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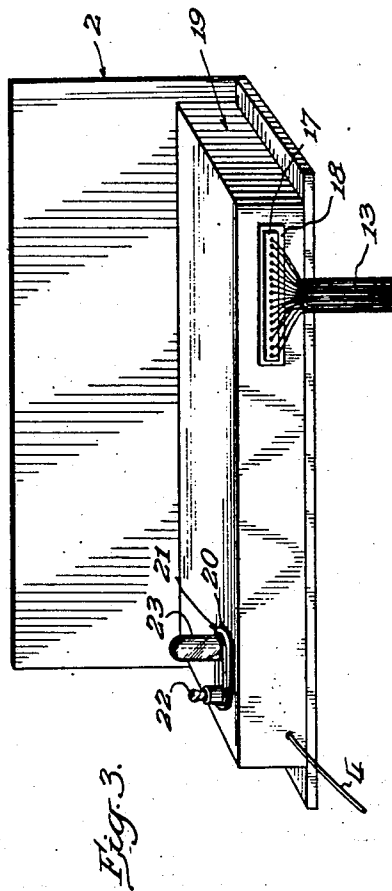
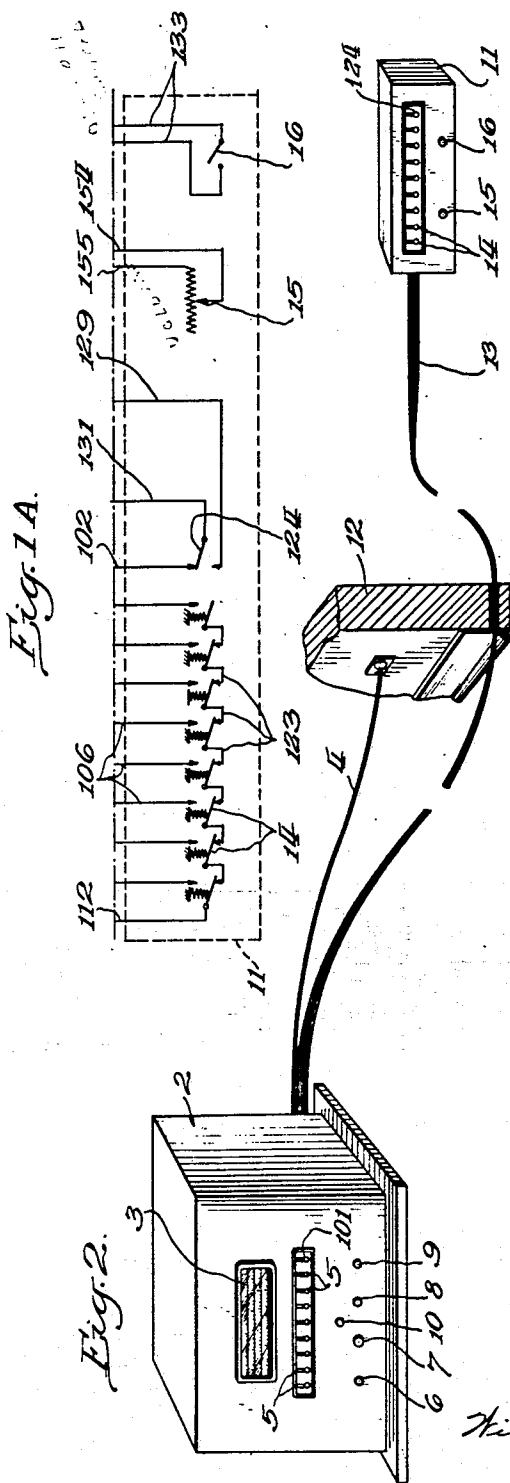
J. K. KAHN ET AL

