March 3, 1942. S. W. H. W. FALLOON 2,275,254

DIRECTIONAL RADIO TRANSMITTING AND RECEIVING SYSTEM

Filed Feb. 28, 1940 2 Sheets-Sheet 1

Fig. 1

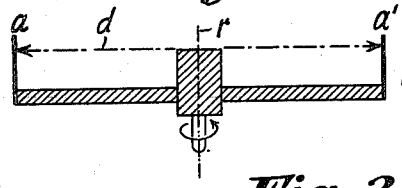


Fig. 2

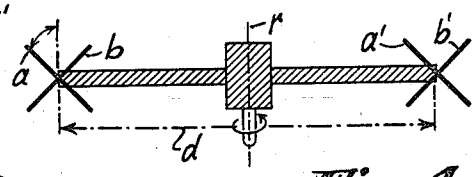


Fig. 2a

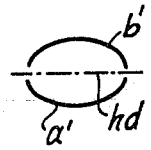


Fig. 3

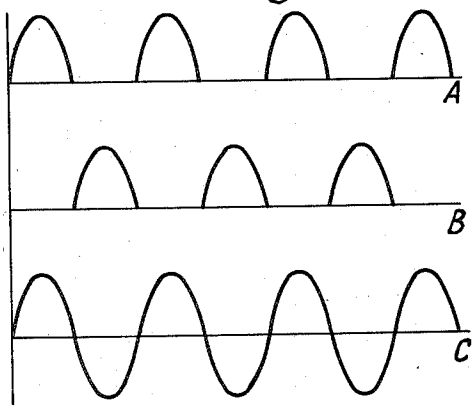


Fig. 4

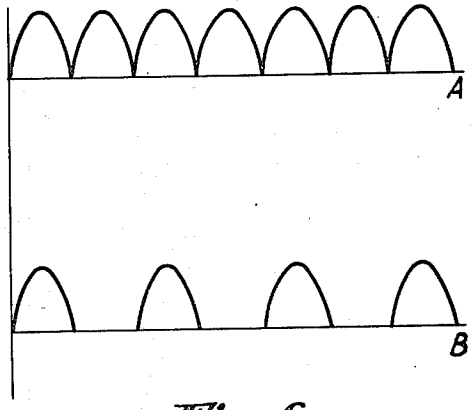


Fig. 5

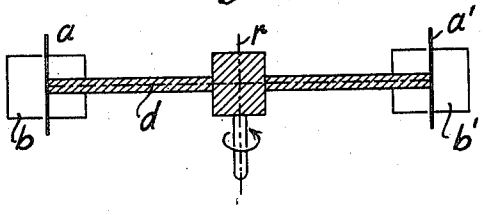


Fig. 6

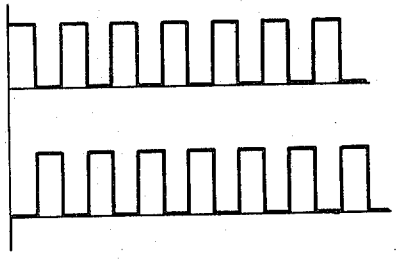
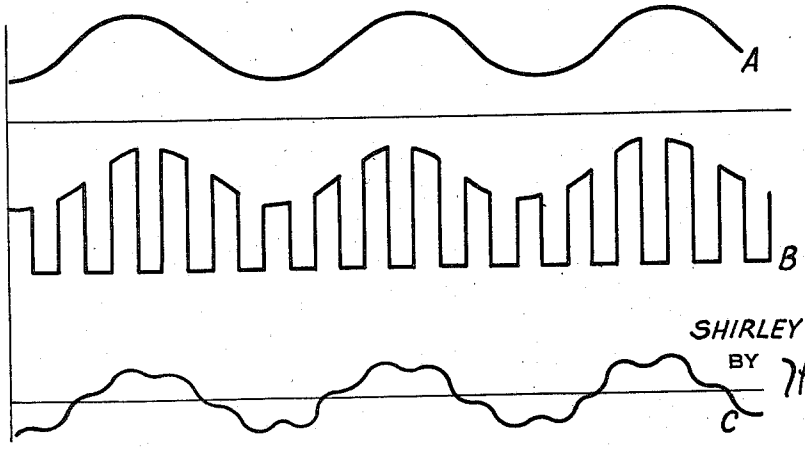


