

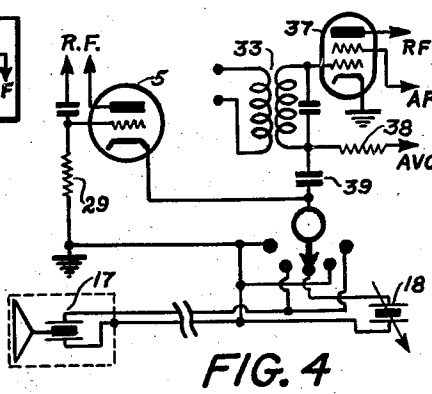
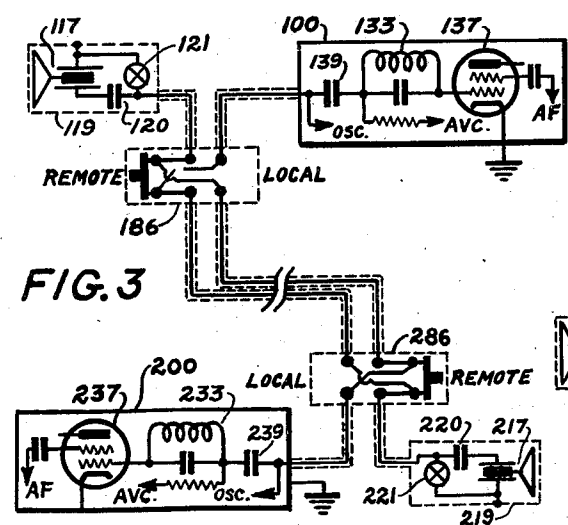
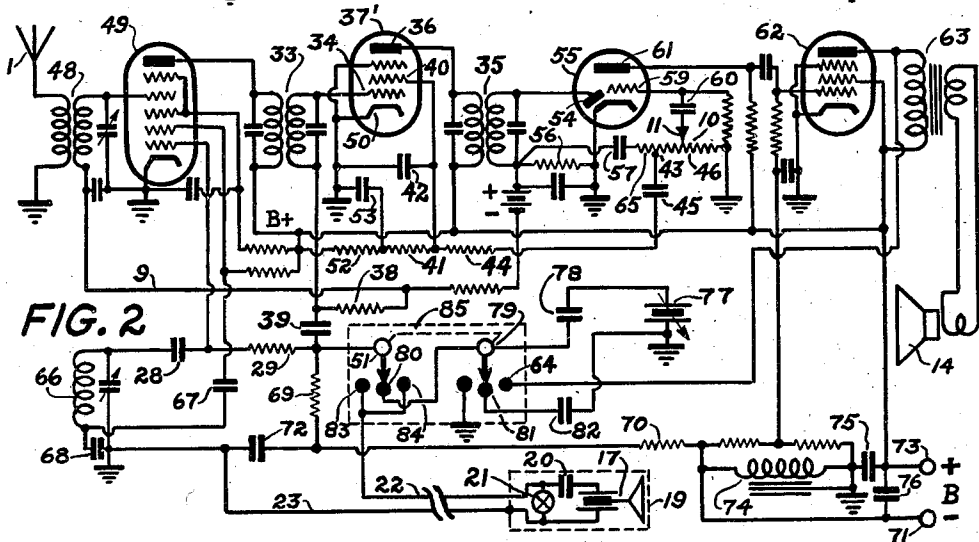
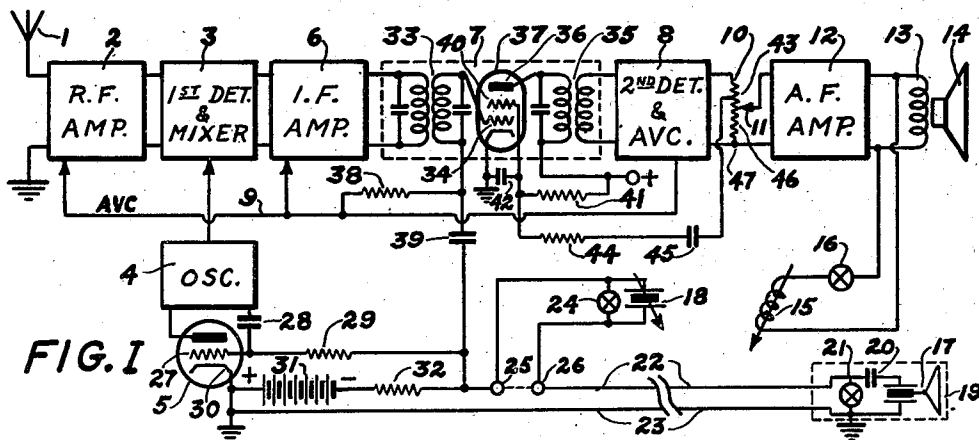
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COMBINATION RADIO-RECORDING-COMMUNICATION SYSTEM

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COMBINATION RADIO-RECORDING-
COMMUNICATION SYSTEM

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20 Claims. (Cl. 179—100.11)

This invention relates to a combination radio-recording-communication system, and more particularly to a system normally adapted to receive and record radio broadcasts, but having locally or remotely controlled means for disabling the system for radio reception and selectively conditioning it for line communication with the remote point or for reproducing and recording from microphone or pickup.

