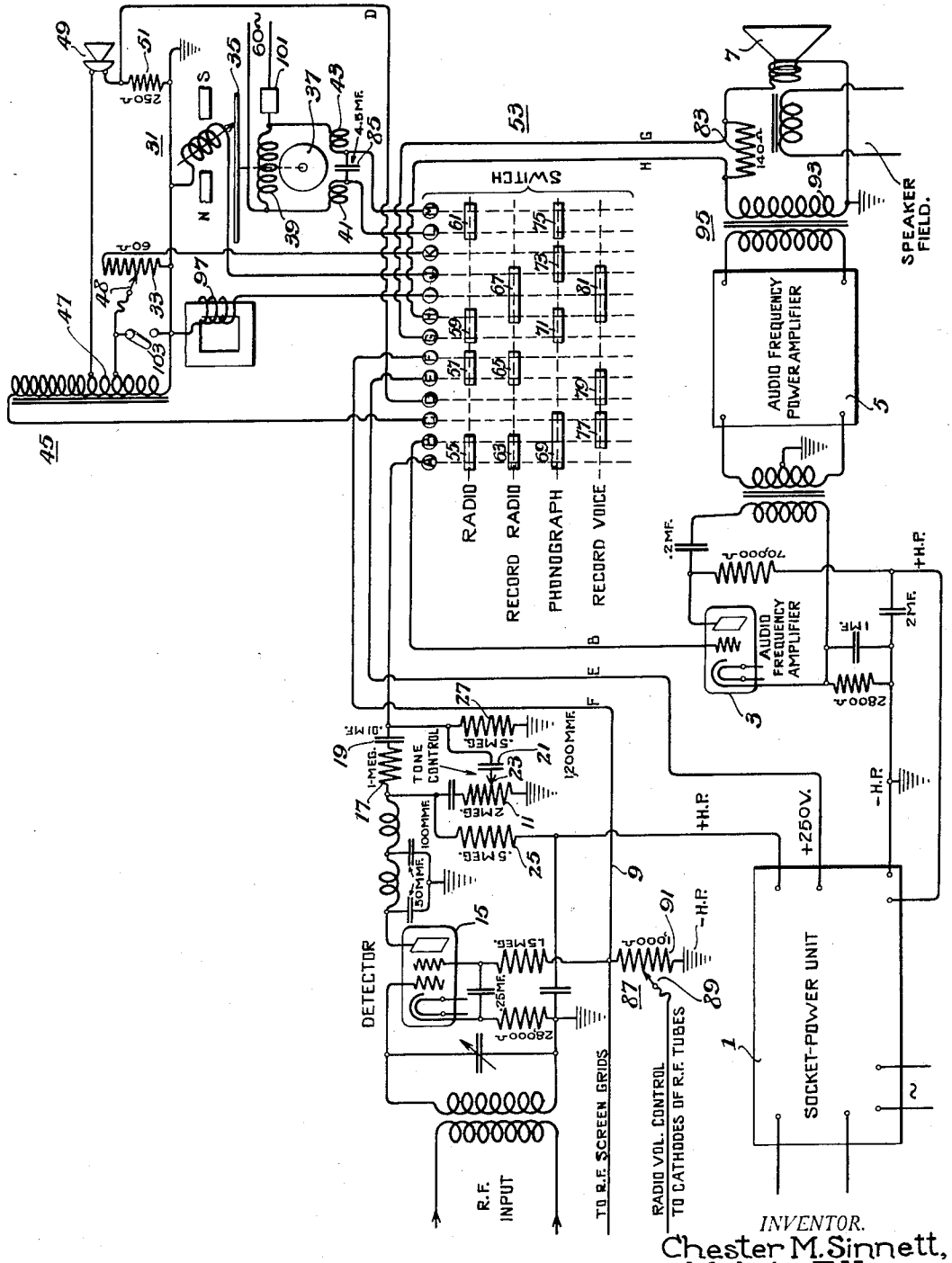
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SOUND RECORDING AND REPRODUCING SYSTEM

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SOUND RECORDING AND REPRODUCING SYSTEM

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Our invention relates to sound recording and reproducing systems and it has particular relation to home-recording systems of the general type disclosed in the patent to Goldsmith, #1,724,191.