2,223,619

REMOTE CONTROL FOR RADIO RECEIVERS

Filed July 28, 1938

2 Sheets-Sheet 2



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2 Sheets-Sheet 1

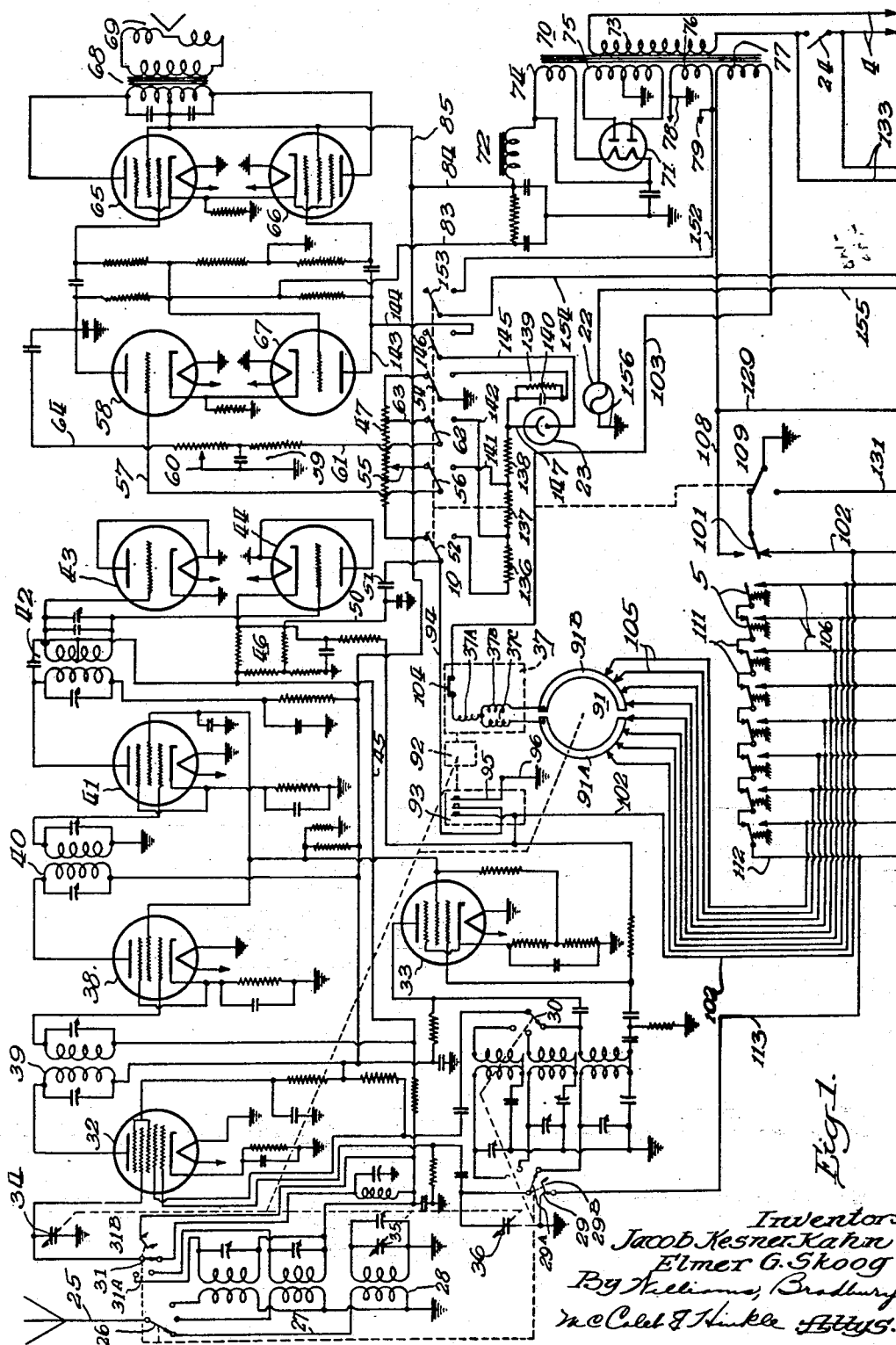


Fig. 1.

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## UNITED STATES PATENT OFFICE

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## REMOTE CONTROL FOR RADIO RECEIVERS

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8 Claims. (Cl. 250—20)

The present invention relates to the control of radio apparatus and particularly to the remote control of radio receiving sets.

The control of a radio receiving set at a point remote from the set, as well as at the set itself, has long been desired and is being utilized more and more. The control is relatively simple when only the energization of the radio is controlled, because this necessitates only the exertion of control over the power supply. However, when it is desired to control also the volume and the tuning both at the set and at a point remote therefrom, the controls become considerably more complicated and give rise to difficulties that have not heretofore been surmounted except by the use of complicated or expensive mechanical equipment.

One of the primary difficulties results from attempts to control the volume from a distance. When this control is effected through conductors extending from the remote point to a control grid of the amplifier, unstable and noisy operation results because of the excessive length of the grid connection. Attempts have been made to overcome the aforementioned difficulty by the use of combined electrical and mechanical means, but, because of the resulting increase in initial cost, the increased probability of service difficulties, etc., these have not found a widespread use. For example, remote volume control has been attempted through the use of variable resistances in the grid circuit controlled from a distance through a pawl and ratchet mechanism or reversible motor. Attempts have likewise been made to control the volume through mechanical means alone, as through the use of flexible shafts and the like, but these arrangements are expensive and also give rise to mechanical difficulties. The difficulties mentioned above are present even when the distance between the control element and the amplifier are relatively close, as in an automobile, where a flexible shaft has been used with but indifferent success.

It is the primary object of the present invention to provide a remote volume control for radio apparatus that is relatively inexpensive, easily installed, free from mechanical difficulties, and which does not deleteriously affect the operation of the apparatus.

A further object of the invention is to provide a remote volume control comprising a remotely controlled light source that is electrically independent of an impedance element associated with the radio apparatus whereby the volume may

be controlled from a remote point simply by controlling the intensity of the light source.

A more specific object of the invention is to provide a remote volume control for radio receiving apparatus which comprises a photoelectric impedance element in circuit with and located in proximity to suitable elements of the apparatus, the value of which is selectively varied by controlling the intensity of a light source associated therewith from a point remote from the apparatus.

Another object of the invention is to provide a simplified control for radio receiving sets whereby the energization, volume, and tuning may be controlled from a point remote from the set.

