same cross sectional area as the large end of said horn throughout its length.

7. In combination, an antenna operative with radiant energy waves having a predetermined plane of polarization, a tapered rectangular conductive horn, said antenna being adapted to introduce radiant energy waves into the small end of said horn whereby the major portion of said energy is radiated in the direction of the large end of said horn, and a rectangular conductive shell surrounding said horn, said shell being connected to said horn at the large end thereof, said shell having substantially the same cross sectional area as the large end of said horn and the surfaces thereof being perpendicular to and parallel to said plane of polarization, said shell entirely enclosing said horn and being closed at its end remote from said connection to said horn.

8. In combination, an antenna operative with radiant energy waves having a predetermined plane of polarization, a tapered rectangular conductive horn, said antenna being adapted to introduce radiant energy waves into the small end of said horn whereby the major portion of said energy is radiated in the direction of the large

end of said horn, and a conductive shell surrounding said horn, said shell being connected to said horn at the large end thereof, said shell having substantially the same cross sectional area as the large end of said horn throughout its length, said shell having such length as to prevent the flow of energy over the exterior surface of said horn.

9. In a radio relay system, a pair of antennae operative with radiant energy waves having mutually perpendicular planes of polarization, a tapered conductive horn associated with each of said antennae, said horns facing in different directions and a rectangular conductive shell surrounding said horns, the surfaces of said shell being perpendicular to and parallel to said planes of polarization.

10. In a radio relay system, a pair of antennae operative with radiant energy waves having mutually perpendicular planes of polarization, a tapered conductive horn associated with each of said antennae, said horns facing in different directions and a rectangular conductive shell surrounding said horns, the surfaces of said shell being perpendicular to and parallel to said planes of polarization and transducer means connected between said antennae and located within said shell.

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