In the patent referred to there is shown and described an arrangement for receiving radio programs, reproducing phonograph selections or recording phonograph selections derived from broadcast programs or from a local source. Switching means are included in the patented system whereby any one of the several functions thereof may, at will, be utilized and whereby the sound reproducer or loudspeaker may serve also as a microphone for recording sounds of local origin.

It may be admitted without prejudice, therefore, that the broad concept of home-recording in connection with a radio receiver was known prior to our invention. There are, however, numerous technical obstacles that must be overcome before a home-recording system, suitable for commercial exploitation under present day conditions, can be profitably manufactured.

In the first place, since radio receivers, amplifiers, and loudspeakers have become fairly well standardized, it is highly desirable that factory facilities for making such devices shall be employed as well in the manufacture of the home-recording apparatus. In order to reduce the expense of manufacture it is, of course, also desirable that the design of the standard amplifiers should not be changed and that additional sensitivity, if required, should be gained in other ways.

Furthermore, magnetic pickup devices are also fairly well standardized for phonograph record reproduction and, since certain of their characteristics are not quite suitable for recording purposes, means must be provided for their adaptation thereto.

Again, the majority of modern radio receivers are of the full electric type employing no batteries, and energy for a microphone, if one is employed, must, in some way, be derived from the socket-power unit which transforms commercial alternating current into currents at potentials suitable for the radio receiver.

We have also discovered, during the course of our experimental work, that phonograph motors of the induction disc type, although especially suited for record-reproduction, do not, as a rule, have sufficient torque to enable the proper recording of phonograph selections. Means, therefore, must be provided for increasing the torque of the phonograph motor during the recording operation.

In addition, we have found that when recording selections on home-recording blanks of the type disclosed and claimed in the copending application of Albertis Hewitt, Serial No. 480,059, filed September 6, 1930 and assigned to RCA Victor Company, Inc., the recording stylus would tend to jump from the groove pre-formed in the blank and ride across the record if the potentials, representing sounds to be recorded, were impressed at too large amplitudes across the terminals of the pickup device. This condition was particularly objectionable at low frequencies since the standard amplifier is so constructed that its response is substantially flat down to an audio frequency of the order of 30 cycles per second.

In other words, as the frequency of the sound being recorded decreases, the amplitude of the stylus movement increases proportionately, and becomes much too great unless proper attenuation means are present, which means are increasingly effective as the frequency decreases.

We have also found it advisable to discontinue the use of the loudspeaker as a microphone and to provide means whereby an especially designed microphone may be utilized, at will, during the process of recording sounds of local origin.

It is, accordingly, the principal object of our invention to provide a home-recording system, of the type described, whereby the aforementioned difficulties shall be overcome and which may be manufactured from standard parts without substantial alteration thereof.

To attain the foregoing object, we prefer to provide a system wherein a plurality of standard electrical devices such as an amplifier, a microphone, an electrical pickup, a radio receiver and a loudspeaker may, selectively, be included in circuit through the operation of a single switching device. The complete system also comprises means, under the control of the aforesaid switch, for supplying appropriate potentials to the apparatus referred to and for introducing additional devices such as reactors, resistors and the like whereby the characteristics of the apparatus may be modified in accordance with the several functions it is successively called upon to perform.

The novel features that we consider characteristic of our invention are set forth with particularity in the appended claims. The invention in its entirety, however, both as to its organization and its method of operation, together with additional objects and advantages thereof, will best

be understood from the following description of a specific embodiment when read in connection with the accompanying drawing.

The single figure of the drawing is a diagrammatic view of a portion of a sound recording and reproducing system constructed according to our invention, those elements familiar to persons skilled in the art having been omitted therefrom in order to render the diagram less complex.

Referring to the drawing, a preferred commercial embodiment of our invention comprises a radio receiver and an electrical phonograph having a socket-power unit 1, an audio frequency amplifier 3, a power amplifier 5 and a loudspeaker 7 in common, means enabling the recording of incoming radio programs and means for recording sounds of local origin.

Preferably, the radio receiver is of the type comprising a plurality of radio frequency amplifier tubes (not shown) of the screen-grid type wherein the gain may be controlled, for a purpose hereinafter to be explained, through the application of positive potentials to the screen-grids thereof over a conductor 9 adapted to be connected to the socket-power unit.

