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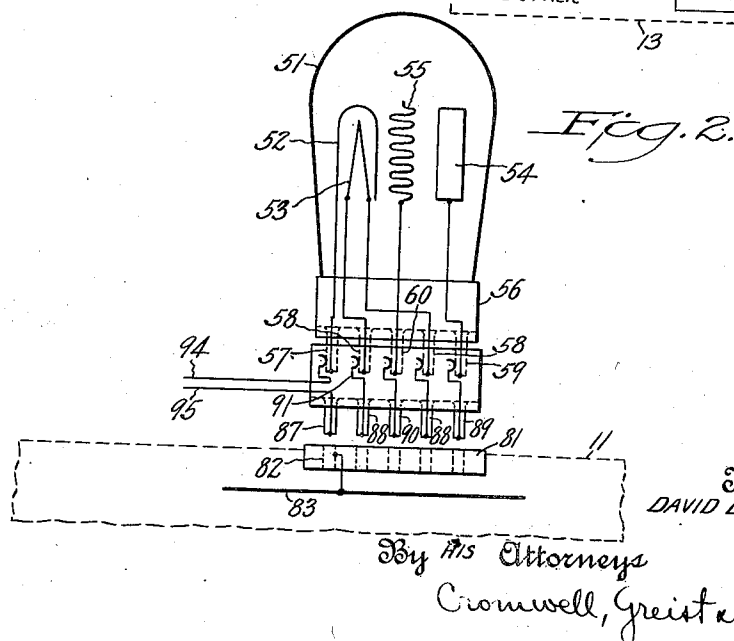
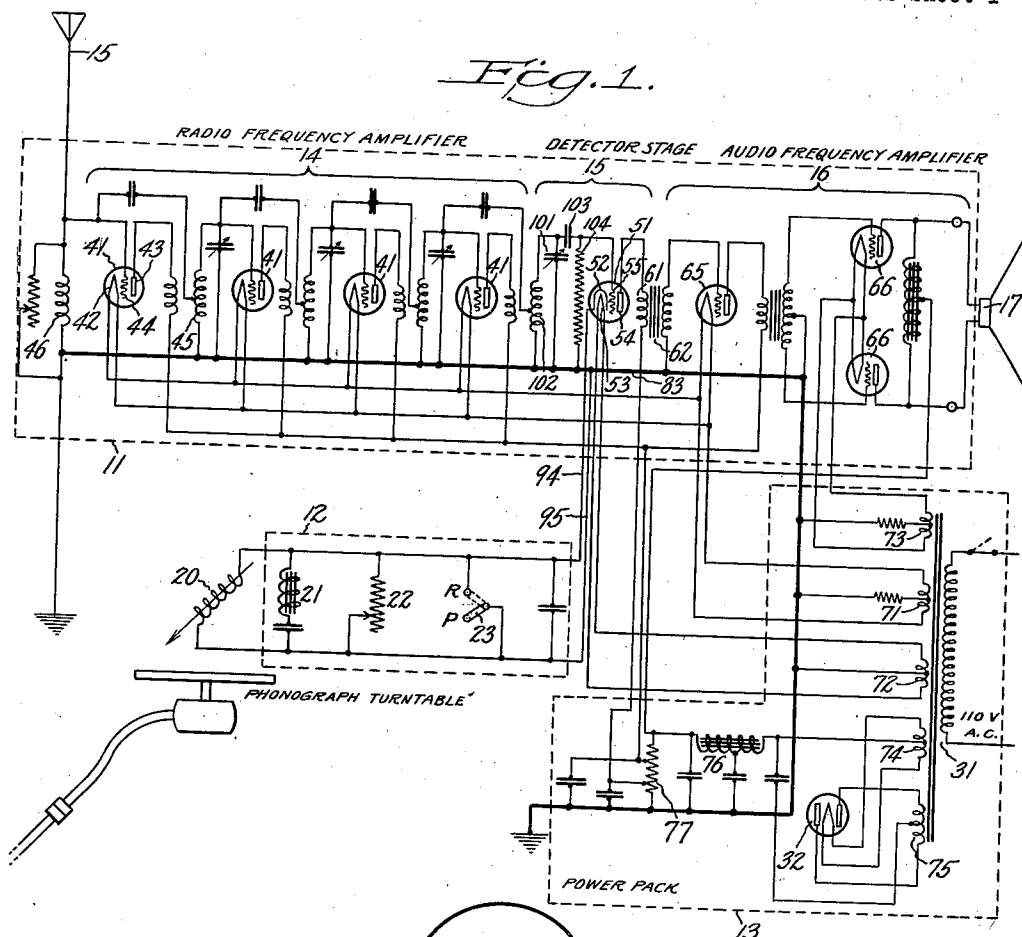
D. E. SPARKS

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ELECTRICAL AMPLIFYING SYSTEM

