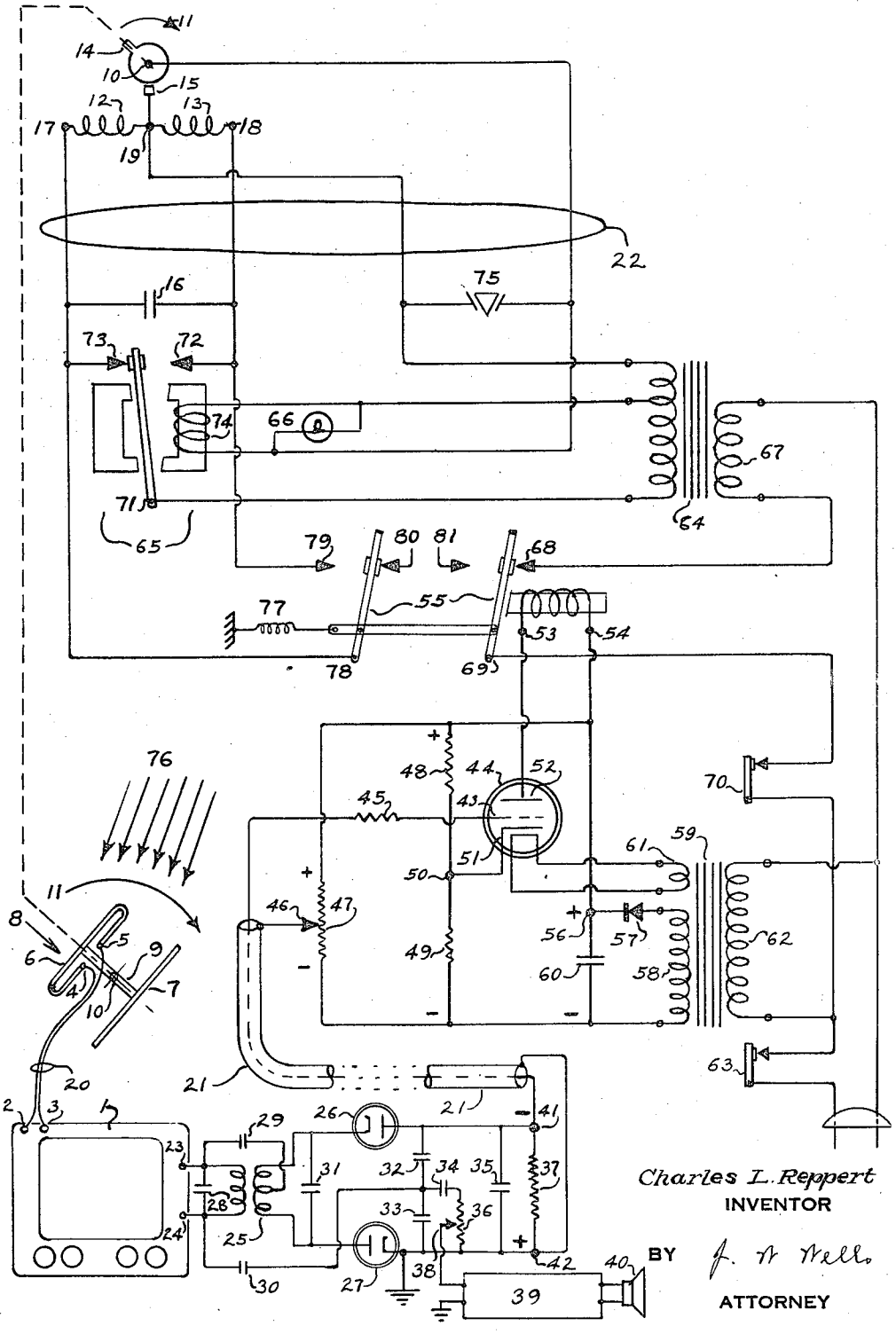
Aug. 23, 1960 C. L. REPPERT 2,950,478

AUTOMATIC ANTENNA POSITIONING UNIT

Filed March 11, 1954



Charles L. Reppert
INVENTOR

BY J. N. Wells
ATTORNEY

United States Patent Office 2,950,478
Patented Aug. 23, 1960

2,950,478

AUTOMATIC ANTENNA POSITIONING UNIT

Charles L. Reppert, 509 Perry St., Trenton, N.J.