It is also desirable that the audio-frequency amplifier shall be preceded by means for controlling the tone of the sound-output from the loudspeaker and that the tone-control means shall be available when the system is operated to reproduce sounds from a phonograph record as well as during radio reception.

In the specific radio receiver we have chosen for purposes of illustration the tone-control means comprises a resistor 11 and a condenser 13 connected in series between the plate and cathode of the detector tube 15, a resistor 17 and a blocking condenser 19 series-connected between the plate of the detector tube and the grid of the audio frequency amplifier tube. The blocking condenser 19 has a high capacity and has negligible reactance at audio frequencies. At low audio frequencies the condenser 13 has very high reactance, as has also a condenser 21 interposed between the grid of the audio frequency amplifier and a variable contact device 23 associated with the resistor 11.

The detector output voltage, therefore, is divided between the resistor 17, interposed between the plate of the detector and the grid of the audio-frequency amplifier, a resistor 25, in the plate potential supply circuit of the detector, and a grid-leak resistor 27 normally connected between the grid of the audio-frequency amplifier and the cathode thereof. The low frequency attenuation, accordingly, depends upon the relative magnitudes of the resistors enumerated and if the resistor 27 were decreased or shunted by another impedance device the attenuation would be increased and if the resistor 17 were decreased the attenuation would be lessened.

The high frequency attenuation is controlled by the position of the variable contact arm 23 on the resistor 11. When the arm is in its lowermost position the series resistor 17 is not shunted to an appreciable degree while the grid-leak resistor 27 is shunted by the condenser 21 in series with the said arm. This condenser has a capacity of 1200 mmf. Its reactance is only 27000 ohms at 5000 cycles but it has very high reactance at low frequencies. Consequently, the high frequencies are attenuated much more than the low frequencies and bass notes predominate in the sound issuing from the loudspeaker.

To obtain predominance of the high frequencies the arm is moved to its upper position on the resistor 11 which establishes a shunt around the series resistor 17 offering a reactance, at high frequencies, lower than the resistance of the said series resistor. At the same time, the shunting effect of the condenser 21 upon the grid-leak resistor 27 is substantially removed, with the final result that the high frequencies are less attenuated than the low frequencies. Naturally, any proportion of high to low frequency, between the extremes described, may be had by suitable adjustment of the contact arm.

The specific tone control network per se, considered apart from the other elements of our improved sound recording and reproducing system, forms no part of our present invention. This network is disclosed and claimed in the co-pending application of R. A. Bierwirth, Serial No. 630,991, filed August 30, 1932, and assigned to the Radio Corporation of America.

The manner in which the tone-control network may be utilized in radio reception, record reproduction and sound recording will be hereinafter explained.

That portion of our system which provides for the electrical reproduction of phonograph records includes a pickup device 31, a volume control resistor 33 which is connected in shunt thereto during the sound reproducing process, as will hereinafter be explained, a phonograph turntable 35, a driving motor 37 of the induction disc type having a plurality of current coils 39, 41 and 43 and an auto-transformer 45. The entire winding of the auto-transformer is included in the input circuit of the audio frequency amplifier stage, and a part of the primary winding 47 is permanently connected in shunt to the movable contact device 48 associated with the resistor 33.

We also provide a telephone transmitter 49 which, in series with a resistor 51, is permanently connected in shunt to a portion of the primary winding 47 of the auto-transformer. The transmitter is supplied with energizing current from the same potential source which supplies the thermionic tubes, the resistor, when sounds of local origin are recorded, being connected in shunt across the said source to give the necessary potential.

In order that the system may conveniently be changed from radio reception to condition for recording radio programs, for reproducing phonograph selections, or for recording sounds of local origin, we provide a switching device 53 constituted by 13 stationary contact elements, designated on the drawing by the letters A to M inclusive, and 14 arcuate metallic commutator elements carried by a rotatable cylindrical insulator (not shown). The commutator elements are indicated in the drawing by a plurality of rectangles numbered 55, 57, 59, 61, 63, 65, 67, 69, 71, 73, 75, 77, 79 and 81.

