

May 10, 1932.

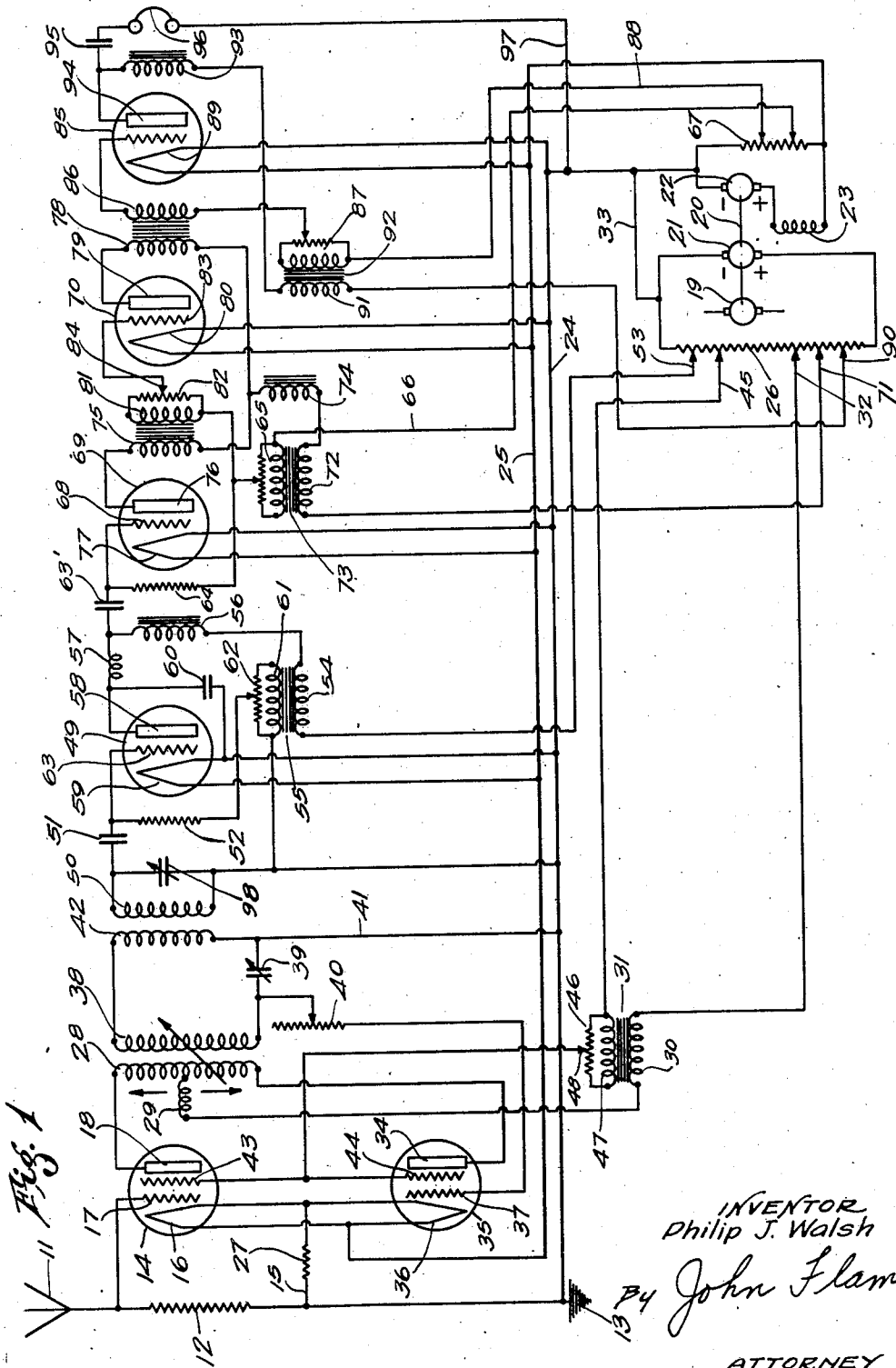
P. J. WALSH

1,857,901

CONSTANT CURRENT AMPLIFIER SYSTEM

Filed July 30, 1928

4 Sheets-Sheet 1



May 10, 1932.

