June 14, 1949. W. R. KOCH 2,473,377

GROUND WIRE SYSTEM

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Fig. 1.

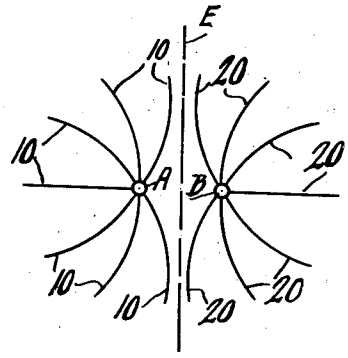


Fig. 2.

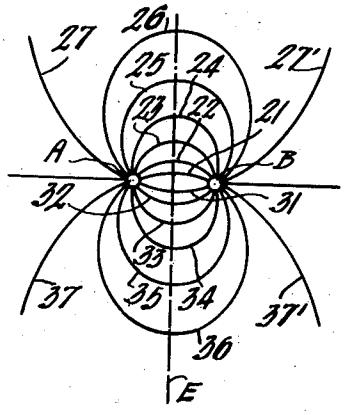


Fig. 3

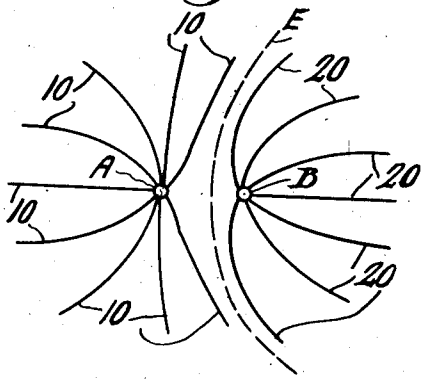
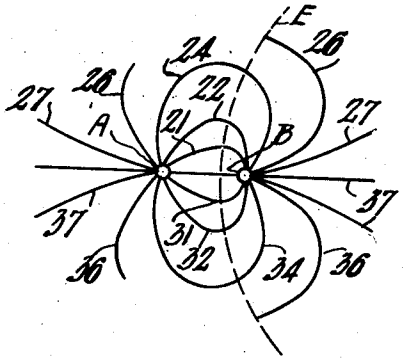


Fig. 4.



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GROUND WIRE SYSTEM

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10 Claims. (Cl. 250—33)

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The present invention relates to a ground wire system for multiple element broadcast antennas. It has heretofore been the practice in constructing multiple element broadcast antenna systems to provide a ground wire system at the base of the radiator elements for the reason that in order to obtain the desired radiation pattern the ground in the vicinity of the antenna system should have as low and as constant a value of resistance as possible. Where the ground characteristics are not such as to provide this without the addition of conducting material to the ground, a ground mat or ground wire system is buried in the ground.

Heretofore known arrangements usually consist of 100 or more conductors arranged generally in a radial formation about the base of each radiating element and plowed into the ground a sufficient distance to prevent the conductors from being damaged. Since the radial extent of the conductors is rather large, the conductors radiating from the base of one antenna overlap those from other antennas, making the burying of the conductors in the ground difficult. Furthermore, each conjunction or crossing must be bonded together as by soldering or brazing in order to prevent intermittent contacts. This results in a high installation cost, a waste of conductors in some cases or in high earth-current losses in other cases.

An object of the present invention is to improve the efficiency of ground wire systems for broadcast antennas which utilize two or more elements excited in a predetermined phase relationship.

Another object of the present invention is to reduce the cost of ground wire systems as aforesaid.

Another object of the present invention is the provision of a ground wire system for multiple element antenna arrays in which the outwardly extending conductors from one antenna do not overlap those of the other antennas.

Another object of the present invention is to reduce the installation cost of ground wire systems for broadcast antennas.

A further object of the present invention is to reduce earth-current losses in ground wire systems for broadcast antennas.

Still a further object of the present invention is to provide a simple ground wire pattern for multiple element broadcast antennas.

The foregoing objects and others which may appear from the following detailed description are attained by installing the wires forming the ground wire system of the multiple element

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broadcast antenna system along lines in which the current would tend to flow if the ground were perfectly conducting. In other words, the conductors lie along lines which correspond to the direction of propagation of the magnetic wave fronts or at right angles to the contours of equal electrostatic field.

The present invention will be more fully understood by reference to the following detailed description which is accompanied by a drawing in which:

Figure 1 shows the general layout of a ground wire system for a pair of equal height antenna elements energized with the same amount of power and in the same phase relationship.

Figure 2 illustrates the general shape of the ground wire system for a pair of antennas as in Figure 1 but with the energy supplied in an out-of-phase relationship.

Figures 3 and 4 are similar to Figures 1 and 2 except that a greater amount of power is supplied to one of the radiator elements than the other.

Referring now to Figure 1 there is shown in plan view an arrangement of a pair of vertical radiators of equal height. The location of the radiators is designated by reference letters A and B. Radiating from the base of the antenna at A and preferably plowed into the ground a depth of a foot or more are a plurality of ground wire conductors 10. The conductors are so arranged as to follow paths in which the current would flow in the ground if the ground were perfectly conducting. The paths which the wires 10 may take may be defined in another way by saying that the paths correspond to the direction of propagation of the magnetic wave front or at right angles to the contours of equal electrostatic field. Conductors 20 are similarly arranged about the location B at the base of the other antenna. It will be noted that none of the conductors 10 cross the conductors 20. No conductor crossed dotted line E, midway between the radiators. Thus, either system may be independently installed without danger of disrupting any of the conductors of the other system. Since the wires follow the paths in which the current would tend to flow if the ground were perfectly conducting, the field pattern of the radiation from each of the antennas is substantially undistorted from that which would exist if the antennas were located over a perfectly conducting earth.

