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C. S. FRANKLIN

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AERIAL FOR USE IN WIRELESS SIGNALING

Original Filed June 12, 1924

Fig. 1

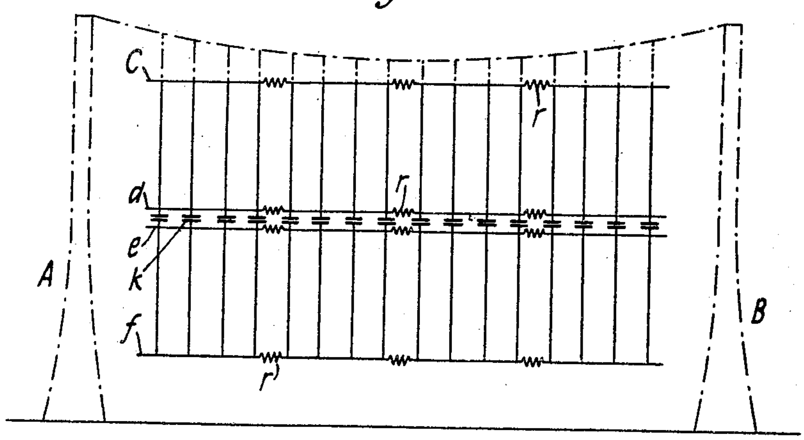
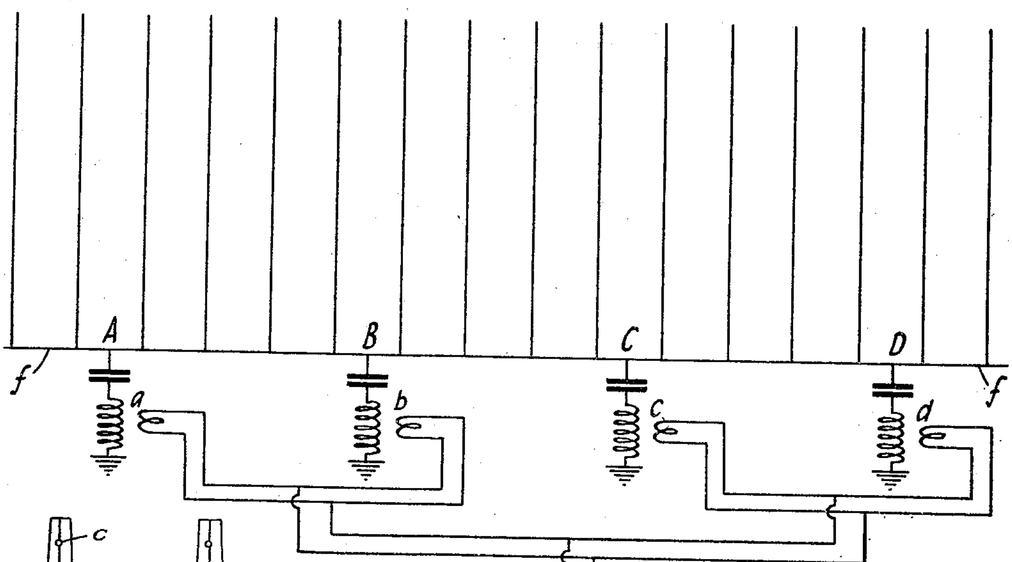


Fig. 2



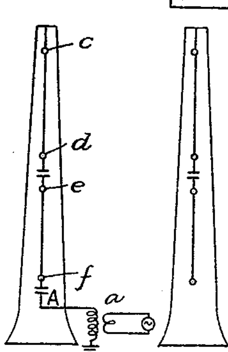


Fig. 3

CHARLES S. FRANKLIN
INVENTOR

BY [signature]

ATTORNEY

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CHARLES SAMUEL FRANKLIN, OF BUCKHURST HILL, ENGLAND, ASSIGNOR TO RADIO CORPORATION OF AMERICA, A CORPORATION OF DELAWARE

AERIAL FOR USE IN WIRELESS SIGNALING

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This invention relates to improvements in aerials for use in wireless signaling and is particularly applicable for use with short waves.

