April 15, 1941. K. KOSCHMIEDER 2,238,269

RADIO DIRECTION FINDER OR EMITTER

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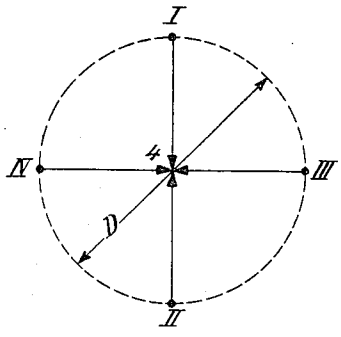

Fig.1

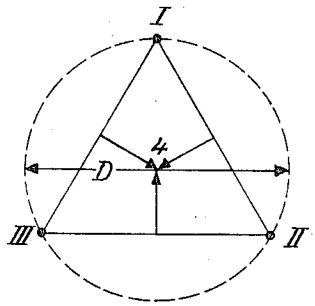

Fig.2

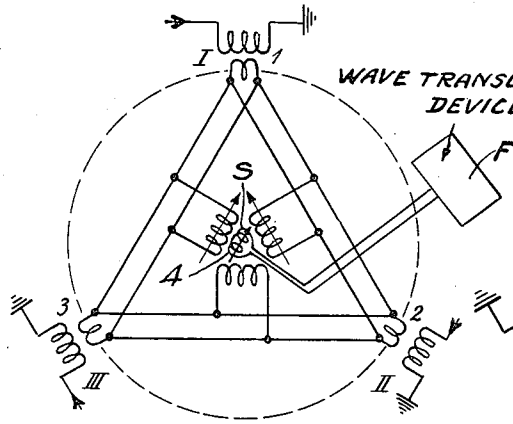

Fig.3

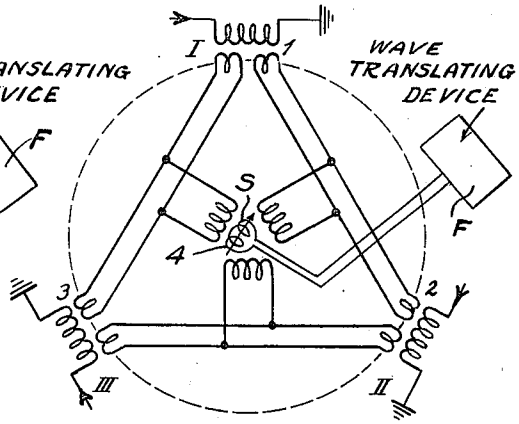

Fig.4

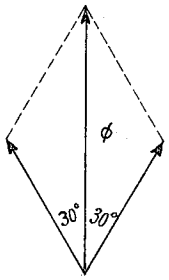

Fig.5

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RADIO DIRECTION FINDER OR EMITTER

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1 Claim. (Cl. 250—11)

The invention relates to direction finders of the kind having antennae and a radio goniometer, and it has for its object to provide for an appropriate field distribution within this goniometer. To such end the invention relinquishes the use of the two-phase goniometers employed in prior arrangements and instead makes use of three-phase or polyphase goniometers, as will be understood from the following description and be particularly pointed out in the appended claims, reference being had to the accompanying drawing in which

Fig. 1 is a purely diagrammatic plan view of a known direction finder comprising a two-phase goniometer, Fig. 2 is a view similar to Fig. 1 and illustrates the fundamental arrangement peculiar to direction finders as provided by the invention, Fig. 3 is a diagrammatic plan view of a constructional example of an arrangement constructed on the basis of Fig. 2, Fig. 4 is a view similar to Fig. 3 and shows a slight modification of the arrangement represented in Fig. 3, Fig. 5 is a vector diagram that serves to explain the function of devices of the kind illustrated in Figs. 2 to 4.

In order to prevent the so-called night effect from deflecting the beam of radio direction finders it is customary to employ arrangements of the type shown in Fig. 1. The aerial system represented in Fig. 1 is of the Adcock type, comprising four antennae I, II, III, IV arranged in the angles of a square, the plane common to antennae I, II thus being normal to that of the antennae III, IV. The electromagnetic field within the goniometer, positioned at **4**, is here produced by two vectors which are normal to each other. This two-phase arrangement has the drawback that the antennae must be disposed on the circumference of a circle of a large diameter D in order to obtain sufficiently high receiver input voltages thus to insure sharpness of direction finding. Another disadvantage is that the field within the two-phase goniometer here employed, and in which the well known search coil is turned, is not uniform, this entailing deviations from the true direction which are designated as coupling errors. Furthermore, such two-phase arrangement is in certain cases, e. g., on board an aeroplane, not easy to erect.