Well-known to the art are combination radio-phonograph-recording machines which, under the control of a circuit switch mounted on the machine and movable to a number of positions corresponding to the number of different functions, can be selectively conditioned by the operator to perform any of the following functions:

1. To receive radio programs which are audibly reproduced by means of a loud-speaker.

2. To record radio programs on a suitable record blank, with or without an accompanying sound reproduction by means of a loud-speaker.

3. To reproduce or play-back records electrically by means of a loud-speaker, the machine being disabled for radio reception meanwhile.

4. To record local selections picked up by a local microphone, with or without an accompanying sound reproduction by means of a loud-speaker.

5. To audibly reproduce in amplified relation by means of a loud-speaker, local programs or announcements picked up by a local microphone.

Such machines usually include a radio-frequency amplifier and detector for the radio reception and recording functions, followed by a volume-control, audio amplifier, and loud-speaker common to all of the functions. During normal reception of powerful broadcast carrier waves, the radio-frequency amplifier and detector usually deliver to the volume-control signal potentials averaging several volts, whereas the local microphone generally produces a potential of only a small fraction of a volt. This large discrepancy necessitates the addition of a pre-amplifier between the microphone and the input of the volume-control and common audio-frequency amplifier and loud-speaker, in order to bring the level of the microphone signal up to a point where it will satisfactorily operate the recording device or the loud-speaker.

To supply this extra microphone amplification, one or more additional electron tubes are usually added to the complement required for radio reception only, and these additional tubes draw current and age during any other function of

the machine as they do during the comparatively limited time that they are actually at work amplifying the microphone potentials, since no provision is generally made for disconnecting the heaters of these extra tubes during those functions when the microphone is not in use.

In addition, when only a single pre-amplifier tube is provided, the output level of this tube, while perhaps sufficient to operate the common audio-frequency amplifier to drive the recording tool or loud-speaker when the common volume-control is set at or near full volume, is still considerably below the level of the average rectified radio carrier, so that continual and careful manipulation of the volume-control as well as of the change-over switch is necessary in changing from one function to another. If the record reproducing pick-up is also arranged to be connected across the common volume control, it too will likely have an output level substantially different from that of either the radio detector or the microphone, further complicating the problem of controlling the various input voltages to a suitable operating level. Should the operator neglect to turn back the volume-control before switching from microphone recording to radio reception, for example, a terrific blast would be heard from the loud-speaker, or if the recording unit remains connected to the amplifier output, it may be permanently damaged by the excessive voltages across it.

One object of the present invention is to provide a system of the general type hereinbefore described, including a dual-function electron tube and circuit therefor capable of acting as both a radio-frequency or intermediate-frequency amplifier and an audio-frequency pre-amplifier for boosting the level of a microphone or other pick-up, thus obviating the necessity for including extra tubes and circuits for the latter purpose.

Another object of this invention is to provide circuit means for coupling a dual-function high- and low-frequency amplifier to a detector and common audio amplifier, whereby either high-frequency signals may be amplified and demodulated, or low-frequency signals may be amplified only, without requiring switching of said circuit means.

A further object of my invention is to provide means for combining or mixing the various inputs from radio, microphone, and pick-up to the common volume-control and audio amplifier so that a given adjustment of the volume-control will result in a substantially equal loud-

speaker volume from any of the different input sources, without requiring individual adjustment of the volume-control setting as the function is changed.

An additional object of this invention is to provide a new and simplified means of disabling the radio receiving portion of the system, requiring a minimum of circuit switching.

A further object of the present invention is to provide novel means for simultaneously disabling the radio receiving portion of the system and operatively connecting a microphone or pickup thereto.

Another object of my invention is to provide novel means, locally or remotely controlled, for simultaneously disabling the radio receiving portion of the system and operatively connecting thereto a locally or remotely located microphone or pickup.

Another object of this invention is to provide a plurality of radio-recording-communication stations, normally adapted to receive radio broadcast programs, with means by which any station may disable the radio receiving portion of another station and communicate therewith or send program material for recording thereto, and which may in turn be similarly conditioned by remote control from the other station, thus allowing a two-way intercommunication between the two stations.

It is also an object of my invention to provide one or more radio-recording-communication stations, normally adapted to receive and reproduce radio programs, with improved means whereby a microphone or other pickup may be connected with any one station, and through the operation of a single-circuited switch means carried by the microphone, will simultaneously disable that station for radio reception and place it in condition to amplify and reproduce or record sound currents picked up by the microphone.

Another object of the present invention is to provide a radio-recording-playback system with improved and simplified three-position switching means permitting the function-selecting control to be manually operated or automatically controlled by movement of the recording and playback mechanism into position, in conjunction with switch means carried by a microphone allowing instantaneous cut-in and control of sound reproduction or recording by the operator of the microphone.

Supplementary objects and advantages of my invention will be apparent from the remainder of this specification and from the annexed drawing, in which:

Fig. 1 is a generalised circuit diagram indicating one form of my invention using separate recording and reproducing units, the conventional elements of the circuit familiar to those skilled in the art being indicated in block form to avoid undue complexity.

Fig. 2 is a more detailed schematic circuit diagram of a system similar to that indicated in Fig. 1, but including a single combined recording-reproducing unit and three-position circuit switch therefor.

Fig. 3 indicates how two systems of the type represented in Fig. 1 or Fig. 2 may be interconnected to provide a selective intercommunication system.

Fig. 4 is a partial schematic circuit diagram indicating several modifications which may be made in the radio-disabling circuit and in that of the function-changing circuit switch.