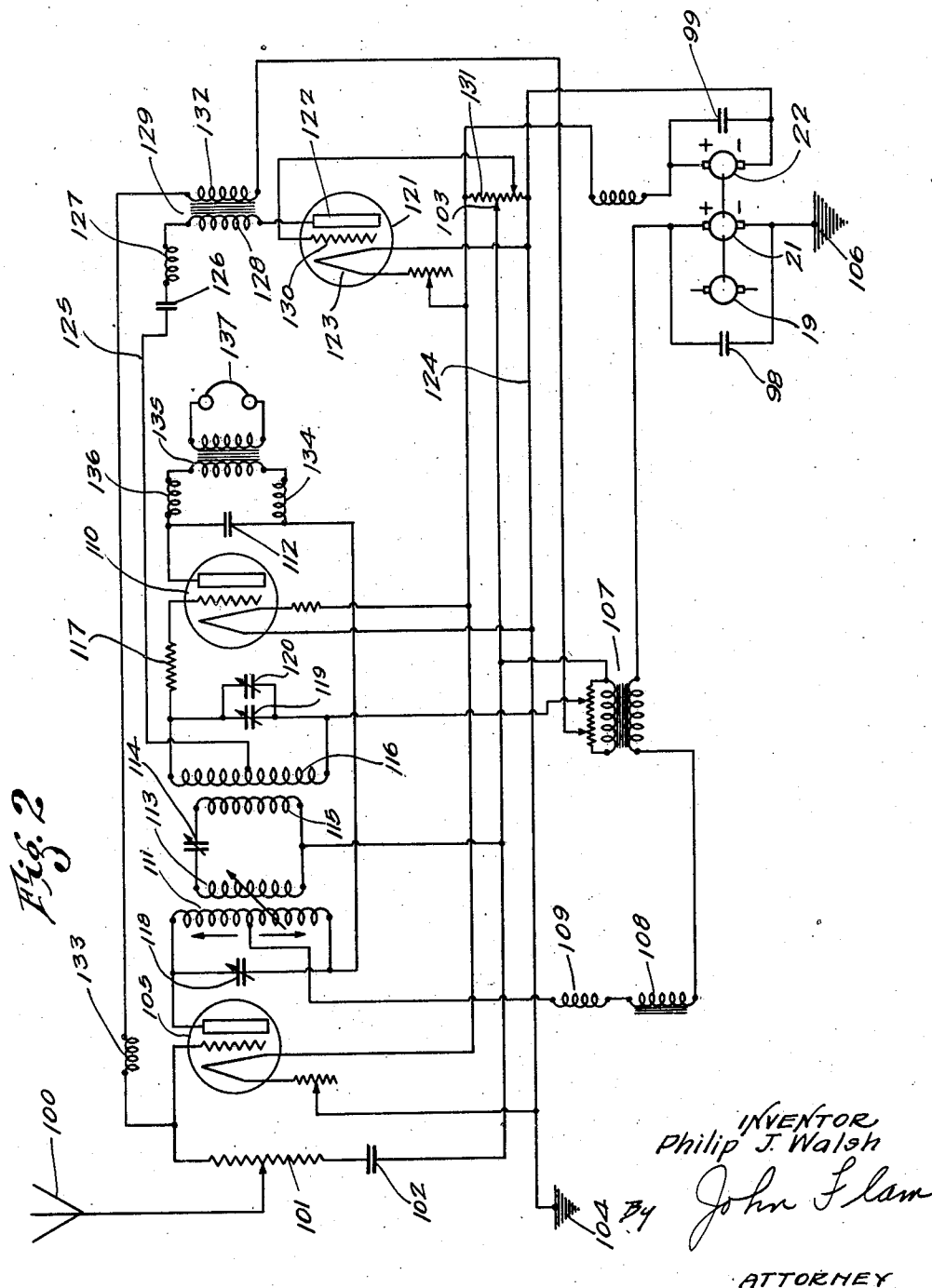
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CONSTANT CURRENT AMPLIFIER SYSTEM

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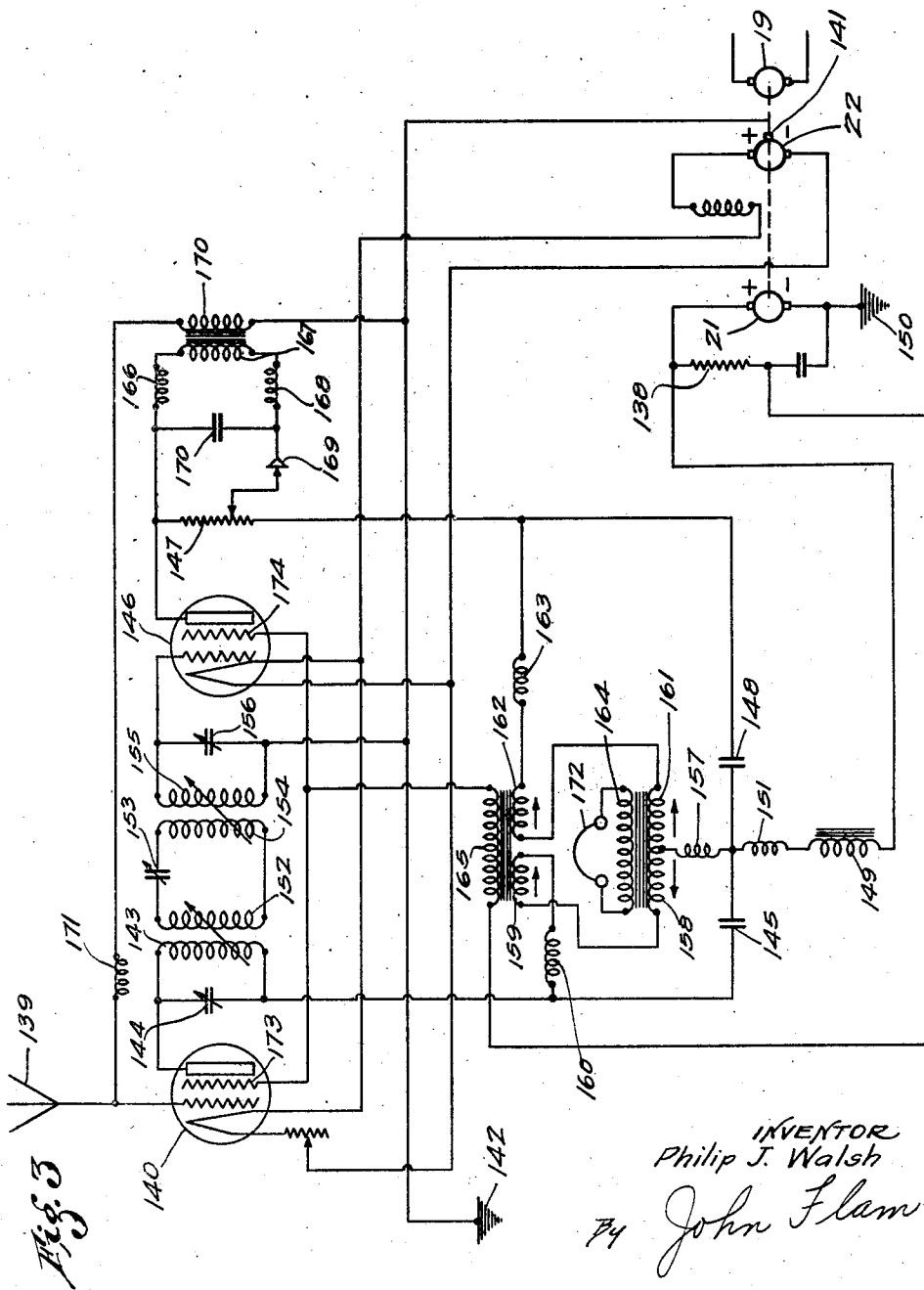
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CONSTANT CURRENT AMPLIFIER SYSTEM