Filed Mar. 11, 1954, Ser. No. 415,559

5 Claims. (Cl. 343—117)

This invention relates to radio receiving systems which use directional antennae of a type which may be rotated in azimuth. The functions necessary to the operation of my automatic antenna positioning unit are identical in both television receivers and radio receivers. Therefore, all remarks pertinent to the use of my invention in combination with a radio receiver are to be construed as applicable to its use in combination with a television receiver and vice versa. In the receiving systems under consideration, the antenna assembly is mounted upon the output shaft of a reduction gearing assembly on the antenna mast; the gearing being driven by a small induction motor. The motor is of the type which derives its torque from a rotating magnetic field generated by two sets of field windings. One set of windings is in series with a condenser which introduces a phase shift in the current of associated winding. The motor is reversed by switching the condenser out of the circuit of the first winding and throwing it in series with the other winding. The motor is energized and reversed through suitable switches located in a control box at the radio receiver. It is the usual practice to provide a pair of shorting contacts on the switch which turns the motor on and off; these contacts being arranged to short circuit the motor windings as soon as the power circuit is opened. The mechanical momentum of the rotating parts is then dissipated very rapidly due to the back currents generated in the shorted windings, resulting in a braking torque being applied to the rotating antenna assembly. This enables the operator of the radio receiver to stop the movement of the antenna at the moment when it is oriented to his satisfaction. Some systems of the type described are equipped with an antenna position indicator, located at the control box; others merely have an indicator lamp which lights when the antenna rotating mechanism reaches its limit of travel in one direction.

Antenna positioning systems of the type described in the foregoing are most frequently used in conjunction with frequency modulation and television receivers of the commercial broadcast type, but are applicable to any type of service in which directional antennae are used and in which accuracy of orientation of the antenna is not critical. Where a higher degree of precision is required, as in direction finding receivers, the methods of antenna positioning described are inadequate.

It is to be pointed out that orientation of the antenna for optimum signal reception is an operation entirely distinct from that of tuning the receiver to the frequency of the incoming signal. The former operation is necessary for nearly all types of reception at very high frequencies. Commercial TV and FM reception are among the services of which this is true.

Various types of radio receiving systems used in military and navigational work are equipped with rotating antennae which are made to "home on" or automatically seek out the direction of the transmitting station to which the receiver is tuned. However, these "homing" antenna

units are of necessity many times more expensive than the permissible cost of antenna systems for private entertainment service. Most homing antennae for military and navigational service depend upon detection of phase differences in the incoming signal at opposite sides of the antenna, and the use of these differences to apply a correcting torque to the antenna rotating mechanism.

One of the principal objects of my invention is to provide means which can be applied to conventional radio and television receivers with electrically rotatable antennae for automatically orienting the receiver's antenna so that the antenna's axis of maximum sensitivity is in approximate coincidence with the direction of arrival of the signal to which the receiver is tuned.

Another object of my invention is to provide a device which, once installed and adjusted, will provide proper orientation of the receiver's antenna regardless of the azimuthal location of the transmitting station to be received; this function being performed without the intercession of the operator of the receiver.

Still another object of my invention is to provide a device of the character mentioned which may be assembled out of standard non-precision electrical and mechanical instrument components, and which may be assembled, inspected and installed by persons lacking in a high degree of technical training.

A further object of my invention is to provide an automatic antenna positioning unit of the character mentioned which can obtain its control information from any point within the receiver circuit where a unidirectional electrical potential which varies with the strength of the incoming radio signal's carrier component can be found. An example of such potential is that which is developed across a resistor in an ordinary diode detector circuit; this potential, after suitable filtering, is frequently used to provide grid bias to the radio frequency amplifiers of a receiver for the purpose of effecting automatic volume (or gain) control.

Still further objects and advantages of my improved automatic antenna positioning unit will be apparent upon study of the following specification and reference to the accompanying drawings forming a part hereof, in which the figure shown is an electrical circuit schematic diagram, showing one embodiment of my improved automatic antenna positioning unit in combination with a conventional television receiver and antenna.

