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DIRECTIONAL RADIO RECEIVER

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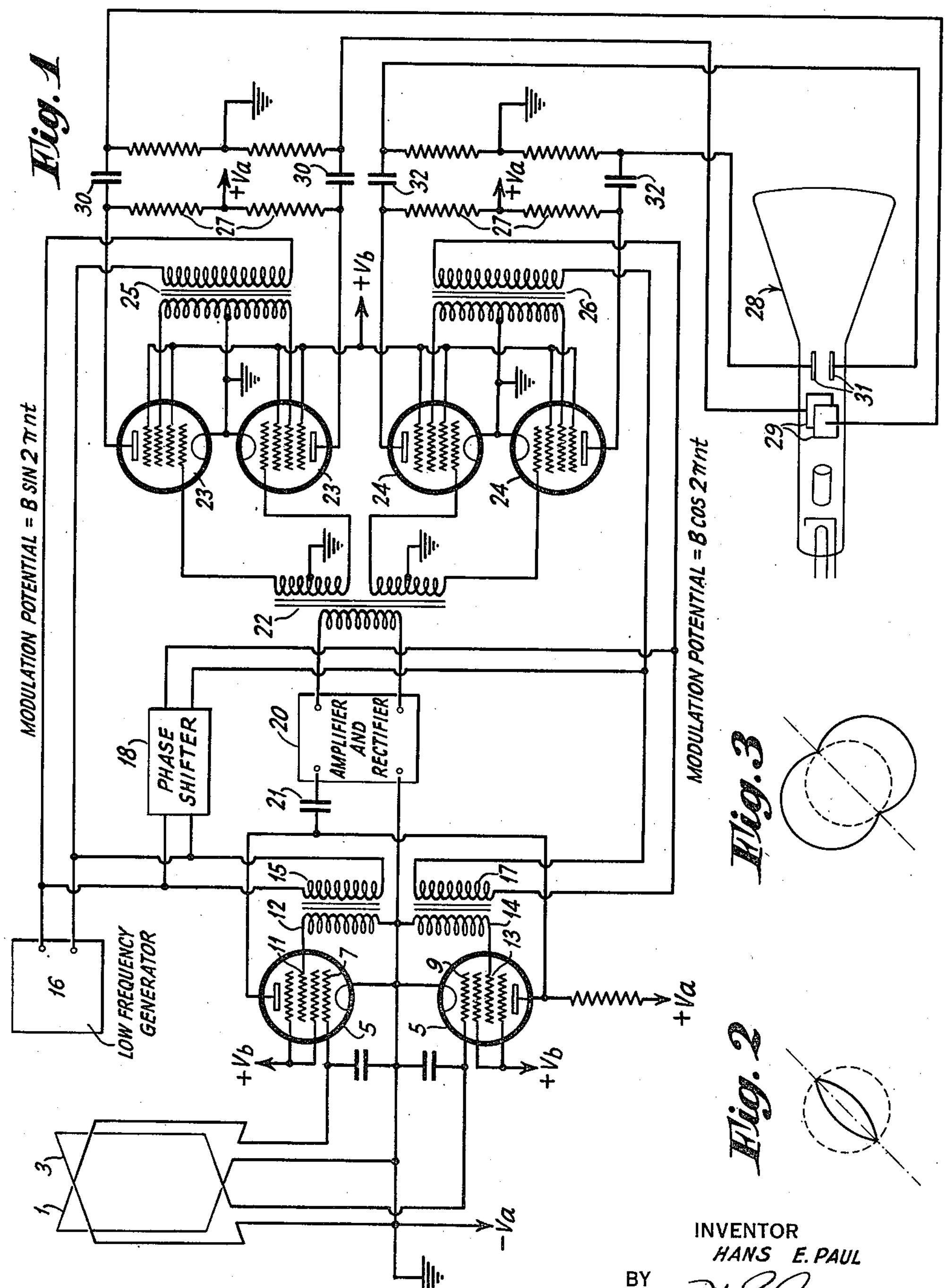

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DIRECTIONAL RADIO RECEIVER

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This invention relates to directional radio receivers particularly of the type adapted to determine the direction from which electromagnetic waves are received on a plurality of stationary but differently oriented directional antennae.

