Sept. 3, 1940. E. C. CORK ET AL 2,213,692

AERIAL SYSTEM

Filed Feb. 28, 1939 2 Sheets-Sheet 1

Fig. 1a

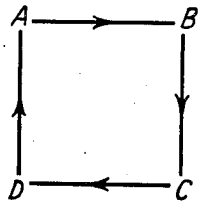


Fig. 1b

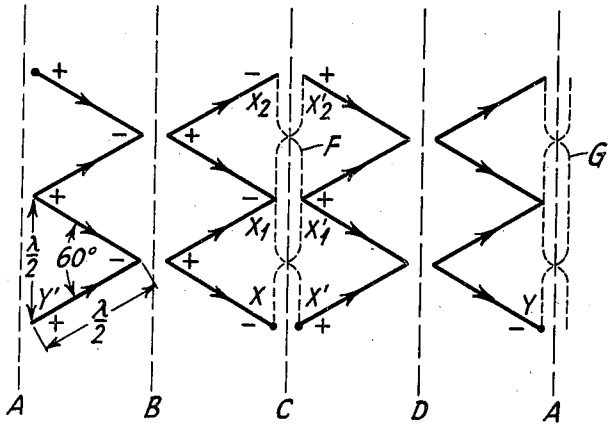


Fig. 2

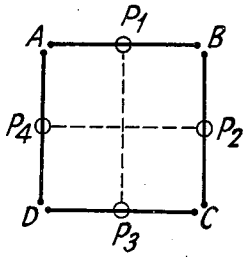


Fig. 3

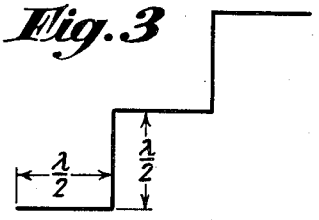


Fig. 6

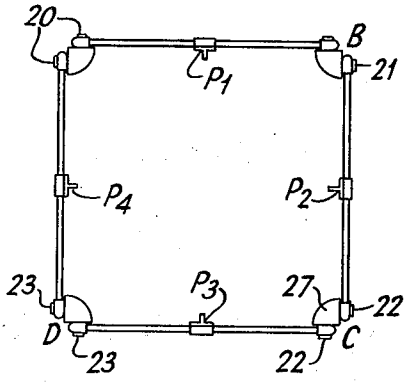
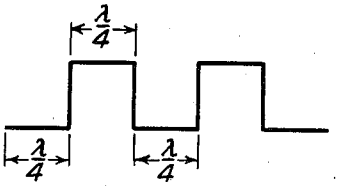


Fig. 4



INVENTORS
EDWARD CECIL CORK AND
JOSEPH LADE PAWSEY

BY H. S. Sawer

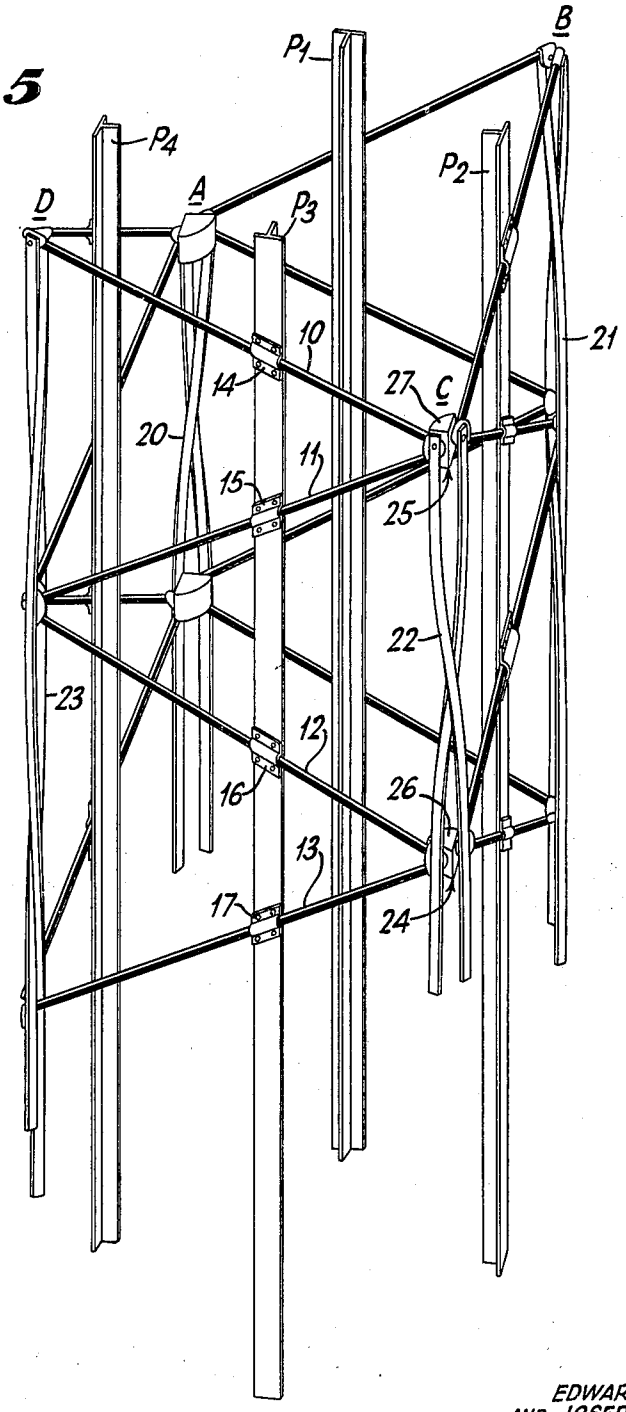
ATTORNEY.