Referring to Fig. 1, a suitable receiving antenna 1 is connected to the input terminals of a radio-frequency amplifier 2, which in turn is connected to first-detector and mixer stage 3, to which is also connected the high-frequency oscillator 4, part of which is the oscillator tube 5. The mixing of the locally generated high-frequency current with the incoming received radio-frequency current in stage 3 is accomplished in a manner well-known to the art, and results in an intermediate-frequency current which is applied to the intermediate-frequency amplifier 6, and in turn to the final intermediate-frequency stage 7. The intermediate-frequency output of stage 7 feeds into second-detector and rectifier stage 8, which in a well-known manner converts the amplified intermediate-frequency voltage fed to it into a direct-current automatic-volume-control voltage which may be fed back along AVC connection 9 to automatically control the gain of any or all of stages 2, 6, and 7. In addition, second-detector stage 8 delivers to the outer terminals of volume-control 10 an audio-frequency voltage representative of the modulation originating upon the incoming radio-frequency current or carrier wave picked up by antenna 1. The movable contact 11 on volume-control 10 serves to control the amount of the audio-frequency voltage fed to the input of audio-frequency amplifier 12, the amplified output of which in turn feeds into the speaker coil 13 which operates loud-speaker 14 to audibly reproduce the translated audio-frequencies representative of the original carrier modulation.

To the output terminals of audio-frequency amplifier 12 may be connected the recording unit 15 through the controlling switch 16, which upon being open-circuited will operatively disconnect unit 15, and may be combined with other switch means to disconnect or reduce the volume of loud-speaker 14 when unit 15 is in operation. In the diagram, recording unit 15 is indicated as being of the electro-magnetic type, but may also be of any of the other types suitable for the purpose and well-known to the art, such as piezo-electric, etc.

Microphone 17 and pickup 18 are indicated in the diagram as being of the piezo-electric or crystal type, but may likewise be of other well-known types of inherent high impedance, or made so through a suitable coupling transformer. Microphone 17 may conveniently carry within its case 19 the blocking condenser 20 and the microphone switch 21, which latter may be a single-circuit toggle or push-to-talk switch which open-circuits when it is desired to use the microphone. Switch 21 may be connected as indicated across the microphone leads 22, which is the high-potential lead, and 23, which is the grounded lead and may conveniently take the form of an encircling shield or braid around the suitably insulated lead 22 to protect it from external electrical disturbances.

Pickup 18 is also supplied with a pickup switch 24, which may be connected across its leads as shown, and will serve to place the pickup into condition to be used when the switch is open-circuited. 25 and 26 represent the input terminals for the pickup 18, and may be short-circuited as indicated in the diagram by the dotted lines, when pickup 18 is removed from the circuit.

Oscillator tube 5 may have its control-grid 27 coupled to oscillator 4 by means of the grid condenser 28, and grid resistor 29 serves to control the direct-current bias of the control-grid 27,

being normally adapted to connect with oscillator cathode 30 when the circuit is conditioned for radio reception. Interposed between grid resistor 29 and oscillator cathode 30, however, is connected the source of direct potential 31, its positive pole connected with cathode 30, its negative pole connected to the return end of grid resistor 29 through resistor 32. Microphone switch 21 and pickup switch 24 may be serially connected as shown across the junction point of resistors 29 and 32 and cathode 30, so that when both switches are closed, grid resistor 29 will be returned directly to cathode, allowing oscillator 4 to function normally. The value of potential 31 is made high enough so that, when either switch 21 or 24 is opened, the additional negative potential placed upon control-grid 27 will block oscillator tube 5, causing it and oscillator 4 to positively cease oscillation. When this happens, no intermediate-frequency voltage is produced by mixer stage 3, and the system is inoperative insofar as reproduction of received radio programs is concerned. The impedance of resistor 32 is made high enough so as not to appreciably load microphone 17 or pickup 18 when their respective control switches are open, and so as to protect potential source 31 when both switches are closed.

Final intermediate-frequency amplifier stage 7 may include the input intermediate-frequency transformer 33, feeding into control-grid 34, and output intermediate-frequency transformer 35, feeding out of plate 36 of amplifier tube 37, all in a conventional manner. The grid return end of transformer 33 may be connected through resistor 38 to the AVC connection 9, and also through condenser 39 to the microphone-pickup input terminal 25, which is normally grounded when switches 21 and 24 are closed. Thus condenser 39 acts as control-grid-return bypass to the cathode of amplifier tube 37 when input terminal 25 is grounded, and as audio coupling condenser to control-grid 34 for microphone 17 or pickup 18 when switch 21 or 24 is open, the secondary of input transformer 33 presenting a negligible impedance to audio-frequency currents flowing through it.

Amplifier tube 37 has at least one additional grid electrode 40 located between control-grid 34 and plate 36, which is biased positively through resistor 41 connected to the high-potential plate power supply. When amplifier tube 37 is functioning as an intermediate-frequency amplifier in the usual manner, grid 40 acts as a screen-grid electrode, bypass condenser 42 serving to hold it effectively at ground potential for these frequencies. The value of condenser 42 is made large enough to effectively bypass high-frequency currents, and yet small enough so as not to appreciably attenuate audio-frequency currents which may appear upon grid 40, a suitable value for which may be in the neighborhood of 200 micro-microfarads.