Directional radio receivers are known in the art in which the received radiant energy is caused to make an indication on the fluorescent screen of a cathode ray tube. Such an indication signifies the direction from which the energy is received. Usually two directional loop antennae are employed, these being arranged to cross each other at an angle of 90 degrees and the two antennae being made rotatable about their axis of symmetry. In order to produce indications in that manner, it has been found necessary to employ considerable power and more or less complicated equipment. If the received energy happens to be modulated at the transmitter, there is an added complication in obtaining synchronism of rotation of the directional loops.

It is an object of my invention to provide a directional radio receiving system wherein the antennae are maintained stationary and where modulations of the received energy are applied at the point of reception rather than at the transmitter.

It is a further object of my invention to provide a directional radio receiver in which locally applied low frequency modulations are caused to deflect the beam of electrons in a cathode ray tube thereby to give an indication of direction of high frequency energy collected by a plurality of differently oriented directional antennae.

Further objects and advantages of my invention will be made apparent by the following detailed description when read in view of the accompanying drawing in which

Figure 1 shows diagrammatically a circuit arrangement suitable for use in carrying out my invention, and

Figs. 2 and 3 show respectively different paths that may be traced by the "spot" on the fluorescent screen of a cathode ray tube, the deflecting circuits of which are jointly controlled by the received high frequency energy and by a local source of low frequency energy.

Referring first to Fig. 1, I show a pair of crossed directional loop antennae 1 and 3 having a common connection to the cathodes of a push-pull arrangement of electron discharge tubes 5. These tubes are here shown as hexodes, although tubes of other types may be employed, if desired. The separate circuits of different antennae are connected to the grids 7 and 9 respectively of the tubes 5. The grids 11 and 13 are connected respectively to transformer windings 12 and 14. A low frequency generator 16 supplies modulating potentials directly to the transformer primary 15 and through a phase shifter 18 to the transformer primary 17. A phase difference of 90 degrees is preferably maintained between the currents in the primaries 15 and 17. The tubes 5 are jointly controlled by the high frequency and modulating frequency potentials. Thus, it is possible to determine the angle of incidence of the incoming waves.

A receiving amplifier and rectifier 20 is shown having an input circuit connected between the common cathode lead of the tubes 5 and a common anode lead to said tubes. A blocking condenser 21 is provided for avoiding the impress of the high anode potential V_a upon the grid (not shown) of the first stage in the receiver 20. The output energy from the receiver 20 is fed through a transformer 22 which has two center tapped secondaries each connected to the grids of two pairs of electron discharge tubes 23 and 24. The tubes 23 are thus caused to operate as a push-pull arrangement, likewise the tubes 24 are caused to operate as a push-pull arrangement. Each pair of tubes 23 or 24 has an additional input circuit constituted by a center tapped transformer secondary winding on the transformers 25 and 26 respectively. The primaries of these transformers are fed with energy through different circuits, one from the source 16 and the other from the source 18 of low frequency modulating potentials.

Direct current plate potentials are applied to the anodes of the tubes 23 from a source V_a through impedances 27. The negative side of the source V_a is, of course, grounded, as are the cathodes of the tubes 23 and 24.

For indicating the directivity of the incoming signal, and for indicating the relative response of the different antennae 1 and 3 to the collected energy, I preferably employ a cathode ray tube 28. This may be of a conventional type in which two sets of capacitive deflecting plates are employed. One set of plates 29 provides a horizontal deflecting component under control of potentials derived in the push-pull output circuit from the tubes 23, these potentials being impressed upon the condensers 30. The other set of deflecting plates 31 is fed with energy across the condensers 32 from the output circuit of the push-pull tube arrangement 24.

