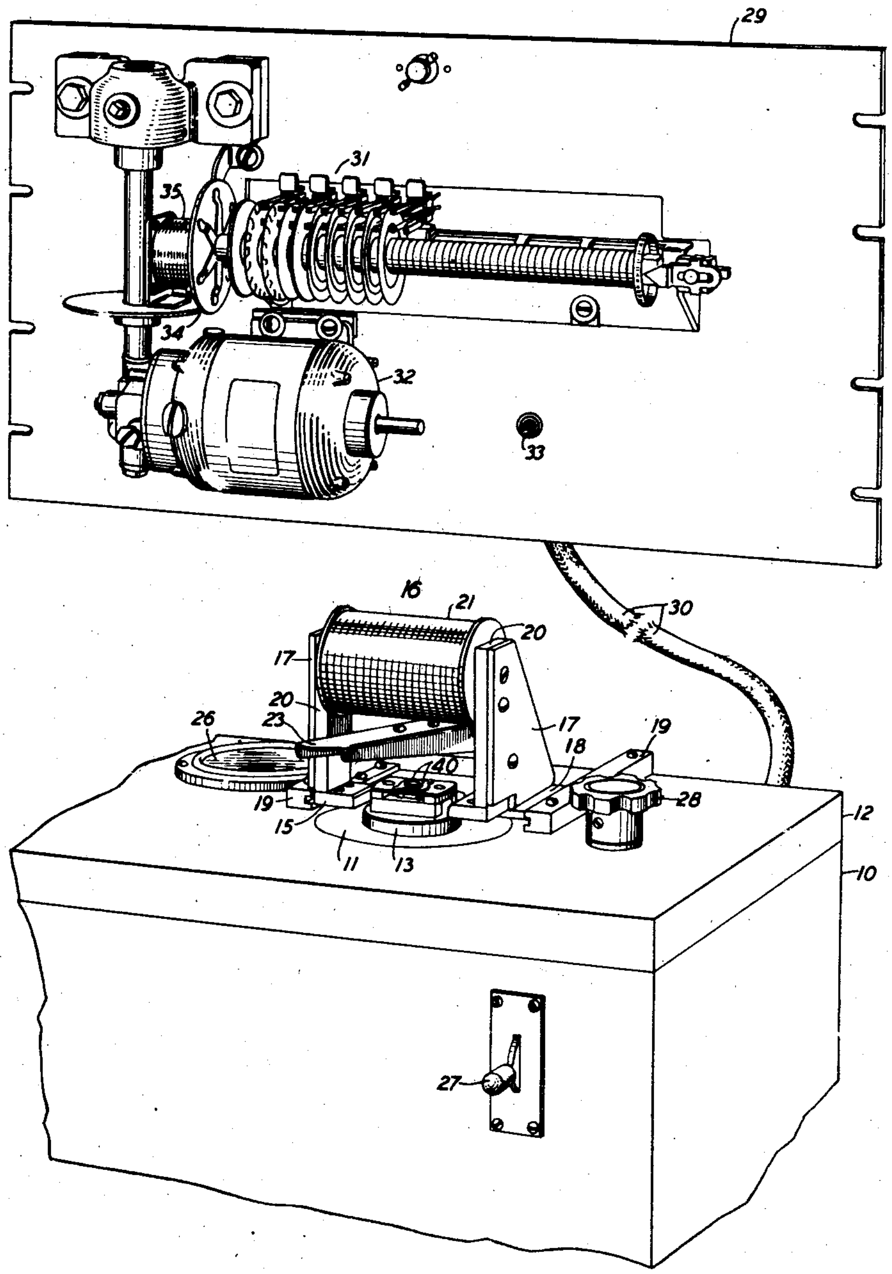
Sept. 19, 1939. W. KALIN 2,173,481

MANUFACTURE OF ELECTROACOUSTIC DEVICES

Filed Oct. 19, 1938 3 Sheets-Sheet 1

FIG. 1



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Filed Oct. 19, 1938 3 Sheets-Sheet 2

