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RADIO DIRECTION FINDER

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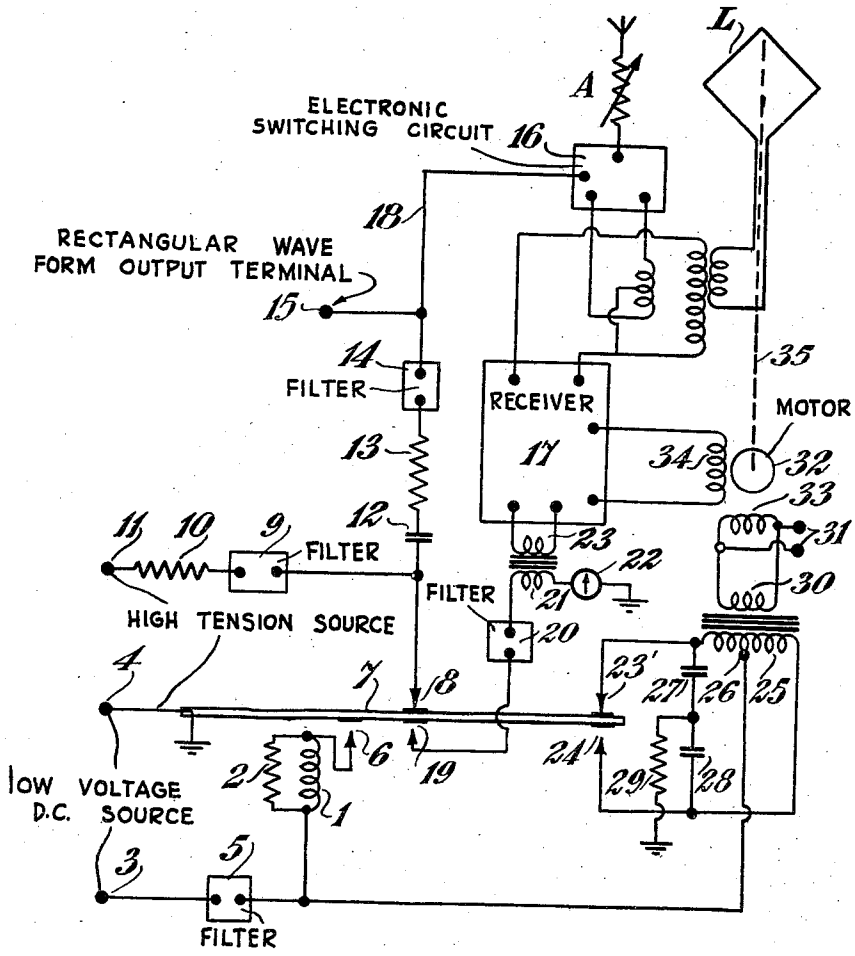

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RADIO DIRECTION FINDER

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8 Claims. (Cl. 343—117)

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This invention relates to radio direction finders and more specifically to radio direction finders of the so-called "switched cardioid" type. In this well known type of radio direction finder the receiver proper is fed with the combined signals from a directional aerial system of variable directivity (usually, though not necessarily a loop aerial) and from a non-directional aerial system (usually an open aerial) the sense of combination being reversed at, a predetermined frequency (the so-called cardioid switching frequency) in synchronism with a corresponding switching of the output circuit of said receiver so that an indicator fed with said switched output will give an indication of "course" error. Usually the indicator is a central zero instrument which deflects to left or right in dependence on the sense of the "course" error and reads zero when the incoming signal direction and the orientation of the directivity of the directional aerial or system coincide.

The invention seeks to provide improved and simplified means for providing or controlling the necessary input and output switching in a radio direction finder of the switched cardioid type said means utilizing a more or less standardized, readily available, lightweight and small component both for providing an approximately rectangular wave form for effecting one of the two required switching operations electronically and also for itself effecting the other required switching operation mechanically. In its preferred embodiments the invention also utilizes the same component for providing an A. C. output which is at the cardioid switching frequency and is available for such purposes as operating indicator repeaters and/or automatically controlling the directivity of the directional aerial system in such manner as to provide a simple, automatic, self-orienting direction finder.