Filed June 6, 1929

2 Sheets-Sheet 1



Inventor
DAVID E. SPARKS

By *His Attorneys*
Cromwell, Geist & Warden

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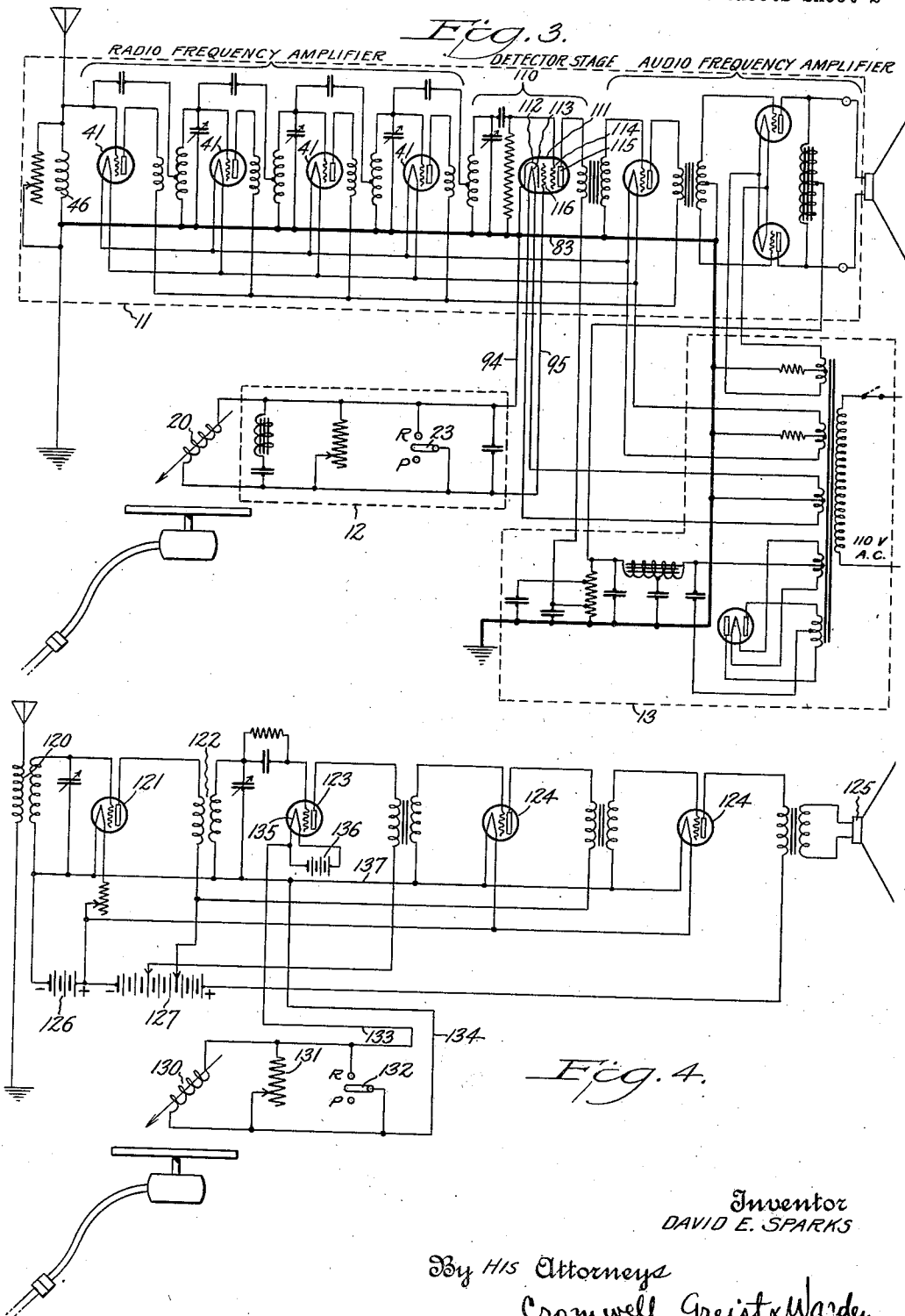
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Inventor
DAVID E. SPARKS

By HIS Attorneys
Cromwell, Geist & Warden

UNITED STATES PATENT OFFICE

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ELECTRICAL AMPLIFYING SYSTEM

David E. Sparks, Chicago, Ill.

Application June 6, 1929, Serial No. 368,910

11 Claims. (Cl. 179—100.11)

This invention relates to electrical amplifying systems, and it has particular reference to tube amplifying systems such as are adapted for use in radio receiving sets, electric phonographs, and the like.

Among the objects of the invention is an improved amplifier system of the foregoing type and method for operating the same, whereby a common amplifier chain may be used for amplifying different types of impulses supplied to the input stage of the amplifier system.

The foregoing and other features of the invention will be best understood from the following description thereof, reference being had to the accompanying drawings wherein,

Fig. 1 is a diagrammatic view of an amplifying system embodying the invention;

Fig. 2 is a detail diagrammatic view of the arrangement and the connections of the detector stage of the amplifier system shown in Fig. 1;

Fig. 3 is a diagrammatic view of an amplifier system similar to that shown in Fig. 1, illustrating a modification of the invention; and,

Fig. 4 is a diagrammatic view of an amplifier system illustrating a further modification of the invention.