FIG. 2

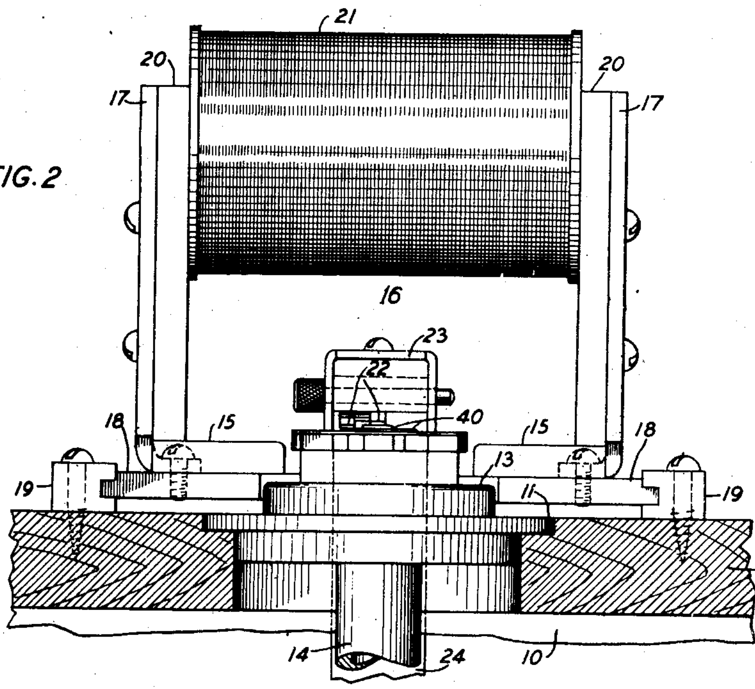
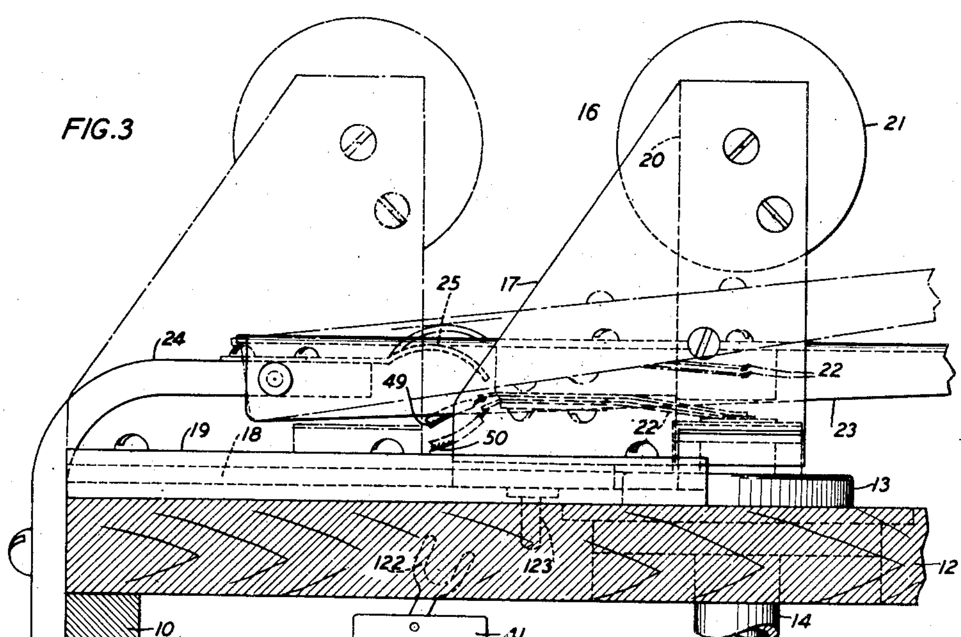


FIG. 3



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Filed Oct. 19, 1938 3 Sheets-Sheet 3