Fig. 7



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Filed Feb. 28, 1940 2 Sheets-Sheet 2

Fig. 8

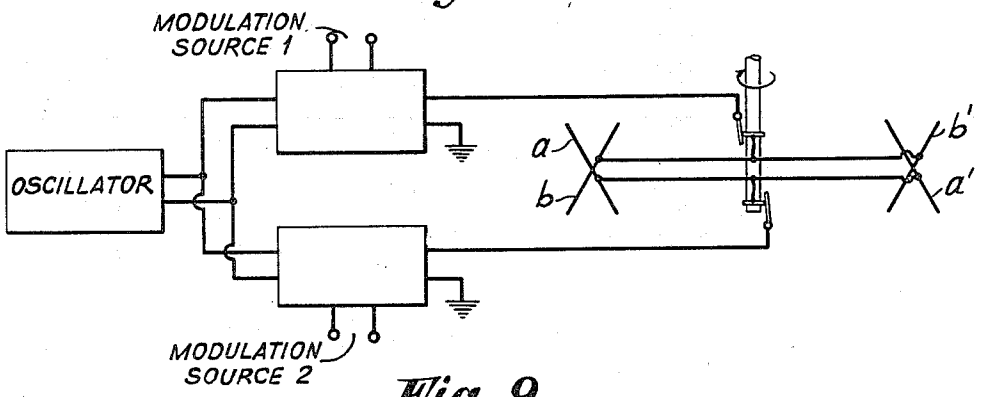


Fig. 9

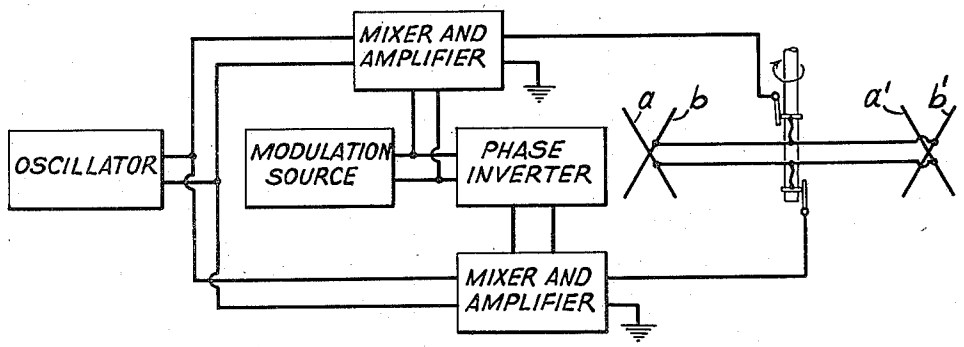
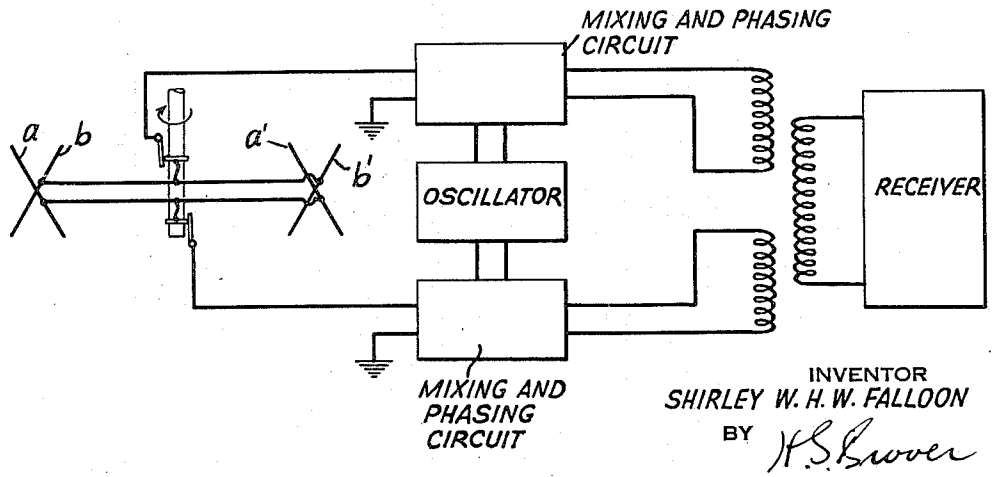


