July 1, 1941. H. H. BEVERAGE 2,247,743

ANTENNA

Filed Dec. 10, 1938

Fig. 1

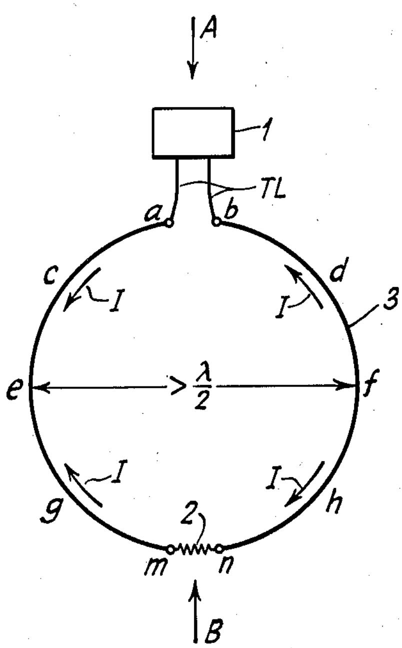


Fig. 2

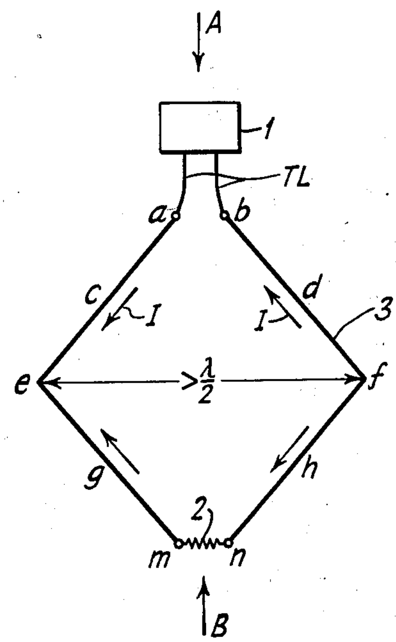


Fig. 3

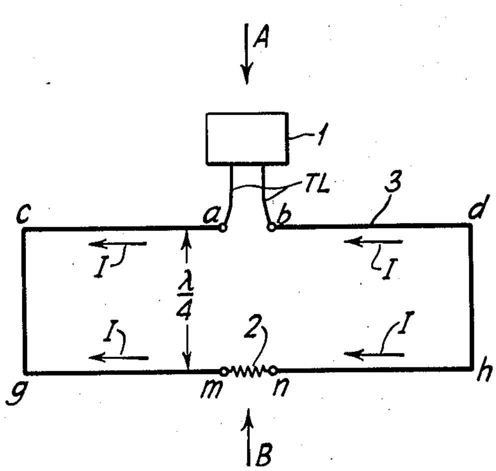
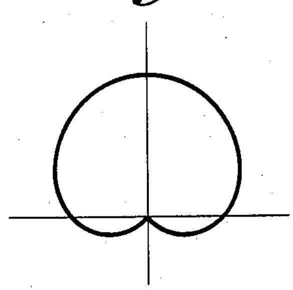


Fig. 4



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Patented July 1, 1941

2,247,743

UNITED STATES PATENT OFFICE

2,247,743

ANTENNA

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Application December 10, 1938, Serial No. 244,897

6 Claims. (Cl. 250—33)

The present invention relates to short wave antennas and, more particularly, to antennas for receiving horizontally polarized waves over a wide band of frequencies.

An object of the present invention is to enable the reception of horizontally polarized signals over a wide band of frequencies such as is at present used in television.

Another object of the invention is to provide a wide band receiving antenna for horizontally polarized signals.

Still another object of my invention is to provide an antenna having a horizontal directivity diagram which is uni-directional.

The foregoing objects and others which may appear from the following description are accomplished by providing a circular or rectangular single turn loop antenna with a damping resistance at its center equal to the surge impedance of the loop in order to make it aperiodic. The loop antenna is arranged in a horizontal plane. If the diameter of the loop is substantially less than half the length of the operating wave the directive pattern is substantially uni-directional, having somewhat the shape of a cardioid.

A more complete understanding of the invention will be had by reference to to the following detailed description which is accompanied by a drawing in which Figure 1 illustrates a preferred form of my antenna; Figure 2 illustrates a modification thereof, while Figure 3 illustrates, still a further modification of my invention and Figure 4 illustrates the directive diagram of the antennas shown in Figures 1 to 3.

Figure 1 shows a receiver **1** connected by means of transmission line TL to my loop antenna, the antenna being denoted by the reference numeral **3**. The diameter of the antenna is preferably made somewhat less than a half the length of the operating wave. The loop may be constructed of copper tubing and arranged to be practically self-supporting. As an example, one-half inch tubing may be used, formed into a circle having a diameter of .966 meter. At the side of the loop opposite the transmission line is connected a damping resistor **2** as shown in the figure and which, in the example given, may have a value of 700 ohms. Assuming that the antenna **3** is arranged in a horizontal plane and that a horizontally polarized wave is arriving at the antenna in the direction indicated by arrow B, a voltage is induced in branches *nhf* and *mge* in the same direction as indicated by the arrows I. The voltage induced in any elemental portion of the antenna such as *g* or *h*, for example, causes a current to start flowing in both directions. Due to the damping resistance **2** the currents flowing toward *m* and *n* are not reflected and never reach the transmission line TL at *ab*. The only energy that reaches the transmission line is that traveling toward *e* and *f*. As soon as the wave in space has progressed beyond points *e* and *f* on the antenna, the direction of the induced voltage is reversed since conductors *ae* and *bf* are sloped in a direction opposite to conductors *em* and *fn* with respect to a wave traveling in the direction B. Consequently, the voltage induced in conductors *ae* and *bf* is equal to and is 180 degrees out of phase with the component of the voltage induced in conductors *em* and *fn* and which is traveling towards the transmission line TL at *ab*. Hence, no voltage from the direction B reaches the receiver **1** for any frequency lower than the frequency for which the distance *ma* is less than half the wave length.