A still further object of the invention is to provide a radio receiving set and a remote control unit therefor so constructed that the set may be operated either in the ordinary manner by controls constructed as a unit therewith, or from a remote point by means of the control unit, which is arranged to be plugged into a suitable receptacle conveniently mounted upon the set.

Another object of the invention is to provide a radio receiving set of the type described with a selector switch whereby the circuit connections may be controlled to condition the receiver for control from either the set or the remote point.

A further object of the invention is the provision of a remote volume control which can be merchandised as a separate and optional unit, which can be readily installed in new or existing radio sets by a layman, and which involves a minimum disturbance of electrical circuits in the sets.

Other objects and advantages of the present invention will become more apparent from the ensuing description in the course of which reference is had to the accompanying drawings, in which:

Fig. 1 is a diagrammatic representation of a radio receiving set embodying the present invention;

Fig. 1A is a diagrammatic view of the wiring of a remote control unit, the wiring being a continuation of that shown in Fig. 1;

Fig. 2 is a schematic representation of the invention applied to a radio receiving set, the remote control unit being illustrated in a room separate from the one in which the set is located; and

Fig. 3 is a partial perspective view of the rear of a radio receiving set illustrating the manner in which the amplifier control unit and the con-

trol conductors are attached to the chassis of the receiving set.

In brief, the present invention consists in the utilization of a photoelectric cell in suitable circuit arrangement with the amplifier of the receiving set and adapted to be influenced by an electrically energized light source which is in turn controlled by means of a rheostat forming part of a remote control unit.

The present invention, in its broader aspects, is adapted to be used with various types of radio receiving sets but, in order better to illustrate its advantages, it has been illustrated in conjunction with a radio receiving set provided with many of the more recent improvements. For instance, while the invention has been illustrated in connection with a radio receiving set provided with an automatic volume control, it may be used quite independently thereof.

Before proceeding with the detailed description of the circuit arrangement, it may be well to outline the invention generally. If reference is had particularly to Fig. 2, it may be noted that the reference numeral 2 illustrates a radio receiving set provided with the usual dial 3 and adapted to be supplied with power through the insulated conductor 4 connected to an outlet. From the ensuing description of the invention, it will be noted that the outlet is connected to a suitable source of 110 volt alternating current.

The receiving set is further illustrated as being of the type having electric push button tuning, the various stations being selected by means of a plurality of push button switches 5, each switch being associated with a predetermined station. The receiving set is provided with the usual power and volume control switch 6, a tone control 7, a manual station selector 8, and a band switch 9. In addition to these appurtenances the receiving set is provided with a two-position switch by means of which the receiving set may be selectively conditioned for local or remote control, this switch being indicated by reference numeral 10.

When the selector switch is operated to condition the receiving set for control from a remote point, the set may be controlled from a control unit 11 which may be located at a substantial distance from the set. In Fig. 2 the control unit has been illustrated as being located in a room other than the one in which the set is located, the two rooms being separated by a partition 12. The remote control unit is connected to the receiving set by a plural conductor cable 13, the cable being made relatively flat in order that it may be run along the floor without taking up too much space.

The remote control unit 11 is provided with a plurality of push button switches 14 corresponding to similar switches 5 on the set proper and with a volume control switch 15 and a power switch 16. These controls are so arranged with the controls on the receiving set that either the former or the latter may be rendered effective upon proper operation of the selector switch 10. While illustrated as being separate, the volume control switch 15 and power switch 16 may be combined to form a single unit.

To enable the remote control to be applied to a receiving set which is preferably built ready to receive it, the various conductors comprising cable 13 are all connected to an elongated flexible plug 17 adapted to be plugged into a suitable receptacle 18 mounted upon the chassis 19 of

the receiving set, as illustrated in Fig. 3. Upon reference to this figure it may be noted that the usual tubes and controls of the set have not been illustrated. It is believed those skilled in the art will appreciate that the chassis 19 may be of any usual construction and may be modified as indicated for the reception of the plug 17.

The chassis 19 is also provided with a receptacle 20 so as to receive another plug-in type unit 21 which includes the light source 22 and the light responsive photoelectric cell 23 adapted to be influenced thereby, and forming part of the heart of the present invention. The photoelectric cell and light are both removably mounted upon sockets so that they may be replaced when necessary. The receptacles in which the plug-in units 17 and 21 are mounted have their various terminals so connected that, with the selector switch 10 in its remote control position and the plug-in units in place, the photoelectric cell is connected in circuit with the amplifier of the receiving set and so that, as the intensity of the light emanating from the lamp is varied, the volume of the receiving set is varied. The arrangement, as will appear more fully from the detailed description about to follow, is such that the remote control unit and the conductors connecting it to the receiving set are electrically independent of the amplifier circuit, thereby to eliminate the effect of any electrical disturbances upon either the remote control or the conductors.

