July 28, 1936. G. A. MATHIEU 2,049,070

AERIAL SYSTEM

Filed Sept. 10, 1932

Fig. 1

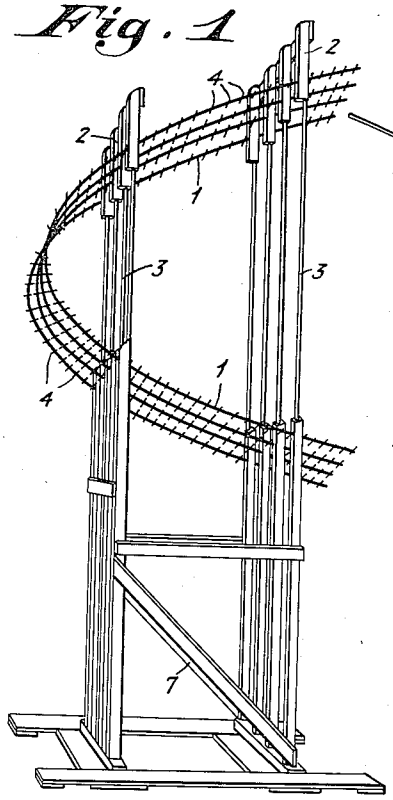


Fig. 3

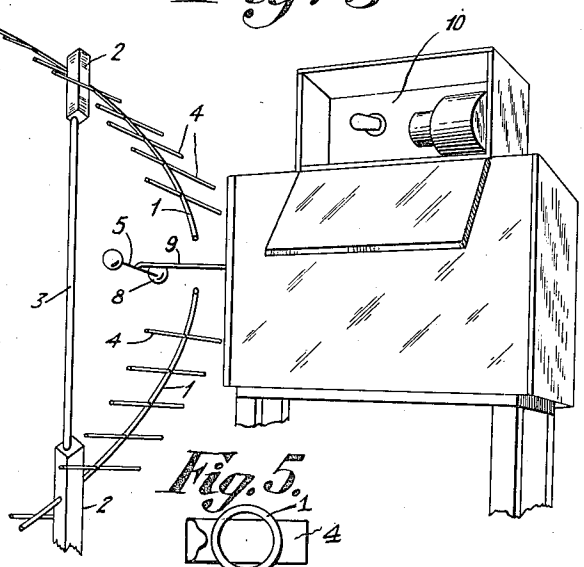


Fig. 5.

Fig. 4

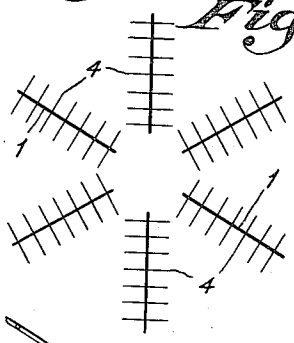


Fig. 2a

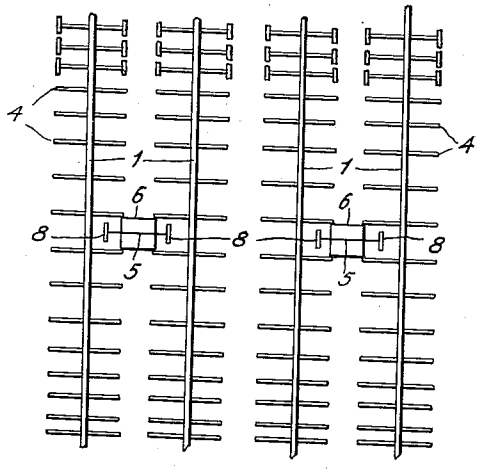
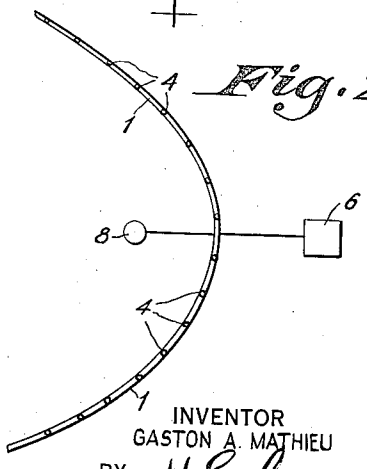