FIG. 4

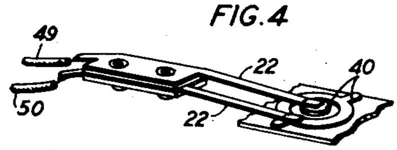


FIG. 6

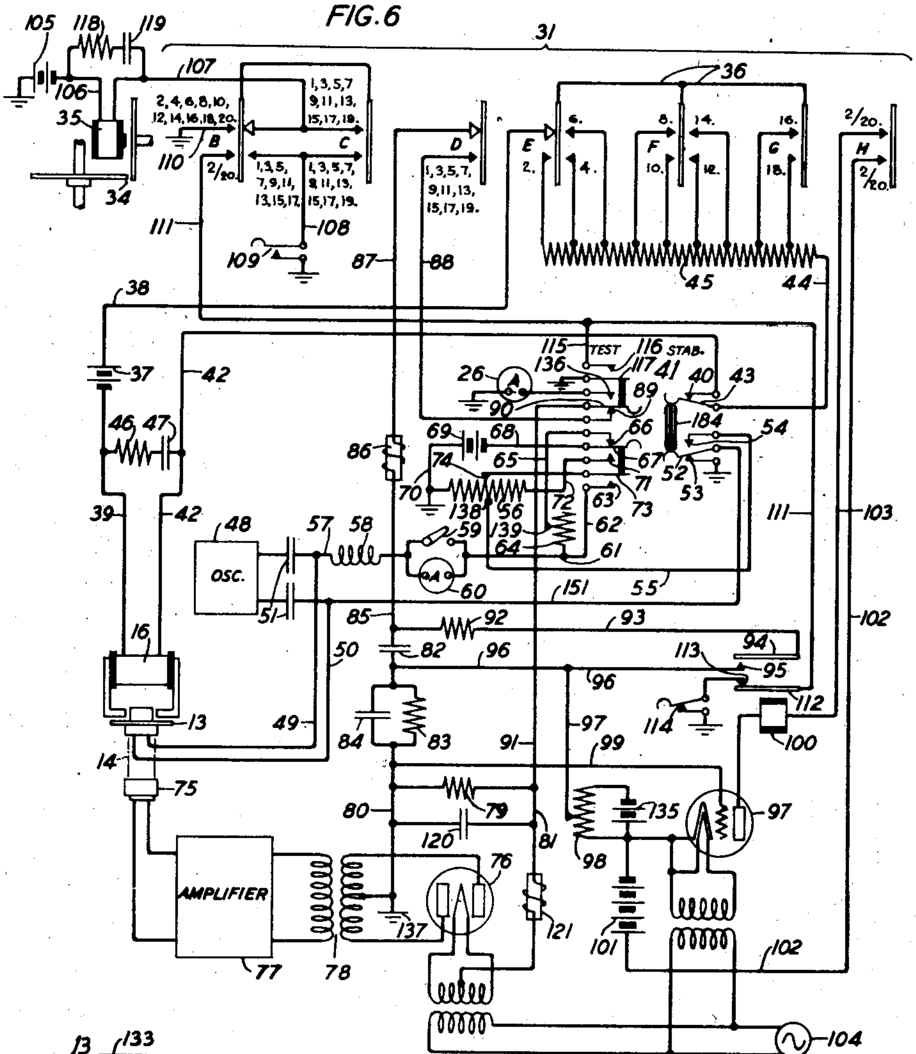
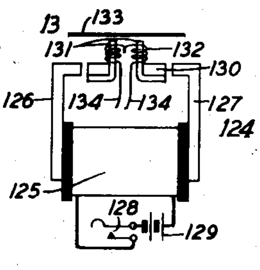


FIG. 5



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UNITED STATES PATENT OFFICE

2,173,481

MANUFACTURE OF ELECTROACOUSTIC DEVICES

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Application October 19, 1938, Serial No. 235,751

15 Claims. (Cl. 179—175.1)

This invention relates to the manufacture of electromagnetic devices and more particularly to the conditioning of electroacoustic devices, such as telephone receivers, of the permanent magnet type.

In high quality telephone receivers, such for example, as described in the applications, Serial No. 93,792, filed August 1, 1936, and Serial No. 161,936, filed September 1, 1937, of Louis A. Morrison and Edward E. Mott, an important factor in the attainment of high efficiency and uniform response characteristics is the utilization of the magnetic materials in a manner enabling realization of their maximum capabilities. It has been found highly desirable, in order that the maximum output of the receiver may be obtained, that the permanent magnet flux be stabilized within a relatively narrow range. Because of manufacturing tolerances and variations in manufacturing conditions, attainment of the optimum flux values prior to assembly of the constituent elements of the receiver is impractical and economically unfeasible.

One general object of this invention is to enable conditioning of electromagnetic devices facilely and economically.

More specifically one object of this invention is to obtain facile, expeditious and economic stabilization of the permanent magnet flux in acoustic devices, such as telephone receivers, within the range of values requisite for optimum performance characteristics.

Another object of this invention is to allow conditioning of permanent magnet acoustic devices, such as telephone receivers, after the devices have been assembled.

A further object of this invention is to obtain substantially uniform operating characteristics for a multiplicity of telephone receivers of similar construction.

In accordance with one feature of this invention, the permanent magnet or magnets of an electromagnetic device, such as a telephone receiver, is magnetized to a degree providing more flux than is requisite for maximum efficiency. The magnet is then subjected to demagnetizing forces until the optimum flux conditions are established.

In accordance with another feature of this invention, the magnet is demagnetized in successive small increments and control means are provided for automatically causing cessation of the demagnetization action when the permanent magnet flux is at substantially the optimum value.

In accordance with still another feature of the invention, actuation of the control means is effected directly in accordance with the output of the device, the permanent magnet of which is being conditioned.