Sept. 3, 1940. E. C. CORK ET AL 2,213,692

AERIAL SYSTEM

Filed Feb. 28, 1939 2 Sheets-Sheet 2

Fig. 5



INVENTORS
EDWARD CECIL CORK
AND JOSEPH LADE PAWSEY

BY H. S. Brower

ATTORNEY.

Patented Sept. 3, 1940 2,213,692

UNITED STATES PATENT OFFICE

2,213,692

AERIAL SYSTEM

Edward Cecil Cork, Ealing, London, and Joseph Lade Pawsey, Ickenham, England, assignors to Electric & Musical Industries Limited, Hayes, Middlesex, England, a company of Great Britain

Application February 28, 1939, Serial No. 258,988
In Great Britain March 15, 1938

5 Claims. (Cl. 250—33)

This invention relates to aerial systems for the transmission of short and ultra short waves and, more particularly, to directional arrays which possess a circular horizontal diagram with vertical directivity.

The invention is of importance with regard to television and to the radiation of horizontally polarized waves, though not exclusively to either. Moreover, it envisages the use of the elements of the array as members in a mast lattice, in which such members may form the greater part of the bracing of the mast structure.

The use of the whole mast structure as radiator has definite advantages over other forms of aerial as is well known in the art. However, such an aerial has only been proposed for the radiation of vertically polarized waves, and it is not obvious that a mast structure can be made to act as a radiator of horizontally polarized waves.

For the production of waves possessing a horizontal polarization it has been proposed to employ an arrangement of triangles formed of horizontal half wave dipoles and supported on a system of feeders. Here, however, the advantages of a mast structure are not easily realized, and it is found, moreover, that in order to obtain a truly circular horizontal diagram, adjustment must be carried out with a high degree of accuracy.

In the invention it is proposed according to one object to employ a radiating array, preferably an array not critically dependent on accurate adjustment, which is easily incorporated in the mechanical structure of a mast, and which is suited to the radiation of horizontally polarized waves.

However the scope of the invention is not confined to the radiation of horizontally polarized waves, for although it is known to use a mast as a radiator for vertically polarized waves, yet examples of such an arrangement have only consisted of a single radiating element, which has been the mast structure regarded as a whole.

Thus, according to the invention, a mast structure is provided having bracing members, some or all of said members being arranged to form the radiating elements of a short wave aerial array capable of radiating substantially uniformly in a horizontal plane, said bracing members which form the radiating elements being connected to feeding conductors incorporated in the mast structure.

In order that the said invention may be clearly understood and readily carried into effect, the same will now be more fully described by way of example with reference to the drawings accompanying the following detailed description.

