

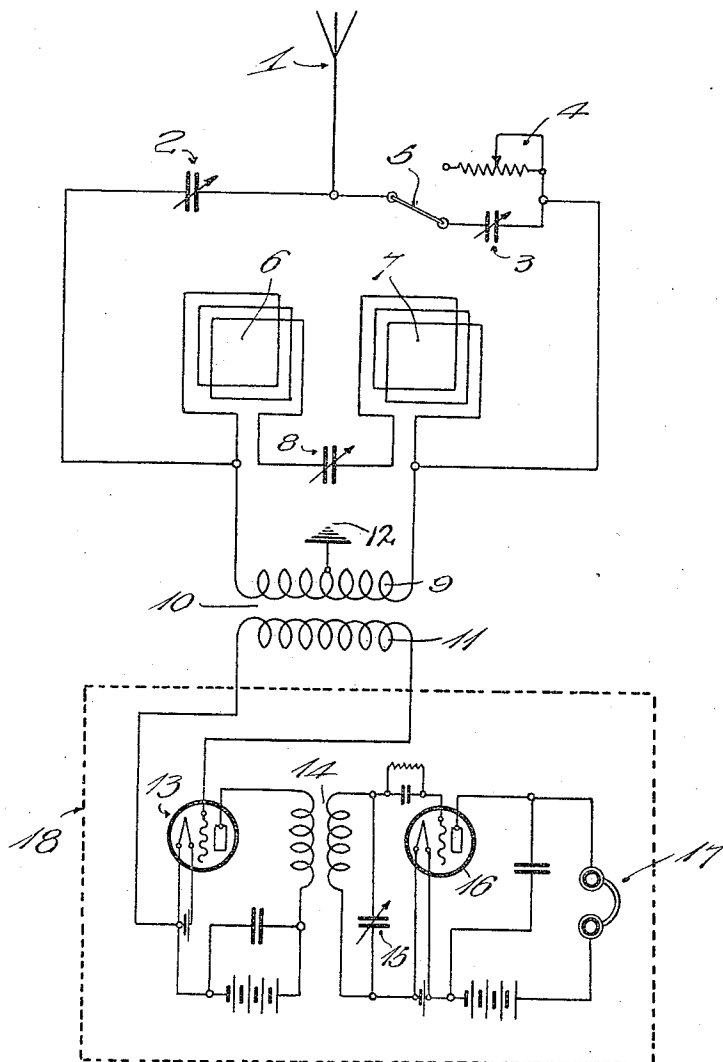
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DIRECTION FINDING SYSTEM

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# UNITED STATES PATENT OFFICE

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## DIRECTION FINDING SYSTEM

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My invention relates broadly to direction finding systems, and more specifically to antenna arrangements for direction finding systems.

5 One of the objects of my invention is to provide an antenna system in which a plurality of antennæ are interconnected and cooperate to impress signaling energy, induced into the antennæ by wave trains transmitted from one direction, upon the input  
10 circuit of a translating device.

Another object of my invention is to provide an antenna system in which a plurality of interconnected antennæ cooperate together to impress signaling energy received from one or more determinable directions upon the circuits associated with an observing device.

15 Still another object of my invention is to provide an antenna system which may be employed either in unidirectional or multidirectional reception.

A further object of my invention is to provide an antenna system which may be readily converted from a unidirectional to a bidirectional system.

25 A still further object of my invention is to provide an antenna system for use on moving craft for reception of signals and for determining the direction from which the signals approach the moving craft.

30 Other objects of this invention will be apparent to those skilled in the art to which the invention pertains from the following specification and by reference to the accompanying drawing.

35 According to this invention an antenna of a substantially nondirectional type is connected to a circuit arrangement comprising an inherently directional antenna system, a plurality of series connected condensers, a coupling transformer for transferring signaling energy from the circuit arrangement to signal translating and interpreting devices and a tuning condenser for tuning the inherently directional antenna system. The nondirectional antenna is connected to the terminals of the directional antenna system and terminals of the primary winding of the coupling transformer through the series connected condensers to permit the adjustment of the phase  
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relation between the currents flowing to opposite terminals of the directional antenna system and the primary winding of the coupling transformer and thus eliminate or partially eliminate the effects of the substantially  
55 nondirectional antenna and render the whole antenna system, which comprises the nondirectional, as well as the directional antennæ, directive in a certain direction or in certain directions. A resistance unit is connected  
60 into circuit instead of one of the series connected condensers by means of a simple switching arrangement, when it is desired to obtain an antenna system having the conventional cardioidal signal diagram.

65 Referring to the drawing, the sole figure illustrates a circuit diagram embodying a form of this invention.

In the drawing reference numeral 1 designates a vertical or horizontal antenna having substantially nondirectional characteristics. A variable condenser 2 and a switch 5 are connected to the antenna 1. A variable resistance unit 4 and a variable condenser 3  
75 are connected to contact points of the switch 5. A directional antenna, comprising the sections 6 and 7 which may be separate loop antennæ positioned adjacent to each other or portions of a split loop antenna, is connected across the primary winding 9 of the coupling transformer 10. A ground connection 12  
80 comprising a connection to the metal framework of an aircraft, ship or land vehicle upon which this system is employed, is provided at the electrical center or approximate electrical center of primary winding 9. Where the system of my invention is employed in permanent land installations, such as aircraft landing fields, any conventional ground connection may be employed. A condenser 8 is  
85 connected between sections 6 and 7 of the directional antenna and is employed for tuning the circuit of the directional antenna. The input circuit of an electron discharge device 13 is connected to the secondary winding 11 of the transformer 10. A coupling transformer 14 is connected between the output circuit of the device 13 and the input circuit of the device 16.

