March 16, 1943. V. D. LANDON 2,314,093

AUTOMATIC RADIO DIRECTION FINDER

Filed June 28, 1940

Fig. 1.

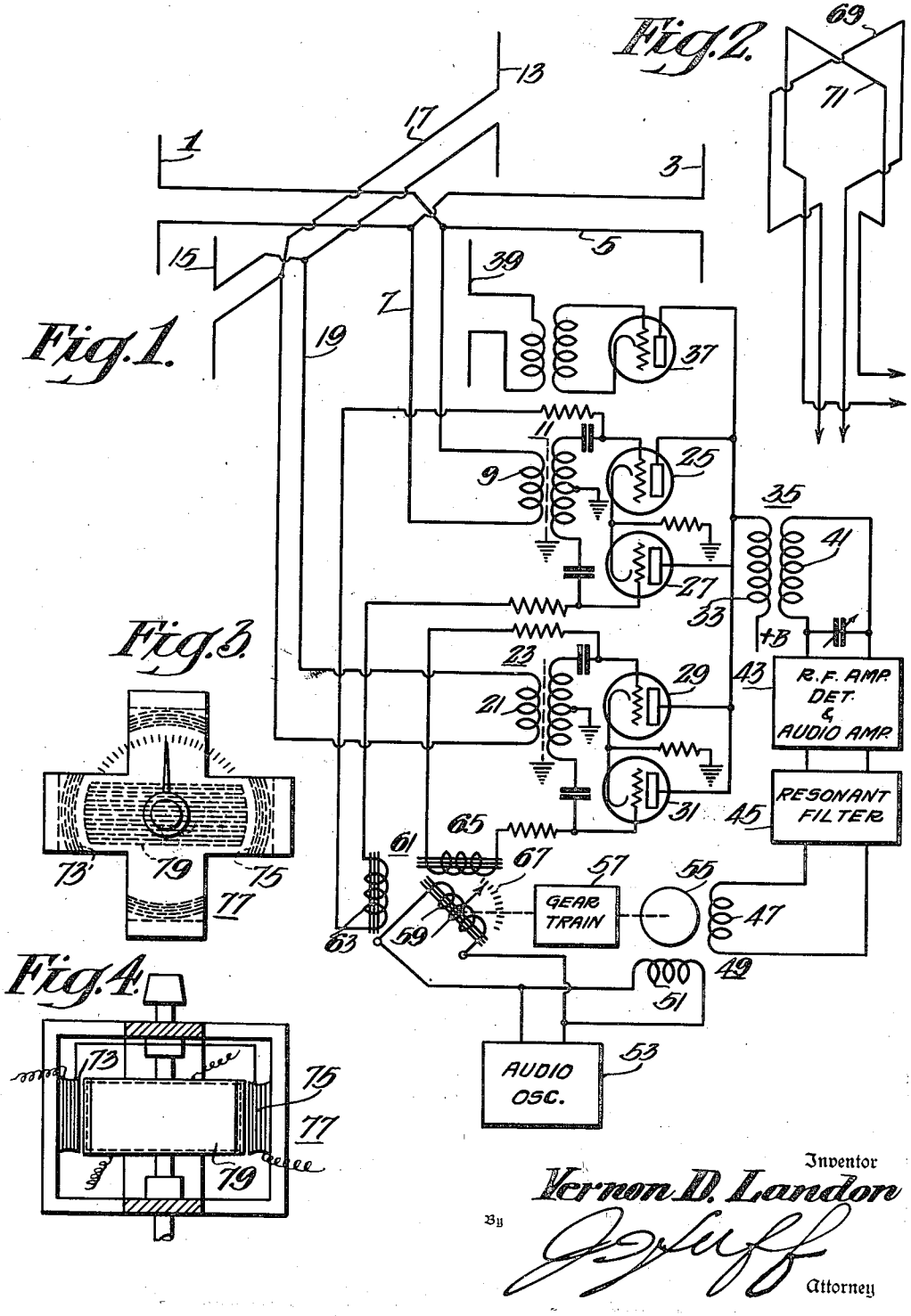


Fig. 2.

Fig. 3.

Fig. 4.

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Patented Mar. 16, 1943 2,314,093

UNITED STATES PATENT OFFICE

2,314,093

AUTOMATIC RADIO DIRECTION FINDER

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Application June 28, 1940, Serial No. 342,864

11 Claims. (Cl. 250—11)

This invention relates to radio direction finders and especially to radio direction finders of the automatic or self-orienting type in which the self-orienting mechanism includes an audio frequency goniometer.