The invention and the foregoing and other features thereof will be understood more clearly and fully from the following detailed description with reference to the accompanying drawings in which:

Fig. 1 is a general perspective view illustrating the construction of stabilizing apparatus for conditioning electromagnetic devices, such as telephone receivers in accordance with this invention;

Fig. 2 is a detail front view showing a portion of the apparatus of Fig. 1 and the association of a telephone receiver therewith;

Fig. 3 is a side view of the apparatus illustrated in Fig. 2, portions being shown in two positions assumed during operation;

Fig. 4 is a fragmentary perspective view illustrating the manner in which electrical connection to the receiver is established when it is in the stabilizing apparatus;

Fig. 5 is a diagrammatic view showing how a telephone receiver may be magnetized; and

Fig. 6 is a circuit diagram illustrating the electrical association of the various components of stabilizing apparatus illustrative of one embodiment of this invention.

Referring now to the drawings, Fig. 1 shows a general view of the apparatus as seen from the viewpoint of the one operating it. A box or cabinet 10 forms a convenient support for those parts of the apparatus directly under the supervision of the operator. An acoustic coupler, one head 11 of which is mounted in the top 12 of cabinet 10, conveys the acoustic output of the receiver unit 13 to a sound pick-up means such as a microphone or another receiver unit, the electrical output of which is measured by means to be later described.

As may be seen more clearly in Figs. 2 and 3 the receiver unit 13 is placed diaphragm down on the coupler head 11. A tube or duct, part of which is shown at 14, connects the head 11 to a similar head with which the sound pick-up means is associated.

The receiver for which the illustrated demagnetizer is designed is of the type having a permanent magnet in the form of a straight bar. Such a receiver is shown diagrammatically in Fig. 5 associated with a magnetizing means. The essential elements of this receiver are a permanent magnet 130 of bar type, pole-pieces 131 attached to the magnet, voice coils 132 wound on the pole-pieces and a diaphragm 133 spaced from the pole-pieces. In the complete unit, the coil leads 134 are connected to contact means, such as the contacts 40, shown in Fig. 4. The magnet 130 is usually made slightly oversize so that when fully magnetized it will furnish more flux than that required for maximum receiver efficiency.

The demagnetizing means may take the form shown in detail in Figs. 2 and 3 in which the demagnetizer is designated generally by 16. A pair of frame members 17 of non-magnetic material, such as brass or bronze, are mounted on parallel supports 18 which are fitted to slide in the side rails 19 mounted on the cabinet top 12. Supported between the frame members 17 are pole members 20 and a magnetizing coil 21. The coil 21 is wound on a suitable core of magnetic material (not shown) extending between the pole members 20. Pole-pieces 15 are attached to pole members 20 and are separated by a gap of sufficient width to accommodate the permanent magnet portion of the receiver to be stabilized. Although the demagnetizer illustrated is designed for handling receivers having straight bar type permanent magnets, the construction may be modified to accommodate receivers having differently shaped magnets.

As shown in Fig. 3, the demagnetizer is movably mounted so that it may be shifted between the operative position shown in full line and the inoperative position shown in broken line. This construction allows the receiver to be conveniently and quickly inserted and removed and also allows for checking the receivers for maximum efficiency after stabilization without magnetic interference from the demagnetizer.

Electrical connections may be made to the contacts 40 of receiver 13 by means of contactors 22, best seen in Fig. 4. Leads 49 and 50 are attached to the contactors for making the circuit connections shown in Fig. 6. The contactors 22 may be mounted on an operating handle or lever 23 which may be pivoted to a bracket 24 supported on the cabinet 10. Lever 23 may be biased to inoperative position by a leaf spring 25.

Other parts of the apparatus which may be mounted on the cabinet 10 are the meter 26, starting switch control means 27 and potentiometer knob 28, the functions of which will appear more fully in the description to follow. The cabinet 10 may be employed to house such other parts of the apparatus as may be conveniently contained therein. Connections may be made to the rest of the apparatus including that on the panel 29 by means of a multi-conductor cable 30.

Mounted on panel 29 is a sequence switch denoted generally as 31, which may be of conventional type. The one shown is driven by a motor 32 which may be controlled by a switch 33. In the embodiment shown the motor runs continuously while the set is in use, connection to the sequence switch being made by way of a clutch 34 having an electromagnetic operating means 35.

The means for magnetizing the receiver unit 13 may take any convenient form, one of which is shown diagrammatically in Fig. 5. The magnetizer 124 may comprise a coil 125 wound on a suitable core having pole-pieces 126 and 127. The receiver unit may be inserted between the pole-pieces and switch 128 closed to supply magnetizing current from a source, such as a battery 129. As has been previously noted, the receiver magnets are made over-sized so that when they are completely magnetized the receiver is over-magnetized and below its best efficiency.