In the construction of electrically operated phonographs and radio receiving sets, it is of extreme importance to reduce the number of parts to a minimum and utilize all the elements in the most efficient manner, while at the same time securing a high quality of reproduction. In apparatus of this type, it is very important to use the audio frequency amplifier that is ordinarily a part of the chassis of the radio receiving set also for amplifying the output of the electric pick-up head of the phonograph.

The general arrangement of such apparatus is shown in Fig. 1, where the chassis of the radio receiving set is indicated by a dotted-line rectangle 11, the electric phonograph pick-up attachment is indicated by the dotted-line rectangle 12, and the power pack for supplying the operating current to the amplifier circuits of the receiving set chassis, by dotted line 13. The receiving set chassis 11 includes the radio frequency amplifier chain 14, to the input side of which is connected a radio reception circuit such as an aerial 15 of familiar construction. To the output side of the radio frequency amplifier chain 14 is connected the detector stage 15, which in turn, has its output side connected to an audio frequency amplifier chain 16. The output side of the latter is connected to a suitable output device such as a loud-speaker 17.

The phonograph attachment 12 includes an electric pick-up head 20 of the familiar type, which has associated therewith a scratch-filter circuit 21, a volume control rheostat 22, and a change-over switch 23 for changing the opera-

tion of the apparatus from phonograph to radio reception and vice versa.

The power pack 13 includes the usual alternating current transformer 31 with a rectifier 32, and the associated filter and supply circuits for delivering cathode heating current, and input and output supply energy to the circuits of the amplifier tubes of the radio chassis 11.

In the practical design of radio receivers it has been found necessary to sacrifice the audio amplification to a considerable extent in order to obtain the maximum in quality of reproduction. In contrast to the transformation ratio of 5 or 10 to 1, used formerly in audio stage transformers, modern receivers use audio transformers having a step-up ratio of only 2 or 2½ to 1. Likewise, the power amplifying tube in the last audio amplification stage of modern receivers is made for modern apparatus with an amplification factor of approximately only 3 as compared to 8 used previously. This marked reduction in the amplification at the audio end of modern radio receiving sets is compensated for by increasing the amplification obtained with the radio frequency stages, for instance, by adding additional radio amplification stages to the chain.

When a radio receiving set of the foregoing type is combined with a phonograph pick-up, the output of the latter is ordinarily applied to the audio frequency stages of the receiving set chassis and because of the relatively low degree of amplification present in the ordinary receiving chain of such chassis as used in modern sets, only a relatively small output volume is obtained from the loud-speaker or output device as compared to the output volume when the set operates as a radio receiver.

The method generally followed heretofore in connecting the pick-up head to the audio amplifier chain of the receiving set chassis consists in connecting the pick-up head into the plate circuit of the detector tube directly across the primary winding of the audio frequency transformer in the output circuit of the detector stage. This method of connection has a twofold limitation. First, the amplification produced in the audio stages following the pick-up is, as explained before, not sufficient for a great many purposes where phonograph music is desired, for instance for dancing, where a large output volume is ordinarily necessary. Second, the impedance of the audio transformer ordinarily does not match that of the pick-up head in the way suitable for efficient operation.

In ordinary practice, the transformers for the audio amplifier stages are made so as to have a very high primary winding impedance compared with the impedance of the tube and the plate circuit to which it is connected. On the other hand, because of the necessity of keeping

its weight and size small, the impedance of most of the practical pick-up heads is relatively low, and as a matter of fact, much too low in comparison with the primary impedance of the audio transformer winding. Such combination of a pick-up head of low impedance working into an audio transformer of high impedance, is very inefficient.

Attempts have also been made to use the detector stage tube as an additional amplifying stage for phonograph operation by connecting the leads from the phonograph pick-up head to the grid and the cathode, respectively, of the detector stage tube. Such arrangement secures the desired degree of amplification of the phonograph input but it is impossible to make practical use of it in modern receiving apparatus.

For the convenient use and handling of such apparatus by laymen it is absolutely necessary that a switch shall be provided for changing over from radio to phonograph reception and vice versa. In practice, the lead from the grid to the switch has a substantial length, and since the grid of the detector stage is at high radio frequency potential, it results in instability of the operation of the grid on radio reception because of the unstabilizing capacity effect of such grid pick-up leads. As a result of the foregoing difficulties, the last described method of connecting the pick-up to the grid side of the detector stage tube has been given up in practice, and substantially all of the commercial sets on the market employ the first described method of connecting the pick-up head to the primary winding of the audio frequency transformer connected in the output circuit of the detector stage, notwithstanding the deficiencies of such arrangement from the standpoint of output volume in phonograph operation.