From the wiring diagram of the receiving set, shown in detail in Fig. 1, those skilled in the art will recognize that it is a multi-range superheterodyne receiver adapted to be energized from the usual 60 cycle, 110 volt alternating current source through the conductors 4 and the power supply switch 24 which has been illustrated in Fig. 1, for purpose of clarity, as separate from the volume control switch 6 of Fig. 2. However, it should be understood that switches 6 and 24 may be and usually are combined in one unit. Further details of the power supply proper will be described hereinafter.

The multi-range superheterodyne receiver comprises an antenna circuit 25 connected to a radio frequency selector switch 26 illustrated in contact with a conductor 27 leading to a coupling circuit 28 tuned to condition the receiver for reception on the standard broadcast band. The switch 26 is adapted to be actuated simultaneously with switches 29, 30, and 31, which, together with switch 26, constitute the previously described band switch 9 of Fig. 2, and like switch 26 are shown in positions conditioning the set for reception on the standard broadcast band. The range selector switch controls, in customary manner, the circuits of the usual mixer tube 32 (type R. C. A.-6A8), and the local oscillator tube 33 (type R. C. A.-6J7). Switch 29 has a pair of contacts 29A and 29B, the latter serving also as a control for the electric tuning, it being so arranged and constructed that electric tuning is obtainable only on the standard broadcast band.

The receiving set may be tuned by means of three condensers 34, 35 and 36 joined together for operation as a unit, either manually by the knob 8 in the usual manner, or by an electric motor 37 comprising part of the electric tuning means. The position of the condensers may be controlled by the motor, in accordance with the present invention, either from the receiving set

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itself or from a remote point, all as will appear shortly.

The receiving set comprises two stages of intermediate frequency amplification. The output of the mixer tube 32 is coupled to the first stage intermediate frequency amplifier comprising the tube 38 (type R. C. A.-6K7) through a tuned transformer 39. The output of the tube 38 is coupled through a tuned transformer 40 to the input of the second stage intermediate frequency amplifier which comprises the tube 41 (type R. C. A.-6K7).

The output of the second stage intermediate frequency amplifier tube 41 is coupled through a tuned discriminator transformer 42 to a pair of three element vacuum tubes 43 and 44 (both of type R. C. A.-6J5). The tubes 43 and 44 perform the dual functions of a detector and a source of automatic gain control. The automatic gain or volume control bias potential is applied in conventional manner to the mixer tube 32 and the first stage intermediate frequency amplifier tube 38 through a conductor 45, the bias potential itself being derived from the voltage drop obtained in usual manner from a resistance network indicated generally by reference numeral 46.

The audio frequency output of the detector tube 43 is impressed across a volume control resistor 47, which has a value of approximately one megohm in accordance with usual practice. The connection of the detector output to the resistor 47 is effected by a conductor 50 having interposed therein a condenser 51 and a switch blade 52 of the two-position multi-blade selector switch 10 mentioned previously in the description of Fig. 2. The selector switch is illustrated in the position it occupies when conditioning the receiver for control from the set. In this position the opposite end of the resistor 47 is grounded through another blade 54 of the selector switch.

The volume of the receiving set is controlled in conventional manner by means of a potentiometer connection 55 (which may be made, as indicated above, a part of the combined volume and power control unit 6) leading to the upper one of two contacts associated with a third switch blade 56 of the selector switch. The connection is movable to the left to increase the volume and to the right to decrease it, in accordance with standard practice. Blade 56 is connected by a conductor 57 to the grid of a three-element audio frequency amplifier tube 58 (type R. C. A.-6J5).

The receiving set is also provided with the usual tone control indicated generally by reference numeral 59 and including a contact 60 movable by knob 7. The tone control is connected by conductor 61, a blade 62 of the selector switch and conductor 63 to the volume control resistor 47 and by conductor 64 to the plate of tube 58. The second stage of audio frequency amplification is provided by a pair of vacuum tubes 65, 66 connected in push-pull relationship. The first push-pull tube 65 is driven by the amplifier tube 58, and the second is driven through a phase reversing tube 67. This is a well-known method of supplying the second tube of a push-pull power amplifier with a voltage equal to, but opposite in phase to the exciting voltage of the first tube.

The output of the push-pull amplifier is connected to an output transformer 68, which is in turn connected to a loud speaker unit indicated by reference numeral 69.

The receiving unit per se is supplied with power from the alternating current source through the

customary power pack comprising a transformer 70, a full-wave rectifier 71 of the vacuum tube type, and a filter 72. The transformer consists of a primary winding 73 and four secondary windings 74 to 77, inclusive. The secondary winding 74 supplies a suitable potential to the filamentary cathode of tube 71 (type R. C. A.-5Z3) and the secondary winding 75 supplies suitable anode potentials to that tube. The secondary winding 76 serves as a source of low voltage current for the cathode heaters of the various tubes of the receiving set. One side of the secondary winding is grounded through conductor 78 and the other is connected by a conductor 79 to the various cathode heaters.

The secondary winding 76 also serves as a low potential source for energization of the light source 22 of the remote control, while the secondary winding 77 serves as a source of potential for the reversible tuning motor 36. The details of the remote control and electric tuning means will be discussed hereinafter after the completion of the description of the power supply. The rectified and filtered direct current output of the power pack is connected to the receiving set proper through leads 83 and 84 the former leading to the anode circuits of the first stage audio frequency amplifier and the phase reversing tubes 58 and 67, and the latter through a branch conductor 85 to the anode and screen-grid circuits of the other tubes, all in accordance with well-known principles.