The wiring diagram of Fig. 6 shows how the various elements described in the foregoing may be interconnected with other means for performing the stabilizing operation.

The cam 184 of switch 41 is shown in the position for stabilizing as indicated by the notation "STAB." When a receiver unit 13 is positioned in the demagnetizer 16 and handle 23 is depressed the receiver is connected to a source of audio frequency 48. Source 48 may be a vacuum tube oscillator or other suitable means and is connected to receiver 13 by conductors 49 and 50. Condensers 51 keep direct current out of the oscillator 48. A conductor 151 connects conductor 50 to contact 52 of switch 41. With the switch 41 in stabilizing position as illustrated, contact 52 is connected to ground through contact 53. In the alternative or test position of switch 41 contact 52 is connected to contact 54 which is connected by lead 55 to a center tap 138 of potentiometer 56. Conductor 49 is connected by lead 57 to choke coil 58, through switch 59 when closed or ammeter 60 when switch 59 is opened, to a junction point 61. The circuit branches at 61, one part going via lead 62 to contact 63 and the other through variable resistor 64, adjustable contact 138, and lead 65 to contact 66. With switch 41 in the stabilizing position as shown, the circuit is from contact 66 to contact 67 via lead 68 to battery 69, thence via lead 70 to one end of potentiometer 56 and ground. In the test position of switch 41 contact 67 is disconnected from 66 and connected to contact 71, the circuit running from 71 through lead 72 to the other end of potentiometer 56. In this position of switch 41 contact 63 connects to contact 73 which is connected to slider 74 of potentiometer 56.

The sound pick-up means 75 has its electrical output connected to a measuring circuit via a rectifier, such as the vacuum tube rectifier 76, through suitable amplifier and transformer means 77 and 78, respectively. The rectified output is applied to a resistor 79 through conductors 80 and 81. The voltage across resistor 79 is employed to charge condenser 82 by way of the following circuit: One end of resistor 79, resistor 83, condenser 82, lead 85, choke coil 86, lead 87, contacts associated with cam D of sequence switch 31, lead 88, contact 89 of switch 41, to contact 90, when said switch is in stabilizing position, lead 91, back to the other end of resistor 79.

A discharge circuit for condenser 82 may be traced as follows: One side of condenser 82, resistor 92, lead 93, contacts 94 and 95 of relay 100, lead 96, back to the other side of condenser 82.

The voltage drop across resistor 83 is applied to the grid circuit of trigger tube 97 through the following circuit: One end of resistor 93, lead 96, lead 97, variable biasing resistor 98 to the cathode of tube 97, grid of said tube and lead 99 back to the other end of resistor 83.

The anode voltage for tube 97 is supplied by a source, such as a battery 101, which has one pole connected to the cathode and the other through lead 102, contacts associated with cam H of the sequence switch 31, lead 103, coil of relay 100 to the anode. The heater is supplied with current from a suitable source 104 which also supplies current to the cathode of rectifier 76.

A source of biasing potential such as battery 135 is connected across resistor 98.

The clutch control magnet 35 receives current from grounded battery 105, through lead 106. The other side of the magnet 35 may be connected to ground through various paths during the complete operating cycle of the set. With the sequence switch in the initial or No. 1 position, this path is as follows: Magnet 35, lead 107, contacts associated with cam C, lead 108, switch 109 to ground. Switch 109 is normally biased to open position being closed only to start the sequence switch. When the sequence switch has moved to position No. 2 the ground for magnet 35 is via lead 107, upper contacts associated with cam B, lead 110 to ground. This connection is made for all even numbered positions of cam B. A further ground connection may be made to the lower contacts of cam B which are closed from positions 2 to 20, inclusive, as indicated by the notation 2/20, then via lead 111, contacts 112 and 113 of relay 100, switch 114 to ground. After the tube 97 has fired and during testing, relay 100 is in the operated condition and contacts 112, 113 are opened and an alternative ground is made from lead 111, via lead 115, contacts 116 and 117 of switch 41, to ground.

If it is desired to advance the sequence switch step by step during stabilizing, the switch 114 is opened. Since contacts 116 and 117 of switch 41 are also opened at this time there is no ground connection to conductor 111. The ground connection is therefore through upper contacts of cam B for even sequence switch positions and through contacts of cam C, lead 108, switch 109 to ground for odd positions of the sequence switch. Since switch 109 is normally biased to open position the sequence switch stops at each odd position and must be restarted by closure of switch 109.