As already mentioned, the drawing is a schematic circuit diagram of my invention installed in a television receiver 1. The receiver input terminals 2 and 3 are connected by a two conductor transmission line 20 to terminals 4 and 5 of antenna 6 which is of the type known to the art as a "folded dipole." The antenna 6, in combination with the reflector 7, forms a unit which is highly sensitive to signals traveling in the direction indicated by arrow 8, and which is much less sensitive to signals arriving from other directions. The antenna 6 and reflector 7 are maintained in fixed relation to one another by means of supporting member 9, and the entire assembly consisting of 6, 7 and 9 is mounted upon a shaft 10 which enables said assembly to be rotated through about 365 degrees of azimuth as indicated by arrow 11.

Rotation of shaft 10 is accomplished by means of an electric motor and reduction gear assembly represented schematically by the two sets of windings 12 and 13 respectively, and the members 14 and 15, which serve the dual purposes of limiting the angular travel of shaft 10, and of closing an electrical circuit which results in the reversal of the motor assembly when the limit of travel in either direction is reached. Member 14 is affixed to and rotated with shaft 10. Condenser 16 is properly a component of the antenna motor, although it is remotely located from the latter.

The motor represented is of the capacitor start and run type, and is designed to operate on 32 volt, 60 cycle current. As shown, winding 12 is connected across the source of power, while winding 13 is connected in series with condenser 16; the series circuit formed being connected across the power supply. The direction of rotation is clockwise. If winding 13 is connected directly across the power source and condenser 16 connected in series with winding 12, the direction of rotation will be counterclockwise. If the source of power is disconnected and terminals 17 and 18 are short circuited, rotation will stop abruptly; the braking action being provided through the dissipation of back currents in the windings resulting from the mechanical momentum of the rotating assembly.

Under most circumstances the antenna assembly and the motor assembly are located at a considerable distance from the receiving set 1 and the antenna positioning unit. The antenna positioning unit is located near the receiver to which it is connected through shielded cable 21. The output of the antenna positioning unit is connected to the antenna motor assembly by means of a four conductor cable 22.

The antenna positioning unit, when operated as shown derives its input information from the D.C. potential in the receiver's audio detector; this potential being developed through rectification of the amplified incoming signal. This portion of the receiver's circuitry is shown in detail in the drawing and is typical of audio detector circuits currently in use in television and frequency modulation receivers. The remainder of the receiver is represented in block diagram form.

Terminals 23 and 24 are the output of the receiver's intermediate frequency amplifier for sound reception, and are connected to the primary winding of transformer 25, forming the input to the ratio detector. In addition to transformer 25, said ratio detector is comprised of two thermionic diodes 26 and 27, eight condensers 28, 29, 30, 31, 32, 33, 34 and 35, a potentiometer 36, and a fixed resistor 37. Potentiometer 36 serves as the sound volume control for the receiver. The slider 38 comprises the ungrounded audio output of the detector circuit, and is connected to the input of the receiver's audio amplifier 39. The amplified audio signal is then fed to the receiver's loud speaker 40, where the audio signal is converted into sound.

As a consequence to the normal operation of the ratio detector, a D.C. potential is developed between terminals 41 and 42 which is a function of the strength of the radio frequency carrier received at terminals 2 and 3. This potential at terminal 41 is negative with respect to terminal 42, and is unaffected by the audio modulation component of the signal received. Terminal 42 is grounded at the cathode of diode 27 in the receiver. Therefore, terminal 41 maintains a negative potential with respect to the grounded portion of the circuit; this potential being a function of the strength of the signal received from the antenna. It is this potential which furnishes the control information for my antenna positioning unit.