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CONSTANT CURRENT AMPLIFIER SYSTEM

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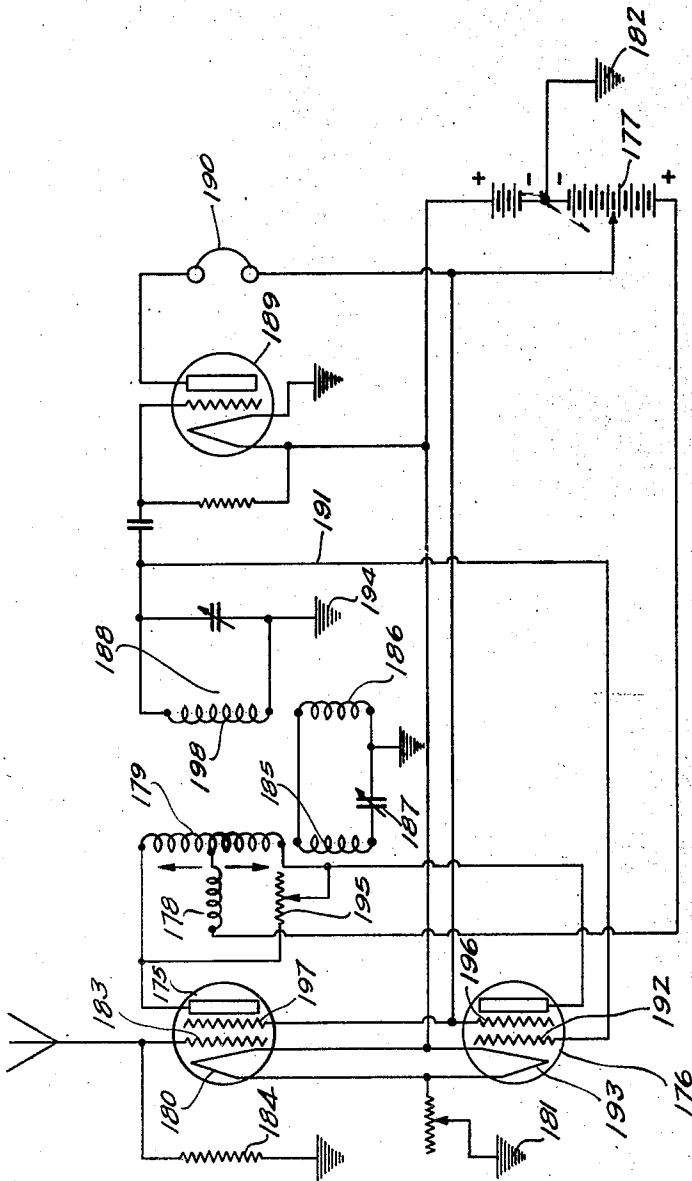


Fig. 4

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UNITED STATES PATENT OFFICE

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CONSTANT CURRENT AMPLIFIER SYSTEM

Application filed July 30, 1928. Serial No. 296,140.

This invention relates to the amplification of weak currents, such as are encountered in connection with radio reception.

In my prior patents, having Numbers 1,594,582; 1,669,958; and 1,669,959, I describe amplifier systems in which use is made of a number of electronic emission amplifiers. These amplifiers are each in the form of an evacuated vessel, enclosing a plurality of electrodes. One electrode is an electron emitting electrode, such as a heated filament; and a stream of electrons is passed to another electrode; usually termed a plate or anode. These two electrodes are joined by an external circuit (usually termed the output circuit) in which is included a source of electric potential, to maintain the plate positive with respect to the electron emitting electrode, and thereby to attract these electrons.