Now, consider a wave arriving at the antenna and traveling in the direction indicated by the arrow A. The elemental voltages induced in conductors *em* and *fn* now have to travel back through the conductor towards the transmission line in the direction opposite to the direction of travel of the oncoming wave. This introduces a time delay which shifts the phase of the energy from conductors *em* and *fn* so that by the time it reaches the transmission line *ab* it is no longer cancelled by the energy induced in conductors *ae* and *bf*. In fact, when the length of the conductors from *g* to *c* approach a length of one-quarter wave length the energy from the two halves of the antenna add in phase for a wave traveling in the direction A.

Figure 2 illustrates a modification of my invention shown in Figure 1 wherein instead of my loop being circular in form it is approximately rectangular. The distance across the corners of a rectangle is still to be considered as somewhat less than a half the length of the operating wave. In such case, the modification shown in Figure 2 operates substantially as described for the embodiment shown in Figure 1.

The further modification of my invention shown in Figure 3 embodies a rectangular antenna with the sides respectively at right angles and parallel to the direction of travel of waves arriving from A and B. The distance between conductors *ca*, *bd* and *gm*, *nh* is preferably a quarter of the length of the operating wave. Thus, for a wave traveling in the direction indicated by arrow B the voltage induced in *ca* and *bd* is equal to and opposite in phase to the voltage induced in *gm* and *nh*. On the other hand, for a wave traveling in the direction indicated by arrow A, a phase difference exists because of the time it takes for the wave to reach conductors *gm* and *nh* and the time it takes for the induced voltage to flow back to the transmission line through conductors *cg* and *dh*. Since the length of these conductors is a quarter of a length of the operating wave, a wave traveling in the direction indicated by the arrow A will reach conductors *gm* and *nh* a quarter wave, or 90 degrees in phase, later than it reaches conductors *ca* and *bd*. The voltage induced in conductors *gm* and *nh* is delayed another quarter wave, or 90 degrees, in traveling back through the conductors *cg* and *hd*. Consequently, the total phase shift is 180 degrees which brings the energy from *gm* and *nh* into phase with the energy from *ca* and *bd* at the receiver 1.

From the foregoing description it will be seen that this antenna operates as a uni-directional antenna for any frequency higher than that frequency for which the dimension of the antenna in the direction of wave travel is substantially less than a half wave length giving a directional diagram as shown in Figure 4, wherein the direction of maximum sensitivity of the antenna is from the side to which the transmission line is connected. In an antenna constructed according to the example given above this directional diagram was practically constant over a frequency range from 45 megacycles to 100 megacycles.

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

I claim:

1. A broad band short wave antenna comprising a single turn horizontal loop, a transmission line connected to one side of said loop, a resistance serially connected in said loop opposite said transmission line, the dimension of said loop between points on said loop midway between said resistance and said transmission line being less than a half length of the operating wave such that said loop has a maximum response in the direction of said transmission line and a lesser response in every other direction.

2. A broad band short wave antenna comprising a single turn horizontal loop, a transmission line connected to one side of said loop and a damping resistance serially connected in said loop opposite said transmission line, the dimension of said loop between points on said loop midway between said resistance and said transmission line being between the limits of one-third and one-seventh of the length of the operating wave such that said loop has a substantially uniform response in one direction for a wide band of frequencies and a smaller response over said wide band in every other direction.

3. A broad band short wave antenna comprising a single turn horizontal loop, a transmission line connected to one side of said loop and a damping resistance serially connected in said loop opposite said transmission line, the transverse dimension of said loop being on the order of one meter whereby substantially uniform response in one direction is obtained for frequencies between the limits of 45 and 100 megacycles and a smaller response over said band in every other direction.

4. A broad band antenna comprising a pair of substantially semi-circular conductors arranged about a common center in a horizontal plane, the radius of curvature of each of said conductors being less than one-quarter the length of the operating wave, a transmission line connected to one pair of adjacent ends of said conductors and a damping resistance connected across the other pair of adjacent ends.

5. A broad band antenna comprising a pair of substantially semi-circular conductors arranged about a common center in a horizontal plane, the radius of curvature of each of said conductors being less than one-quarter the length of the operating wave, a transmission line connected to one pair of adjacent ends of said conductors and a damping resistance connected across the other pair of adjacent ends, said damping resistance having a value equal to the surge impedance of the loop.

6. A broad band antenna comprising a pair of linear conductors each having a length less than half the length of the operating wave, said conductors lying in a common horizontal plane and spaced apart a distance equal to a quarter of the length of the operating wave, connections between the ends of said conductors, a transmission line connected to the center of one of said conductors and a damping resistance serially connected in the center of the other of said conductors the length of said conductors and the spacing therebetween being such that said antenna has a maximum response in the direction of said transmission line in the plane of said antenna and a lesser response in every other direction in said plane.

HAROLD H. BEVERAGE.