The particular construction of the electric tuning means is not of particular moment, except that it should be of a type adapted to provide a dual control, i. e., from a point remote from the set and from the set itself. In the illustrated embodiment the tuning means is of a type well-known in the art, which has been modified in such manner that it may be operated at a point remote from the receiver and conjointly with the remote volume control that forms the primary feature of the present invention. The modification of the tuning control for its present purpose and the association thereof with the particular remote volume control to be described forms an ancillary feature of the invention.

The electrical tuning means, illustrated for greater part diagrammatically only, comprises the previously mentioned reversible motor 37 which may be of the single phase shaded pole type adapted to drive a commutator 91 and the ganged tuning condensers through a clutch 92. The commutator comprises a pair of substantially semi-circular segment contacts 91A and 91B through one or the other of which the main motor winding 37A and either of the auxiliary windings 37B and 37C may be energized to effect rotation of the condensers to predetermined positions. The commutator is, according to usual custom, rotatable directly with the condensers so that its angular position with respect to the condensers is fixed. The motor shaft is normally disengaged from the tuning condensers and commutator, but engages the latter when energized (the engagement may be effected by so constructing the motor that its rotor is moved axially when it is energized).

In order to eliminate undesirable sounds during rotation of the condensers, there is provided a silencing switch 93 adapted to be closed when the motor is energized. When the switch is closed the volume control resistor 47 is short-circuited by connecting both ends thereof to ground. One end of the resistor, it may be remembered, is normally connected to ground through selector switch

blade 54 and when switch 92 is actuated, the opposite end thereof is connected to ground through a circuit including the conductors 94, 95 and 96.

The selective energization of the motor is controlled by one of the station selector push-button switches 5 and a master push-button switch 101, which together constitute what may be termed local tuning control, inasmuch as it is built as a component part of the receiving set. This local tuning control may be of any well-known type and, although the construction of the switches 5 have not been illustrated in detail, they are of the type adapted to remain in a depressed position when pushed in, and, furthermore, are so arranged that when one is depressed, the others are released. However, for the purpose of illustrating the operation of the present invention, the switches 5 have been illustrated as being biased into their uppermost position by means of springs, and the switch 101 has been illustrated as of the type which must be actuated from either one of its positions to the other.

The master push-button switch 101 also serves as a means for selecting either manual or electric tuning. When manual control is desired, the switch must be operated to its depressed position—its normal position and the position in which it is illustrated. In this position it is connected to the conductor 102 leading to the silencing switch for a purpose that will be described more fully hereinafter. When electric tuning is desired, the switch is actuated into its uppermost position. In this position the switch is adapted to condition the motor 37 for energization upon closure of any one of switches 5.

The tuning motor is supplied with energy from the transformer secondary winding 77, through a circuit including, in part, a conductor 103, a thermal-responsive switch 104, the main motor winding 37A, either of windings 37B or 37C, depending upon the position of the commutator segments when one of the switches 5 is pushed in, either commutator segment 91A or 91B, a predetermined one of the plurality of conductors 105 and branch conductors 106, which lead to the push-button electric switches 5. When the master push-button switch 101 is in its uppermost position, it completes the connection of one side of the secondary winding 77 to ground through conductor 108 and a switch blade 109 that is ganged for operation with the selector switch 101. When switch blade 101 has been actuated as indicated, the motor energizing circuit is completed through a predetermined one of the push-button switches 5, a branch conductor 111 connecting the push-button switches in series, and a conductor 112 leading from the push-button switch 5 at the extreme left of Fig. 1 to a conductor 113 connected to ground through the switch segment 29B. Thus, electric tuning is possible whenever the switch 101 is in its uppermost position and the range selector switch is operated to condition the receiving set for reception on the standard broadcast band. The depression of any one of switch blades 5 completes an energizing circuit to the motor 37 through the described conductors and either commutator 91A or 91B. Once energized, the motor operates until the commutator is rotated to a point in which the circuit is broken by the break between the two segments 91A and 91B.

It should be understood that the above described receiving set proper, which, it may be remembered, is well known to those skilled in the art, may be modified by addition of features

other than those described and also by omission of some described. It is possible to realize the advantages accruing from the use of the present invention in many and varied types of receiving sets as will appear shortly from the detailed description of the invention.

The present invention, which was described briefly previously, is directed particularly to the control of radio receiving sets from a point remote from the set. In some cases the remote point may be at a considerable distance from the set, as where the remote control is exercised from a different room from that in which the set is located, or relatively near the set, as in the case of an automobile radio. Some features of the invention are capable of even wider use than that just indicated.

The remote control of the present invention is particularly advantageous in that it can be sold independently of the receiving set. The receiving set is manufactured and sold ready to receive the remote control, so that if the purchaser desires the remote control either at the time of the purchase or subsequently, it can be installed with ease. One of the features of the invention resides in its simplicity and the attendant economical manufacture, whereby the cost of the receiving set, either with or without the remote control is not appreciably increased.