It is obvious that the "space current" flowing between the electrodes also flows through the external circuit. It is found that the impedance of the tube to the passage of this current can be varied at any desired rate, by varying the potential of a point in the tube space. Even minute variations have a comparatively large effect upon the space current, and it is this feature that is utilized to produce the amplification. The control of the amplifier is usually secured by the aid of a third electrode (usually in the form of a grid) interposed between the other two. Now if weak impulses are caused to vary the potential difference between the grid and filament, a comparatively large variation in space current results.

This variation in current can in turn be caused to produce a variable potential difference, as across a resistance, an inductance, or a capacity; and these potential differences can be applied to a succeeding stage.

In my prior patents referred to, a pair of amplifiers are fed with space current from a common source, so arranged as to remain substantially constant. The variations in impedance of one of them are caused oppositely to vary the impedance of the other, so that the constant current divides between the two devices inversely in accordance with their impedances. The resultant difference in cur-

rent flow in the two paths is utilized as the output characteristic. It is one of the objects of my present invention to improve such systems in general; and especially to render them not only efficient as amplifiers, but also so selective that no difficulty is encountered in tuning to signals of any desired frequency to the exclusion of other signals having frequencies even in the neighborhood of that of the desired signals.

It is another object of my invention to make it possible, with a constant current system of this character, to provide a "reflex" system, whereby at least some of the amplifiers are used twice; once, to amplify the carrier waves that are modulated with signaling impulses; and again, to amplify the detected signals.

It is still another object of my invention to improve in general, that feature of my prior inventions which relates to the compensation or nullification of pulsations due to the use of rectified alternating currents for applying positive potentials to the plates of the amplifier.

In some of the more recent amplifier tube designs, use is made of a supplementary grid, called a screen grid, which is interposed in the space current path. This is kept at a high potential with respect to the control electrode, and serves when so used to stabilize the radio frequency circuits, against parasitic oscillations. It is another object of my invention to utilize a tube of this character, in which the supplemental electrode serves not only its usual function, but also to vary the impedance of the tube to compensate for the pulsations in the source of plate supply.

My invention possesses many other advantages, and has other objects which may be made more easily apparent from a consideration of several embodiments of my invention. For this purpose I have shown a few forms in the drawings accompanying and forming part of the present specification. I shall now proceed to describe these forms in detail, which illustrates the general principles of my invention; but it is to be understood that this detailed description is not to be taken in a limiting sense, since the scope

of my invention is best defined by the appended claims.

Referring to the drawings:

Figure 1 is a wiring diagram of one form of my invention;

Fig. 2 is a wiring diagram of another form, utilizing a "reflex" system;

Fig. 3 is a wiring diagram of still another form of my invention; and

Fig. 4 is a wiring diagram of a still further modification.

In Fig. 1, I show a conventional type of pick-up circuit, such as elevated conductors or antennae 11, an impedance, such as a resistance 12, and a ground connection 13. An amplifier 14 is connected so as to be influenced by the radio frequency fluctuations in electromotive force, across at least a portion of this pick-up circuit; for example, one terminal of resistance 12 connects to the control electrode or grid 17 of the amplifier 14; and the other terminal is connected, by the aid of conductor 15, to the electron emitting electrode 16. In this way, the space current between the electrode 16 and an anode 18 is controlled in accordance with the signaling impulses.

Before discussing this feature of the system in greater detail, I shall now describe how the electron emitting electrode 16 is provided with current to heat it; and how a potential, positive with respect to electrode 16, is impressed on the plate 18. For this purpose, I indicate in this instance sources of current that can readily be obtained in a large majority of homes, although some sacrifice as to steadiness of potential is necessary. For example, I may provide a speed regulated universal motor 19 that can be light socket operated, to drive a shaft 20 upon which a compound armature 21, 22 is mounted. This armature includes a pair of windings 21, 22, that can be wound in common slots, and affected by a common field winding 23. Armature 22 is arranged to supply the heating current for all of the electron emitting electrodes of the system. For this purpose, the leads 24, 25 connect to opposite terminals of the armature 22, and these leads in turn connect across the filament 16. The negative lead 24 can be grounded as by ground 13. Field winding 23 can be inserted in series in the filament heating circuit.

The armature 21 can be connected across a potentiometer resistance 26, from which taps can be taken off to provide the desired potential differences.

Returning now to amplifier 14, the use of resistance 27 in the filament circuit ensures a normal negative potential of grid 17 with respect to filament 16, and thus ensures that the amplifier will operate on an efficient portion of its characteristic. The output circuit, including the space current path in amplifier 14, can be traced as follows: from armature

21, lower portion of resistance 26, tap 32, a primary coil 30 of a transformer 31 (the use of which will be later explained), a radio frequency choke coil 29, the upper portion of coil 28, plate 18, space of tube 14, filament 16, conductors 15, 24, 33, to the other terminal of armature 21.