When it is desired to receive a radio program the switching device is turned to the position marked "Radio" and the stationary contacts A—B, E—F, G—H and L—M are thus conductively connected together in pairs by the the elements 55, 57, 59, and 61. The connecting together of the contacts A—B completes the circuit between the detector plate and the audio frequency amplifier grid; the connecting together of the contacts E—F causes high potential to be applied to the screen-grids of the detector and the preceding radio frequency amplifier tubes (not shown) over the conductor 9; the element

across the contacts G—H serves to short-circuit a resistor 83 connected in series with the voice coil of the loudspeaker, and the connecting together of the contacts L—M completes a shunting circuit around a condenser 85 which is interposed between the current coils 41 and 43 of the motor. The function of the condenser will be referred to hereinafter. In the "Radio" position, therefore, the system functions purely and simply as a radio receiver, the incoming signals being demodulated in the detector tube and thereafter being amplified at audio frequency for application, with full amplitude, to the loudspeaker.

In the "Radio" position, volume-control may be had by adjusting a potentiometer 87 the arm 89 of which is connected to the cathode of the radio frequency amplifier tubes and the resistance element 91 of which is connected between the conductor which supplies high potential to the screen-grids of the tubes and the negative terminal of the high potential source.

When it is desired to record a radio program, the switch 53 is turned to the next position, indicated on the drawing as "Record Radio". In this position the connections are substantially the same as those effected when the switch is in the "Radio" position except that the commutator elements 59 and 61, which short-circuit the resistor 83 in the loud-speaker voice coil circuit and the condenser 85 in the motor circuit, respectively are omitted, and an additional element 67 is provided. The element 67 connects the high potential terminal of the secondary winding 93 of the output transformer 95, which feeds the loudspeaker 7, to ground through a reactor 97 and also connects it to ground through the winding of the pickup device 31 whereby the reactor, the pickup device, and the voice coil of the loudspeaker are all connected in shunt to the secondary winding 93 of the output transformer, the resistor 83 now being included in the voice-coil circuit for the purpose of reducing the sound-output.

In this position, therefore, in addition to hearing the incoming radio program we are enabled to record it upon a suitable blank record by the movement of the stylus of the pickup device in response to output currents from the audio frequency power amplifier 5. The reactor 97 is so designed that it attenuates all frequencies below 300 cycles per second since such frequencies do not record properly at maximum output and apparently introduce distortion. Furthermore, the presence of the reactor prevents the stylus of the pickup device from moving at so great an amplitude as to jump out of the sound groove as hereinbefore referred to.

Inasmuch as the reactor is disposed in parallel with the pickup device, practically all current delivered by the output transformer secondary 93 divides between it and the said pickup device. Every decrease in frequency results in a decrease in the inductive reactance of the reactor resulting in an increase in the current flow in the said reactor and a decrease in current flow through the pickup device.

The interposition of the condenser 85 between the current coils 41 and 43 of the inductor motor causes the current in these coils to more closely approach phase coincidence with the applied potential than when the condenser is omitted, thus causing torque to be applied during a greater portion of the time and enabling the increased load imposed upon the system by the recording process to be satisfactorily carried.

When it is desired to electrically reproduce a phonograph record, the switch is turned to the position designated "Phonograph" on the drawing. In this position the voice coil of the loudspeaker is directly connected to the secondary winding of the output transformer over the jumper 71 in order that the loudspeaker may operate at full efficiency. The motor condenser 85 is removed from circuit by a jumper 75 and, since in this position the jumper between the high potential source and the conductor 9 which supplies potential to the screen-grids of the amplifier tubes is omitted, radio signals are prevented from coming through even though the cathodes of the said tubes are not de-energized.

The pickup device 31 is connected in shunt relation to the volume-control resistor by the commutator segment 73 and another segment 69 connects the entire primary and secondary winding of the auto-transformer 45 between the grid of the audio frequency amplifier tube 3 and ground by bridging the contacts B—C. The last mentioned segment also functions by closing the circuit between contact elements A—B, to connect the tone-control network between the grid of the audio frequency amplifier tube and ground in order that manual control may be had of the tone quality of the sound reproduction in the manner hereinbefore explained.