Grid 40 may be connected with tap 43 on volume-control 10 through resistor 44 and coupling condenser 45. Resistor 44 in conjunction with bypass condenser 42 forms a low-pass filter effectively preventing intermediate-frequency voltage originating on grid 40 from reaching volume-control 10, yet permitting audio-frequency voltages to pass thereto.

Tap 43 may be so located intermediate the total resistance of volume-control 10 that the portion 46 between tap 43 and low potential end 47 has a resistance value whose ratio to the total re-

sistance value of volume-control 10 is substantially equal to the ratio of average audio-frequency voltage delivered by grid 40 when amplifying microphone voltages, to the average audio-frequency voltage delivered by second-detector stage 8 when radio programs are being received. The actual physical position of tap 43 is placed close to the upper end of volume-control 10; for example with an angular range for the total resistance of 270 degrees, the lower portion 46 may occupy an angular range of about 225 degrees, or approximately 85 percent of the total rotation of travel of movable contact 11. In this manner, a substantially equal audio input is fed to audio-frequency amplifier 12 for a given setting of movable contact 11 upon lower portion 46 of volume-control 10, in spite of switching the audio source to microphone, pickup, or rectified radio carrier of moderate strength. For weak radio carrier waves, movable contact 11 may be moved into contact with any portion of the remaining upper part of volume-control 10 above tap 43, but for most requirements will remain below this point.

From the foregoing description and from Fig. 1, it will be apparent that amplifier tube 37 can act to amplify either audio-frequency or high-frequency voltages applied between control-grid 34 and ground, the amplified high-frequency voltages being taken out between plate 36 and ground in the usual manner, and the amplified audio-frequency voltages being outputted between screen-grid 40 and ground. The audio-frequency voltage gain of an amplifier tube when connected for screen-grid output as indicated will lie somewhere between the gain obtainable with tube 37 triode-connected (with screen-grid and plate tied together), and that obtainable with the orthodox tetrode or pentode connection (screen-grid positively biased, output taken off the plate). Experimental values of voltage gain obtained ranged from 25 for tubes having grids with remote cut-off characteristics, to 50 for tubes having grids with sharp cut-off characteristics. An audio-frequency voltage gain of this magnitude, in conjunction with the usual gain of audio-frequency amplifier 12, is generally more than sufficient to raise the output level of microphone 17 to a point where it will satisfactorily operate loud-speaker 14 or recording unit 15, thus making unnecessary the addition of an external microphone pre-amplifier.

With both switches 21 and 24 closed and switch 16 open, the system is in condition to reproduce radio program material audibly through loud-speaker 14 in the usual manner. Closing switch 16 will permit recording unit 15 to record this radio program material upon a suitable record blank. Opening switch 21 will simultaneously and automatically disable oscillator 4 and operatively connect microphone 17 to the input of amplifier tube 37, and if switch 16 remains closed, program material picked up by microphone 17 may be recorded by recording unit 15. Since control switch 21 is mounted on the microphone, and may be located at a distance from the main portion of the amplifying apparatus, the operator of the microphone may at any moment break into a radio program being recorded to make an announcement or transmit other material, and instantly bring back the radio program by closing switch 21 when the announcement is concluded. If switch 16 is open, opening switch 21 will allow the microphone operator to break in upon the audible loud-speaker reproduction of

the radio program to make amplified announcements through loud-speaker 14. Again closing switch 21 and opening switch 24 will connect pick-up unit 18 to the input of amplifier tube 37, permitting amplified reproduction of records through loud-speaker 14, the radio receiving portion of the system being disabled.

Referring now to Fig. 2, which shows a more detailed commercial embodiment of one form of my invention, antenna 1 now feeds into antenna coil 48, which in turn is connected to the control-grid of converter tube 49, which in this case replaces stages 2, 3, and 6, and oscillator tube 5 of Fig. 1, acting as combined radio-frequency amplifier, oscillator tube, mixer, and intermediate-frequency amplifier, in a manner well-known to the art. The output plate of converter tube 49 feeds into input intermediate-frequency transformer 33, which is connected to control-grid 34 of amplifier tube 37', which is similar to tube 37 of Fig. 1, but has an additional suppressor-grid located near plate 36 and connected to cathode 50, which may be grounded as shown. The grid-return terminal of transformer 33 is connected to the automatic-volume-control lead 9 through resistor 38, which may have a value of 1 megohm, and to the movable switch-arm 51 through condenser 39, which may have a value of 0.01 microfarad. Screen-grid electrode 40 of amplifier tube 37' is bypassed for intermediate-frequencies by condenser 42, and connected for audio-frequency transmission to volume-control tap 43 through resistor 44 and coupling condenser 45, which may have values of 0.1 megohm and 0.01 microfarad, respectively. Screen-grid 40 in addition is positively biased through resistors 41 and 52 serially connected to the high-voltage plate supply lead B+, while condenser 53 connected between the junction point of these two resistors and ground forms with resistor 52 an audio-frequency decoupling filter. Suitable values for resistors 41 and 52 and condenser 53, might be 0.25 megohm, 0.05 megohm, and 4 microfarads, respectively.