Variations in impedance at radio frequency in the space of tube 14 can have no appreciable effect upon the flow of current through coil 29, because this coil maintains constancy of current. Accordingly, these variations affect oppositely the flow of current in a path paralleling tube 14 but combining with the current through that tube, in coil 29. This parallel circuit can be traced from choke 29 as follows: lower half of coil 28, plate 34 of amplifier 35, filament 36, thence via conductors 15, 24 and 33 to the negative side of armature 21. Filament 36 is heated in parallel with filament 16.

As thus far described, it is obvious that, whatever variations in current flow result in tube 14, an opposite variation must result in tube 35, due to the fact that the sum of their currents through coil 29 must be constant. However, the arrangement is such that this difference in current flow is accentuated, by controlling the impedance of tube 35 in accordance with, but opposite to the variations of tube 14. For this purpose the control electrode 37 for tube 35 is responsive to the unbalance between the two parallel currents. Thus a coil 38, variably coupled with coil 28, is arranged to form a tunable circuit with a variable condenser 39. The drop in potential across any element in this tunable circuit can be impressed on the input of tube 35. For example, one terminal of condenser 39 can be connected, through a high variable resistance 40, to grid 37; and the opposite terminal of condenser 39 is connected to filament 36 by way of conductors 41, 15 and grid bias resistance 27. It is of course understood that, in accordance with the teachings of my prior patents, a balance in impedances of tubes 14 and 35 ensures that no electromotive force can be induced in the coupled coil 38; but as soon as an unbalance exists, there is an induced electromotive force proportional to the unbalance.

It is thus seen that the greater the unbalance, the greater the drop across condenser 39, and the tube 35 is so controlled by this unbalance as to increase it. This increase in unbalance starts the cycle again, and this building up process continues until the difference in current in the two paths is much greater than at the beginning of the process. Accordingly, greatly amplified electromotive forces exist in the link circuit 38, 39, 42. The control of the building up process can be secured either by varying the resistance 40 (which may have a maximum value of the order of one half megohm), or by varying the

coupling between coils 28 and 38. Condenser 39 is used to tune the link circuit so that it may respond strongly to the frequency of the desired signaling impulses.

5 It is apparent that commutator ripple or the like may produce undesired audio frequency pulsations in the plate circuits of tubes 14 and 35. To compensate for these pulsations, I utilize a second control grid 10 43 or 44 in each tube 14 and 35. When undesired fluctuations occur, these grids control the impedance of the tubes in such a manner as to reduce them. Furthermore, these grids can be used as positive potential screens, to prevent instability in the radio frequency circuits, in a manner now well understood. 15 These grid circuits can be traced from the filament side of the amplifiers as follows: from filaments 16 and 36, connections 15, 24, 33, tap 45 on resistor 26, an adjustable portion of a resistance 46 supplied with electromotive force from the secondary 47 of transformer 31, to grids 43 and 44. When fluctuations occur in the source 21, these fluctuations passing through primary 30, will induce an elec- 25 tromotive force in coil 47. By careful adjustment of tap 48 on resistance 46, a grid potential variation is secured to counterbalance this fluctuation. When the potential difference of source 21 increases, the grids 30 43, 44 have their potentials reduced to increase the space current impedance; and vice versa. By proper adjustment of tap 45, the correct positive potential can be secured to provide the desired screening effect. 35

Link circuit 38—39—42 can be connected to succeeding stages of amplification; but since the mode of connection to secure this result is well known, I do not show them. 40 Instead I couple the link circuit to a detector. This may be either a crystal detector or an electronic emission detector. In the present instance I show an audion detector 49, the input side of which is connected across the 45 tunable circuit 50 coupled to the link circuit. The use of this tunable circuit with the link circuit imparts a high degree of selectivity to the system; this is a highly desirable characteristic where many stations are simultane- 50 ously transmitting within a narrow frequency range.

The input circuit includes the usual grid condenser 51. A grid leak resistance 52 is also included between the grid and filament. 55 In series with the resistance 52 is a pulsation compensating device, operating just as transformer 31 with its associated parts. The operation of this pulsation compensator will be hereinafter referred to.

60 The output circuit can be traced as follows: from the positive terminal of winding 21, to tap 53 on resistance 26, primary 54 of pulsation compensator transformer 55, a high impedance 56, radio frequency choke 57, plate 65 58, filament 59, back to the negative termi-

nal of winding 21, via conductors 24 and 33. There is a capacitive path also between the plate 58 and filament 59, including condenser 60. This can be of about .00025 microfarads, 70 and in conjunction with coil 57, serves as a filter to prevent radio frequency from passing through coil 56 and the source 21. The pulsation compensation is accomplished as before. The secondary 61 of transformer 54 supplies an electromotive force for potenti- 75 ometer resistance 62, a variable portion of which is included in the grid leak circuit. In this way, the control electrode 63 has its bias varied in accordance with the fluctuations in the current through coil 54. The audio frequency currents from detector 49 are intended to pass only through a blocking con- 80 denser 63¹ and a high resistance 64. This resistance is connected to the filament 59 through the pulsation compensator potentiometer 65, lead 66, a potentiometer 67 connected across winding 22, and lead 24 to filament 59. The potentiometer 67 is used to supply a biasing potential to the grid 68 of the succeeding audio frequency ampli- 90 fier tube 69.