According to this invention the required synchronous input and output switching in a radio direction finder of the switched cardioid type is effected by means including an electro-magnetic vibrator the armature of which actuates a make-and-break contact forming part of a network whereby a steady potential is transformed into an approximately rectangular wave form which is then employed for effecting one of the required switching operations electronically, said armature also actuating a second make-and-break contact which is employed as a mechanical switch for effecting the other of the required switching operations.

Preferably the armature also actuates further contacts forming part of a second network whereby a steady potential is transformed into an alternating potential which is thus available for operating indicator repeaters of known form e. g. so-called Selsyn repeaters. Preferably, however, this A. C. potential is utilized in addition (or instead) to provide one phase input to a two-phase or similar motor which is employed for orienting the directivity of the loop or equivalent aerial system of the direction finder, another phase input to said motor being provided from the receiver proper. With this arrangement the two phase inputs will, of course, be of the same frequency (the cardioid switching frequency) and the motor will therefore automatically rotate the loop, or its equivalent, to the "on-course" position and will then stop since, in this position, the motor phase input from the receiver disappears.

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Preferably the second make-and-break contact actuated by the armature is employed to constitute mechanical switching means, actuated at the cardioid switching frequency, for securing response of the indicator substantially only for alternate half waves of said frequency.

The invention is illustrated in the accompanying drawing which shows in simplified diagrammatic manner, one embodiment thereof.

Referring to the drawing, in the embodiment therein illustrated there is employed an electromagnetic vibrator of the kind commonly employed, for example, in radio receivers for use on automobiles for deriving high tension anode potential from a low voltage source constituted for example by the automobile lighting and starting battery. The operating coil 1 of the vibrator is shunted by a surge limiting resistance 2 and is included as in the usual way in a circuit extending between one terminal 3 of a suitable low voltage D. C. source (whose other terminal 4 is earthed) and earth, said circuit comprising in series a smoothing filter 5, the coil 1 itself, an operating contact 6 on to which the vibratory armature 7 "makes" when released by the coil, and a portion of the said armature.

A first contact 8 adjacent the armature is connected through a suitable filter 9 and resistance 10 in series to the live terminal 11 of a high tension source (whose other terminal is earthed and therefore common with terminal 4) and is also connected through a condenser 12, resistance 13 and further filter 14 in series, to an output terminal 15 at which a square wave output is available for any purpose that may be required. It will be seen that when the armature 7 "makes" to the contact 8 the potential at the adjacent side of the condenser 12 will fall abruptly to

earth potential while when the circuit is opened at said contact the potential at the point in question rises sharply to a value determined by that of the high tension source. There is thus produced a rectangular wave from the D. C. component of which is stopped by the condenser 12 but the A. C. component of which is passed via resistance 13 and filter 14 to the rectangular wave form output terminal 15. This wave form while available, as stated, for any desired suitable purpose, is employed, in any convenient manner known per se, to control any suitable known electronic switching circuit represented by the rectangle 16 for effecting cardioid switching at the input side of the receiver 17, i. e. for reversing the sense of combination of the inputs from the direction and non-directional aerials indicated at L and A respectively. As these input circuits and the circuit details at 16 and 17 form per se no part of the invention and may be as known per se, no further description or illustration is necessary herein, the rectangular switching wave being indicated simply as fed to the circuit 16 over the lead 18.

The armature 7 also co-operates with a second adjacent contact 19 which is connected through a suitable filter 20 and the secondary 21 of a transformer to one terminal of a central zero left-right indicator instrument 22 the other terminal of which is earthed. The primary 23 of this transformer is fed with L. F. output from the direction finding receiver 17. It will then be seen that the contact 19 in conjunction with the armature 7 thus provides receiver output switching at the cardioid switching frequency in such manner as to secure response of the indicator substantially only for alternate half waves of the said switching frequency, said indicator being unresponsive at other times.