Fig. 2b



INVENTOR
GASTON A. MATHIEU
BY H. S. Grover
ATTORNEY

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AERIAL SYSTEM

Gaston Adelin Mathieu, Shirehall Park, London, England, assignor to Radio Corporation of America, a corporation of Delaware

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13 Claims. (Cl. 250—11)

This invention relates to aerial systems and more particularly to short wave direction aerial systems of what may be termed the "skeleton" type, i. e. the type in which an aerial having directional qualities by virtue, inter alia, of its shape, is made up of a number of rod-like radiators or aerial members which are so positioned as to lie along or in a shape which the aerial as a whole may be deemed to possess; for example, what is herein termed a "skeleton" type aerial of parabolic form would consist of a plurality of rod-like radiators arranged to lie along a parabola.

The principal object of the present invention is to provide what is herein referred to as a "skeleton" type aerial which shall be electrically efficient and of such structure as to be mechanically simple, cheap to manufacture and convenient to employ.

According to this invention a skeleton type aerial comprises a plurality of rod-like radiators or aerial members supported solely substantially at their middle points (where current nodes occur), the ends of the rod-like radiators being free in space.

The invention will now be described with reference to its application to reflector type aerials and transmitting and receiving aerial systems embodying reflectors. Although the primary and main application of the invention is to reflector aerials, the said invention is not limited exclusively to such application but may be applied to directly energized aerials.

The invention is illustrated in and further explained with reference to the accompanying drawing wherein Figures 1 to 4 illustrate various embodiments of the present invention. Figure 5 illustrates a cross sectional top view of the hollow supporting tube showing the manner in which the individual aerial rods pass through holes in the tube. In this figure the aerial rod is partly broken away to show its hollow interior.

Referring to Figure 1 which shows in perspective a reflector aerial structure consisting of four parabolic reflector aerials mounted side by side each aerial comprises a supporting tube 1 made, for example, of hard copper of small diameter and bent into the shape of a parabola having a suitable focus for the wave length of the waves to be transmitted or received, (e. g. approximately one-quarter of the wave length, though this may be increased to a value of three-quarters of the wave length or to a value of 1¼ of the wave length without much change in the results obtained). At suitable points in the length of the tube are arranged wooden blocks 2 which are positioned by suitable lengths of quartz glass tubes or rods 3 spanning the parabola and which in conjunction with the wooden blocks assist in preserving the shape of the tube. The wooden blocks may be fixed to the tube in any convenient way, for example, by means of brass screws, and the glass rods or tubes conveniently fixed to the wooden blocks by being tightly fitted and glued in suitable depressions therein. Holes are bored in the parabolic copper tube at intervals a suitable distance (e. g. one-quarter of the working wave length) apart and the rods 4 which make up the skeleton aerial are fitted into these holes at the middle of their lengths, for example, by means of screws. The rods 4 thus project on either side of the supporting tube 1 at right angles to the plane of the parabola so that in side view the aerial appears as a parabola and in front view as a rectangle. Preferably each of the rods carries at each end thereof a small tube of metal (not shown) which fits over the appropriate rod end and may be slid along the said rod and clamped thereto in any position by means of a set screw. In this way the effective lengths of the rods 4, i. e. the length over-all of the rods with their tubular extensions, may be adjusted experimentally to produce the best results. A small transmitter of known form comprising a rod aerial at the focus of and at right angles to the focal line of the parabola and suitable energizing means therefor may be mounted upon a second copper tube passing through a hole bored through a main supporting copper tube 1 and in the plane of the parabola. The exact focussing of the transmitting aerial is secured by moving its supporting tube backwards or forwards in the hole in the main supporting tube and clamping it in the correctly adjusted position by means of set screws.

No transmitting arrangements are shown in Figure 1 but a somewhat similar arrangement to that just described is shown in front view in Figure 2*a* and in side view in Figure 2*b*. In this arrangement however the transmitting aerials 5 alone are inside the parabolic reflectors, the associated energized valve transmitters 6 being outside the reflectors instead of, as in the above described arrangement, inside. The aerial structure is supported as a whole (see Figure 1) by a suitable trestle-like base or stand 7 or in any other convenient manner.

