Dec. 15, 1931. C. W. HANSELL 1,836,069

ANTENNA

Filed Jan. 18, 1927

Fig. 1

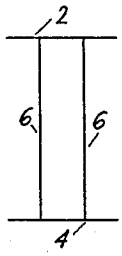


Fig. 2

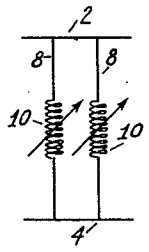


Fig. 3

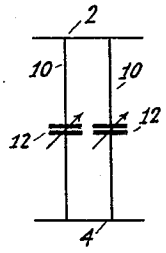


Fig. 4

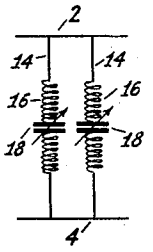


Fig. 5

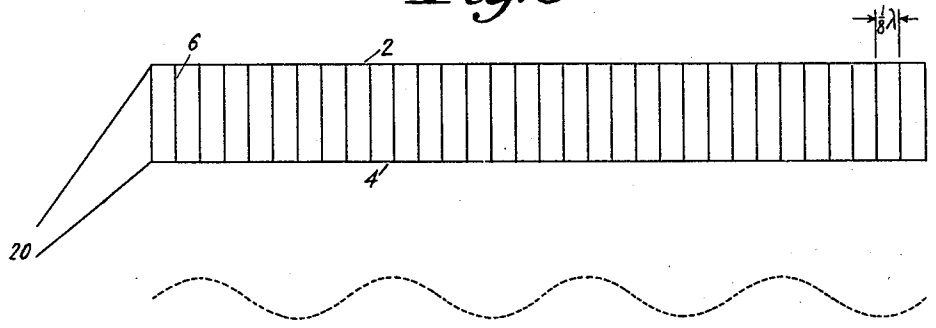
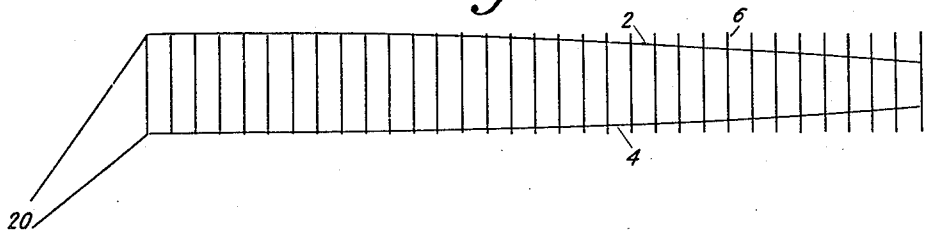


Fig. 6



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UNITED STATES PATENT OFFICE

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ANTENNA

Application filed January 18, 1927. Serial No. 161,771.

An object of my invention is to provide a directional short wave antenna. This I propose to do by employing to some extent, the principles involved in a wave antenna.

In attempting to transmit from two long wires, like a transmission line extending in the direction of transmission, it is found that very little radiation can be effected. This I believe is due to the fact that the currents are progressing in the direction of the wave to be transmitted. An object of my invention is to greatly increase the radiation of such an antenna, and this I do by employing a plurality of cross wires, which are, in effect, individual radiators for the wave to be transmitted, and which, being normal to the direction of transmission radiate efficiently.

If these cross wires are used as oscillators at remote spacing the results obtained are not satisfactory. I have found that if they are spaced so closely that they plot the wave form in space, so to speak, remarkable improvement results. Accordingly, it is a further object of my invention to so arrange a plurality of short wave radiators that they cooperate to actually build up a wave in space.

Having these radiators in location, it is next desirable, when transmitting, that the phase relationship in the successive radiators be slightly in advance of the natural phase displacement of a wave in space, at the same distances apart, in order that each radiator may add an additional radiating impulse to the wave which is already being transmitted. When receiving, on the contrary, the phase in the individual cross aerials should lag slightly, relative to the natural phase of the received wave in space, in order that each aerial may have impressed upon it an additional cumulative impulse from the wave in space. I attain this result by controlling the velocity of current flow in the longitudinal feeder conductors. Thus, when transmitting, this velocity should be slightly greater than that of light, whereas, when receiving, it should be slightly less than the velocity of light. Accordingly, it is another object of my invention to control the velocity of current flow in the transmission line portion of my antenna, and this I am able to do without any additional agency other than the cross wires already provided. The individual radiators are circuits which affect the inductance and capacitance relation of the transmission line, and by detuning these oscillators slightly from their proper theoretical value for the wave worked with, the velocity of transmission in the feeder lines may be altered.