According to my invention, the deficiencies of the prior art arrangements are overcome and a highly efficient amplifier system suitable for combined use of a radio receiving set and a phonograph pick-up is obtained. A practical embodiment of my invention is shown in Figs. 1 and 2, referred to before.

As shown in the drawings, the radio frequency amplifier chain 14 comprises four radio frequency amplifier stages of which each includes a three-electrode tube 41, having a cathode 42, a plate or anode 43, and a grid or control electrode 44. The four tubes of the radio frequency chain are connected in series, the output circuits and the input circuits of the successive tubes in the chain being coupled to each other by means of radio frequency transformers 45. The input circuit of the first tube of the radio frequency chain is connected to the input coil 46 of the aerial circuit 15. The output from the last tube of the radio frequency amplifier chain is applied to the amplifier tube 51 of the detector stage, the latter tube being shown more in detail in Fig. 2 of the drawings. This tube 51 comprises a metallic cathode shell 52, a heater filament or coil 53 for heating the cathode shell, a plate or anode 54, and a control grid 55.

In tubes of this type, which are now quite generally used in radio receivers and the like, the heating coil 53 is ordinarily insulated and spaced from the cathode shell 52. The shell is usually provided with a highly electron-emitting oxide coating, and electron emission is obtained from this cathode by heating it indirectly through the filament 53 which may be energized with alter-

nating current without introducing any alternating current hum into the reception output.

As shown in the drawings, the tube has a base 56 with five terminal prongs, namely, a cathode terminal prong 57, two heater prongs 58, an anode prong 59, and a grid prong 60.

When used for ordinary radio reception the cathode 52 and the plate 54 constituting the output terminals of the detector tube are connected directly to the primary winding 61 of the first audio frequency transformer 62, the secondary winding of which supplies the series of additional tubes constituting the audio frequency amplifier chain. In the example shown in the drawings, the audio frequency amplifier chain comprises a three-electrode tube 65, the output of which is applied to two tubes 66 connected into a push-pull amplifier circuit, the output of the latter circuit being directly connected to the loud-speaker output device 17.

The operating circuits of the radio receiving set of Fig. 1 are completed by connections to the power pack 13 referred to before, the latter including in addition to the rectifier 32, a secondary transformer winding 71 for supplying heating current to the cathodes of the radio frequency amplifier tubes 41, and to the first audio frequency amplifier tube 65; a secondary transformer winding 72 for supplying the heating coil 53 of the detector tube; a secondary transformer winding 73 for supplying heating current to the cathodes of the tubes 66 of the audio frequency chain; a secondary transformer winding 74 for heating the cathode of the rectifier tube 32; and a secondary transformer winding 75 for supplying rectified plate current to the several tubes of the radio receiving set chassis.

The plate supply circuit connected to the rectifier tube 32 includes the usual filter system 76 for smoothing out the alternating current ripples, and a potentiometer resistor 77 for tapping off voltages of suitable value to the various plate circuits of the several tubes. As shown in the drawings, the voltage applied to the plate circuit of the amplifier tubes 41 and 65 is of a lower value than that applied to the plates of the push-pull amplifier tube 66, and the plate voltage of the detector tube 51 is of a still lower value. The circuit arrangements described thus far are those commonly employed in the present type radio receiving sets and no further explanation of their operation is here necessary.

When such set is ordinarily operated as a radio receiver, the detector tube 51 is placed directly in the socket 81 of the chassis 11, as shown in Fig. 2, thereby establishing the circuit connections between the detector tube and the remainder of the circuit. When the tube 51 is thus directly inserted in the socket 81 there is established a direct conducting connection between the cathode 52 and the ground conductor 83, through which the cathode of the detector tube is connected with the remaining circuit so as to operate as a detector for radio frequency reception, this being the normal construction and arrangement of the set.

In order to utilize the amplifier in the chassis of the radio receiving set as an electric phonograph amplifier in addition to its function as a radio reception amplifier, I plug into the normal socket 81 of the detector tube as described before, a special adapter 85 shown in Fig. 2. This adapter has five terminal prongs, 87, 88, 89, and 90, corresponding respectively to the prongs 57 to 60 of the detector tube 51, and socket terminals

91 corresponding to the socket terminals of the socket 81 of the chassis, so that the tube 51 may be plugged into the adapter 85 in the same way as it would be plugged into the chassis socket 81.

The corresponding socket terminals and prongs of the adapter 85 have a direct conductive connection within the adapter, except for the socket and for the prong which are in circuit with the cathode 52 of the tube, this socket and prong having terminal leads 94, 95, for connection to the phonograph pick-up attachment 12, described before. When so connected the chassis circuits will operate as ordinary radio receiver circuits if the change-over switch 23 is thrown to the dotted-line position R; and the entire audio frequency amplifier chain together with the detector tube of the chassis will operate as a phonograph amplifier if the switch 23 is thrown into the full-line position P.