The diameter of the main supporting tubes 1 should be small in comparison with the length

of the aerial members 4. A ratio which has been successfully adopted in practice is 1:35.

Preferably the supporting means for the aerial as a whole, i. e. the trestle-like feet or whatever other form of mechanical support is employed, are so arranged as to permit of easy adjustment of the direction of the reflector; i. e. means should be provided for allowing of the rotation or inclination of the parabolic aerial with respect to the feet and the locking of the said parabolic aerial in any adjusted position.

As will be seen from Figures 2*a* and 2*b* a plurality of aerials may be arranged side by side and energized from a suitable number of co-phasially excited transmitters so that a large area beam is emitted from the installation as a whole. For a similar arrangement reference is made to British Patent No. 252,272 which shows a plurality of parabolic reflectors each having its own transmitting aerial and suitable co-phasial energizing means for the said aerials. Where such an installation is employed the multi-aerial system can be made mechanically very strong by mechanically connecting the wooden or equivalent blocks 2 of each aerial system by quartz-glass or like members (not shown) to the appropriate blocks of the neighbouring aerial systems. Further, in such multi-aerial installation component aerial rods may be shortened and small disks attached thereto at the ends as shown on some of the rods, by way of example only, these disks being employed to give small coupling capacities between the corresponding rods of one aerial and those of its neighbour; i. e. in such an aerial each rod in each aerial might be arranged in the same straight line with a corresponding rod in all the other aerials (as shown in Figures 1 and 2), the rods in the same straight line being electrically coupled to one another by the capacities between the adjacent disks upon the neighbouring ends of the rods. This type of capacity coupling may also be adopted between the adjacent directly energized transmitter rod aerials associated with the various reflector arrays, see for example, the disks 8 on the aerials 4 of Figures 2*a* and 2*b*. In this way a uniform current distribution throughout the whole installation is obtained and proper co-phasial energization facilitated.

It will be seen that the parabolic aerial structures shown in the accompanying drawing secure a horizontally polarized wave, the vertical diagram of the resultant beam depending upon the aperture of the mouth of the parabola while the horizontal diagram (at right angles to the direction of polarization) will depend upon the number of transmitter aerials arranged side by side within the reflectors. Thus by altering the number of aerials and the parabola aperture practically any desired diagrams of radiation in the horizontal and vertical plane can be obtained.

It is possible to obtain vertical polarization by utilizing aerial structures as shown in the accompanying drawing on their sides, i. e. by turning the complete aerial structure through 90°, suitable modifications of the means for supporting the aerial structure being of course made. The illustrated arrangements, which give horizontal polarization are, however, preferred since it is found in practice that with these arrangements the parabolic reflectors form quite efficient earth screens so that the losses are kept quite small and unwanted reflections largely avoided. These factors are apt to be important when the aerial structures are erected upon metal surfaces, e. g. upon a metal covered roof, as may often occur in practice. Nevertheless, owing to the fact that it is found that the plane of polarization remains unchanged during propagation, i. e. a horizontally polarized transmitted wave is received as a horizontally polarized wave, the possibility of securing polarization in any desired plane is of considerable importance since duplex working on one wave length is thereby rendered possible. For such duplex working two aerial systems constructed to emit mutually perpendicularly polarized waves are utilized, each system working on the same wave length but for the transmission of a different message. Two similar mutually perpendicularly arranged aerials are employed for reception. This feature of securing duplex working on one wave length by transmitting on mutually perpendicularly polarized waves may be carried into effect not only by aerial systems as described herein but by a combination of any two aerial systems each of which is adapted to emit waves polarized in a plane at right angles to the plane of polarization of the other system. There are many known aerial systems adapted to emit plane polarized waves and which can be employed for effecting duplex working in accordance with this feature of the invention.