In the event that it is desired to make a record of sounds of local origin the switch is turned to the position designated "Record Voice" in the drawing. In the latter position the contact elements B—C are bridged by the segment 77 and both windings of the auto-transformer are connected between the grid of the amplifier tube 3 and ground to serve as the input circuit for the said tube. The motor condenser is now in circuit since no jumper appears across the contacts L—M and, since no jumper is inserted across the contacts E—F, the radio frequency amplifying and detector tubes are deprived of screen-grid potential to prevent radio signals from marring the record. The conductor which supplies positive potential for the screen-grids through the conductor 9, which first named conductor terminates in the contact element E, is now connected by a jumper 79 and the contact element D to one end of the resistor 51 which is in circuit with the microphone and, since the other end of the resistor and the negative terminal of the high potential source 1 are both connected to ground, a voltage drop appears across the resistor and is utilized for energizing the microphone.

In the preferred commercial embodiment of our invention the resistor has a magnitude of approximately 250 ohms and the voltage drop thereacross is in the neighborhood of 8 volts. Since the primary winding of the auto-transformer is also in circuit with the transmitter and the resistor, the actual voltage available for the transmitter is of the order of 4 volts and the direct current in this circuit varies from 10 to 4 milliamperes depending upon the loudness of the sound impressed upon the microphone.

Attention is also called to the fact that, in the voice-recording position, the bias resistor 27 for the audio frequency amplifier, which resistor is connected to the fixed contact element A, is disconnected from the grid of the said tube since it is desirable to utilize all of the amplification available in order to make a satisfactory record without overloading the microphone.

It will further be noted that the volume-control device associated with the electric pickup,

since it is in the form of a potentiometer circuit, serves to maintain the load on the pickup substantially constant regardless of the position of the arm 48. This gives rise to substantially the same frequency characteristic regardless of the degree of volume with which a record is reproduced.

We also find it desirable to so proportion the windings of the auto-transformer that the impedance of the pickup and microphone may be matched with the input impedance of the audio frequency amplifier.

Substantially all modern electric phonographs are provided with means for automatically depriving the motor of current when a phonograph selection is completed. We have, accordingly, shown a switch 101 in the drawing and it is to be understood that the said switch may be of any conventional type, operated through movement of the tone arm of the phonograph (not shown) to its central position on a phonograph record. In addition, we find it advisable to provide an additional switch 103 so disposed as to be also actuated by the tone arm, the latter switch being connected across the magnetic pickup and being for the purpose of short-circuiting the said pickup at the end of a selection to prevent the scratching noise occasioned by the needle gliding in an unrecorded groove form, causing unpleasant sounds to issue from the loudspeaker.

Our invention is mainly advantageous in that its operation requires no technical skill. The change from radio reception to phonograph record reproduction or recording is accomplished by a single switch and, since the various elements are all inter-locked for unicontrol, there is no likelihood of incorrect operation.

Furthermore, by means of our invention, the addition of home-recording to combined radio-phonographs may be accomplished at a very reasonable cost and without the necessity of utilizing a large number of especially designed elements.

Although we have illustrated a specific embodiment of our invention, and have described certain variants thereof, numerous other modifications will be apparent to those skilled in the art. Our invention, therefore, is not to be restricted except insofar as is necessitated by the prior art and by the spirit of the appended claims.

We claim as our invention:

1. In combination, a microphone, an electrical pickup device, an amplifier, a loudspeaker, connections whereby said microphone, amplifier and pickup may be utilized to record sounds and connections whereby said loudspeaker is energized during the recording process to emit sounds at low volume for monitoring purposes.

2. The combination as defined in claim 1 characterized in that the last named connections include a resistor.

3. The combination as defined in claim 1 further characterized in that means are provided for reducing the energy delivered to the pickup device from the amplifier at frequencies below four hundred cycles per second.

4. In combination, an amplifier, a microphone, an electrical pickup device, a loudspeaker, switching means for selectively utilizing said system for the reception of radio signals, the recording of radio signals or the recording of sounds impinging upon said microphone and means whereby the loudspeaker is so energized during either of the recording processes that sounds at low volume are emitted therefrom for monitoring purposes.