In distinction from the prior art arrangements suitable for practical application, the phonograph amplifying circuit shown in Figs. 1 and 2 make use of the amplifying effect of the detector tube 51 in addition to the amplification of the tubes in the audio frequency amplifier chain, thereby securing a much larger volume than that obtained with practical sets as made heretofore. On the other hand, the system of connections shown in Figs. 1 and 2, does not introduce an unbalancing or unstabilizing effect on the grid circuit of the detector tube when the set is used for radio reception, notwithstanding the employment of a change-over switch 23 and the circuit leads thereto.

The foregoing advantageous utilization of the detector tube as a part of the phonograph amplifying chain is made possible by the fact that in my improved arrangement the electrical impulse generating coil of the phonograph pick-up head 20 is arranged to be connected in series between the cathode 52 of the detector, and the point where the cathode is normally joined to the plate and the input circuits of the tube. This method of connection gives a number of desirable and advantageous effects.

First, the connection of the pick-up head in the lead between the cathode and the ground conductor constituting the connection to the remainder of the circuit of the set, eliminates the possibility of grid capacity unbalance that would result from long lead connections to the grid itself, such as referred to before. In my arrangement, the pick-up head and the associated wire are located at the low potential end of the radio frequency input circuit leading between the cathode 52 and the grid 55 of the detector tube, and at this point the long leads have no practical disturbing effect on the operation of the grid input circuit when the set is used for radio reception.

Second, since the pick-up head generating coil 20 is connected between the cathode and the circuit leading to the grid, the voltage produced in the coil by the operation of the phonograph is impressed directly upon the grid 55 of the detector tube, the impressed pick-up voltage being amplified through the action of the grid in the output circuit of the detector tube 51, which thus acts as the initial amplifying stage in advance of the audio frequency amplifier chain 16 of the chassis in phonograph reproduction.

As seen in the drawings, the circuit connections from the ground conductor 83 to the grid 55 on the input side of the detector tube 51 comprise in addition to a tuning condenser 101, a

radio frequency tuning inductance 102, a grid condenser 103, and a grid leak resistor 104 shunting the grid condenser 103.

The potential variations derived from the pick-up head are thus applied to the grid 55 indirectly through parallel paths consisting of inductance, capacity and resistance. In ordinary radio receiving sets the grid leak resistor 104 is usually of the order of two megohms, and the capacity of the grid condenser is usually around .00025 microfarad. The effect of the inductance 102 may be neglected in considering the conditions applicable to audio frequency impulses derived from the pick-up head. Although the grid leak resistor 104 and the grid condenser 103 will thus present a substantial impedance in the circuit through which the phonograph impulses generated in the pick-up head are impressed upon the grid, this effect will nevertheless result in a very considerable increase of the phonograph output volume from the output device 17 as compared with the arrangements where the output is impressed on the first audio frequency transformer 62 as was the practice heretofore.

In this connection it should also be noted that where an arrangement such as described above is used, the impedance of the grid condenser 103 of the detector tube varies with the frequency, having a very high value for low audio frequencies, and a small value for high audio frequencies. This effect tends to increase the amplification of high frequencies and reduce that of low frequencies impressed by the pick-up head. I have found that in practical operation with tubes such as are now on the market, such slight discriminating effect exercised by the grid condenser 103 connected in the grid circuit does not detrimentally affect the operation of the set. As a matter of fact, because of the falling frequency characteristics of most commercial pick-up heads and dynamic speakers, the rising frequency characteristics resulting from the presence of the grid condenser 103 in the input circuit of the amplifier tube 51 is in many cases helpful in securing good quality of reproduction. Notwithstanding the foregoing limitations of the high impedance in the grid input circuit of the detector tube for audio frequency signals supplied from the pick-up head connected as shown in Fig. 1, the over-all sound volume derived from the output device 17 is very much increased compared to ordinary arrangements, and as a rule, the output of the loud-speaker is considerably more than required for ordinary home use.

Third, in addition to the amplification obtained through the impression of the pick-up head potential upon the grid, there results a further advantage from the fact that the pick-up head is directly connected in series with the plate circuit of the detector tube 51. Because of this connection, a part of the potential variations produced in the pick-up head will be directly impressed upon the primary winding 61 of the input transformer 62 of the audio frequency amplifier chain. As pointed out before, the primary winding impedance of the audio frequency transformer 62 is usually made large in comparison with the tube impedance. Because of the connection of the pick-up head in series with the tube and the primary winding of the audio frequency transformer 62, the voltage generated in the pick-up head will produce a current through the plate circuit. Since the impedance of the primary transformer winding is relatively large, a substantial part of the voltage of the pick-up

head will be impressed on the primary winding 61. Accordingly, there will appear across the primary winding of the audio frequency transformer 62 in addition to the impressed voltage resulting from the amplifying control action of the grid, a further cooperatively acting voltage directly applied through the pick-up head connection in the plate circuit.

Fourth, my improved system as shown in Figs. 1 and 2, gives a further amplifying effect by reason of the fact that the heater electrode 53 is made to exercise a control action on the electron flow of a similar nature as the control action exercised by the grid 55 of the detector tube 51, but in addition thereto.