In the accompanying drawing which is only illustrative of my invention, Figure 1 indicates an antenna comprising a pair of aerial systems each system consisting of a plurality of cophasally excited wires or rods.

Figure 2 illustrates apparatus for cophasally exciting the wires or rods of a system such as shown in Figure 1, and

Figure 3 indicates, in cross section, an antenna such as shown in Figure 1 and a reflector therefor for obtaining unidirectional propagation of electromagnetic waves.

British specification No. 128,665 describes a directional system in which an aerial is located at the focus of a parabolic reflector consisting of two or more sets of rods arranged on a parabolic surface, each rod being in tune with the aerial. To obtain really sharp directional effects with such a system it is necessary that the dimensions of the reflector should be very large compared with the wave length both in the horizontal and vertical directions. Moreover, when once the reflector has been erected it is not capable of being readily extended.

According to the present invention I construct an aerial of a number of vertical wires or rods spaced a fraction of a wave length apart in a plane which is at right angles to the desired direction of working. The wires or rods are connected together at the top and bottom and each rod together with the wires connecting it to the top and bottom of the next rod is in tune with the waves to be used when in its position in the aerial. The actual length will depend upon the spacing and to some extent upon the number of vertical rods used.

Such an aerial system can be extended indefinitely without appreciably affecting the tune. By making this system of a length which is several times the wave length of the waves employed very sharp transmission or reception in a horizontal plane is obtained, the directional effect being a function of the length of the system relative to the wave length. Moreover, by arranging two or more such systems one above another and feeding them from a common supply I can obtain sharp directional effects in the vertical plane also.

Figure 1 illustrates such a system. The horizontal wires *c*, *d*, *e* and *f*, with their connecting vertical wires as shown are two aerial systems, one above the other. They are indicated as being supported by the two masts or towers A and B.

Each of the aerial systems *c*, *d*, and *e*, *f*, as associated, are in tune in the vertical direction with the wave to be transmitted or received. The two systems are coupled together electrostatically through the small condensers *k* shown between the horizontal wires *d* and *e*. In practice the capacity between the wires *d* and *e* is usually sufficient as a coupling condenser. One, two, three, or more systems can be used above each other, each coupled to the one above it electrostatically, or in an equivalent manner.

Oscillations produced in any one of the systems will then produce oscillations in the systems above and below. The lengths of the vertical members and the coupling capacities should be so adjusted that the currents are in the same phase in each system.

Such an aerial system is capable of extension in the vertical and horizontal directions without affecting appreciably the natural tune of the aerial. If fed correctly from a transmitter the currents in all the vertical members of the aerial will all be in the same phase, and the aerial will radiate two "beams" in opposite directions, and at right angles to the plane of the aerial.

The concentration of the radiation is a simple function of the dimensions of the aerial both vertically and horizontally.

It is desirable that no oscillations in the aerial in the horizontal direction should be allowed as these would represent a loss of energy. The aerial may be separated into units, as, for instance, by introducing breaks into the horizontal wires; or resistances *r*, Figure 1, inserted in the horizontal members will suppress any such oscillations.

I have found that with an aerial which is large compared with the wave length in order to produce currents in all vertical members of substantially the same phase and intensity it is essential that power should be fed to it at a number of points simultaneously. The feeding points should not be more than one wave length apart, and are preferably about half a wave length apart.

The alternating E. M. F.'s impressed at each feeding point must all be of the same phase and intensity. I attain this by leading a cable from each feeding point to the generator, and arranging that the length of this cable from each point to the generator is the same.

Figure 2 shows one arrangement for feeding. *f* is the bottom horizontal wire of an aerial, similar to the one shown in Figure 1. A, B, C and D, are equally spaced feeding points which are connected each through a condenser and the secondary of a transformer to earth or a balancing capacity. The primaries of the transformers *a*, *b*, *c* and *d*, are each connected to a cable. Separate cables of equal length, or equivalent length electrically may be used, or they may be connected as shown in Figure 2 so that the length from any transformer to the generator is the same. It is necessary for efficient working that no reflection of the oscillations transmitted through the cable by the generator should take place at the feeding points. This can be attained by arranging the ratio of the transformers so that the effective resistance of each portion of the aerial fed by the transformer as applied to the cable is equal to the critical resistance required at the cable terminals to prevent reflection. Under these conditions, no reflections will take place, and no stationary wave effects will be produced in the cables.