Self-orienting radio direction finders in which the directional antenna of a radio compass is rotated automatically by a motor controlled by the received signals are known to those skilled in the art. In such devices, the rotation of an antenna of substantial size presents a problem because of the tendencies to overshoot and to hunt. If a conventional goniometer and fixed antennas are substituted for the rotating antenna, the goniometer rotator may be made small enough to reduce the overshooting and hunting problems but the radio bearings will not be as accurate because of goniometer errors.

The present invention deals with the foregoing problems by employing a novel audio goniometer in the audio frequency circuit with a circuit arrangement including an audio modulator. This device is so named because of its physical similarity to the conventional radio goniometer, the device being distinguished by its design which adapts it for operation at audio frequencies. It is one of the objects of the invention to provide means for indicating automatically the bearing of a radio wave by means of a self-orienting audio goniometer. Another object is to provide means whereby the signals from a directional antenna array may be modulated by an audio goniometer. Another object is to provide means for modulating the signals from a pair of directional antennas by an audio goniometer which is automatically oriented to modulate said signals equally to indicate the bearing of the signals.

The invention will be described by referring to the accompanying drawing in which Figure 1 is a schematic circuit diagram of an embodiment of the invention; Figure 2 is a circuit diagram of a modified antenna; and Figures 3 and 4 are views, top plan and elevation, respectively, of one form of audio goniometer.

Referring to Fig. 1, a first pair of vertical dipole antennas 1, 3 are connected by transmission lines 5, 7 to the primary 9 of a balanced transformer 11. A second pair of vertical dipole antennas 13, 15 are connected by transmission lines 17, 19 to the primary 21 of a second balanced transformer 23. The antennas, transmission lines and transformers, which preferably include electrostatic shields, are carefully balanced. The secondaries of the respective transformers 11, 23 are connected through blocking capacitors to the input circuits of equally sensitive pairs of balanced modulator tubes 25, 27, and 29, 31, respectively. The output circuits of the four tubes are connected to the primary 33 of a radio frequency transformer 35. The primary 33 is also connected to the output circuit of a radio frequency tube 37 whose input is coupled to a nondirective antenna 39.

The secondary 41 of the radio frequency transformer is connected to any suitable radio receiver 43, detector and audio amplifier. The receiver is preferably tunable to the desired frequencies and preferably includes a filter 45 which is resonant to currents of the modulation frequency. The filter 45 is connected to one field winding 47 of a two phase motor 49. The second field winding 51 is connected to an audio oscillator 53. The rotor 55 is coupled through reduction gears 57 to the movable winding 59 of an audio goniometer 61. The terminals of the winding 59 are connected to the audio oscillator 53. The fixed windings 63, 65 of the goniometer 61 are connected, through resistors to the inputs of the balanced modulators 25—27 and 29—31, respectively.

The operation of the circuits may be explained as follows: If the movable coil 59 is inducing equal audio currents in the fixed coils 63, 65 and if the antennas 1, 3 and 13, 15 are receiving waves of equal strength, the modulation signals applied to the received waves will be equal and opposite and will therefore balance out leaving only the carrier component in the receiver 43. The carrier alone will not produce the modulation signal currents and therefore the rotor 55 of the motor will not move by the current of modulation frequency. If the received waves do not apply equal currents to the antennas, unequally modulated components will modulate the carrier and will be applied to the receiver. The demodulation of these components will produce a current of the local modulation frequency, which current will be applied to the field winding 47 of the motor 49. The motor will therefore be driven in a direction determined by the phase until equal modulation components are produced. Briefly, the percentage modulation is adjusted until equal and opposite modulation components are produced in the pairs of balanced modulators. This condition is indicated by the scale and pointer 67 which may be coupled to the moving coil 59 of the goniometer. The indicator will thus assume positions corresponding to the bearing to the waves with respect to the antennas and will be bidirectional.

Instead of using pairs of vertical dipoles, a pair of crossed loops 69, 71 such as shown in Fig. 2 may be used. The leads from the loops will be connected in place of the transmission lines 7, 19 from the dipoles 1, 3, etc. It should be understood that vertical antennas may also be substituted for the dipoles.

One audio goniometer arrangement is shown in Figs. 3 and 4. The field winding is divided between the poles 73, 75 of a suitable iron core 77.