Figure 1(*a*) shows diagrammatically and in plan a mast of square cross-section suitable for the radiation of horizontally polarized waves having sides AB, BC, CD, DA;

Figure 1(*b*) shows in elevation the sides AB, BC, CD, DA of the mast in a developed diagram, the full lines of which indicate the radiating elements;

Figure 2 is another plan view of the cross-section of the mast, the circles P_1, P_2, P_3, P_4 indicating the locations of the main vertical members of the mast;

Figures 3 and 4 illustrate possible alternatives to the zig-zag array incorporated in the arrangement of Figures 1(*a*) and 1(*b*);

Figure 5 shows in perspective a mechanical structure in accordance with the diagrammatic illustrations afforded by Figures 1(*a*), 1(*b*) and 2; and Figure 6 is a plan view of Figure 5.

Referring to Figure 1(*b*) it will be seen that each side of the mast consists of an array which radiates horizontally polarized waves perpendicularly to its plane when, assuming that a stationary wave system is established, the current directions in each half wave element are as shown by the arrow heads. If the phases of the currents in all four sides of the mast are the same, then as is indicated in Figure 1(*a*) a number of horizontal rings of equal phase currents are effectively set up. Each ring is roughly equivalent to a magnetic dipole which has a similar radiation diagram to a Hertzian dipole, though of course, the polarization is different. The example of a four sided mast has been selected, each side comprising a single zig-zag array, since with this arrangement a close approach to uniform horizontal radiation is attained. The invention, however, is not limited to this particular arrangement.

The feeding of the array may be carried out in various ways. For example, the array may be fed from the points XX^1 and YY^1 by means of balanced feeders. However, if the array is fed at one end only the current distribution tends to be non-uniform, which modifies the directional diagram and usually leads to a degree of selectivity undesirable in applications to television. In Figure 1(*b*) the feeding is shown effected at a number of points XX^1, $X_1X_1^1$, $X_2X_2^2$, by a feeder F and at a number of corresponding points on the opposite side of the mast by the feeder G, this particular mode of feeding being rendered possible by the choice of an angle of 60° between the elements, so that the distances XX_1, X_1X_2 are a half wave length.

In order to convert the array into a mechani-

cal structure, use is made of the fact that the center points of the radiating elements are all at zero high frequency potential, so that at these points the elements may be metallically connected to vertical members as indicated diagrammatically in Figure 2 at the points P_1, P_2, P_3, P_4. If an even number of elements is employed, then the E. M. F.'s induced in the vertical members by the radiating elements will cancel out. Further consideration shows that in Figure 2 the lines P_1P_3 and P_2P_4 are symmetrically situated with respect to the radiating elements and therefore the vertical planes through these lines are planes of zero E. M. F. Hence, metallic bracing members can be used in these planes without the absorption of energy. It is further possible to brace the structure by using insulators between such points as $X_1X_2^1$. Bracing may also be applied along the diagonals AC and BD and the joins of the points P_1P_2, P_2P_3, P_3P_4, P_4P_1 without serious effect. The top of the mast may consist of the sides and diagonals of the square P_1, P_2, P_3, P_4, with any necessary platform lamp fittings. The power to the lamp may be fed alongside or inside the previously mentioned vertical members. The whole structure may be mounted on the top of a steel mast of approximately the same size, and in order to reduce any energy passing to the main mast structure a skirt may be provided at the base of the aerial structure so as to form a shield, or various earthing devices may be used.

In a way similar to that already described, other arrays such as those illustrated in Figures 3 and 4 may be developed though the structure set out here has special merits from the point of view of simplicity. The stepped arrangement of Figures 3 and 4 may be substituted for the diagonal arrangement of Figure 1(*b*). Moreover, the array described has been evolved for use as a horizontal radiator, but in a similar manner arrays for vertical polarization may be provided. As a further alternative, a stationary wave system need not be set up on the array, but the array may be suitably terminated to act as a travelling wave array. This has the advantage of a lesser selectivity but the disadvantage of a smaller gain.

Figure 5 shows, in accordance with the invention, a particular embodiment of the mast structure described with reference to Figures 1(*a*), 1(*b*), and 2, but with the addition of more specific mechanical details, the illustration being in perspective to enable the nature of the structure to be more readily appreciated, while Figure 6 shows a top view of Figure 5 similar to Figure 2. P_1, P_2, P_3, P_4, as in Figure 2, are the main vertical members and are shown as possessing a T-section, which enables the radiating elements to be firmly affixed to them in an easy manner. Thus the radiating elements **10**, **11**, **12**, **13** on the side of the mast CD are braced to the pillar P_3 at the points **14**, **15**, **16**, **17**, by means of the bracing pieces indicated thereat. On the other sides DA, AB, BC, of the mast the arrangement is, of course, similar.