I have found that cables built up of parallel tubes or rods like a Lecher wire system and enclosed in metal conduits are best and give a very high efficiency. It is sometimes convenient to insert the transformers in the centre of the vertical portions of the aerial, and if the resistance of the aerial is equal or nearly equal to the critical resistance of the cable, the cable may be directly connected in the vertical members without having recourse to transformers. The secondaries of the transformers may also be inserted between the sections of the aerial, e. g. between the wires *d* and *e* (see Figure 1).

I have found that two aerial systems such as described in Figure 1 arranged in parallel planes one behind the other and spaced a quarter wave length or an odd multiple of a quarter of a wave length apart may be used. Such a system is shown diagrammatically in Figure 3 where the apparatus marked *c*, *d*, *e*, *f* is an aerial system such as shown in Figure 1 and, the unlettered apparatus illustrates similar apparatus one-quarter wave length or an odd multiple of a quarter wave length apart from the aerial. If one is used as a transmitter the other functions as a reflector and unidirectional transmission or reception with any desired degree of concentration is obtained. In this combination the transmitting aerial may if desired be smaller in height than the reflecting aerial. As the reflecting aerial does not require any power feeding arrangements it may easily be extended vertically several wave lengths and great concentration in the vertical direction may thus be obtained. One possible arrangement is a transmitting aerial of low height compared with the wave length in combination with a reflector high compared with the wave length arranged in the form of a cylindrical parabola with its focal line horizontal and coincident with the transmitting aerial.

As a practical indication of the dimensions and results to be obtained from such aerials as described, I give the following:—

For an aerial as shown in Figure 1, I find that a practical horizontal spacing between the vertical members is ⅛ of the wave length and for this spacing the distance between the horizontal members (i. e. the distance *c d* or *e f* in Figure 1) is about one-third of the wave length. Using a combination of a transmitting aerial and reflecting aerial I find that with an aerial one square wave length in area the energy radiated or received on a line at right angles to the aerial is ten times that which would be radiated or received by an ordinary aerial radiating the same total energy. Also that for aerials of more than one square wave length the effect is practically proportional to the area.

An aerial of 10 square wave lengths will give 100 times the energy in the required direction, and would receive from that direction 100 times the energy received by an ordinary aerial. The combination at both the transmitting and the receiving station of aerials of 10 square wave lengths provided with reflectors will give 10,000 times the energy obtained with ordinary aerials. If the aerials are one wave length high and ten wave lengths wide practically no energy will be radiated or received outside an angle of 5° to 7° from the direction joining the station.

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. An aerial for directional wireless telegraphy and telephony comprising a number of vertical rods or wires, the rods or wires being connected together by horizontal wires, said wires and rods forming a radiating surface, a source of oscillations, and means for supplying oscillations to the rods or wires, simultaneously and in the same phase so that all of the wires of the aerial oscillate

in phase, at a number of points equi-distant from said source.

2. An aerial for directional wireless telegraphy and telephony having a radiating surface made of a number of units assembled above one another and coupled together, said units lying in a single plane, and each unit comprising a number of vertical rods or wires connected together by spaced horizontal wires, substantially as described.

3. An aerial according to claim 1 and having resistances inserted at points along the horizontal connecting wires to prevent oscillations taking place in the aerial in the horizontal direction while allowing oscillations in the vertical direction.

4. The combination of an aerial as described in claim 2 with oscillation generator, and a cable feeder system for supplying oscillations to the aerial simultaneously and in the same phase at a number of points equidistant from said generator.

5. An aerial for directional wireless telegraphy and telephony made of a number of units assembled above one another and capacitively coupled together, each unit comprising a number of vertical rods or wires connected together by horizontal wires, a second aerial arranged parallel to said first mentioned aerial, said first mentioned aerial acting as a transmitting unit and said other aerial acting as a reflecting unit for the purpose of obtaining unidirectional working.