In ordinary commercial indirectly heated cathode tubes, the cathode shell 52 usually surrounds the heater electrode 53 so that the electron flow control effect of this heater electrode is relatively small compared to the control effect of the main grid 55. However, even in such ordinary indirectly heated tubes the control effect of the heater electrode 53 is very substantial and I secure a very marked degree of amplification by connecting the pick-up head between the cathode and the heater electrode in the way shown in Figs. 1 and 2. While this amplifying effect resulting from the use of the heater electrode as an input electrode is not as large in present commercial constructions as that which would result from direct use of the main control grid 55, it is nevertheless very substantial and a marked degree of added amplification is obtained by following the principles of the arrangement shown in Figs. 1 and 2 of the drawings, even if no use is made of the amplifying effect of the main grid and of the direct impression of the part of the pick-up impulses on the primary winding of the audio transformer 62.

As seen from the foregoing, my invention contemplates the improvement of the operation of apparatus of the type under consideration through a number of different effects taken individually, and also through the combined cooperative relationship of the several advantageous effects. I have found that the individual effects each by itself greatly improves the amplification of signals impressed on the audio frequency amplifier chain from the phonograph pick-up, and I desire it to be understood that within the contemplation of my invention, each one of these effects may be used separately.

In other words, as against the ordinary system of connecting the phonograph pick-up head to the audio frequency amplifier chain, it will be of advantage to use by itself either the system of connection in which the pick-up head is connected between the cathode and the ground terminal of the input circuit elements leading to the main control grid of the tube; or the system whereby the pick-up head is connected between the cathode and the lead to the output primary transformer winding; or between the cathode and the heater electrode. The advantageous effect is of course increased by combining two or three of the foregoing effects, i. e., if the pick-up head is connected to be in circuit with the normal control electrode, with the heater electrode, as well as with the primary winding of the output transformer in the plate circuit of the tube, so that the total voltage produced across the audio transformer primary winding is the sum of three voltages, namely, one due to the grid control function, one due to the heater electrode con-

trol function, and the third due to the direct effect on the plate circuit.

A distinctive phase of my invention are the features of the arrangement shown in Figs. 1 and 2, whereby an ordinary radio receiving set wired without consideration to its utilization in connection with an electric phonograph may be readily adapted for the latter use without changes in its wiring, but retaining the normal connections of the radio receiver chassis. As explained before, the radio receiving chassis and its appurtenances may be manufactured entirely independently and without consideration of the essential distinct elements entering into an electrical phonograph attachment.

In order to adapt such standard receiving set chassis for combined use as a radio receiver and phonograph amplifier, it is merely necessary to remove from its ordinary socket 81, the detector tube 51, replacing the radio tube by an adapter socket 85, and then plugging in the radio tube 51 into the adapter circuit terminals in the same way as the tube was originally mounted in its chassis socket 81. The adaptation is then completed by connecting the circuit wires 94 and 95 to the terminals of the phonograph pick-up head attachment as shown in Fig. 1. The apparatus will then be ready to be used at will, either as a radio receiver or as a phonograph amplifier, by merely turning the change-over switch 23 to the upper position R, in which the pick-up head is short circuited and the cathode 52 is directly connected to the ground conductor 83; or to the position P in which the generating coil 20 of the pick-up head is connected in the circuits of the grid control electrode, the heater control electrode, and the transformer primary winding.

Such adapter arrangement greatly simplifies the merchandising and the manufacturing methods of such apparatus. For instance, the radio chassis may be manufactured at one factory, the cabinet at another, and the phonograph turntable with its pick-up head attachment, adapter and associated wiring at still another factory. The three units may then be individually shipped to the dealer or layman who will easily assemble them to meet his needs without requiring any special technical knowledge.

In the above described arrangement of Figs. 1 and 2, I have referred to the use of the ordinary commercial indirectly heated tubes for the detector stage of the chassis. If no use is intended to be made of the heater electrode control effect, an ordinary tube suitably constructed to operate with alternating current cathode heating may be used instead.

Where it is important that the beneficial control effect exercised by the heater electrode shall be made large, I contemplate the use of indirectly heated tubes in which the heater electrode is not altogether surrounded by the cathode shell, but is so placed that it exercises a strong heating action on the body constituting the cathode and at the same time also as a substantial control effect comparable to the main control electrode. This may be obtained, for instance, by placing the heater electrode so as to extend at least for a part into the space between the main cathode body and the main control electrode.

My invention also contemplates the use of a separate control electrode for the pick-up head. Such additional control electrode may be arranged so as to be normally at ground potential with respect to the radio frequency currents. It

would then not affect the regular operation of the radio set.