The control potential is applied to the grid 43 of a thermionic amplifier triode 44 through the inner conductor of cable 21. Isolation resistor 45 is interposed between said conductor and grid 43 to prevent undesired coupling effects between the antenna positioning unit and the receiver's detector circuit. The outer conductor of cable 21 is grounded at terminal 42, and is connected at the other end to slider 46 of potentiometer 47. Resistors 48 and 49 comprise a voltage divider with terminal 50 connected to the cathode 51 or triode 44. Potentiometer 47, resistor 48 and resistor 49 comprise a bridge circuit the purpose of which is to provide an adjustable source of bias for triode 44. The anode 52 of triode 44 is connected to terminal 53 of the winding on D.C. relay 55. Terminal 54 of the relay winding is connected to terminal 56, the plate circuit being completed through selenium rectifier 57 and secondary winding 58 of transformer 59. Transformer 59, rectifier 57 and filter condenser 60 comprise a source of D.C. power for relay 55. Amplifier triode 44, together with potentiometer 47 and resistors 48 and 49 serves as the control element for relay 55. A 6.3 volt secondary 61 on transformer 59 provides heater power for triode 44. Primary winding 62 of transformer 59 is connected to the 117 volt A.C. power line through power switch 63. The power supply delivers about 125 volts to the relay circuit. Triode 44 may be any of a number of small radio receiver tubes, such as Radio Corporation of America type 12AT7 with both triode sections connected in parallel. Transformer 64 supplies 32 volts A.C. as power for the antenna motor, and 6.3 volts for the impulse relay 65 and indicator lamp 66. The primary winding 67 is supplied with A.C. from the 117 volt power line through terminals 68 and 69 of relay 55, and through switch 70 and switch 63.

There are two functions of relay 55. The first is to energize antenna motor power circuit at all times when the signal being received by the receiving set is below a predetermined minimum, thus allowing the antenna to scan the horizon in search of a signal. The second is to shut off the motor power and short circuit motor windings 12 and 13, thus abruptly stopping the rotation of the antenna assembly as soon as a signal of appropriate strength has been received.

The function of relay 65 is to connect condenser 16 in series with winding 12 when contacts 71 and 72 are together, and to connect 16 in series with winding 13 when contacts 71 and 73 are together, thus affording means for reversing the direction of rotation when the antenna assembly reaches its limit of travel in either direction. Relay 65 is of the impulse type, requiring that winding 74 be energized for about one tenth of a second in order to perform the switching operation. The construction of the relay is such that 71 makes contact with 73 and 72 on alternate impulses.

Switch 75 is provided as means for reversing the antenna rotation manually if it is desired to do so before the limit of travel has been reached.

Indicator lamp 66 is energized simultaneously with winding 74; the resulting brief flash signaling that the antenna assembly has reached its limit of rotation and is about to reverse.

Operation of the automatic antenna positioning unit is as follows:

The receiver and the antenna positioning unit are turned on. The receiver is tuned to a station the signal of which is arriving from the direction indicated by the group of arrows 76. The antenna 6, being improperly oriented with respect to the incoming signal, fails to deliver sufficient signal to receiver 1 to provide adequate reception. Thus the potential developed across terminals 41 and 42 is low or nonexistent.

Potentiometer 47 has been previously adjusted to a point at which the negative bias on grid 43 is sufficiently low to allow triode 44 to conduct current. Therefore, the winding of relay 55 is energized, permitting 69 to make contact with 68, thus applying power to transformer 64. Transformer 64, in turn, energizes the antenna motor windings, resulting in the clockwise rotation of the shaft 10 on the antenna assembly (since condenser 16 is in series with winding 13).

As the antenna axis 8 approaches alignment with the direction of travel of the incoming signal 76, the signal strength in the receiver 1 increases, resulting in an increase of potential between terminals 41 and 42 and, consequently, an increase in negative bias upon grid 43 of triode 44. At a signal strength determined by the setting of potentiometer 47, the negative bias upon grid 43 becomes sufficiently high to prevent the flow of current between cathode 51 and anode 52 of

triode 44. Then the magnetic field of the winding of relay 55 is no longer strong enough to hold the armature against the pull of spring 77, and so the primary circuit of transformer 64 is opened, shutting off the power to the antenna motor. At the same time, contact is made between contacts 78 and 79, short circuiting the antenna motor windings 12 and 13 and assuring rapid braking action upon the antenna assembly. Since the signal strength necessary to obtain satisfactory radio and television reception yields an adequate D.C. control potential at terminal 41 of the conventional ratio detector (between three and five volts), the antenna assembly has assumed a position allowing satisfactory reception of the station selected.