5. The combination as defined in claim 4 characterized in that the last named means includes a resistor.

6. In a sound recording and reproducing system, the combination of a potential supply circuit for energizing a portion of said system, an amplifier, a potential source, an auto-transformer, a resistor connected in shunt to said source, said microphone and the primary winding of said transformer being connected in series with said resistor, switching means in said first named resistor connection for selectively completing the same or providing a connection between said source and the first named circuit, and connections whereby the secondary winding of said auto-transformer is included in the input circuit of said amplifier.

7. In combination, an amplifier having an input circuit constituted by the primary and secondary windings of an auto-transformer connected in series, a microphone, a pickup device, and switching means for selectively connecting said microphone or said pickup device across predetermined portions of said primary winding.

8. The combination as defined in claim 7 further characterized in that a variable resistor is connected across a portion of the primary winding to serve as a volume-control device.

9. The combination as defined in claim 7 further characterized in that the amplifier has an output circuit and that the switching means is so constructed and arranged as to enable the pickup device to be included at will in said output circuit or said input circuit.

10. In combination, means for supporting a phonograph record, motive means therefor, a pickup device, means whereby the pickup device may be utilized for reproducing sounds from a phonograph record or for making a sound-record, a control switch and means whereby the torque of the motive means is increased when the switch is moved to the "recording" position from the "reproducing" position.

11. In combination, radio receiving apparatus having an audio frequency output circuit, a tone control network for said circuit, record reproducing apparatus having an output circuit, and switching means for rendering the radio receiving apparatus inoperative to deliver signals to said first named output circuit and for connecting said tone control network in circuit with said second named output circuit whereby it is effective to control the tone of sounds reproduced from a record, or sounds resulting from received radio signals.

12. In combination, means including a motor driven turntable for reproducing sounds from a phonograph record, means including the aforesaid turntable for recording sounds upon a blank record and means whereby the torque of the motor during the sound recording process is automatically made greater than during the sound reproducing process.

13. In a signal amplifying apparatus, the combination of a telephone transmitter, an audio frequency amplifier connected therewith, means connected with said apparatus for converting alternating current to direct current at suitable potentials for energizing said apparatus, and means whereby said converting means may be disconnected from a portion of the apparatus and connected to supply energy to said transmitter.

14. In a sound recording and reproducing system, the combination of a radio receiver includ-

ing a tone control means in the output circuit thereof, and a gain control circuit adapted to be energized whereby the receiver is responsive to signals, an audio frequency amplifier connected with said receiver, a loudspeaker connected with said audio frequency amplifier, a power supply unit connected with said first named circuit to supply an operating potential thereto, an audio frequency coupling device, an electric pickup device, a volume control means therefor, a switching means whereby said pickup device is connected thru said volume control means with said coupling device, a telephone transmitter connected with said coupling device, a resistor in series with said telephone transmitter, switching means for disconnecting said power supply means from the first named circuit and connecting the same to said resistor, a frequency corrective reactor, said first named switching means including contacts whereby said reactor is connected with said electric pickup device, and having contacts whereby the output of said audio frequency amplifier is connected with said pickup device and reactor, switching means for disconnecting the audio frequency amplifier from the radio receiver and providing a connection with said coupling device, and means for changing said connections in a predetermined sequence.

15. In a sound recording and reproducing system, the combination with a radio receiver, an audio frequency having an input circuit and an output circuit and a power supply unit therefor, of a loudspeaker, an electric pickup, a telephone transmitter, a tone control network, switching means for controlling said elements and selectively connecting them into cooperate relation for recording and reproducing sound, said switching means including contacts operative selectively to render the radio receiver insensitive to signal potentials and to energize the transmitter, contacts operative selectively to connect the input circuit of the amplifier with the receiver, the tone control network and the transmitter, contacts operative selectively to connect the electric pickup with the output circuit of the amplifier and with the input circuit of the amplifier, and means for controlling said switching means, whereby said contacts are operative simultaneously and in a predetermined sequence, thereby to control said elements and selectively to connect them in cooperative relation for recording and reproducing sounds.