An arrangement of the foregoing type in which a special additional control electrode is disposed within the tube for use in connection with the pick-up head is shown in Fig. 3. The arrangement of the circuit and the parts in Fig. 3, is in general exactly the same as that described in connection with Figs. 1 and 2, except that the detector stage 110 is provided with an amplifier tube 111 which in addition to an indirectly heated cathode 112, a heating electrode 113 therefore, a radio frequency input control grid 114, and a plate 115, has an additional control grid 116 arranged in general in the same manner as the ordinary control grid 114 is arranged within the tube. This additional control grid is then directly connected to the lead 95 of the phonograph pick-up head attachment 12 in a way similar to that shown in Figs. 1 and 2.

In the arrangement of Fig. 3, the pick-up head coil 20 is connected directly between the additional control grid and the cathode, and when so used, the combined set may be employed either for radio reception by throwing the change-over switch 23 of the attachment to the upper position R in which the additional grid is directly short circuited to the ground conductor 83; or the set may be used for phonograph operation by throwing the change-over switch 23 to the lower position P in which case, the control voltage generated in the pick-up head is impressed upon the additional grid 116.

My invention also contemplates the use of a double grid tube such as shown in Fig. 3 under utilization of the other beneficial effects resulting from the combination of elements described in connection with Figs. 1 and 2.

The principles of my invention are of course not limited to radio receivers in which the cathodes are energized by alternating current but are likewise applicable with advantage, to battery operated receivers and in general, to various types of amplifiers as used in the art. For purposes of illustration, I have shown in Fig. 4, my invention as applied to a battery operated radio receiver. Radio frequency impulses from an aerial 120 are applied to a radio frequency amplifier tube 121 through the familiar tuned input circuits. The output of the radio frequency amplifier tube 121 is then impressed through a radio frequency transformer 122 into the input circuit of a detector tube 123, and the output of the latter is then amplified through two tubes 124 forming an audio frequency amplifier chain, and impressed upon an output device 125, such as a loud-speaker.

As shown in the drawings, the cathodes of the radio frequency amplifier tube 121 and the audio frequency amplifier tubes 124, are supplied in parallel from a common direct current source 126 shown in the form of a battery, and the plate circuits of the several tubes are all supplied by means of taps on the direct current source of plate voltage 127, which is also shown in the form of a battery. The pick-up attachment is shown comprising a pick-up head 130 with a volume control rheostat 131 and change-over switch 132, the two leads 133, 134 from the pick-up attachment being connected between the cathode 135 of the detector tube 123, and a common ground lead of the several amplifier stages.

Upon throwing of the change-over switch 132 of the phonograph attachment to the upper position R a direct conducting connection is es-

tablished between the cathode 135 of the detector tube 123, and the common ground lead of the several amplifier stages, and the set will then operate as an ordinary radio receiver. If it is desired to operate the phonograph with the audio frequency amplifier chain of the set, the change-over switch 132 is thrown to the downward position P, thereby inserting the pick-up head coil 130 into the circuit connection between the cathode 135 of the detector tube and the common ground connection.

It will be noted that the cathode 135 of the detector tube is not energized by the battery 126 which supplies in common the cathodes of the other tubes of the set, but by a separate current source in the form of a battery 136 that is insulated from the remaining battery and from the common ground conductor 137. Accordingly, when the change-over switch 132 is in the lower phonograph position P the voltage generated by the pick-up head coil will be impressed on the control grid of the detector tube 123 as well as on the output transformer connected to the plate circuit of the tube in a way analogous to the arrangement shown in Figs. 1 and 2. As a result, the impulse from the phonograph pick-up head 130 will pass through an additional stage of amplification in the detector tube, thereby securing a higher output volume as described before in connection with Figs. 1 and 2.

The principles of my invention will be found applicable and useful in many other arrangements and in many other types of amplifiers. These principles involve in some respects the use of an amplifier chain having an input tube arranged to receive input energy from a plurality of distinct sources of substantially different frequencies, and adapted to utilize the first tube to amplify the impulses, whether coming from high frequency sources or whether coming from low frequency sources. The principles of my invention involve further, the direct application of the output of the impulse sources to the plate as well as to the control electrode circuits of the first tube of the amplifier chain; the use of adapters for readily utilizing an ordinary radio receiver set for phonograph amplification under utilization of the audio frequency amplifier chain as well as the detector tube of the receiving set chassis; the utilization of distinct control electrodes selectively cooperating to impress the input of additional sources on the amplifier chain; and the employment of the heater electrode in indirectly heated tubes as such additional control electrodes.

As many arrangements embodying the foregoing principles of the invention will suggest themselves to those skilled in the art, I desire that the appended claims be given a broad construction commensurate with the scope of the invention within the art.

I claim:

1. In an electron tube amplifying system, an electron tube comprising a cathode, an anode and a grid, a cathode terminal, a connection between said cathode and said cathode terminal, an input circuit connected between said cathode terminal and said grid, an output circuit connected between said cathode terminal and said anode, means for translating high frequency current in said input circuit into low frequency current in said output circuit, and means including an independent source of low frequency energy in series with the circuit connection between said cathode and said cathode terminal.