If desired, aerial structures as illustrated in Figures 1 and 2*a* and 2*b* may be modified by omitting some of the reflector rods 4 in the middle of the parabola so as to facilitate the passage of feeder rods associated with a dipole aerial at the focus. Such an arrangement which is more especially advantageous for reception is shown in Figure 3 in which it will be observed that certain of the reflector rods 4 are omitted in the neighbourhood of the feeder rods 9 from the receiving aerial 5. The omission of the rods, and incidentally of a portion of the tube 1 avoids losses which would otherwise result from the contiguity of the parts 1 and 9. The receiver proper (10 in Figure 3) is housed in a copper screening box which is preferably so positioned that the distance between the reflector parabola and the nearest wall of the box is approximately one-quarter of the working wave length. This arrangement results in a considerable degree of compensation for the omission of certain of the rods 4. It will, of course, be appreciated that although in Figure 3 a gap has been left in the tube 1 this gap is only intended to be an electrical gap and, for reasons of mechanical strength the two parts of the copper tube may, if desired, be joined together by any suitable insulating and supporting material.

Transmission and reception can be effected to and from a single installation; e. g. where a single transmitter and a single receiver are required the combined reflector installation would consist of two reflector units side by side. Similarly, for a double transmitter and a single receiver, a minimum of three reflector units side by side are required.

For highly efficient transmission however it is preferred to employ an extra reflector unit on each side of a unit at whose focus a transmitting aerial is mounted, so that for a double transmitter it is preferred to use four reflector units. The accompanying Figure 2*a* shows a double transmitter comprising four reflector units, the energizing aerials 5 being mounted at the foci of the two inner reflector units.

The optimum length of the reflector rods 4 depends upon their spacing round the parabola,

the closer they are together the longer must they be. If their separation is below say 1/20th of a wave length the optimum length will reach nearly a full wave length and in such a case each set of reflector rods which are end to end in an installation (such as that shown in Figure 1) consisting of several reflector units side by side could be constituted by a single rod passing through and at right angles to the tubes 1.

It will be noted that in this type of construction the ends of the rod like radiators of each reflector are not free in space since only the ends of the long transverse rods running right across the multi-reflector structure are free in space and each of these rods in effect constitutes a plurality of rod like radiators, namely as many as there are reflectors, one rod-like radiator being in each reflector. Nevertheless the construction is electrically closely equivalent to the other skeleton aerial structures herein described. The illustrated constructions are, however, considered more preferable from the economic point of view.

Skeleton aerials in accordance with this invention may if desired be so constructed that steam, hot water or other heating fluid may be circulated through them, i. e. steam or hot water may be circulated through the members, 1, 3, 4, and 5 all of which may be made hollow for the purpose. In this way the aerials may be efficiently employed in the open air despite the occurrence of snow or silver frost. Alternatively, heating may be accomplished electrically by means of resistance wires housed within the various tubes. Where steam heating is employed it is preferred to provide a valve for controlling the amount of steam to each reflector unit so that the steam flow can be correctly adjusted to avoid or minimize condensation.

Skeleton aerial systems in accordance with this invention may be employed for broadcasting purposes (e. g. television broadcasting on ultra-short wave lengths) by arranging a plurality of reflector units facing outwards round a circle. Such an arrangement is shown schematically in Figure 4. In such an arrangement each reflector unit is preferably provided with its own separate energizing aerial and transmitter all the transmitters being co-phasially excited. If, however, the reflectors be energized in rotation and one at a time a rotating wireless beacon (useful for navigating purposes) is obtained and by arranging each transmitter to send a different characteristic signal (e. g. a letter or tone) a means of securing timing or ascertaining the actual position of each beam may be provided so that a receiving station may be informed of its direction relative to the station.

It is not necessary, of course, that the skeleton aerials should be of parabolic form. Any other form can be adopted, for example, a beam effect may be obtained by employing a plurality of skeleton aerials arranged side by side each being of a "fish bone" like structure. In such a structure the main supporting tube referred to in the preceding detailed description would not be of parabolic form but would be straight, the aerial rods projecting from the said main supporting tube on either side thereof as above described. Such a structure viewed from the front would be of rectangular shape and from the side would appear as a vertical straight line.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. A short wave skeleton type aerial comprising a plurality of parallel rod-like aerial members disposed in different vertical planes and supported solely substantially at their middle points by a curved metallic conductor, the ends of the rod-like radiators being free in space.