The present invention provides three or more antennae connected in opposition to each other, thus causing compensating currents to flow in the goniometer coils. These currents are proportional to the differential voltages that arise in consequence of phase differences.

The most important advantage of the novel arrangement is that while the diameter thereof may be the same as in prior devices yet higher input voltages and thereby a greater sharpness of direction finding are insured than has been the case heretofore. In other words, with the same voltage relationships the novel arrangement may be of smaller diameter than the known devices.

In accordance with the invention, illustrated in Figs. 2 to 5 by way of example, three vertical antennae I, II, III are erected in the angles of an equilateral triangle. These antennae are interconnected in opposition to each other to constitute differential systems. Such interconnection may be accomplished with the aid of transformers **1**, **2**, **3** arranged either as shown in Fig. 3 or as shown in Fig. 4. The direction of the oncoming wave is determined by means of a goniometer **4** which in accordance with the three-phase antenna arrangement I, II, III is three-phase to, having three field coils connected in the manner represented in Figs. 3 and 4. Thus in Figs. 3 and 4 antennae I and II, and II and III, and III and I form pairs respectively, connected in opposition. In these field coils, in consequence of the differential connection of the antennae, compensation currents will flow which are proportional to the respective differential voltages. As illustrated in Fig. 5, the resultant magnetic flux ϕ is in vector fashion composed of two vectors making an angle of 60° with one another, the oncoming wave being assumed to arrive in normal direction with respect to the antenna structure II, III. Only two vectors are present at this time since the energy received in antenna II and **3** neutralize with respect to each other. For any other direction of reception except when this is perpendicular to the line formed by any one pair of antennae there will be three vectors. From this fact as compared with the usual two-phase systems an advantage results which is very important, namely, that in the case of the novel three-phase system the actual voltage is greater by the third part if both systems are of the same diameter.

A comparison of the two systems thus shows that in mine the sharpness of direction finding is greater with the same space requirements, or less space is required with the same sharpness of operation. Furthermore, the field distribution within the three-phase goniometer is more appropriate than in the case of two-phase goniometers, since in the case of a three-phase goniometer the conditions are similar to those of a

three-phase motor. The novel three-phase arrangement is of special advantage on board aeroplanes, since these too are of a somewhat triangular configuration.

Instead of three antennae associated with three goniometer coils a multiple of such three-phase arrangements may be provided. For instance, six, nine or any other suitable number of antennae may be interconnected in opposition to each other and a goniometer having the same number of coils may be associated therewith. The greater the number of antennae disposed in circular relation as receiving aerials, and the greater the number of goniometer coils, the more ideal will be the manner of receiving the transmitter field, and of producing it within the goniometer, that is to say, the less important will be the errors in direction finding as compared with those which occur in the two-phase systems. Also, arrangements as provided by the invention may comprise four antennae, for instance. These, however, are not connected in the manner adopted in two-phase systems, as in the case of the Adcock arrangement, but are interconnected to constitute a four-phase system.

While the novel antenna arrangement is described here as employed for directional reception yet in accordance with the principle of reciprocity it is to be understood that this arrangement may be rendered suitable also for directional transmission. In such case the arrangement does not act as a differential system, but is made to act as an integrating system, that is to say, the utilised voltage is not the differential voltage of two antennae interconnected in opposition to one another, but is the integration voltage thereof.

What is claimed is:

A direction finding system comprising a plurality of antennae arranged to form effectively more than two pairs, the antennae of each pair being interconnected in opposition so as to constitute a differential system, connection lines for oppositely interconnecting pairs of said antennae, transformers adapted to couple said antennae to said connection lines establishing a plurality of differential systems, a goniometer having field coils and a finder coil, the number of said field coils corresponding to the number of said differential systems, said finder coil being connected to a wave translating device.

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