2. In an electron tube amplifying system, an electron tube comprising a cathode, an anode and a grid, a cathode terminal, a connection between said cathode and said cathode terminal, an input circuit connected between said cathode terminal and said grid, an output circuit connected between said cathode terminal and said anode, said circuits having means for causing said electron tube to integrate variations of the amplitude of high frequency energy applied to said grid and convert the same into a relatively low frequency energy, and means including in series with the circuit connection between said cathode and said cathode terminal an independent source of low frequency energy.

3. In an amplifying apparatus, an amplifying tube chassis including a radio frequency amplifying unit, an audio frequency amplifying unit, and an intermediate circuit unit interposed between said radio frequency amplifying unit and said audio frequency amplifying unit, said intermediate unit including an electron discharge valve having a cathode, an anode, a grid and a base provided with terminals for making connections to said electrodes, a socket in said chassis for receiving said intermediate valve, said socket having a cathode socket terminal, an anode socket terminal and a grid socket terminal for establishing connections with the cathode, anode and grid terminals, respectively, of said valve, a high frequency input circuit connected between said cathode socket terminal and said grid socket terminal, a relatively low frequency output circuit connected between said cathode socket terminal and said anode socket terminal, means associated with said intermediate valve for translating high frequency currents impressed upon the input circuit into low frequency currents in the output circuit, an adapter adapted to be inserted into said socket in lieu of said valve, said adapter having terminals corresponding to those on the base of said valve for insertion into said socket and making connections with the terminals thereof, socket terminals in said adapter corresponding to the socket terminals of said socket for receiving the terminals on the base of said valve, and a source of variable current energy connected in series between the cathode terminal and the corresponding socket terminal on said adapter.

4. In a radio receiving apparatus, a radio frequency amplifier, an audio frequency amplifier, said amplifiers including electron discharge valve means having each a cathode, an anode and a grid electrode, additional valve means having a cathode, an anode and a grid electrode, the cathodes of said valve means having a common conducting connection, an input circuit for said additional valve means connected between the grid and the cathode thereof, a high frequency input element connected in said input circuit to impress the output of said radio frequency amplifier upon said additional valve means, means associated with said additional valve means for translating high frequency impulses in the input circuit thereof into low frequency impulses in the output thereof, means impressing the output of said additional valve means on said audio frequency amplifier, and an independent low frequency input source connected in series with the input circuit of said additional valve means between the cathode thereof and said common conducting connection.

5. In an electron tube amplifying system, an

electron tube comprising a cathode, an anode and a grid, an input circuit connected between said grid and said cathode, an output circuit connected between said anode and said cathode, means for translating high frequency current in said input circuit into low frequency current in said output circuit, an additional source of relatively low frequency input energy connected in said input circuit in series relationship between said high frequency input source and said cathode, and a ground connection to a point of said input circuit between said high frequency input source and said low frequency input source.

6. In combination with a tube having a cathode circuit, an electric pick-up interposed in said cathode circuit and a volume control connected across the terminals of said pick-up and having contact means for short-circuiting said pick-up and completing the cathode circuit independently of the pick-up.

7. In a radio receiver, a detector tube having a cathode, an anode and a control grid, a connecting conductor leading from said cathode to the circuits of said tube, an electrical pick-up interposed in said connecting conductor, and means for cutting out said electrical pick-up and completing the circuit of said electrical conductor.

8. In an amplifying device, an amplifying tube having a cathode, an anode and a control grid, a base on said tube provided with terminals connected to said electrodes, a holder for holding said tube having terminals adapted to engage said tube terminals and connecting conductors leading from said holder terminals to circuits of said tube, and an electrical pick-up interposed between the holder terminal engaging the base terminal of the cathode of said tube, and a connecting conductor leading from said holder terminal.

9. In an amplifying device, a detector tube having a cathode, an anode and a control grid, a base on said tube having a plurality of terminals connected to said electrodes, an adapter having socket terminals for engaging said base terminals, and circuit terminals for connection to circuits of said tube, and an electrical pick-up interposed between the socket terminal engaging the base terminal connected to the cathode of the tube and the associated circuit terminal.

10. In a radio receiver, a detector tube having a cathode, an anode and a control grid, an input circuit connected between said grid and said cathode, an output circuit connected between said anode and said cathode, said input circuit and said output circuit having a common connecting conductor leading to said cathode, an electrical pick-up interposed in said connecting conductor, and means for cutting out said electrical pick-up and completing the circuit of said electrical conductor.

11. In a radio receiver, a detector tube having a cathode, an anode and a control grid, an input circuit connected between said grid and said cathode, an output circuit connected between said anode and said cathode, said input circuit and said output circuit having a common connecting conductor leading to said cathode, an electrical pick-up in said connecting conductor, a volume control connected across the terminals of said pick-up, and contact means for short-circuiting the said pick-up and completing the circuit through said connecting conductor to said cathode independently of said pick-up.

DAVID E. SPARKS.