The two audio frequency amplifier tubes 69 and 70 are connected in such a way that they form parallel paths for a constant current, just as tubes 14 and 35. Thus the out- 95 put circuits of the two tubes 69 and 70 can be traced as follows: from the positive terminal of winding 21, to tap 71 on resistance 26, primary 72 of pulsation compensator transformer 73, audio frequency choke 74, 100 for keeping the current constant; thence the current divides, one part flowing through coil 75 to plate 76 of tube 69, then to filament 77 and by way of conductors 24 and 33 to the negative side of winding 21. The other 105 part of the current from coil 74 passes to coil 78, plates 79 of amplifier 70, filament 80, and by way of leads 24 and 33 back to the negative side of winding 21.

It is apparent that since the input elec- 110 trodes of tube 69 are connected across resistance 64, the impedance of tube 69 varies in accordance with the audio frequencies present in the output of detector tube 49. These variations are caused to affect the im- 115 pedance of tube 70 in an opposite direction, in order to obtain the building up process. Thus coil 75 is coupled to coil 81, across which a comparatively high resistance 82 is connected. The grid 83 of tube 70 is connected 120 by a variable tap 84, to the resistance 82; and the input circuit of tube 70 is completed by way of device 65, lead 66, resistance 67, lead 24, to filament 80. Thus the impedance of tube 70 is varied, and this variation is 125 augmented until a very large variation in current flow in coil 78 results. The building up process can be controlled by varying the position of tap 84 on resistance 82.

A power tube 85 can be coupled as by coil 130

86 to the output coil 78 of tube 70. The input of this tube includes the pulsation compensator device 87, lead 88, part of resistance 67, lead 24, filament 89. The output circuit
 5 includes a constant current circuit from tap 90 on resistance 26, primary 91 of pulsation compensator transformer 92, constant current choke 93, plate 94, and filament 89. As the impedance of tube 85 varies, more or less
 10 current will flow through a circuit paralleling the choke 93, since the current through this choke is constant. This parallel circuit includes blocking condenser 95, a translating device, such as phones 96, and conductors 97,
 15 24 to filament 89.

The pulsation compensating devices for tubes 49, 69, 70 and 85 operate in substantially similar fashion to the device 31—47—46—48 detailed in connection with the radio
 20 frequency tubes 14 and 35. Instead of connecting with a separate grid however, such as 43, 44, these tubes 49, 69, 70 and 85 utilize the usual control grids, that are in series with their respective input circuits, and also with
 25 an adjustable portion of resistance 67, for the purpose of impressing the desired negative bias on the grids.

The provision of a variably coupled and tuned link circuit 38—39—42 is advantageous. By its aid, selectivity is greatly improved; and it is possible to control the building
 30 up process with ease, yet without danger of disturbing the tuning. If considered desirable, all variable tuning devices, such as condenser 39 and the variable condenser 98 of tunable circuit 50, can be controlled by a
 35 common actuator.

It is possible to utilize fewer amplifiers by providing a reflex arrangement, so that each
 40 amplifier acts both upon the detected audio frequency signals as well as the radio frequency system. This can be accomplished by well known filtering schemes whereby interference between the audio and radio frequency
 45 circuits is avoided. One such scheme is shown in Fig. 2.

In this case, the motor 19 drives, as before, the two windings 21 and 22; and I show in this instance large by-pass condensers 98, 99
 50 for passing most of the pulsations. The absorbing or pick-up circuit is shown as including elevated conductors 100, a variable resistance 101, a blocking condenser 102, neutral point 103 on a potentiometer resistance
 55 bridging winding 22, through a portion of this resistance to ground 104. The first amplifier 105 has its input circuit connected across at least a portion of the pick-up circuit. Its output positive potential is supplied
 60 as before by winding 21, the negative terminal of which is grounded as shown at 106, so that thereby a connection is made to the filament of amplifier 105. At its positive terminal, it connects to the pulsation compensating
 65 transformer 107, thence to an audio

frequency choke 108, a radio frequency choke 109, and to the output of the tubes 105 and 110 in parallel, by way of the balancing coil 111.

Thus one parallel circuit includes the upper
 70 half of coil 111, and the space of tube 105; the other parallel circuit includes the lower half of coil 111, condenser 112, and the space of tube 110. The operation is the same as
 75 before; there is a building up process accentuating the difference in current flow in these two paths upon a signaling impulse being received. This accentuation is due to the use of a link circuit 113, 114, 115, variably
 80 coupled to coil 111 and also coupled to the input of tube 110, as by the aid of coil 116. The input circuit of tube 110 includes a damping resistance 117, and the pulsation compensator device 107, which operates just
 85 as those disclosed in the first form.

Variable condensers 118, 114, 119 and 120 are used to tune their associated circuits to the radio frequency of the desired signals. Of these, condensers 118, 114, and 119 can be
 90 on a common shaft for simultaneous operation; and condenser 120 can be used as a trimming condenser for circuit 116—119.