The control of the present invention comprises the previously described light source, the photoelectric cell in circuit with and located in proximity to the receiver amplifier, and the remote control unit. The latter is provided with means for electrically tuning the receiving set, and volume and power control means.

Electric tuning at the remote station is accomplished by means of the station selector push button switches 14 connected in parallel to the push button switches 5 by extensions of the branch conductors 106. The energizing circuit for the motor 37 is adapted to be completed by selective closure of the push button switches 14, which correspond, both in construction and arrangement, to the switches 5. In their normal positions the switches 14 are all connected in series by the conductors 123 and they are all connected to ground through the branch conductor 112. The remote control unit is also provided with a master push-button switch 124, corresponding to switch 101 and adapted in its normal position to complete a circuit to the extension of conductor 102.

The control circuits are so arranged that the selector switch 10 has to be actuated into its displaced or remote control position before the volume and tuning controls at the remote point can be used to control the set. This operation is made possible by the switch blade 109 through which one side of the tuning motor energizing circuit is connected to ground. With the selector switch and blade 109 in their normal positions, the master push-button switch 124 at the remote control unit cannot complete the ground circuit. However, when the selector switch is in its displaced position, depression of switch 124 completes a circuit to ground through conductors 129 and 131 and switch 109.

The supply of power to the receiving set is controlled at the remote control unit by means of the power control switch 16 connected in parallel with the local power control switch 24 by a pair of conductors 133.

The remote volume control, which forms a primary feature of the present invention, comprises

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the previously mentioned light source 22 and photoelectric cell 23, the latter constituting a control element whose impedance varies in response to the intensity of the light source. The photoelectric cell is connected in circuit with a plurality of resistors 136 to 139, inclusive, and a condenser 140 which are adapted selectively to be placed in the amplifier circuit with the cell in such manner that the volume may be controlled from the remote control unit simply by varying the intensity of the light source.

When the selector switch 10 is operated to its displaced position, the switch blade 52 connects the resistors 136 to 139 to the output of the detector tube 44 in place of resistor 47. At the same time the potentiometer lead 55 is disconnected from conductor 57 and the latter is connected by switch 56 to a conductor 141 leading to the junction of resistors 137 and 138. The switch blade 62 disconnects conductors 61 and 63 and connects the former to a conductor 142 leading to the junction of resistors 136 and 137. Switch blade 54 grounds resistor 139, thereby completing the connection of the series connected resistors 136 to 139, inclusive, in the amplifier circuit in place of the resistor 47.

The photoelectric cell 23 is adapted to be activated from a source of direct current potential having a value in proximity to 90 volts. In the present embodiment this potential supply is obtained from the plate connection 143 of the phase reversing tube 67 which is adapted to be connected to the anode of the photoelectric cell by conductors 144 and 145 and a switch 146. The cathode of the photoelectric cell is connected by a conductor 147 to the junction of resistors 138 and 139 whereby the potential applied to this point from the 90 volt source may be varied by controlling the value of the impedance of the photoelectric cell. Variation of this potential in turn effects a change in the potential of the grid of the first stage audio amplifier tube 58 and a change in volume.

Energy is supplied to the light source 22 from the secondary winding 76 of transformer 70 under the control of the selector switch 10 and the volume control rheostat 15 forming part of the remote control unit. This supply circuit extends from the secondary winding 76 through conductor 152, switch blade 153 and conductor 154 to the rheostat 15 and from the latter directly through conductor 155 to one terminal of the light source 22. The other terminal of the light source is grounded at 156.

Prior to describing the operation of the remote control in detail, it might be well to review briefly the operation of the receiver itself. Assuming that the switches are all in the positions indicated, the set is conditioned for manual control at the receiving set. When the power supply switch 24 is closed, the transformer 70 is energized and power is supplied to the radio receiving set. With the range selector and control selector switches in the positions indicated, the set is conditioned for reception on the standard broadcast band and reception will be had on the frequency corresponding to the station last tuned in. At this time conductors 102 and 113 are connected to ground, the former establishing a ground connection for the receiver and the latter conditioning the electric tuning for operation upon proper actuation of the selector switch 10. Other stations may be tuned in in accordance with usual practice by manually operating the ganged tuning condensers, and the volume may be controlled

in customary manner by operation of the potentiometer 55.

When it is desired to utilize electric tuning and to tune in the various stations at the receiving set, the master push-button switch 101 is operated to its uppermost position, thereby grounding one side of the secondary winding 77 through the electric switch blade 109, as previously described. This conditions motor 37 for energization upon the depression of any one of the station selector push-button switches 5. The selected switch 5 is maintained in its depressed position until the motor 37 stops rotating, which occurs when the circuit thereto is broken at the break between the segments of the commutator. The radio is silenced during energization of the tuning motor by actuation of the switch 93, which, as previously described, acts to short-circuit the volume control resistor 47.

When it is desired to tune in some other station another push-button switch 5 corresponding to the desired station is depressed and the motor 37 again energized to operate the tuning condensers to a predetermined position.