A tuning element 15 is connected into the  
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input circuit of device 16 and an observing device 17 which may consist of a telephone receiving device, a vibrating reed indicating instrument or any other device adapted for observing signaling energy. Any type of receiving set may be employed in conjunction with the antenna system herein described in place of the receiving set 18.

When it is desired to employ an antenna system having a bilateral signal response characteristic for the reception of signals from opposite directions, the directional antenna is oriented so that signals which it is desired to receive are received with a minimum intensity. The condensers 2 and 3 are then adjusted until the nondirectional antenna currents are balanced out as is indicated, usually by a further reduction in the signal as observed through the operation of device 17. The directional antenna comprising sections 6 and 7 is then oriented so that the observed signal is substantially zero and in this position the plane of the directional antenna will be perpendicular to the direction of the line of approach of the signal. If the directional antenna is rotated to the position of maximum signal strength the plane of the directional antenna will be in line with the direction of approach of the signals. When it is desired to obtain the heart shaped or cardioidal signal response characteristic in the antenna system and thus determine the sense of direction, the resistance 4 is connected into circuit by means of the switch 5. The capacity 2 is preferably left constant at the value employed when the antenna system was used as a bilateral system and the variable resistance unit 4 is varied to obtain the desired phase shift between the currents flowing to the terminals of the winding 9.

In employing the antenna system as a unilateral or unidirectional system it is not desirable to eliminate the total effect of the antenna 1, and the resistance unit 4 is adjusted accordingly until the maximum response is obtained from signals approaching from one direction. Once the values of capacities 2, 3 and 8 and the resistance unit 4 are adjusted for any wave length the system may be employed either in unilateral or bilateral reception by manipulating the switch 5 and connecting either the resistance unit 4, which is preferably noninductive, or the capacity 3 into circuit.

While I have described my invention in one of its preferred embodiments, I desire it to be understood that other modifications thereof may be made and that no limitations upon this invention are intended other than are imposed by the scope of the appended claims.

What I claim as new and desire to secure by Letters Patent of the United States is as follows:

1. In a direction finding system, the combination of an antenna having a substan-

tially nondirectional characteristic, a directional antenna, said directional antenna comprising a plurality of sections, a condenser connected to said sections for tuning said directional antenna, a condenser connected between said nondirectional antenna and one of the sections of said directional antenna, a resistance unit, a second condenser, means connected with said resistance unit and said last mentioned condenser for selectively connecting either said resistance or said last mentioned condenser into circuit between another one of the sections of said directional antenna and said nondirectional antenna, and a coupling device associated with the circuits of said antennæ for transferring energy therefrom.

2. In a direction finding system, a directional antenna comprising a pair of sections, a tuned circuit interconnecting said pair of sections, a non-directional antenna, a balancing condenser connected between said non-directional antenna and one of the sections of said directional antenna, a second balancing condenser, a resistor, a switch, a circuit connecting said non-directional antenna to the other of said sections of said directional antenna through said switch whereby either said resistor or said second balancing condenser may be selectively connected in said last mentioned circuit, a signal receiving circuit and means connecting said signal receiving circuit across the sections of said directional antenna.

3. In a direction finding system, a directional antenna comprising a pair of sections, a tuned circuit connecting said sections in series, a non-directional antenna, a balancing condenser connected between said non-directional antenna and one of the sections of said directional antenna, a second balancing condenser, a variable resistor, a switch, a circuit connecting said non-directional antenna to the other of said sections of said directional antenna through said switch whereby either said resistor or said second balancing condenser may be selectively connected in said last mentioned circuit, a signal receiving circuit and coupling means interconnecting said circuit and the terminals of said directional antenna.

4. In a direction finding system, a directional antenna comprising a pair of sections, a tuned circuit connecting said sections in series, a non-directional antenna, a balancing condenser connected between said non-directional antenna and one of the sections of said directional antenna, a second balancing condenser, a resistor, a switch, a circuit connecting said non-directional antenna to the other of said sections of said directional antenna through said switch whereby either said resistor or said second balancing condenser may be selectively connected in said last mentioned circuit, an output circuit connected

across said directional antenna, a ground connection approximately at the electrical midpoint of said output circuit and a receiving circuit connected with said output circuit, said antenna system being selectively connected to impart a unilateral or a bilateral characteristic to said receiving circuit.

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5. In a direction finding system, a directional antenna comprising a pair of sections, a tuned circuit connecting said sections in series, a non-directional antenna, a balancing condenser connected between said non-directional antenna and one of the sections of said directional antenna, a second balancing condenser, a resistor, a switch, a circuit connecting said non-directional antenna to the other of said sections of said directional antenna through said switch whereby either said resistor or said second balancing condenser may be selectively connected in said last mentioned circuit, an output circuit connected to said directional antenna, and a signal responsive system connected in electrical relation with said output circuit, whereby when said switch is connected to said second balancing condenser a true null setting may be obtained and when said switch is connected to said resistor a true pointing minimum setting may be obtained.

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