16. In a radio apparatus, the combination of a radio receiver, an electrical transmitter responsive to sound, switching means for selectively rendering the radio receiver insensitive to signal potentials and energizing the transmitter, an audio frequency amplifier having input and output circuits, a tone control network, a second switching means for selectively connecting said amplifier input circuit with the receiver, the tone control network and the transmitter, an electric pickup device, a frequency compensating means therefor, a third switching means for selectively connecting said electric pickup device with the output circuit of the amplifier, the frequency compensating means and the input circuit of the amplifer, and control means connected with all of said switching means for operating the same simultaneously to provide a desired sequence of and to establish desired operative connections in said apparatus.

17. In a sound recording and reproducing system including a radio receiver, an audio frequency amplifier, a loudspeaker, a telephone transmitter, a phonograph motor, and an electric pickup, of circuit means and a switching device connected therewith for controlling a condition of operation of the receiver, of the loudspeaker, the phonogroph motor and the telephone transmitter in a predetermined manner, whereby sound derived electrically from said receiver and transmitter may be recorded through said pickup device and sounds derived electrically from said receiver and said pickup device may be reproduced by said loudspeaker, said switching device having a single movable element whereby said control is effected.

18. In a sound recording and reproducing system, the combination with a radio receiver, an audio frequency amplifier, an electric pickup device, a sound producing device, and a telephone transmitter, of a single switching device having contacts and control means providing predetermined positions of adjustment therefor, whereby said apparatus may be selectively connected for amplifying and reproducing radio signals, for amplifying the electrical output of said pickup device, and for amplifying sounds recorded by said transmitter, certain of said contacts being arranged to control a condition of operation of the radio receiver and to energize the telephone transmitter selectively, and certain other of said contacts being arranged to change the sound volume delivered by said sound producing device.

19. In a sound recording and reproducing system including a radio receiver, a sound reproducing device, an electric pickup and an electrical sound actuated transmitter, of electric circuit means interconnecting said apparatus and a switching device therein for changing certain of the connections provided thereby, said switching device being movable to positions wherein sounds generated in said transmitter and signals derived from said radio receiver selectively may be applied to said electric pickup device for recording purposes, and means controlled by said switching device for reducing the output of the sound producing device when said electric pickup is so connected.

20. In a sound recording and reproducing system including a radio receiver, a sound reproducing device, an electric pickup and an electrical sound actuated transmitter, of electric circuit means interconnecting said apparatus and a switching device therein for changing certain of the connections provided thereby, said switching device being movable to positions wherein sounds generated in said transmitter and signals derived from said radio receiver selectively may be applied to said electric pickup device for recording purposes, means controlled by said switching device for reducing the output of the sound producing device when said electric pickup is so connected, and means controlled by said switching device for selectively causing said radio receiver to respond to radio signals and to energize said transmitter.

21. The combination with a radio receiving system having an audio frequency amplifier and a loudspeaker, of a phonograph motor, an electric pickup, a telephone transmitter and a switching device, said device having contacts connected in circuit with said apparatus and having a movable control element whereby said contacts are actuated to provide operating connections in said system, in one position of said movable control element, said contacts being actuated to connect the apparatus for radio reception, in a second position to connect the apparatus whereby ra-

dio signals may be applied to the electric pickup for recording purposes, in a third position to connect the apparatus for reproducing sounds generated in said pickup device, and in a fourth position to connect the apparatus to apply amplified signals generated in said telephone transmitter to the electric pickup device for recording purposes.

22. The combination with a radio receiving system having an audio frequency amplifier and a loudspeaker, of a phonograph motor, an electric pickup, a telephone transmitter and a switching device, said device having contacts connected in circuit with said apparatus and having a movable control element whereby said contacts are actuated to provide operating connections in said system, in one position of said movable control element, said contacts being actuated to connect the apparatus for radio reception, in a second position to connect the apparatus whereby radio signals may be applied to the electric pickup for recording purposes, in a third position to connect the apparatus for reproducing sounds generated in said pickup device, and in a fourth position to connect the apparatus to apply amplified signals generated in said telephone transmitter to the electric pickup device for recording purposes, said switching device including contacts and circuit connections therefor, whereby in one of said positions of the movable control element a condition of operation of the radio receiving system is changed, an operating potential is applied to the telephone transmitter and a condition of operation of the loudspeaker and a condition of operation of the phonograph motor are changed.

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