When it is desired to control the operation of the receiving set from the remote control unit, it is necessary only to actuate the selector switch 10 to its displaced position, in which the light controlled volume control means is rendered effective. When the switch is so displaced, the supply of power to the receiving set may be controlled from the remote unit by means of the power switch 16. When the latter is closed, energy is supplied to the primary winding of the transformer 70. Energy is also supplied to the light source 22 whenever the selector switch 10 is operated to its displaced position. This results from the fact that upon such actuation switch 153 connects the light source in series with the volume control rheostat 15 across the secondary winding 76 of the transformer. The intensity of the light source is controlled by the position of the movable arm of the rheostat and, since the impedance of the photoelectric cell is dependent upon and varies with the intensity of the light directed upon it, the volume of the receiving set can be varied by utilization of the variation of the impedance of the cell to apply a variable potential to the junction of resistors 138 and 139. Variation of this potential results in a variation of the bias of the control grid of the amplifier tube 58 to effect a change in volume.

The described arrangement of the photoelectric cell in circuit with the series connected resistor is such that the higher the impedance of the cell, the greater the volume of the receiver. This results from the fact that the photoelectric cell is connected in parallel with the resistance 139 and the grid of the first stage amplifier tube 58 is connected to the junction of resistances 137 and 138 through the switch 56 and conductor 57. Consequently, when it is desired to increase the volume, it is necessary to decrease the intensity of the light source 81, and when it is desired to decrease the volume, it is necessary to increase the intensity of the light source. In other words, the volume is directly proportional to the impedance of the cell, i. e., the greater the volume the greater the impedance and, the less the volume the less the impedance. Since the impedance of the cell is inversely proportional to the intensity of the light source, the maximum volume is obtained when the light intensity is at its minimum and vice versa. However, the advantages of the

present invention could be realized from a circuit arrangement in which the response of the volume in response to changes in cell impedance and light intensity is reversed.

5 In actual practice different types of light sources and photoelectric cells have been used. Excellent results have been obtained by using a 6 volt, 32 candle power "Mazda" lamp as the light source and an R. C. A. No. 923 photoelectric cell. The values of the resistors 136 to 139 may be varied to obtain the desired range of volume attenuation. A very wide range of attenuation has been obtained by making these resistors with resistance values of  $\frac{3}{4}$ ,  $\frac{1}{4}$ ,  $\frac{1}{2}$  and 1 megohm, respectively. These values are given only for illustration and are not intended to limit the invention in any manner. The condenser 140 has a value of .25 microfarad and is provided for the purpose of eliminating a slight hum that occurred with the lamp and photoelectric cell disconnected and the selector switch 10 in its remote control position. If the total resistance of the series connected resistors is decreased to too small a value, a satisfactory minimum volume cannot be obtained and, likewise, if increased unduly the maximum volume obtainable is not satisfactory.

The response of the volume to changes in light intensity is substantially immediate. The connection of the light source to an alternating current supply does not produce, as might be supposed, any hum in the set. It appears that the light source has sufficient inertia so that the light intensity is not varied because of the use of alternating current as the source of heat. The operation of the control is substantially the same when the lamp is connected to a source of direct current, as a storage battery. The lamp may be connected directly to the 110 volt supply, if desired.

Likewise, no hum results from the fact that the anode of the photoelectric cell is connected to the plate circuit of one of the tubes comprising the push-pull amplifier. There is a slight variation in the voltage supplied to the cell, particularly when the set is first turned on, but this has no deleterious effect upon the operation.

When it is desired to tune in the various stations from the remote station, it is necessary only to actuate the master push-button switch 124 to its displaced position, thereby interconnecting conductors 129 and 131. This interconnection completes the connection of conductor 108 to ground through the switch 109, which it may be remembered, was actuated to its displaced position upon actuation of the selector switch 10. Thereafter, the desired station may be tuned in merely by maintaining the desired selector push-button switch 14 in its depressed position.

The circuit arrangement is such that the radio is silenced when the tuning motor 37 is energized from the remote control unit. This results from the fact that the series connected resistors 136 to 139 are short-circuited by means of the switch 93 in a manner identical to the short-circuiting of the volume control resistor 47. The described arrangement, furthermore, has the advantage that the automatic volume control is effective to control the volume of the receiving set when either the local or remote tuning is used.

It should be noted that the selector switch 10 has not been illustrated as controlling the power supply circuit and, consequently, the receiver can

be energized by either of power switches 24 or 16. If desired, a single pole switch could be interposed in circuit with one of conductors 133 to control that circuit. This switch could be made part of selector switch 10 and so arranged that the power supply could not be controlled from the remote control unit except when switch 10 is in its displaced position.

The particular embodiment that has been described above, may be modified to adapt it for use with various types of receivers, and it should not be considered as restricting the invention in any manner.