Supposing that armature 71 of relay 65 had been in its alternate position (in contact with 72 instead of 73) when the antenna positioning unit was first turned on, the antenna assembly would have rotated counterclockwise until member 14 made contact with member 15, whereupon relay 65 would have been energized, moving armature 71 to contact 72, thus initiating the series of events described in the previous paragraph. Thus my automatic antenna positioning unit will orient the antenna 6 to yield satisfactory reception, regardless of the direction the desired signal is coming from.

In the few instances in which the negative side of the ratio detector is grounded instead of the positive, similar results may be obtained by reversing the connections of the inner and outer conductors of cable 21 with respect to terminals 41 and 42, adjusting potentiometer 47 so that triode 44 is nonconducting when no signal is being received and substituting contact 80 for 79, and substituting contact 81 for 68 on relay 55. Then the action of the antenna positioning unit will be the same as previously described with the following exceptions:

The unidirectional control potential furnished at terminal 42 will be positive rather than negative and, with no signal, triode 44 will be non-conducting, and the winding of relay 55 will be de-energized. Upon the arrival of an adequate signal, triode 44 will become conducting, energizing relay 55 and stopping the antenna rotation in the manner described in the preceding paragraphs.

In either of the modes of operation described, the tuning of the receiver to a station located in a new direction results in the antenna assembly resuming rotation until the new station's signal is satisfactorily received.

I claim:

1. In a radio receiving system of the character described, comprising an electrical power circuit, an electrical receiving circuit including a ratio detector circuit and a ratio detector therein, said ratio detector circuit having therein two terminal points between which negative and positive potentials, respectively, are developed, a vertically journaled directional antenna connected with said receiving circuit for transmitting signals thereto from a radio transmitter, an electrical motor having two sets of windings coupled to said antenna for rotating it in either direction, and a combination rotational stop for said antenna and reversing switch for said motor, said system also including switch means for connecting all the aforesaid circuits and elements with said electrical power circuit; means for automatically training said antenna in a direction favorable to adequate signal reception comprising, in combination, an electrically actuated relay means connected with said electrical power circuit, the windings of said motor and said combination stop and switch and including means therein capable in conjunction with the windings of said motor of reversal of rotation of said antenna upon receipt of an impulse from said electrical power circuit initiated by the closing of said combination switch at either limit of its rotation; and a second electrically actuated relay means, also connected with the electrical power circuit, an electron tube of the amplifier type having an adjustable bias means in the circuit with said second relay for controlling the supply of electric current thereto, the functioning of said tube being in response to a change in potential between said two terminal points in said ratio detector circuit as a result of a signal being received in said receiving circuit, said second relay including means for alternately switching electric power to said motor windings for rotating said antenna and short circuiting said windings thereby causing a braking force to be applied to said antenna as a result of back currents generated in said windings.

2. Means in a radio receiving system for automatically training an antenna in a direction favorable to adequate signal reception as in claim 1 in which the electron tube is responsive to the negative change in potential occurring between two terminal points in said ratio detector circuit as a result of a signal being received.

3. Means in a radio receiving system for automatically training an antenna in a direction favorable to adequate signal reception as in claim 1 in which the electron tube is responsive to the positive change in potential occurring between two terminal points in said ratio detector circuit as a result of a signal being received.

4. Means in a radio receiving system for automatically training an antenna in a direction favorable to adequate signal reception as in claim 1 and including means for manually reversing the direction of rotation of said antenna comprising a second switch means, normally open, the terminals of which are connected in shunt across the terminals of the combination stop and switch, said second switch means being momentarily closed in order to effect a reversal of direction of rotation of said antenna.

5. Means in a radio receiving system for automatically training an antenna in a direction favorable to adequate signal reception as in claim 1 and including means for manually stopping the rotation of said antenna comprising an electrical switch means connected in series with the power circuit to the motor windings, said electrical switch means being opened by hand to stop the rotation of the antenna.

References Cited in the file of this patent

UNITED STATES PATENTS

2,262,931	Guanella	Nov. 18, 1941
2,356,922	Eltgroth	Aug. 29, 1944
2,449,859	Penfold et al.	Sept. 21, 1948
2,544,653	Browder	Mar. 13, 1951
2,597,424	Znaidukas	May 20, 1952
2,701,327	Ringoen	Feb. 1, 1955