In explanation of the operation of the device as shown in Fig. 1, a few theoretical considerations will now be presented.

Let it be assumed that the direction of the incoming signal forms with the plane of the antenna loop I an angle ϕ. The potential in the two loops will then be:

$$A \sin \phi . \sin 2\pi ht \text{ and } A \cos \phi . \sin 2\pi ht$$

where h is the frequency of the incoming wave. The two loop potentials are each modulated with an audio-frequency voltage having frequency n being of like amplitude, but shifted in phase an angle of 90 degrees. Hence, the modulation potentials are

$$B \sin 2\pi nt \text{ and } B \cos 2\pi nt$$

The high frequency potentials resulting from modulation are jointly amplified in a standard receiver and rectified. The audio-frequency voltage which is obtained is

$$C \cos (2\pi nt \pm \alpha)$$

where α depnds upon the combination of loop and modulation potentials that has been chosen, but once so chosen is constant for a given arrangement.

If this potential, so far as its phase is concerned, is compared with one of the modulation potentials $B \cos 2\pi nt$ or $B \sin 2\pi nt$, then, with suitable arrangements, the angle, i. e., the angle of incidence of the incoming waves, is determinable.

In a quiescent state, that is to say, when no electrical waves are coming in, a circular pattern appears upon the screen of the Braun tube. The size of the circle is a function of the grid potential of the push-pull device. Upon reception of electric waves stationary patterns will generally appear on the screen of the Braun tube as shown in Figs. 2 and 3 with sharp points.

The position of the line of symmetry of the pattern depends directly upon the angle of incidence of the transmitter in relation to the loop arrangement so that, if the loop is suitably positioned in relation to the Braun tube, it will be readily possible to determine the position of the transmitter. Ambiguity of such indication of direction can be avoided by use of an auxiliary antenna as known in the prior art.

Various modifications of my invention will possibly be suggested by the foregoing description, but they would nevertheless be included in the scope of the invention itself.

I claim:

1. A directional radio receiving system having two differently oriented directional antennae for the collection of high frequency energy, means for separately modulating the energy collected by each antenna, means for maintaining a phase difference between the modulations of the energies collected by different antennae, an indicating device comprising a cathode ray tube having an electron gun for producing a "spot" on a fluorescent screen, and having horizontal and vertical beam deflecting means for causing the "spot" to trace a two-dimensional pattern on said screen, and indicating means including separate circuits to said deflecting means, one circuit constituting means operative in dependence upon the strength of the energy collected by one said antenna for controlling the horizontal deflecting means, the other circuit constituting means similarly operative in respect to the energy collected by the other antenna for controlling the vertical deflecting means, whereby the direction from which the high frequency energy is received is caused to be indicated.

2. Direction indicating apparatus comprising two directional antennae, the directional axes of which are normal one to the other, a receiving circuit having two parallel branches each under separate control of signals received by a respective one of said antennae, a two-phase modulating source, means for impressing differently phased low frequency modulations from said source on different branches of said receiving circuit, a cathode ray tube having two deflecting circuits each under the joint control of an appropriate branch of said receiving circuit and the last said means, and means for causing said cathode ray tube to exhibit a two-dimensional image the pattern of which signifies the direction from which said signals are received.

3. A direction finding system having a pair of stationary directional lop antennae, a receiving and combining circuit having two electron discharge tubes the two input circuits of which are separately fed with energy from one and the other antenna respectively, means including a local low frequency oscillation generator and phase differentiating device for applying to said input circuits modulating potentials having a quadrature phase relationship to one another, indicating means comprising a cathode ray tube oscilloscope having control devices including deflecting circuits for producing a stationary pattern on an oscilloscope screen, and means for rendering said control devices separately responsive to the output energies respectively derived from the output circuits of said discharge tubes.

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