Output intermediate-frequency transformer 35 couples plate 36 of amplifier tube 37' with diode plate 54 contained in combination rectifier-amplifier tube 55, which in a well-known manner rectifies the audio-modulated intermediate-frequency voltage and converts it into an audio-frequency component and a direct-current component, both of which appear across the diode load resistor 56. The direct-current component may be utilized to automatically control the gain of mixer tube 49 and that of amplifier tube 47' through AVC lead 9 connected with the grid return leads of these tubes, with potential source 58 supplying a residual negative grid bias when no radio carrier is being received. The audio-frequency component is fed to volume-control 10 through coupling condenser 57, while movable contact 11 feeds a predetermined portion of this component to audio-frequency grid 59 through coupling condenser 60. The amplified audio-frequency voltage appearing on plate 61 is fed to the input electrodes of power amplifying tube 62 through the elements indicated in the diagram, in a manner well-known to the art. The plate output circuit of power tube 62 may be coupled with loudspeaker 14 through speaker coupling transformer 63, and is also connected to switch-terminal 64 as indicated.

Volume-control 10 is divided by tap 43 into two portions, 46 and 65. By so dividing the volume-control, not only are the audio-frequency

outputs substantially equalized for different sources of input as hereinbefore explained, but portion 65 acts to decouple the diode 54 from screen-grid 40, preventing loading and degenerative effects between these electrodes and their immediate circuits, which effects would seriously affect the operation of the dual-frequency amplifying circuit were portion 65 eliminated. Suggested resistance values for portions 46 and 65 are 0.5 megohm and 1.5 megohm respectively, making a total resistance for volume-control 10 of 2 megohms. The individual values of these resistances may be varied considerably to suit other auxiliary circuit conditions than those indicated, but the ratio between the two resistance portions should remain about 1 to 3 for optimum results. Although the ohmic resistance of portion 65 is considerably greater than that of portion 46, it should occupy a considerably smaller physical portion of the total active resistance length, or travel of movable contact 11. As previously suggested, portion 65 should extend for about 15 percent of the total control length, with portion 46 taking up the remainder. In this manner practically the full control area can be used for control of both radio and local programs, it being seldom necessary to bring movable contact 11 onto portion 65, the over-all gain of the system for radio carriers being great enough to permit full power output with a greatly reduced setting of the volume-control, except on the weakest of carrier waves. When it is necessary to use the full amplification of the system, however, this can be realized by moving contact 11 onto portion 65, or to the full-on position where it connects directly with diode coupling condenser 57. Rotary volume-controls of the composition resistance type, whose resistance per unit of rotation may be tapered or varied to conform with the requirements outlined above, are well-known to the art, and further description of the mechanical features of volume-control 10 is deemed unnecessary.

Oscillator tank tuning circuit 66 may be coupled to the oscillator grid and oscillator anode-grid electrodes contained within mixer tube 49 by condensers 28 and 67, respectively. Oscillations of a frequency dependent upon the constants of the tuning circuit may be generated in a well-known manner through the capacitive coupling afforded by padding condenser 68. The oscillator grid resistor 29, which in the usual oscillator circuit would be returned directly to the cathode of mixer tube 49, in this case is connected to the movable switch-arm 51, to which point is also connected the resistor 69, which latter is also connected through resistor 70 to the negative potential terminal 71. To suppress potential fluctuations which might originate in the external potential source, filter condenser 72 may be connected between ground and the junction point of resistors 69 and 70. Suitable values for resistors 69 and 70 and condenser 72 may be 5 megohms, 5 megohms, and 0.25 microfarad, respectively.

Terminals 73 and 71 are to be connected with a suitable source of high-potential capable of supplying the space current for the various electron tubes, and may be a battery, direct-current power line, or rectified alternating-current supplied power unit of a well-known type. Between the negative terminal 71 and ground may be connected the impedance 74, which may be a choke coil or loud-speaker field which, in conjunction with filter condensers 75 and 76, forms a filter

capable of suppressing voltage fluctuations or ripple originating in the rectified power supply. The voltage drop across impedance 14 is thus, available to supply negative grid bias for any of the amplifier tubes such as power output tube 62, and in addition can supply a negative potential capable of disabling the oscillator portion of mixer tube 49 through resistors 69 and 70 connected to the oscillator grid.

Recording-reproducing unit 77, which may be of any of the reversible types of electro-mechanical transducers capable of translating either electrical oscillations representative of sound into corresponding mechanical stylus vibrations or vice-versa, may be connected through blocking condenser 78 to movable switch-arm 79 and switch-contact 80. From switch-contact 81 to the grounded return lead of unit 77 may be connected the attenuating condenser 82, the function of which is to reduce the normal output of unit 77, when it is connected for playback or reproduction of records, to a level substantially equal to that of microphone 17. It is well known that a capacity in parallel with a piezo-electric type of transducer will reduce its output level in direct proportion to the ratio of the value of the capacity to the effective capacity of the piezo-electric unit itself, without frequency discrimination. If an electromagnetic type of transducer is used, attenuating condenser 82 may be replaced by a fixed resistor attenuator, which will accomplish the above described function of reducing the playback output, in a manner well-known to the art. Suggested values for condensers 78 and 82 are 0.01 and 0.1 microfarad, respectively, but these values may be varied considerably.

Microphone 17, as previously described, is preferably mounted in a casing 19 which may carry the single-circuit control switch 21 and the audio-coupling condenser 20. The purpose of the latter is to block out the direct-current potential which is present across switch 21 when it is open, but it is not absolutely essential, and may even be beneficially eliminated when a type of microphone is used which requires a polarizing potential across it, such as the condenser or electrostatic type. Lead 22 from microphone 17 is connected with both switch-contacts 83 and 84, while grounded lead 23 may conveniently form a shield about lead 22.