Resistor 46 and condenser 47 are connected across the demagnetizer 16; resistor 118 and condenser 119 across magnet means 35; condenser 84 across resistor 83; condenser 120 across resistor 79; choke 86 in lead 87 and choke 121 in lead 81 to perform conventional smoothing, blocking and by-pass functions.

For convenience of operation, switch 41 is mounted adjacent the demagnetizer as shown in Fig. 3. Operating member 122 of switch 41 is mounted to cooperate with a projection or dog 123 on the demagnetizer 16 whereby said switch is operated by movement of the demagnetizer to or from its operating position. Thus when the demagnetizer 16 is moved to the forward or operating position switch 41 is positioned for stabilizing and when the demagnetizer is moved back, the switch is put in its test position.

The operation of the apparatus is generally as follows: An overmagnetized receiver 13 is placed in the coupler and the demagnetizer 16 is moved to operative position. With switch 41 in stabilizing position the sequence switch is started. On the first step audio frequency current from a source 48 is applied to the speech current coils of receiver 13. The sound output is converted into electric current by the pick-up 75, amplified at the amplifier 77 and rectified at the full wave rectifier 78, and the resulting voltage applied to charge condenser 82. In the charging circuit is the resistor 83 which is connected across the grid and cathode of the trigger tube 97. The grid is negatively biased above the critical or breakdown voltage and resistor 83 is so connected that its voltage drop during charging increases this bias.

The tube 97 may be one containing a gas, such as argon, in which the anode circuit becomes conducting only when the control electrode or grid is of a particular positive potential or less than a particular negative potential and continues to pass current even though the control electrode voltage changes. Such a tube is ordinarily made non-conducting by the opening of the anode circuit by means outside the envelope.

When the sequence switch reaches its second position, the measuring circuit is opened at the contacts associated with cam D and the demagnetizer 16 is energized by battery 37 through all of resistor 45. The resulting small current causes a partial demagnetization of the receiver magnet. Since the receiver was initially overmagnetized and consequently below peak efficiency, its output will now be greater than at the first step and on the third sequence switch step, which is a measuring step, the charge on condenser 82 will be increased. Alternate demagnetizing and measuring is continued, each successive demagnetizing step being at a higher current, due to the cutting out of portions of resistor 45 by action of cams E, F and G. A point in the demagnetizing sequence will be reached where the receiver output is no longer increased but is slightly decreased. On the next measuring step the resulting rectified voltage will then be less than that on the condenser 82 due to the charge of the previous step. The current which flows to equalize this voltage difference is in a direction through resistor 83 to reduce the grid voltage of tube 97 below the critical value so that the tube may fire. The anode current of the tube 97 operates relay 100 to stop the sequence switch and discharge condenser 82. The sequence switch is stopped due to the opening of relay contacts 112 and 113 in the then operative ground circuit for clutch operating magnet 35. This circuit it will be recalled is from magnet 35 through lead 107, upper and lower contacts on cam B, lead 111, contacts 112 and 113, switch 114 to ground. The alternative ground circuits for magnet 35 are open at this step in the operation. The condenser 82 is discharged through the previously traced circuit 82, 92, 93, 94, 95, 96, 82 by closing of contacts 94 and 95. Demagnetizer 16 is then removed from receiver 13, which shifts the switch 41 to test position by action of member 123 on switch operator 122 (see Fig. 3). Due to the closing of contacts 116 and 117 of switch 41 a ground connection to magnet 35 is made through the previously traced circuit: 35, 107, B contacts, 111, 115, 116, 117, ground, the sequence switch is restarted and proceeds to its initial position.

Closure of test contacts 99 and 136 of switch 41 establishes a circuit from ground through meter 26, contacts 136 and 99, lead 91, choke coil 121 through rectifier 76 back to ground at 137. This applies the rectified output of sound pick-up 75 to meter 26. Closing of contacts 67 and 71 in switch 41 connects center tapped potentiometer 56 across battery 69, the circuit being: 69, 68, 67, 71, 72, 56, 70, 69. Contacts 63, 73 and 52, 54 of switch 41 are also closed connecting the coils of receiver 13 between the center tap 138 and the slider 74 of potentiometer 56 over the following circuit: 138, 55, 54, 52, 151, 50, 13, 49, 57, 58, 59 (normally closed) 61, 62, 63, 73, 74.