Up the four corners A, B, C, D, as in Figure 1(*b*), there are shown running the balanced feeder lines **20**, **21**, **22**, **23**, four being used since a more symmetrical structure is thereby attained. Midway between the feeding points, for example, the feeding points **24** and **26** in the case of feeder **22**, the feeding lines are crossed. These feeding lines consist of stout metal strip or rod and make an appreciable construction to the strength of the structure. They are braced together by means of mechanically strong insulating blocks; such blocks are shown, for example, at the feeding points **24** and **25** on the feeder **22**, with the reference numerals **26** and **27**, respectively. Thus, at the point **24** there are rigidly connected to the block **26** the ends of the radiating elements **12** and **13** and one of the two lines of the feeder **22**, this line and the radiating elements being in metallic connection. Insulated from these, but firmly held to the same block in a similar manner are the adjacent radiating elements lying in the side BC of the mast and the other line of the balanced feeder **22**. The arrangement is similar at the point **25** and the bracing and feeding at the other corners of the mast are effected in the same way.

Internal bracing may be added in the manner described above, but has been omitted from the drawing of Figure 5 in order to avoid undue complication.

Having now particularly described and ascentained the nature of our invention, and in what manner the same is to be performed, we declare that what we claim is:

1. A prismatic antenna mast structure comprising vertical supporting members along the middle of each side of said mast, radiating elements lying in the plane of each of said sides and conductively connected at their midpoints to said vertical supporting members, the ends of the radiating elements lying in the plane of one of the sides being connected to the adjacent ends of elements lying in the planes of adjacent sides by insulating blocks, said radiating elements being fed at their ends by feeder conductors along the corners of said structure.

2. A prismatic antenna mast structure comprising vertical supporting members along the middle of each side of said mast, diagonal radiating members each having a length equal to half the length of the operating wave lying in the plane of each of said sides and conductively connected at their midpoints to said vertical supporting members, the ends of the radiating elements lying in the plane of one of the sides, being connected to the adjacent ends of elements lying in the planes of adjacent sides by insulating blocks, said radiating elements being fed at their ends by feeder conductors along the corners of said structure.

3. A prismatic antenna mast structure comprising vertical supporting members along the middle of each side of said mast, diagonal radiating members each having a length equal to half the length of the operating wave lying in the plane of each of said sides and conductively connected at their midpoints to said vertical supporting members, the ends of the radiating elements lying in the plane of one of the sides, being connected to the adjacent ends of elements lying in the planes of adjacent sides by insulating blocks, said radiating elements being fed at their ends by feeder conductors along the corners of said structure, the angle of said radiating elements to the horizontal being approximately 30 degrees.

4. A prismatic antenna mast structure comprising vertical supporting members along the middle of each side of said mast, diagonal radiating members each having a length equal to half the length of the operating wave lying in the plane of each of said sides and conductively connected at their midpoints to said vertical supporting members, the ends of the radiating ele-

ments lying in the plane of one of the sides, being connected to the adjacent ends of elements lying in the planes of adjacent sides by insulating blocks, said radiating elements being fed at their ends by feeder conductors along the corners of said structure, the angle of said radiating elements to the horizontal being approximately 30 degrees, said feeder conductors being crossed between adjacent points of connection to said radiating elements.

5. A prismatic antenna mast structure comprising T section vertical supporting members having their flat surfaces lying along the middle of each side of said mast, diagonal radiating elements each having a length equal to half the length of the operating wave lying in the plane of each of said sides and conductively connected at their midpoints to said vertical supporting members, the ends of the radiating elements lying in the plane of one of the sides, being connected to the adjacent ends of elements lying in the planes of adjacent sides by insulating connections capable of withstanding mechanical stress, said radiating elements being fed at their ends by feeder strips along the corners of said structure, said feeder strips being crossed between adjacent points of connection to said radiating elements.

EDWARD CECIL CORK.
JOSEPH LADE PAWSEY.