Fig. 10



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UNITED STATES PATENT OFFICE

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DIRECTIONAL RADIO TRANSMITTING AND RECEIVING SYSTEM

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Application February 28, 1940, Serial No. 321,178
In Great Britain February 16, 1939

5 Claims. (Cl. 250—11)

This invention relates to directional radio transmitting and receiving systems and more particularly to such systems of the kind wherein a plurality of directional aerials is arranged on a diameter so as to be rotatable about the mid-point of said diameter.

The invention will now be described in detail, reference being made to the accompanying drawings in which

Figure 1 shows diagrammatically a rotatable antenna system such as known in the art;

Fig. 2 shows my improved antenna system;

Fig. 2*a* is a diagrammatic end view of the arrangement shown in Fig. 2;

Figs. 3, 4, 6 and 7 are plots of wave impulses which will be referred to in explaining the theory of operation;

Fig. 5 is a modification of my improved antenna system;

Fig. 8 is a schematic diagram of a directional transmitter connected according to one embodiment of the invention;

Fig. 9 is a schematic diagram of a modification of the directional transmitter; and

Fig. 10 is a schematic diagram of a directional receiver embodying the invention.

A known form of radio directional system is shown in Fig. 1, and comprises two frame aerials *a*, *a'*, mounted at opposite ends of, and with their planes at right angles to, a diameter *d* at the mid-point of which is an axis of rotation *r* extending parallel to the planes of the frames. Such a system has the advantage of being substantially free of "night effect" and polarization errors, because it can be rotated about its axis until a phase balance is obtained between the signals on (or from, in the case of reception) the two frames. It has the defect, however, that, as a result of the radiation (or reception) patterns (polar diagrams) of the two frames, there will be undesired minimum signal directions in addition to the desired directions which are along a line perpendicular to the diameter. The present invention seeks to avoid this defect.

According to this invention, a radio directional system comprises at each of the opposite ends of a diameter, a pair of crossed directional aerials, means for rotating the whole aerial system thus constituted about an axis passing through the mid-point of said diameter, and means for modulating carrier energy on (or, in the case of reception, from) the aerials with the same modulating frequency but in such manner that when two aerials—one in each pair—gives maximum output the others give zero output (and vice versa) the cross aerials of each pair being so arranged that the combined ground wave or sky wave outputs from (or in the case of a receiver, inputs to) the two pairs of aerials falls to zero only along a line at right angles to said diameter. The arrangement of the aerials in each pair will be different according to whether it is desired to secure elimination of the undesired minima as respects ground waves or as respects sky waves; i. e., in the case of a transmitter, as to whether long distance transmission is to be effected, to receivers outside the "skip distance" (here obviously, it will be a question of sky waves) or short distance transmission is to be effected to receivers where, though the wave reflected from the ionosphere may be present, the ground wave will predominate. The latter case is of particular interest for ultra-short wave systems.

Where the system is required for sky wave working the aerials of each pair are mutually perpendicular and mounted with a common horizontal diameter perpendicular to the diameter between the pairs, each aerial of a pair being at 45° to the common axis of rotation.

Where the system is required for ground wave working the aerials of each pair are again perpendicular but the plane of one is parallel to or coincident with a plane passing through both the axis of rotation and the diameter between the pairs, the common diameter of either pair being parallel to the axis of rotation.

In Fig. 2 of the accompanying drawings which illustrates diagrammatically an embodiment of a transmitting system for sky wave working, there are two pairs of frame aerials, *a*, *b*, and *a'*, *b'*, one pair being at each end of a diameter *d* through whose mid-point passes a vertical axis *r* for the system as a whole.