Function-control switch 85 may be of the rotary 3-position type with movable arms 51 and 79 movable simultaneously through a single control member. It may be mounted on the chassis carrying the amplifying and radio receiving apparatus and controlled by hand, or it may be mounted in such position as to be automatically operated by movement of unit 77 into recording or reproducing position. Such an automatically controlled switch is shown in my co-pending application, Serial Number 380,462, and switch 85 and its associated connections may readily be adapted to the construction therein described.

With switch 85 in the central or playback position as indicated in Fig. 2, oscillator grid resistor 29 and audio-coupling condenser 39 are both removed from their normal ground connection, the oscillator grid of mixer tube 49 is blocked by the additional negative bias, and as hereinbefore explained, audible reproduction of radio programs is prevented. Unit 77 is now coupled through condensers 78 and 39 and the secondary of transformer 33 to the control-grid of amplifier tube 37', and audio voltages gener-

ated by operatively applying unit 77 to a record will be audibly reproduced by loud-speaker 14 in a manner previously described. Microphone 17 is disconnected in the playback position, and manipulation of switch 21 will have no effect on the circuit operation. Thus records may be played without interference from radio or microphone break-in.

Shifting movable arms 51 and 79 to a position to the left of that indicated in Fig. 2 will condition the system for radio reception, assuming microphone switch 21 is closed. Both oscillator grid resistor 29 and condenser 39 are grounded through switch 21, the extra negative bias is grounded out, allowing normal oscillator action and radio reception, and condenser 39 resumes its normal function as AVC bypass for amplifier tube 37'. Unit 77 is grounded out of the circuit, preventing possible damage.

Opening microphone control switch 21 while switch 85 is in the left-hand or radio position will open the ground connection of oscillator grid resistor 29 and condenser 39, interrupting the audible reproduction of radio programs by loud-speaker 14, and simultaneously operatively connecting microphone 17 to the amplifying system to permit the loud-speaker to audibly reproduce announcements or program material picked up by the microphone. Reclosing switch 21 will instantly restore the original radio program.

Shifting movable arms 51 and 79 to a position to the right of that indicated in Fig. 2 will connect unit 77 to the output circuit of power tube 62 through the blocking condenser 78. With microphone switch 21 again closed, unit 77 will be conditioned to record the radio program being received on a suitable record blank in a manner well-known to the art, the program being also audible through loud-speaker 14.

Opening microphone control switch 21 while switch 85 is in the last-described recording position will again interrupt the radio program and permit microphone announcements and program material to be recorded, either exclusively, or as a portion of a radio program record. If microphone 17 is located near loud-speaker 14 and there is danger of acoustic feed-back between them, additional switch contacts may be added to switch 85 to disconnect loud-speaker 14 or operate it at reduced volume, in a manner well-known to the art, during the recording operation.

From the preceding description it is apparent that I have provided a simplified three-position function-switch circuit, which in conjunction with an auxiliary on-off switch preferably carried by the microphone, offers a system of great flexibility, capable of performing at least five distinct functions. The function-switch may be either manually or automatically operated, the microphone switch may be either locally or remotely located, the disabling of the radio receiver when required is instantaneous and complete, and no switching of the audio circuits is required during any change of function. The greatly simplified switching requirements make possible the use of a simple and inexpensive single-deck control switch with a minimum of lead connections between it and the rest of the system, making it possible to mount it at any convenient point. For a given setting of the volume-control, a substantially equal power output is obtained, regardless of change of input source, and degenerative effects between these sources is avoided. Means are supplied for converting an amplifying

tube normally adapted to amplify high-frequency currents into a low-frequency amplifier, thus providing the added gain required for a microphone or other minute-current generator, such as a photo-cell or dynamic pick-up, without the necessity of additional tubes which would be in useful operation only a small part of the time. Only a single shielded wire is required between a remote microphone and the apparatus proper, and over this wire, which may be up to several hundred feet in length, the microphone operator may selectively control the operation of the apparatus by the natural operation of a simple push-to-talk switch, without the interposition of mechanical relays or other complicated equipment. In addition, for microphones or other types of generators requiring a polarizing potential, means are provided for supplying such a potential through the same elements which serve to disable the radio receiver, making unnecessary the furnishing of additional means for this purpose.

Although I have illustrated in Figs. 1 and 2 the application of my invention to a radio receiver of the superheterodyne type, I wish it to be understood that it is equally applicable to other well-known types of receiving circuits. In the so-called tuned-radio-frequency type of receiver, for example, the tube which would replace the dual-frequency amplifier tube 37 would be the final radio-frequency amplifier tube, i. e., the tube feeding into the detector. The radio-disabling negative potential could be applied through a suitable grid resistor to the control-grid of the next-preceding radio-frequency amplifier tube, the additional negative bias applied, were the microphone switch opened, being sufficient to block this grid and prevent transmission of radio signals beyond this point. Many other circuit variations will be apparent to persons skilled in the art, and therefore I do not wish my invention to be restricted in its scope to the specific forms shown, except insofar as required by the prior art and the range of the appended claims.