6. The combination of an aerial for directional wireless telegraphy and telephony comprising a number of vertical rods or wires arranged in a single plane, means for capacitively connecting the rods or wires together, with a similar aerial in a parallel plane at least equal in size to said first mentioned aerial and cooperatively shielded therewith, one of said aerials being a transmitting aerial and said other aerial being a reflecting aerial.

7. An aerial for directional wireless telegraphy and telephony comprising a number of vertical rods or wires connected together by spaced horizontal wires combined with means for supplying oscillations to the aerial simultaneously in the same phase at a number of points equidistant from said last mentioned means, each of said rods together with its associated horizontal wires being in tune with said supply oscillations and a reflecting aerial associated with said first mentioned aerial.

8. An aerial for directional wireless telegraphy and telephony made of a number of units assembled above one another and capacitively coupled together, each unit comprising a number of vertical rods or wires connected together by spaced horizontal wires, and a similar aerial associated with said first mentioned aerial.

9. An aerial for directional wireless telegraphy and telephony comprising a system, said system comprising a grip of parallel straight wires arranged in a single plane, and another system comprising a group of parallel wires arranged in the same plane the wires of the systems being capacitively coupled together, and means for exciting the wires of both groups cophasally.

10. An antenna comprising a pair of systems spaced apart an odd number of quarter wave lengths each system comprising a pair of groups of parallel straight wires, the wires of pairs of groups being capacitively coupled together, and means for exciting all of the wires of one of the systems substantially cophasally.

11. An antenna system comprising a wire, a plurality of radiating rods lying in one plane connected thereto, another wire, a plurality of radiating rods lying in the said same plane connected to said other wire, and condensers between said wires.

12. An antenna system comprising a wire, a plurality of parallel radiating rods lying in one plane arranged perpendicular to and connected to said wire; another wire, a plurality of parallel rods lying in the said same plane arranged perpendicular to and connected to said other wire, condensers between the wires and means for exciting the rods cophasally.

13. In combination, in a transmitting system, a plurality of aerials arranged in one plane, each of said aerials oscillating at a predetermined phase with respect to each other so that a bilateral sending characteristic in a direction perpendicular to the plane of the aerials is obtained, and a reflector unexcited except for the excitation produced by the aerials in a plane parallel to the plane of the aerials for causing said aerials to have a unilateral directional chracteristic.

14. A unidirectionl radiating system comprising a plurality of antennæ arranged in one plane and excited so that a bilateral radiating characteristic in a direction substantially at right angles to the plane of the antennæ is obtained, and a reflector uncoupled from the antennæ in a plane parallel to the plane of the antennæ for reflecting waves radiated in one direction by the antennæ in such a manner that the entire system comprising the antennæ and reflector has a unidirectional radiating characteristic in a direction away from the plane of the antenna on the side opposite the reflector.

15. A unidirectional radiating system comprising a plurality of antennæ arranged in a single plane and excited to produce a bilateral radiating characteristic in directions substantially at right angles to the plane of the antennæ and means uncoupled from said antennæ for reflecting the waves radiated in one of said bilateral directions by each of the antennæ to produce a unidirectional radiating

characteristic in the other of said bilateral directions.

16. A unidirectional radiating system comprising at least three antennæ arranged in substantially the same plane and excited to produce a bilateral radiating characteristic in a direction substantially at right angles to the plane of the antennæ and means uncoupled from said antennæ for reflecting the waves radiated in one of said bilateral directions by each of the antenna to produce a unidirectional characteristic in the other of said bilateral directions.

17. A unidirectional radiating system comprising at least three antennæ arranged in one plane and excited so that a bilateral radiating characteristic in a direction substantially at right angles to the plane of the antennæ is obtained, and a reflector uncoupled from said antennæ in a plane parallel to the plane of the antennæ for reflecting waves radiated in one direction by the antennæ in such a manner that the entire system comprising the antennæ and reflector has a unidirectional radiating characteristic in a direction away from the plane of the antenna on the side opposite the reflector.

18. In combination, a plurality of vertical transmitting antennæ arranged in a straight line and a reflector uncoupled from said antennæ arranged in a plane parallel to said line.