As so far outlined the antenna consists of a ladder-like grid having two parallel longitudinal conductors running in the direction of transmission, and a series of radiators extending transversely from one conductor to the other. This construction is practicable and gives exceedingly good results. It is, however, open to the defect that because of natural attenuation of the transmission energy, the energy radiation from each succeeding oscillator is less than that from the preceding oscillators. For several reasons, one of which is that the current at the end of the transmission line can be reduced to zero in less overall length of antenna, it is desirable that these cross currents be equalized, and to accomplish this is a still further object of my invention. This I am able to do by applying the energy to successive radiators at progressively increasing degrees of coupling. This is very simply accomplished by running the transmission conductors progressively closer together, instead of parallel, in consequence of which energy is supplied to successive radiators at points intermediate their ends which are increasingly near. The feeder members are connected at each radiator to the primary of an auto-transformer, of which the oscillator itself is the secondary, and these transformers have increasingly greater potential step-up ratios.

The invention is accompanied by drawings in which

Figure 1 shows simple linear radiators;

Figure 2 shows inductively loaded radiators;

Figure 3 shows capacitively loaded radiators;

Figure 4 shows radiators tuned by inductance and capacitance;

Figure 5 represents an antenna constructed according to my invention; and

Figure 6 illustrates an antenna arranged for equalized energy radiation.

Referring to these drawings, in Figure 1 the conductors 2, 4, are of opposite sign, and represent a wire-return transmission line, while the conductors 6 represent the cross wires, or simple linear radiators. These, preferably, are each approximately a half wave length long or are tuned to equivalent half wave resonance.

In Figure 2, as before, 2 and 4 are the feeder members, while the oscillators 8, in this case, are artificially lengthened by the loading coils 10.

Figure 3 is like Figure 2 except that the radiators 10 have been shortened by the condensers 12.

In Figure 4 the oscillators 14 have been shown tuned by both inductances 16 and condensers 18.

The preceding modifications are merely illustrative of possible arrangements. So far I have limited the antennæ actually constructed to the simple type using linear radiators or radiators such as shown in Fig. 2. Referring now to Figure 5, the wire-return transmission line, as before, is composed of the conductors 2 and 4. Transversely connected to these are the oscillators 6, which are sufficiently closely spaced to approximate the characteristics of a smooth line. Probably the farthest that they should be spaced is one-quarter of a wave length, and I recommend a spacing of one-eighth wave length or less. The overall length of the antenna should be such that the current in the feeder members 2, 4, is brought to zero at the end. Because of attenuation, this would tend to increase the length to infinity, but in practice, there is a reaction upon the radiators by the wave in space which, at the last radiator, results in the current of the feeder members being brought to zero in a finite and practical distance. In one embodiment of my invention the antenna length was in the neighborhood of ten wave lengths, but I do not wish to be limited to any numerical value, for, in itself, a numerical value is meaningless. The true specification is that for best results the length should be such that whatever current is to be radiated will be reduced to zero after reaching the last radiator. The transmission line 2, 4, is supplied with energy from conductors 20, which extend from the antenna to a transmitter.

I have already stated that it is desirable to control the effective velocity of energy transfer along the transmission line 2, 4. It is possible to anticipate the altered velocity which will be created by a change in the tuning of the cross wires, but, in practice, I prefer to determine the best tuning value by experiment, largely because the exact velocity, or phase lead, which will give the best cumulative transmission, is not well known. When employing simple linear radiators the tuning is changed by changing the physical length of the wire.

One procedure is to set up a receiver several miles from the antenna in the direction of transmission. The wave length of the transmitted energy is varied over a fairly great range, while keeping the radiators at any one length. The magnitude of the response at the receiver is recorded for each wave length, and then a curve may be plotted showing the response as a function of wave length, and this curve has a peak of best response. This signifies that at a certain wave length, for the given length of cross wire, the best velocity in the feeder members for cumulative transmission is obtained. A different length of cross wire is next used, and the entire experiment is repeated. After this has been done enough times a curve is plotted showing length of cross wire as a function of the wave length radiated for optimum reception. From this curve, for any desired wave length, the corresponding proper length of cross wire may be determined.

Referring now to Figure 6, this modification is much like the preceding, but, as is clearly shown, the wire-return transmission line 2, 4, is coupled to the successive radiators 6 in progressively increasing potential step-up ratios. The profile of the feeder members is determined by the attenuation curve in an equivalent antenna having parallel conductors, but, of course, the curvature will be in the inverse sense.