Referring to Fig. 3, I have there indicated how a plurality of systems such as those shown in Figs. 1 or 2 may be interconnected through a plurality of switches, 186 and 286, to provide a selective two-way intercommunication system. In the drawing the prefix 1 is added to the reference numerals of the various elements at station 1 which are similar to elements shown in Figs. 1 and 2, and likewise, similar elements at station 2 have their reference numerals prefixed by number 2. Only a portion of the microphone input circuit of each station is indicated, it being understood that casings 100 and 200 represent a complete system such as shown in Figs. 1 or 2, except for the microphones, which are indicated separately. Switches 186 and 286 may be similar double-pole double-throw types, preferably of the rotary variety. One switch is located at each station, and they may be connected as indicated, between the shielded cables interconnecting the stations.

With both of switches 186 and 286 in the position shown in Fig. 3, and with both microphone switches 121 and 221 closed, both stations are conditioned to receive radio programs, but each is susceptible to being called by the other. That is, if microphone switch 121 at station 1 is opened, station 1 will continue to receive radio programs, but those of station 2 will be interrupted, and announcements or program material picked

up by microphone 117 will be audibly reproduced by the loud-speaker at station 2. This material may also be recorded at station 2 by throwing its function control switch to the recording position. Likewise, opening microphone switch 221 will permit microphone 217 to control the loud-speaker and recorder of station 1, and if both microphone switches are open at the same time, a running two-way conversation or exchange of program material may take place between the two stations, without requiring further manipulation of switches to "talk" or "listen."

If either station desires privacy, or does not wish to be interrupted by the other station, the double-pole switch at that station (186 or 286), is thrown to the opposite position to that shown in Fig. 3, whereupon each microphone and switch is connected with its own station, and is ineffective to control the other. Throwing either one or both of switches 186 and 286 will accomplish this.

By eliminating switches 186 and 286 in Fig. 3 and connecting each microphone and its control switch to the other station directly, each will be under the control of the other at all times that the systems are in operation. It is likewise possible under these conditions to eliminate the recording function at each station, leaving a plurality of normally radio-receiving systems, with means for either system to interrupt the radio program of the other and communicate therewith.

In Fig. 4 is indicated an alternative means for blocking the oscillator or radio-frequency tube by opening its cathode circuit to disable the radio receiver and simultaneously connect the microphone to the dual-frequency amplifier tube 37. No extra negative potential is thus required, but care must be exercised to avoid microphonic action between the open cathode, which is connected with the input of the amplifier, and ground. In this figure is also indicated how the microphone switch may be taken away from the microphone casing and combined with the function-selecting switch, which would then have as many positions as the number of functions required of the system, in this case five. The remote control feature would be sacrificed, but for some applications it might be advantageous to use a single chassis-mounted function-control switch.

I claim as my invention:

1. In amplifying apparatus, an amplifier including an electron tube having at least a cathode, a plate electrode, a control-grid electrode, and an auxiliary electrode, a signal input circuit coupled with a source of high-frequency currents, a source of low-frequency currents, a high-frequency output circuit for said electron tube connected between the plate electrode and the cathode thereof, a low-frequency output circuit permanently connected between the auxiliary electrode and the cathode of said electron tube, and circuit means connecting said source of low-frequency currents and said signal input circuit in series relation between the control-grid electrode and the cathode of said electron tube.
2. The combination as defined in claim 1, together with means for selectively short-circuiting the said source of low-frequency currents.

3. The combination as defined in claim 1, together with means for selectively rendering ineffective the said source of high-frequency currents.

4. The combination as defined in claim 1, together with selective means for alternately disabling either the said source of low-frequency currents, or the said source of high-frequency currents.

5. In a dual-frequency amplifying system, an electron tube having at least four electrodes including a cathode, a plate electrode, a control-grid electrodes, and an auxiliary electrode, a source of modulated carrier voltages and a separate source of audio voltages connected with the input circuit of said electron tube between the control-grid electrode and the cathode thereof, a volume-control resistor having terminal end connections, a tap connection intermediate its ends, and a variable connection movable between its ends and past the tap connection, a modulation detector having a carrier-frequency input circuit connected between the plate electrode and the cathode of said electron tube and an audio output circuit connected between the terminal end connections of said volume-control resistor, an audio utilization circuit connected between the variable connection and one terminal end connection of said volume-control resistor, and an audio transmission circuit connecting the auxiliary electrode and the cathode of said electron tube with the tap connection and said one terminal end connection, respectively, of said volume-control resistor.

6. The combination as defined in claim 5, together with means for selectively short-circuiting the said separate source of audio voltages.

7. The combination as defined in claim 5, characterized in that the said source of modulated carrier voltages and the said separate source of audio voltages are serially connected with the input circuit of the said electron tube between the control-grid electrode and the cathode thereof, together with means for selectively short-circuiting the said source of audio voltages.

8. The combination as defined in claim 5, characterized in that the said audio transmission circuit between the auxiliary electrode of the said electron tube and the tap connection of the said volume-control resistor includes a resistor and a capacity serially connected therein.

9. In a combination radio-phonograph system, a modulated carrier wave receiver including a modulation detector having an audio output circuit, an amplifier including an electron tube capable of amplifying audio voltages and having audio input and output circuits, a source of audio voltages connected with the input circuit of said amplifier, a volume-control resistor effectively connected in shunt with the audio output circuit of said detector, circuit means effectively connecting the audio output circuit of said amplifier in shunt with a predetermined fixed portion of said volume-control resistor, and an audio utilization means effectively connected in shunt with a manually variable portion of said volume-control resistor.

10. The combination as defined in claim 9, characterized in that the ohmic value of the fixed portion of the said volume-control resistor which is effectively connected in shunt with the audio output circuit of the said amplifier, is less than one-half of the ohmic value of the said volume-control resistor which is effectively connected in shunt with the audio output circuit of the said detector.