What we claim as new and desire to secure by Letters Patent is:

1. In apparatus of the type described the combination including, an amplifier of the type including a vacuum tube, means including a manually operable potentiometer in proximity to said amplifier for controlling the bias applied to a control electrode of said tube for controlling the volume of the amplifier, means for controlling the volume of said amplifier from a point remote from the amplifier, said last mentioned means including a fixed resistance located in proximity to said amplifier and adapted to be connected to said control electrode, a light controlled impedance element in circuit with said resistance for varying the bias applied to said electrode, a light source influencing said element and a rheostat remote from said amplifier for controlling the intensity of the light source, and selectively operable means for rendering either of said volume controlling means operable.

2. In combination, a radio receiving set comprising an amplifier of the vacuum tube type, means including a resistor in circuit with the amplifier and a potentiometer connection leading therefrom to a control electrode of a vacuum tube for controlling the volume of the amplifier at the set, means for controlling the volume of said amplifier from a point remote from the set, said means including a resistor, a photoelectric cell connected to said resistor, a source of potential for said cell, a light source, the intensity of which is variable from the remote point for influencing said cell and a source of energy for said light source, and means for selectively rendering said volume control means effective, said last mentioned means comprising a multi-pole selector switch so constructed and arranged in circuit with both said volume control means, that when the remote volume control is selected, the control electrode of the vacuum tube is connected to a fixed point of said second mentioned resistor and the photoelectric cell and light source are connected to their associated energy sources.

3. In combination, a radio receiving set comprising an amplifier of the vacuum tube type mounted within a suitable cabinet, means including a resistor in circuit with the amplifier and a potentiometer connection leading therefrom to a control electrode for controlling the volume of the amplifier at the set, tone control means including a second connection to said resistor, means for controlling the volume of said amplifier from a point remote from the set, said means including a resistor, a photoelectric cell connected to said resistor, a source of energy for said cell, a light source adapted to influence said cell, means for varying the intensity of said light source from the remote point and a source of energy for said light source, and means for selectively rendering said volume control means effective, said last mentioned means comprising

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a multi-pole selector switch so constructed and arranged in circuit with both said volume control means and the tone control means, that when the remote control means is selected, the control electrode of the vacuum tube and the tone control connection are connected to fixed points upon the resistor and the photoelectric cell and light source are connected to their associated energy sources.

4. In an amplifier system, the combination including, an amplifier of the type employing a vacuum tube comprising an anode, a cathode and a control electrode, means including a resistance having one terminal grounded and the other connected to a signal producing means and a connection intermediate the terminals leading to the control electrode for applying the signal to said amplifier, means including a connection from a point intermediate the ungrounded terminals and the said intermediate connection providing a tone control for said amplifier, and means for varying the bias potential applied to the control electrode thereby to vary the volume of the amplifier, said means including a source of bias potential, a light responsive variable impedance connecting said source to said resistance between the grounded terminal and the said intermediate connection, and a light source for influencing said impedance.

5. In combination, a radio receiving set comprising a detector stage and an amplifier stage, said amplifier stage being provided with a volume control comprising a resistor connected to the detector stage and a manually variable connection therefrom to a control electrode of a tube of the amplifier stage, a plural position selector switch built into the set for controlling the connections of said resistor to said detector stage and the control electrode to said variable connection, a socket built into the set to receive a second volume controlling means, a second socket built into the set to receive conductors forming part of a remote control unit for said second volume controlling means, and circuit connections controlled by said selector switch whereby the volume of the amplifier may be controlled from the remote control unit upon operation of the selector switch into one of its positions and the second volume controlling means and the conductors are placed into their respective sockets.

6. In combination, a radio receiving set comprising detector and amplifier stages of the

vacuum tube type mounted upon a chassis supported by a cabinet, said stages being interconnected by a potentiometer whereby the volume of the receiving set may be varied, a source of power supply for the receiving set, a two-position selector switch adapted in one of its positions to connect said potentiometer in circuit between the detector and amplifier stages and in the other to disconnect said potentiometer, sockets built into the chassis to receive a photoelectric cell and light, a third socket built into the set, and means including circuit connections between said sockets, selector switch, amplifier, and the power supply whereby the volume of the receiving set may be controlled by a remote control unit upon operation of the selector switch into its other position and placing the cell and light into their associated sockets and connecting the control unit to the third socket.

7. In a radio receiving set of the type comprising a chassis, an amplifier mounted thereon and a volume control at the set, a selector switch, a socket built into the chassis to receive a photoelectric cell and a lamp, a socket built into the chassis to receive a remote volume control unit connector, and means including circuit connections between the switch, amplifier and sockets whereby upon operation of the selector switch into a predetermined position and the cell, lamp and connector are inserted into their respective sockets, the remote volume control unit is rendered effective and the first mentioned volume control ineffective.

8. In combination, a radio receiving set comprising means for tuning the set for reception at different frequencies, manually operable means at the set for operating said tuning means, means including a set of switches at the set and a second set at a point remote therefrom and electrical means controlled thereby adapted to control said tuning means for conditioning said set for reception at predetermined frequencies, a control switch at the set and a second control switch at the remote point, each of said switches being operable into a predetermined position to render said last mentioned means effective, and a selector means at the set for rendering the control switch at the set or the remote point operative to control said tuning control means.

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