The directive effect of an antenna such as I have described is in the form of a beam. It is quite immaterial whether the individual radiators be positioned horizontally, vertically, or obliquely. The antenna ordinarily is sufficiently elevated above ground so that there is no appreciable capacity unbalance when vertical radiators are used.

My antenna is suitable for reception and transmission, but preferably should embody velocity changes as already suggested. In the claims which follow I have for convenience termed the longitudinal connecting wires "feeder members" but this is meant broadly as feeding the radiators, if transmitting, and feeding the receiver, when receiving.

I claim:

1. The method of equalizing the energy radiated from a plurality of aerials located in the direction of transmission which includes applying energy from a source to each successive aerial in increasing potential step-up ratio.

2. An antenna structure comprising a wire-return transmission line a plurality of wave lengths long and a plurality of closely spaced linear radiators spaced substantially less than one-quarter wave length apart transversely

coupled thereto, each being approximately tuned to the wave to be radiated, said wire-return being linear throughout its length, free of any series lumped impedances and being connected at one end to high frequency apparatus.

3. An antenna structure comprising a wire-return transmission line a plurality of wave lengths long and a plurality of closely spaced linear radiators spaced substantially less than one-quarter wave length apart transversely coupled thereto, each being approximately a half wave in length, said wire-return being linear throughout its length, free of any series lumped impedances and being connected at one end to high frequency apparatus.

4. An antenna structure comprising a wire-return transmission line a plurality of wave lengths long extending in the direction of desired transmission and a plurality of closely spaced transverse radiators spaced substantially less than one-quarter wave length apart coupled thereto, each being tuned approximately to the wave to be radiated, said wire-return line being linear throughout its length, free from any series lumped impedances and being connected at one end to high frequency apparatus.

5. An antenna structure comprising two feeder members a plurality of waves in length and a plurality of transverse radiators spaced at a distance of the order of one-eighth wave length apart coupled to the feeder members and tuned approximately to the wave to be radiated, said feeder members being linear throughout their length, free of any series lumped impedances and being connected to high frequency apparatus at one end.

6. An antenna in the form of a grid comprising two longitudinal feeder members a plurality of waves in length, and a plurality of simple linear transverse radiators spaced at a distance of the order of an eighth wave length coupled to the feeder members and tuned approximately to the wave to be radiated, said feeder members being linear throughout their length, free of any series lumped impedances and being connected to high frequency apparatus at one end.

7. A directive antenna system comprising a substantially straight, unbroken transmission line free of any series lumped impedances, linear radiators connected transversely and internally thereto, and, high frequency apparatus coupled to one end of the transmission line.

8. In combination, a wire-return transmission line consisting solely of unbroken, substantially straight wires extending in the direction of desired communication and a plurality of transverse linear radiators coupled thereto and so tuned that for a given frequency the velocity of flow in the transmission line is substantially equal to that of light.

9. In combination, a wire-return transmission line consisting solely of unbroken, substantially straight wires extending in the direction of desired transmission and a plurality of transverse radiators coupled thereto and so tuned that for a given frequency the effective velocity of flow in the transmission line is slightly greater than that of light.

10. An antenna comprising a plurality of radiator means fed by feeder means coupled to successive radiator means in increasing potential step-up ratios.

11. An antenna comprising a plurality of longitudinal feeder members and a plurality of transverse radiators tuned approximately to the wave to be radiated, and coupled to the feeder members in such potential step-up ratios that the energy taken from the feeder members by each radiator is substantially equal.

12. A directive antenna comprising two feeder members extending in the direction of radiation and a plurality of transversely disposed radiators tuned approximately to the wave to be radiated, and coupled to the feeder members in progressively increasing potential step-up ratio so that the energy taken from the feeder members by each radiator is substantially equal.

13. A directive antenna comprising two feeder members a plurality of waves in length extending in the direction of radiation, and a plurality of transversely disposed linear oscillators spaced at a distance of the order of magnitude of an eighth wave length, tuned approximately to the wave to be radiated, and coupled to the feeder members in increasing potential step-up ratios.

C. W. HANSELL.

CERTIFICATE OF CORRECTION.

Patent No. 1,836,069. December 15, 1931.

CLARENCE W. HANSELL.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 1, before line 1, insert the following paragraph: This invention relates to antennae, and more particularly to directive and directional antennae for use with very short waves.; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 27th day of September, A. D. 1932.

M. J. Moore,
Acting Commissioner of Patents.

(Seal)