11. In a combination radio-phonograph system, a modulated carrier wave receiver including an

electron tube having at least an anode, a cathode, and a grid electrode adapted to control the space current thereof, a source of blocking potential connected to said grid electrode and capable of biasing it beyond cutoff, thereby to render said electron tube ineffective, an amplifier capable of amplifying audio voltages and having input and output circuits, audio utilization means connected to the audio output circuit of said amplifier, a source of audio voltages, circuit means connecting said source of audio voltages with said amplifier input circuit and effectively in shunt with said source of blocking potential, and selective switch means capable of effectively short-circuiting both of said sources simultaneously, thereby rendering said sources ineffective to block said electron tube or to control said amplifier.

12. The combination as defined in claim 11, characterized in that the said selective switch means comprises a single-pole switch device capable of selectively short-circuiting two terminals effectively connected with both of the said sources.

13. In a combination radio-phonograph system, a modulated carrier wave receiver including an electron tube having at least an anode, a cathode, and a grid electrode adapted to control the space current thereof, a source of blocking potential connected between said cathode and grid electrode through a resistance, said source being capable of biasing said grid electrode beyond cut-off thereby rendering said electron tube ineffective, an amplifier capable of amplifying audio voltages and having input and output circuits, circuit means connecting the audio input of said amplifier through a blocking condenser with the said source of blocking potential, audio utilization means connected to the audio output circuit of said amplifier, power supply means common to both said amplifier and said receiver, a generator of audio currents, and selective switch means having a single operating control member movable to a plurality of positions, in one of which positions said generator is operatively connected with the audio input circuit of said amplifier, and in another of which positions said source is rendered incapable of rendering said electron tube ineffective.

14. The combination as defined in claim 13, further characterized in that the said power supply means is provided with an impedance connected between the cathode of the said electron tube and the negative terminal of the said means, and that a portion at least of the potential drop across the said impedance provides the said source of blocking potential.

15. The combination as defined in claim 13, further characterized in that a common support is provided carrying both the said generator of audio currents and the said selective switch means, said support being portable and located independently of the said receiver and amplifier.

16. In a radio receiving and sound amplifying system, an amplifier including an electron tube having at least a cathode, a plate electrode, a control-grid electrode, and an auxiliary electrode, a source of bias potential, circuit means including at least a resistor conductively connecting said source between said control-grid electrode and said cathode, means for selectively receiving modulated high-frequency currents, a generator of audio currents, a condenser, an inductance coupled with said last-mentioned means and effectively connected between said control-grid

electrode and one terminal of said condenser, and selective switch means and circuits associated therewith capable of effectively connecting either the other terminal of said condenser with said cathode or said generator therebetween, whereby said condenser serves alternately as by-pass for said high-frequency currents or as audio coupling means between said generator and said control-grid electrode.

17. The combination as defined in claim 16, further characterized in that a high-frequency output circuit is connected between the plate electrode and cathode of the said electron tube, and an audio-frequency output circuit is fixedly connected between the auxiliary electrode and cathode of the said electron tube.

18. The combination as defined in claim 16, further characterized in that means are provided for automatically disabling the said means for selectively receiving modulated high-frequency currents when the said selective switch means effectively connects the said generator of audio currents between the said other terminal of the said condenser and the said cathode.

19. In a sound recording and reproducing system, a radio receiver including an audio amplifier and a loud-speaker, a recording unit, a multi-position switch and circuit means associated therewith whereby in one position of said switch the said system is conditioned to audibly reproduce received radio programs, and in another position of said switch the said system is adapted to record received radio programs, a microphone, a casing carrying said microphone, a single-pole switch supported by said casing, a single-circuit cable connecting said microphone and said single-pole switch with said radio receiver and audio amplifier, and means whereby operation of said single-pole switch simultaneously disables the said radio receiver and operatively connects said microphone with the input circuit of the said audio amplifier, thereby permitting sounds picked up by said microphone to be either audibly

reproduced by said loud-speaker or recorded by said recording unit, depending upon the position of said multi-position switch.

20. In a combination radio-phonograph system, a modulated carrier wave receiver including a first electron tube having at least an anode, a cathode, and a grid electrode adapted to control the space current thereof, a source of blocking potential connected between said cathode and grid electrode through a resistance, said source being capable of biasing said grid electrode beyond cut-off thereby rendering said electron tube ineffective, an amplifier including a second electron tube having at least a cathode, a plate, a control-grid, and an auxiliary electrode, a carrier frequency input circuit and a generator of audio currents effectively connected in series relation between the control-grid and cathode of said second electron tube, a volume-control resistor having terminal connections, a tap connection intermediate its terminals, and a variable connection movable between its terminals and past the tap connection, a modulation detector having a carrier frequency input circuit connected between the plate and cathode of said second electron tube and an audio output circuit effectively connected between the terminal connections of said volume-control resistor, an audio utilization circuit connected between the variable connection and one terminal connection of said volume-control resistor, an audio transmission circuit including a condenser and resistor connected between the auxiliary electrode of said second electron tube and the tap connection of said volume-control resistor, a connection between the cathode of said second electron tube and the said one terminal connection of said volume-control resistor, and selective switch means and circuits associated therewith capable of simultaneously rendering ineffective said source of blocking potential and said generator of audio currents.

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