It is apparent that the E. M. F. variations across coil 116 are greatly amplified due to the building up process described in my prior
 95 patents and in connection with Fig. 1. Any desired portion of these variations can be impressed on a detector, such as an electronic emission device 121 that serves as a rectifier. The detector circuit can be traced as follows:
 100 filament 123 of the detector 121, lead 124, center tap 103, compensator device 107, lower portion of coil 116, lead 125, blocking condenser 126, radio frequency choke 127, primary 128 of output transformer 129, plate
 105 122, back to filament 123. Grid 130 is connected to potentiometer 131 to give it the desired negative bias, so that the desired portion of the tube characteristic will be active.

The secondary 132 of output transformer 110
 120 129 serves to re-impress the detected impulses on tubes 105 and 110. Thus the audio input of tube 105 can be traced as follows: from the grid of tube 105, radio choke 133, to keep
 115 radio currents out of this input circuit, secondary 132, pulsation compensator device 107 to affect the grid in accordance with pulsations from source 21, neutral tap 103, potentiometer 131, to the filament of tube 105. The output circuits of tubes 105 and 110 being
 120 connected for radio amplification, serve for the audio amplification also; except that the condenser 112 in the circuit of tube 110, does not pass the audio currents. Instead, these
 125 currents pass through coils 134, 135, 136. This path cannot pass radio currents because of the high impedance thereof to radio frequencies. The translating device 137, such as a phone or loud speaker, is coupled
 130 to coil 135.

Another form of the reflex system is illustrated in Fig. 3. In this case, the sources are similar to those described. Winding 21 and winding 22 serve again as the plate voltage and filament current sources. Resistance 138 of about two megohms, is used as a shunt to the tube circuits. The pick-up circuit includes elevated conductors 139, the input electrodes of amplifier 140, neutral brush 141 on winding 22, and ground 142. The radio frequency output circuit for tube 140 includes coil 143 bridged by tuning condenser 144, and condenser 145 that stops audio currents. The radio frequency output circuit of the other tube 146 includes a resistance 147 and condenser 148 that stops audio currents. These two paths are in parallel with choke 149 that maintains the current in this part constant; radio frequency choke 151; winding 21, grounds 150, 142, back to the filament circuits by way of brush 141.

It is apparent that when the impedance of tube 140 is varied, the resultant variation in radio frequency current flow will produce an opposite variation in current through tube 146, in accordance with the explanations hereinbefore set forth. This difference in current flow is accentuated by impressing upon the input of tube 146, an input electromotive force derived from this difference in current flow. For example, the tuned link circuit 152, 153, 154 can be variably coupled between the output coil 143 and to the input circuit 155 of tube 146. The building up process can be readily controlled by varying these couplings. The tuning condensers 144, 153 and 156 can be simultaneously controlled as by the aid of a common shaft.

The direct current circuit for source 21 is completed to the plates of tubes 140 and 146 through circuits that cannot pass radio frequency. Thus from the positive terminal of source 21, the circuit includes coils 149, 151, radio choke 157, where it divides. One portion goes through coil 158 on a pulsation compensating device, a coil 159 and choke 160 to coil 143; the other portion goes through coil 161, coil 162, coil 163, to resistance 147. Coils 158 and 161 are opposed and balanced so that current fluctuations in source 21 will not affect a coil 164 coupled to them. Coils 159 and 162 however are cumulative for pulsation compensation in a manner to be hereinafter described, and are used to induce in a coil 165, an E. M. F. intended to wipe out the pulsations.

Before explaining in detail how this is brought about, I shall describe the detection and audio frequency amplification.

Thus a detector circuit bridges an adjustable portion of resistance 147. This includes the radio frequency choke 166, the primary 167 of an output transformer, radio frequency choke 168, and a crystal detector 169. A condenser 170 acting in conjunction with

chokes 166 and 168, acts as a filter for preventing radio frequency currents from passing through the transformer primary 167.

The secondary 170 of the output circuit is included in the input of tube 140. This input circuit can be traced as follows: from the filament of tube 140, neutral brush 141 of winding 22, coil 170, radio frequency choke 171, to the grid of tube 140. The tubes 140 and 146 now again act, this time as audio frequency amplifiers. There is a building up process as before. The audio frequency output circuits can now be traced.

The audio frequency currents can flow through coil 157, but due to the provision of condensers 145 and 148, no audio frequencies pass through these. The audio frequency currents divide between coils 158 and 161; one part going through coils 159 and 160 to coil 143 and tube 140; and the other part going through coils 162, 163 to resistor 147 and tube 146. Unbalance in these two paths causes induction in coil 164 that can be directly connected to the translating device 172, which can be either a head phone or loud speaker. The building up process proceeds as before, since the audio frequency currents in coil 143 affect the input of tube 146.

Pulsations are compensated for as in my prior patent. Only direct or audio currents can flow through coils 159, 162, due to the provision of chokes 160 and 163. The coils 159, 162 being respectively in the shunt circuits in which the sum of the currents are constant, it is seen that the total magnetic effect of coils 159 and 162 is constant, for whatever increase in current results in coil 159 is made up by a corresponding decrease in coil 162. However, when pulsations occur in source 21, these pulsations have an additive effect on coils 159 and 162; accordingly, a compensating E. M. F. is induced in coil 165. This E. M. F. can be impressed in series on the shield grids 173, 174 and with the source 21, which provides a constant positive bias to both grids.