In addition to the contacts already mentioned —the operating contact 6 and the first and second contacts 8 and 19—the armature 7 is also associated with two additional contacts 23, 24 which may be termed the third and fourth contacts and between which said armature 7 vibrates. These contacts are connected respectively to the opposite ends of a transformer primary 25 having a center tap 26 connected to the "live" terminal 3 of the low voltage D. C. source through the filter 5 already mentioned. The said contacts 23, 24 are also connected through respective spark suppressing condensers 27, 28 in series with a common resistance 29 to earth. It will be seen that with this arrangement A. C. voltage at the cardioid switching frequency will appear across the secondary 30 of the transformer and this voltage is made available at terminals 31 for operating Selsyn repeaters or the like (not shown) and/or for driving a loop rotating motor and for such other purposes as may be required. Preferably, where an automatic self-orienting direction finder is required this A. C. voltage is used as illustrated to provide one phase input to a two phase loop rotating electric motor the other phase drive of which is derived from the receiver output. As shown the motor 32 which has one phase winding 33 energised from the secondary 30 and the other phase winding 34 fed from the receiver 17, rotates the frame aerial A via a mechanical drive conventionally indicated by the broken line 35. Since the energization of winding 34 will become zero when the loop A is "on course," for in this condition the receiver 17 gives a null or zero output, the loop will be automatically rotated to the "on course" position and then stop. It will be noted that an important advantage obtained with this arrangement is that, since the A. C. voltage provided by the vibrator is, in effect, an independent A. C. rigorously in synchronism with the cardioid switching frequency, bearing errors caused by the introduction of components of cardioid switching frequency into circuits other than those intended therefore are avoided.

We claim:

1. In a radio direction finder of the switched cardioid type having synchronous input and output circuit switching operations, the combination of an electromagnetic vibrator having a vibratory armature, an approximately rectangular wave form producing network including a steady potential source, and a first make-and-break contact actuated by said armature, an electronic switching circuit connected to effect one of said switching operations, a circuit connecting said network with said switching circuit to control the same in accordance with the approximately rectangular wave forms from said network, and a second make-and-break contact actuated by the same armature and connected as a mechanical switch to effect the other of said switching operations.

2. In a radio direction finder of the switched cardioid type having synchronous input and output circuit switching operations, the combination of an electromagnetic vibrator having a vibratory armature, an approximately rectangular wave form producing network, a direct current source connected through said vibratory armature, a first make-and-break contact actuated by said armature, an electronic switching circuit connected to effect one of said switching operations, a circuit connecting said network with said switching circuit to control the same in accordance with the approximately rectangular wave forms from said network, and a second make-and-break contact actuated by the same armature for producing an alternating potential from said direct current source for effecting the other of said switching operations.

3. A radio direction finder of the switched cardioid type as set forth in claim 2 in which said second make-and-break contact connects with opposite terminals of the primary winding of a transformer system having a mid tap return to said direct current source and a secondary winding coupled with said primary winding for exciting one phase of a two phase motor, and means controlled by said first make-and-break contact for controlling the other phase of said two phase motor.

4. A radio direction finder of the switched cardioid type as set forth in claim 2 which includes a loop antenna driven by a two phase motor, a radio receiver connected with said loop antenna, a connection from said first make-and-break contact through said radio receiver for supplying alternating current to one phase of said two phase motor and a connection from said second make-and-break contact with the other phase of said two phase motor for supplying alternating current thereto at the cardioid switching frequency.

5. A radio direction finder of the switched cardioid type as set forth in claim 2 which includes a loop antenna driven by a two phase motor, a radio receiver connected with said loop antenna, a right-left indicator connected with the output of said radio receiver, a connection from said first make-and-break contact with said right-left indicator for supplying alternate half waves to

said indicator at the cardioid switching frequency, a connection from said first make-and-break contact through said radio receiver for supplying alternating current to one phase of said two phase motor and a connection from said second make-and-break contact with the other phase of said two phase motor for supplying alternating current thereto at the cardioid switching frequency.

6. Radio direction finder apparatus as set forth in claim 2 including indicator repeater means and connections for applying said alternating potential as operating potential to said indicator repeater means.

7. Radio direction finder apparatus as set forth in claim 2 including an electric motor having a plurality of phase windings said motor being coupled to the directional aerial system of said direction finder for orienting the directivity of the same, means providing one operating phase input for said motor from the receiver of said direction finder, and means providing another operating phase input for said motor from said alternating potential.

8. Radio direction finder apparatus as set forth in claim 1 in which said mechanical switch is actuated at the cardioid switching frequency, for securing response of the indicator of the radio direction finder substantially only for alternate half waves of said frequency.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,054,160	Leib	Sept. 15, 1936
2,216,708	Kolster	Oct. 1, 1940
2,276,235	Lamb	Mar. 10, 1942
2,279,021	Cooper et al.	Apr. 7, 1942
2,310,052	Bartholy	Feb. 2, 1943
2,360,810	Carlson et al.	Oct. 17, 1944