19. In combination, a plurality of radiating antennæ arranged in a single plane and excited so that radiation therefrom is predominantly bidirectional and substantially perpendicular to the plane of the antennæ; and a reflector, comprising a plurality of tuned antennæ arranged in a plane parallel to the plane of the radiating antennæ, uncoupled therefrom, and unenergized except for the energization caused by radiated energy from the radiating antennæ, for making radiation from the radiating antennæ unidirectional.

20. In an arrangement for directional radio communication the combination with an antenna arrangement comprising at least three antennæ positioned in an approximately straight line and at equal distances from one another; of a reflecting screen built up of electrical conductors and arranged at one side of the said antenna arrangement and in parallel to the row of main antennæ; only the antenna arrangement of said combination being supplied with high frequency energy.

21. In an arrangement for directional radio communication the combination with a main antenna arrangement comprising at least three antennæ tuned to a given frequency and positioned in an approximately straight line and at equal distances from one another; of a reflecting screen built up of a plurality of antennæ tuned to the same frequency and arranged at one side of the said antenna arrangement and in parallel to the row of main antennæ; only the antenna arrangement of said combination being supplied with high frequency energy.

22. In an arrangement for directional radio communication the combination with an antenna arrangement comprising a multiplicity of antennæ tuned to a given frequency and positioned in an approximately straight line and at equal distances from one another; of a reflecting screen arranged at one side of the antenna arrangement and built up of a plurality of suspended conductors with reactors in series arranged in parallel to the row of main antennæ, the said conductors with the said reactors being tuned to the same frequency; and, high frequency apparatus connected to the said antenna arrangement.

23. In an arrangement for directional radio communication the combination with an antenna arrangement for bilateral directional emission and reception of waves; comprising at least three substantially perpendicular antennæ disposed in an approximately straight line and being tuned to a given frequency; of a reflecting screen built up of a plurality of substantially perpendicular conductors arranged at one side of said antenna arrangement and substantially parallel thereto; said screen corresponding an appreciable fraction of or greater than a wave length of the wave corresponding to the natural frequency of the antennæ of the main antenna arrangement; and of high frequency apparatus connected to the said antenna arrangement.

24. In an arrangement for directional radio communication the combination with an antenna arrangement for bilateral directional emission and reception of waves comprising at least three substantially perpendicular antennæ tuned to a given frequency and positioned in a substantially straight line and at equal distances from one another; of a reflecting screen built up of a plurality of substantially perpendicular antennæ, arranged substantially in parallel to the main antennæ, said perpendicular antennæ being tuned to the same frequency and positioned at distances from one another substantially equal to one-eighth of the wave length of the natural frequency of said antennæ; said antenna arrangement being connected to high frequency apparatus.

25. In an arrangement for directional radio communication the combination with an antenna arrangement comprising at least three antennæ positioned in an approximately straight line and at equal distances from one another; of a reflecting screen built up of electrical conductors and arranged at one side of the said antenna arrangement and in parallel to the row of main antennæ; and, high frequency apparatus connected to the said antenna arrangement.

26. In an arrangement for directional radio communication the combination with a main antenna arrangement comprising at least three antennæ tuned to a given frequency and positioned in an approximately straight line and at equal distances from one another; of a reflecting screen built up of a plurality of antennæ tuned to the same frequency and arranged at one side of the said antenna arrangement and in parallel to the row of main antennæ; and high frequency apparatus connected to the said main antenna arrangement.

27. In an arrangement for directional radio communication the combination with an antenna arrangement comprising at least three antennæ positioned in an approximately straight line and at equal distances from one another; of a reflecting screen built up of electrical conductors and arranged at one side of the said antenna arrangement and in parallel to the row of main antennæ; and, high frequency transmitting apparatus connected to the said antenna arrangement.

28. In an arrangement for directional radio communication the combination with a main antenna arrangement comprising at least three antennæ tuned to a given frequency and positioned in an approximately straight line and at equal distances from one another; of a reflecting screen built up of a plurality of antennæ tuned to the same frequency and arranged at one side of the said antenna arrangement and in parallel to the row of main antennæ; and high frequency transmitting apparatus connected to the said main antenna arrangement.

CHARLES SAMUEL FRANKLIN.