2. A short wave skeleton-type aerial comprising a plurality of parallel rod-like aerial members in different vertical planes supported solely substantially at their middle points by a metallic curved conductor devoid of concentrated reactance, the ends of the rod-like aerial members being provided with capacity members and being free in space, and a transmitting aerial parallel to said aerial members located substantially in the focus of said curved conductor.

3. A skeleton type aerial comprising a plurality of rod-like aerial members supported solely substantially at their middle points by a conductor bent into parabolic form, said aerial members being at right angles to the plane of the parabola, the ends of said rod-like aerial members being free in space.

4. A skeleton type aerial comprising a plurality of rod-like aerial members supported solely substantially at their middle points by a conductor bent into parabolic form, said aerial members being at right angles to the plane of the parabola and the ends of said members being free in space, said parabolic conductor being spanned by a strut of insulating material whereby said conductor is stiffened structurally in order to maintain its desired shape.

5. A skeleton type aerial comprising a plurality of rod-like aerial members supported substantially at their middle points by a conductor bent into parabolic form, said parabolic conductor being a tube of relatively small diameter having apertures in which the rod-like members are fitted, and said rod-like members being at right angles to the plane of the parabola.

6. A short wave skeleton type aerial comprising a plurality of parallel rod-like aerial members disposed in different vertical planes and supported solely substantially at their middle points by a curved metallic conductor, the ends of the rod-like members being free in space, said rod-like members carrying discs near their ends, an aerial member located substantially at the focus of said curved conductor and parallel to said rod-like members, and high frequency apparatus coupled to said last aerial member.

7. In combination, a skeleton type aerial comprising a plurality of parallel rod-like aerial members disposed in different vertical planes and supported solely substantially at their middle points, the ends of the rod-like members being free in space, another similar skeleton aerial mounted side by side with said first aerial and with the correspondingly located rod-like aerial members of both skeleton aerials substantially in the same straight line, and a transmitter rod aerial parallel to said rod-like members and located substantially within the focal plane of said two skeleton type aerials.

8. A skeleton type aerial system comprising a plurality of parallel rod-like aerial members disposed in different vertical planes, the ends of which are free in space, said aerial members being supported by a plurality of conductors bent into parabolic form, said aerial members being at right angles to the plane of the parabola, the spacing between the aerial members being small relative to the working wave length.

9. The combination with a skeleton type aerial comprising a plurality of parallel rod-like aerial members supported solely substantially at their middle points by a conductor bent into parabolic form, the ends of the rod-like aerial members being free in space, of high frequency apparatus, and a radiator connected to said high frequency apparatus, said radiator being located within the parabola on the focal line thereof and extending at right angles to the focal line.

10. In combination, a skeleton type aerial comprising a plurality of parallel rod-like aerial members supported solely substantially at their middle points by a conductor bent into parabolic form, said aerial members being at right angles to the plane of the parabola, high frequency apparatus, an aerial connected to said high frequency apparatus and located within the parabola and along the focal line thereof, said last aerial extending at right angles to the focal line, said high frequency apparatus being located externally of the parabola, the members of said parabolic aerial structure being omitted near the place where said high frequency apparatus connects with said focally situated aerial.

11. A skeleton type aerial comprising a plurality of parallel rod-like aerial members supported substantially at their middle points by a conductor, another similar skeleton aerial mounted side-by-side with said first aerial and with the rod-like aerial members of one skeleton aerial substantially in the same straight line with the correspondingly located ones of the other aerial, and capacity elements at the ends of said rod-like aerial members for enabling capacity coupling between corresponding members of said skeleton aerials.

12. A short wave skeleton type aerial comprising a plurality of parallel rod-like members arranged to lie along a parabola and supported solely substantially at their middle points by a metallic conductor, the ends of said rod-like aerial members being free in space, and an aerial member located at the focus of said parabola, said last member being parallel to said first members.

13. In combination, a plurality of skeleton-type aerials each of which comprises a plurality of rod-like radiators supported substantially at their middle points by a parabolic conductor, the ends of the rod-like radiators being free in space, said aerials being so located and arranged that the curves of said parabolic conductors open outwardly away from a central point.

GASTON ADELIN MATHIEU.