With the foregoing test circuits established movement of potentiometer slider 74 to one side and then the other of its center position by means of knob 28, successively applies currents of opposite polarity to the receiver coils. The unidirectional field of the receiver is thus increased or reduced depending on current direction. If the receiver has been conditioned to maximum efficiency either change in magnetization will reduce the output reading on meter 26. If more than a predetermined allowable deviation from maximum efficiency is indicated on meter 26 the receiver is rejected. The receiver is then removed and the cycle repeated with another receiver.

When the sequence switch has returned to its initial or No. 1 position, the contacts associated with cam H are opened. This breaks the anode circuit of tube 97 allowing the tube and relay 100 to return to the normal or unoperated condition.

Following the foregoing procedure, the receivers will be stabilized at substantially maximum efficiency, being slightly "off-peak" on the descending side of the efficiency curve, due to the necessity of passing beyond maximum output to operate the trigger tube 97. To control the point on the efficiency curve at which the trigger tube will operate, a small direct current may be superposed on the receiver windings. This current may be applied from battery 69 through variable resistor 64, over the following circuit: ground, lead 70, battery 69, lead 68, contacts 66 and 67 (closed in stabilizing position of switch 41) lead 65, slider 139, resistor 64, junction point 61, meter 60 (switch 59 being open) choke 58, leads 57 and 49, receiver 13, leads 50 and 151, contacts 52 and 53 (closed in stabilizing position of switch 41) to ground. After slider 139 is adjusted to apply the desired current which will be indicated on meter 60, shunting switch 59 is closed and remains closed for subsequent stabilizing operations. The adjustment may be such that the tube 97 becomes conductive or fires right on the peak of the efficiency curve or slightly before maximum efficiency is reached. The latter may be desirable in the interests of stability in some receivers.

The sequence switch shown has twenty positions and seven operators or cams, designated by the letters B to H, inclusive. The small numerals adjacent each contact denote the position at which said contact is closed. The designation 2/20 has been employed to indicate that the particular contacts designated are closed for the positions 2 to 20 inclusive. Cams E, F and G of the switch 31 are connected in parallel as by conductor 36 and to a battery 37 by a common lead 38. The other side of battery 37 is connected by conductor 39 to one terminal of the demagnetizer 16, the other terminal of which is connected by conductor 42 to a contact 40 in switch 41. A cooperating contact 43 of the switch is connected by lead 44 to one end of a resistor 45. A plurality of taps are taken from resistor 45 to contacts of the scquence switch 31. These taps are so connected that advancement of the sequence switch cuts out portions of resistor 45 to apply successively higher current increments to demagnetizer 16.

The foregoing detailed description is necessarily specific to the particular details shown in the drawings, in order that the operation of the illustrative embodiment may be clear. It is believed obvious, however, that various changes in form of apparatus and manner of circuit connection may be made without departing from the invention. For example, other means such as a relay chain could be used in place of the sequence switch. In other words, various functions ancillary to the fundamental operation may be performed by suitable equivalents of the means particularly set forth. The scope of the invention is limited not by the specific disclosure but by the appended claims only.

What is claimed is:

1. Apparatus for conditioning an electromagnetic device having a permanent magnet, said apparatus comprising means for indicating the output of said device, means for demagnetizing said magnet, and means controlled by said indicating means for rendering said demagnetizing means inoperative when the output of said device is substantially at maximum value.

2. Apparatus for conditioning an acoustic device having a permanent magnet, comprising means for demagnetizing said magnet, output means connected to said device, a condenser in circuit with said output means, and means controlled by said condenser for controlling said demagnetizing means.

3. In apparatus for conditioning an acoustic device having a permanent magnet, means including an energization circuit for demagnetizing said magnet, an output circuit for said device, and means for controlling said demagnetizing means in accordance with the output of said device comprising a space discharge device, an input circuit for said device, a condenser connected in said output circuit and to said input circuit, and an output circuit for said device including means for controlling said energization circuit.

4. Means for stabilizing the magnetization of permanent magnet means, included in an acoustic device, at a point corresponding to maximum efficiency of said device, comprising means for applying constant power to said device, means for measuring the output of the device, means for changing the magnetization of the permanent magnet means to thereby adjust the efficiency of the device, and means responsive to the measuring means and connected to the means for changing the magnetization to deenergize the latter when maximum efficiency of the device is obtained.

5. A device for stabilizing permanent magnet acoustic devices comprising means for overmagnetizing a device, means for partially demagnetizing said device in successive small increments, means for applying audio frequency power to said device, means responsive to the output of said device, control means for rendering the demagnetizing means inoperative, and relay means connected between said control means and said output responsive means for stopping demagnetization at the point of substantially maximum output.