The movable core 79, which may include an iron core, is rotatably mounted within the poles 73, 75. The other field winding and its core is mounted normal to the first core, but it has not been shown in Fig. 4 to avoid confusion. The top view, Fig. 3, indicates the disposition of the cores and field windings.

Thus the invention has been described as a radio compass in which a pair of directional antennas are connected to balanced modulators. The balanced modulators are coupled through an audio goniometer to an audio oscillator. The goniometer has a motor drive which adjusts the goniometer to maintain automatically equal modulation components of the currents corresponding to the received waves. The goniometer movable coil position indicates the bearing of the waves.

I claim as my invention:

1. An automatic direction finder including a pair of directive antennas, a pair of balanced modulators, means for applying currents induced in said antennas to said respective modulators, a source of modulation current, means for applying said modulation current to said modulators to apply modulation to the antenna currents, a radio receiver connected to said balanced modulators for demodulating the currents thus applied, and means responsive to the demodulated currents for varying the application of said modulation currents to said balanced modulators to equalize the modulation components from said respective pairs of antennas.

2. A direction finder according to claim 1 including a non-directive antenna and means coupling said non-directive antenna to said radio receiver.

3. An automatic radio direction finder including a pair of directive antennas having differently oriented response patterns, a pair of balanced modulators, means connecting one of said pair of directive antennas to one of said pair of balanced modulators, means connecting the other of said pair of directive antennas to the other of said pair of balanced modulators, a radio receiver connected to the outputs of said balanced modulators, a source of modulation current, means for applying said modulation current to said modulators, said means including a pair of angularly disposed field windings and a movable winding, means connecting, respectively, said field windings and said modulators, means connecting said movable winding with said source of modulation current so that current from said source is applied to said balanced modulators and combined with currents from said directive antennas, and means in the output of said receiver responsive to the modulation components for controlling the position of said movable winding.

4. A direction finder according to claim 3 including a non-directional antenna and means coupling said non-directional antenna to said radio receiver.

5. An automatic radio direction finder including a pair of directive antennas each including a pair of vertical dipoles having differently oriented response patterns, a pair of balanced modulators, means connecting one pair of said vertical dipole antennas to one of said balanced modulators, means connecting the other pair of said vertical antennas to the other of said balanced modulators, a radio receiver connected to the outputs of said balanced modulators, a source of modulation current, a pair of angularly disposed field windings and a movable winding inductively coupled to said field windings, means connecting respectively said field windings and said modulators, means connecting said movable winding with said source of modulation current so that current from said source is applied through said windings to said balanced modulators where it combines with currents from said antennas, a two phase motor including a rotor and a pair of motor field windings, means mechanically connecting the rotor of said motor to said movable winding, means connecting one of the motor field wnidings to said modulation source, and means connecting said other motor field winding to the output of said receiver.

6. A direction finder according to claim 5 including a reduction gear for coupling said motor rotor to said movable winding.

7. A direction finder according to claim 5 including a non-directional antenna, and means coupling said non-directional antenna to said radio receiver.

8. An automatic radio direction finder including a pair of directive antennas each including a pair of dipoles having differently oriented response patterns, a pair of balanced modulators, means connecting one of said pair of dipoles to one of said balanced modulators, means connecting the other of said pair of dipoles to the other of said pair of balanced modulators, a radio receiver connected to the outputs of said balanced modulators, a source of modulation current, a pair of angularly disposed field windings and a movable winding in coupling relation thereto, means connecting, respectively, said field windings and said modulators, means connecting said movable winding with said source of modulation current so that current from said source is applied to said balanced modulators and combined with currents from said antennas, and means in the output of said receiver responsive to the modulation components for controlling the position of said movable winding.

9. An automatic radio direction finder including a pair of directive antennas each including a loop, said loops having differently oriented response patterns, a pair of balanced modulators, means connecting one of said loops to one of said balanced modulators, means connecting the other of said loops to the other of said pair of balanced modlators, a radio receiver connected to the outputs of said balanced modulators, a source of modulation current, a pair of angularly disposed field windings and a movable winding in coupling relation thereto, means connecting, respectively, said field windings and said modulators, means connecting said movable winding with said source of modulation current so that current from said source is applied to said balanced modulators and combined with currents from said antennas, and means in the output of said receiver responsive to the modulation components for controlling the position of said movable winding.

10. A direction finder according to claim 8 including a non-directional antenna, and means coupling said non-directional antenna to said radio receiver.

11. A direction finder according to claim 9 including a non-directional antenna, and means coupling said non-directional antenna to said radio receiver.

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