The two frames of a pair are mounted with a common horizontal diameter *hd* perpendicular to the line joining the opposite pairs of frames, and with the planes of the frames (e. g. *a*, *b*,) constituting one pair mutually perpendicular and inclined at 45° to the vertical V. For this aerial system there is employed a transmitter (as shown in Fig. 8 for example) with a common carrier drive driving two separate identical output stages each capable of independent modulation. One output stage feeds two parallel aerials *a*, *a'* (or *b*, *b'*)—one in each pair—and the other feeds the others. Both are modulated by the same audio frequency—e. g. 500 cycles per second—but by alternate half waves thereof in such manner

that when one gives full H. F. output, the other is inoperative and vice versa. This is represented conventionally in Fig. 3 of the accompanying drawings where A, B, C, represent respectively the high frequency outputs and the audio frequency. This may be accomplished by the apparatus shown in Fig. 9 where the output from the H. F. oscillator is applied through a separate mixer and amplifier to each of the pairs of aerials. The modulation is applied directly to one of the amplifiers and is applied through a phase inverter to the other amplifier. With this arrangement, owing to the mutual perpendicularity of the frames in each pair, only one pair can give a "false zero" at a position, and the effect of this will be noticeable in a receiver merely as a change in the received tone and not as a fall to zero. This is represented conventionally in Fig. 4 of the accompanying drawings where A represents the signal heard on a receiver except at the true zero position when the signal will fall to zero, and B represents change in the received tone and not a fall to zero.

In Fig. 5 of the accompanying drawings, which illustrates diagrammatically in elevation an embodiment of transmitting system for ground wave working, each pair of frames is somewhat differently arranged. Two frames *a* and *a'*—one in each pair—are mounted with their planes vertical and perpendicular to the line *d* joining their centers, while the other frames *b* and *b'* are mounted with their planes vertical and with their horizontal diameters coincident with the line *d* joining their centers. The transmitter and feed arrangements are as in the first embodiment.

The above described embodiments may be modified for reception by taking the output from two parallel aerials (one in each pair) through one mixing and phasing circuit to one H. F. amplifier and the output from the other aerials through another mixing and phasing circuit, to another H. F. amplifier. The H. F. amplifiers are modulated as in the transmitting system, but in place of a sinusoidal audio frequency modulation, a square wave form at a supersonic frequency illustrated conventionally in Fig. 6 of the accompanying drawings, is preferably used. The outputs from the H. F. amplifiers are taken to a common receiver proper as shown in Fig. 10.

Fig. 7 illustrates conventionally the amplitude of modulation in the incident wave (A), the signal passing through the receiver when, e. g. frame *b* is at zero position (B), and the effective audio resultant in the headphones (C). The ripple in Fig. 7 (C) is at supersonic frequency and represents the residue after attenuation in L. F. circuits. The signal supplied to the receiver is a combination of the signals received on each pair of frames and will never fall to zero except at the point of true bearing when the output from both pairs of frames *aa'* and *bb'* is zero simultaneously.

I claim:

1. A directional radio aerial system comprising a diametric supporting member having an axis of rotation perpendicular thereto, a connected pair of parallel directional aerials located at opposite ends of said diametric member each in a plane perpendicular to the plane defined by said axis and said member and at an angle of 45 degrees to a plane defined by said member and perpendicular to said axis, and a second connected pair of similar parallel directional aerials located at opposite ends of said diametric member each in a plane perpendicular to both the plane defined by said axis and said diametric member and the planes defined by the first pair of aerials.

2. A system according to claim 1 in combination with a transmitter connected to drive both pairs of directional aerials, and modulating means for separately and oppositely modulating the inputs to the two pairs of aerials.

3. A system according to claim 1 in combination with a transmitter connected to drive both pairs of directional aerials, and independent modulating means for separately and oppositely modulating the inputs to the two pairs of aerials.

4. A system according to claim 1 in combination with a transmitter connected to drive both pairs of directional aerials, and a single modulating means connected through a phase inverted for separately and oppositely modulating the inputs to the two pairs of aerials.

5. A system according to claim 1 in combination with a mixing and phasing circuit in the circuit from each pair of aerials, a modulator separately and oppositely modulating the outputs from the two pairs of aerials by a square wave form at a supersonic frequency, and means for applying the modulated outputs to a common receiver.

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