6. Means for stabilizing the magnetization of the permanent magnet means of a telephone receiver at a point corresponding to maximum receiver efficiency comprising means for applying constant power to said receiver, means for measuring the receiver output, means for changing the magnetization of the permanent magnet means to thereby adjust the receiver efficiency, and means responsive to the measuring means and connected to the means for changing the magnetization to deenergize the latter when maximum receiver efficiency is obtained.

7. Means for stabilizing the magnetic circuit of a permanent magnet telephone receiver comprising means for over-magnetizing said receiver, means for applying a current of audible frequency to the voice coils of said receiver, means coupled to said receiver for measuring its sound output, means for partially demagnetizing the overmagnetized receiver in successive small increments, relay means connected for stopping demagnetization when maximum sound output of the receiver is approximately obtained, and means operatably connecting said relay means for response to the sound output measuring means.

8. Means for stabilizing a permanent magnet type telephone receiver comprising means for overmagnetizing said receiver, means for applying audio frequency current to the voice coils of said receiver, means responsive to the output of said receiver for producing a direct current voltage varying directly with said output, magnetic means for partially demagnetizing said receiver in successive small increments, and means responsive to said direct current voltage, including a relay connected to the magnetic means, for stopping demagnetization substantially at the point of maximum direct current voltage.

9. In a stabilizing device for permanent magnet acoustic receivers, means for overmagnetizing a receiver, means including an electromagnetic demagnetizer for partially demagnetizing said receiver in small steps, means for applying electric power to said receiver, means for measuring the output of said receiver, and relay means responsive to said measuring means and connected to control the demagnetizer, said relay means being adjusted to stop the demagnetization upon a slight reduction in output immediately following the peak output.

10. A magnetic stabilization means for a permanent magnet telephone receiver comprising means for overmagnetizing said receiver, means for applying an audio frequency current to the voice coils of the receiver, means responsive to the sound output of said receiver for producing a direct current voltage that is a direct function of said output, means for applying a demagnetizing force to the permanent magnet in successively greater increments to thereby incrementally increase the sound output of the receiver to a peak and then decrease it, relay means, and means for connecting said relay means to respond to a value of the direct current voltage occurring immediately after the peak output, said relay means being connected to thereupon stop the demagnetization means.

11. A device for stablizing permanent magnet sound receivers comprising means for overmagnetizing a receiver, means for partially demagnetizing the receiver in successive small increments, means for applying audio frequency current to said receiver, means responsive to the sound output of said receiver, control means for rendering the demagnetizing means inoperative, and relay means connected between said control means and said sound responsive means for stopping demagnetization at the point of substantially maximum sound output.

12. A device for stabilizing sound receivers as defined in claim 11 in which the sound responsive means includes means for producing a direct current voltage that is a direct function of the sound output, the control means comprising an electromagnetic circuit controller and the relay means including a gas-filled electron tube of the trigger type.

13. Means for stabilizing a permanent magnet telephone receiver comprising means for overmagnetizing said receiver, means for applying audio frequency current to the voice coils of the receiver, means for measuring the sound output of the receiver, means for demagnetizing said receiver in successive small increments, control means for alternately connecting the demagnetizing means and the measuring means to the receiver, relay means responsive to the measuring means and connected to the demagnetizing means for deenergizing the latter when substantially maximum output is measured, and means for adjusting the point at which the relay means responds comprising means for applying a biasing potential to said voice coils.

14. A magnetic stabilizer for overmagnetized permanent magnet telephone receivers comprising an oscillator connected to the voice coils of said receiver for applying a constant audio frequency current thereto, a sound pick-up means, means for coupling the receiver output to the sound pick-up means, means for rectifying the output of the latter means, a condenser, a charging circuit for applying the resulting voltage to charge said condenser, electromagnetic means applied to said receiver for demagnetizing the permanent magnet, switching means including means for energizing the electromagnetic means and charging the condenser in alternate steps, means controlled by the switching means for increasing the demagnetizing effect of the electromagnetic means at each successive step to thereby incrementally increase the receiver output to a maximum and then to decrease it, resistor means included in said charging circuit, a tube of the trigger type having its control electrode connected to said resistor and its anode circuit including a relay connected to the electromagnetic means, said control electrode-resistor connection being such that the relay is operated to deenergize the electromagnetic means at the step immediately following that resulting in the maximum output of said receiver.

15. The method of stabilizing a permanent magnet acoustic device which comprises overmagnetizing said device, applying electric power to said device and measuring its sound output, while partially demagnetizing it in successive small increments, and stopping the demagnetizing when substantially maximum output is measured.

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