Now, if the radiators A and B are energized in an opposing phase relationship, the conductor

arrangement will be as shown in Figure 2. Since the antennas A and B are energized in opposing phase relationship the contours of equal electrostatic field are compressed between the two antennas. Some conductors, for example conductors **21** and **31**, progress almost directly from antenna A to antenna B, crossing line E at nearly right angles. Successive conductors such as conductors **22** to **26** and conductors **32** to **36** also connect points A and B but enclose progressively larger areas. Conductors **27** and **27'** and conductors **37** and **37'** if continued to points where they would contact each other would enclose such a large area that their lengths would be excessive and a large portion thereof would be in regions of low field strength. They are therefore cut off at a reasonable distance from the base of antennas A and B.

Where, two antennas, still of equal height, are fed with unequal powers and in an in-phase relationship the arrangement as shown in Figure 3 is obtained. The power radiated from antenna A of Figure 3 is somewhat greater than that radiated by antenna B. It will be noted that line E, denoting the neutral plane between the two antennas, is curved about the base of antenna B causing all the conductors to be warped somewhat to the right of the figure. Otherwise, the arrangement is the same as in Figure 1.

Similarly, Figure 4 shows the arrangement where antennas A and B are fed in an out-of-phase relationship and with a greater power in antenna A than in antenna B. Again the neutral plane E is curved about antenna B and the conductors **21**, **31**; **22**, **32** and **24**, **34** are so arranged that the areas enclosed thereby are warped about antenna B. If antennas of unequal height are employed the pattern will be somewhat distorted from the pattern shown above but the exact pattern can still be calculated for any desired case.

The present system cannot be easily employed for antennas excited in other phase relationships than those disclosed with a reference to Figures 1 to 4 because the pattern of the earth currents shifts continuously during each cycle.

It will be observed that the pattern of lines along which the conductors are laid is non-intersecting otherwise than at the base of each antenna.

While I have illustrated a particular embodiment of the present invention, it should be clearly understood that it is not limited thereto since many modifications may be made in the several elements employed and in their arrangement without departing from the spirit and scope of the invention.

What is claimed is:

1. A ground wire system for a broadcast antenna array having antennas, including a plurality of conductors plowed into the ground and radiating from the base of each antenna of the array, said system of conductors following paths in which the current would tend to flow if the ground were perfectly conducting, said paths being non-intersecting except at the base of each antenna.

2. A ground wire system for a broadcast antenna array having antennas, including a plurality of conductors plowed into the ground and radiating from the base of each antenna of the array, the said conductors following non-intersecting paths which correspond to the direction of propagation of the magnetic wave front of the energy radiated by said antennas.

3. A ground wire system for a broadcast antenna array having antennas, including a plurality of conductors plowed into the ground and radiating from the location of each antenna of the array and otherwise non-intersecting, the said conductors following paths at right angles to the contours of equal electrostatic field of the energy radiated by said antenna.

4. A ground wire system for an antenna array having antennas, including a plurality of conductors plowed into the ground and radiating from the base of each antenna of the array, said system of conductors following non-intersecting paths in which the current would tend to flow if the ground were perfectly conducting.

5. A ground wire system for an antenna array having two vertical antennas, including a plurality of conductors plowed into the ground and radiating in a non-intersecting pattern of lines from the base of each antenna of the array, the said conductors following paths which correspond to the direction of propagation of the magnetic wave front of the energy radiated by said antennas.

6. A ground wire system for an antenna array, having two vertical antennas, including a plurality of conductors plowed into the ground and radiating from the location of each antenna of the array, the said conductors following paths at right angles to the contours of equal electrostatic field of the energy radiated by said antenna.

7. A ground wire system for an antenna array having two vertical antennas one of which is energized with a current in phase with the current with which the other antenna is energized, said system including a plurality of single wire conductors radiating from the base of one antenna, and a plurality of similar conductors radiating from the base of the other antenna, said conductors radiating from said bases in a horizontal plane along otherwise non-intersecting lines corresponding to the direction of propagation of the magnetic wave front of the energy radiated by said antennas when so energized.

8. A ground wire system for an antenna array having two vertical antennas one of which is energized with a current 180° out of phase with the current with which the other antenna is energized, said system including a plurality of single wire conductors radiating from the base of one antenna, and a plurality of similar conductors radiating from the base of the other antenna, said conductors radiating from said bases in a horizontal plane along otherwise non-intersecting lines corresponding to the direction of propagation of the magnetic wave front of the energy radiated by said antennas when so energized.

9. A ground wire system for an antenna array having two vertical antennas one of which is energized with a current in phase with the current with which the other antenna is energized, said system including a plurality of single wire conductors radiating from the base of one antenna, and a plurality of similar conductors radiating from the base of the other antenna, said conductors radiating from said bases in a horizontal plane along otherwise non-intersecting lines corresponding to the direction of propagation of the magnetic wave front of the energy radiated by said antennas when so energized, the said conductors radiating from the base of one antenna being positioned on one side of a line between said two antennas and the said conductors radiating from the base of the other said antenna lying on the other side of said line.

10. A ground wire system for an antenna array

having two vertical antennas one of which is energized with a current 180° out of phase with the current with which the other antenna is energized, said system including a plurality of single wire conductors radiating from the base of one antenna, and a plurality of similar conductors radiating from the base of the other antenna, said conductors radiating from said bases in a horizontal plane along otherwise non-intersecting lines corresponding to the direction of propagation of the magnetic wave front of the energy radiated by said antennas when so energized, some of said conductors being joined to form a single

wire conductor between the said bases of said antennas.

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