In the form of my invention illustrated in Fig. 4, I do not show a reflex circuit; and pulsation compensation schemes have been omitted in order to simplify the figure. The amplifiers 175 and 176 divide a constant current between them, in their output circuits. This constant current is supplied in this instance by a battery 177. The output circuits can be traced as follows: from the positive terminal of battery 177, to a constant current choke 178 (of about 250 millihenries), where the current divides; one portion flowing through upper half of coil 179, through the space of tube 175, to filament 180, grounds 181 and 182 to the negative side of battery 177. The other portion flows through the lower half of coil 179, and through the space of tube 176, whence it unites at ground 181 with the first portion.

The pick-up circuit affects the impedance of tube 175, as by connecting directly to its control electrode 183. A high resistance 184 (of about 3 megohms) can bridge the input side of this amplifier 175. Thus it is seen that, as before, signals that are received in the pick-up circuit will cause an unbalance in the currents flowing in the output side. This unbalance is accentuated by controlling the impedance of tube 176 in the manner hereinbefore described. Thus a tunable link circuit 185—186—187 is coupled to coil 179 and is also coupled to the tunable circuit 188 in the input of a conventional detector 189, supplying its output current in this instance directly to a translating device 190. The input of tube 176 is connected across circuit 188, by way of connection 191, control electrode 192, filament 193, and ground connections 181 and 194. Thus the impedance of this tube is controlled, and in such manner as to produce the building up process in link circuit 185—186—187.

This link circuit, as well as circuit 188 can if desired be simultaneously tuned. The control of the building up process is novel in this form, and includes a resistance 195 (of about 150,000 ohms) that bridges coil 179. This resistance can be variable for such purposes as volume control.

I find that link circuit 185—186—187 need not be variably coupled to coil 179 or circuit 188, when this resistance type of control is used. Furthermore, when resistance 195 is once set for proper building up at, say, a low frequency, so as to retain stability of the circuit, then it will not become unstable even at higher frequencies. This is due to the fact that at higher frequencies, more of the energy is transferred from coil 179 to the link circuit, but the resistance 195 also absorbs more energy.

If desired, screen grids 196 and 197 can be used, biased to about 45 volts from battery 177.

I have found on actual trial that for the broadcast range, coil 179 can be wound with 190 turns of No. 36 wire on a $1\frac{7}{8}$ " diameter tube. Coil 185 can be wound with 60 turns of #24 wire, and the end thereof can be quite close to the end of coil 179; say about $\frac{1}{4}$ ". Coil 186 can be wound with 27 turns of #24 wire, spaced about $\frac{1}{2}$ " from the coil 198 in circuit 188. This latter coil can have 75 turns on a $1\frac{7}{8}$ " diameter tube.

I claim:

1. In an amplifier system, a pair of devices the impedances of which can be varied in accordance with signaling impulses, means for varying the impedance of one of said devices in accordance with the signaling impulses to be amplified, a source of constant current for supplying current to both devices in parallel, and a link circuit connecting the two devices, for impressing on the other

of said devices, impulses present in the first device, in such a direction as to vary the impedance of the said other device in a sense opposite to the variation of the impedance of the said first device.

2. The combination as set forth in claim 1, in which the link circuit is variably coupled to the first device.

3. In an amplifier system, a pair of devices the impedances of which can be varied in accordance with signaling impulses, means for supplying said devices in parallel with current from a constant current source, means for varying the impedance of one of said devices, a tunable link circuit coupled to both devices for affecting the impedance of the second device in accordance with the impedance variations of the first device but in an apposite sense, and another amplifier device also coupled to the link circuit.

4. The combination as set forth in claim 3, in which the link circuit includes a variable condenser and in which the second device is coupled to the link circuit by connections made from each side of the condenser to the second device.

5. In an amplifier system, a pair of electronic emission devices, each having an electron emitting electrode, a control electrode and an anode, means for impressing signaling impulses between the electron emitting electrode and control electrode of one of said devices, means for supplying a constant direct current to both devices in parallel, through the spaces between the electron emitting electrode and the anode, and a link circuit connected between the two devices for impressing on the second device, an electromotive force between its electron emitting electrode and its control electrode, said electromotive force being derived from the variations in current flowing between the anode and the electron emitting electrode of the first device.

6. The combination as set forth in claim 5, in which the link circuit is variably coupled to the first device, and is tunable.

7. The combination as set forth in claim 5, in which each of the amplifying devices includes a supplementary electrode, together with means for maintaining this electrode at a potential positive with respect to the electron emitting electrode, and means whereby fluctuations in the constant current supply means affect said electrodes to vary the impedances of the devices for reducing the effect of these pulsations.

8. In an amplifier system, a device the impedance of which can be varied in accordance with signaling impulses, means for supplying constant current through said device, a shunt path paralleling said device to permit variations in current flow therein, and means for varying the impedance of said device in accordance with fluctuations in the current

supplying means, for compensating for the effect of these fluctuations, said means including a transformer having a primary winding in the constant current path.

5 9. In an amplifier system, an electronic emission device having an electron emitting electrode, a control electrode and a cathode, means forming a parallel path to said device, a source of constant current for supplying
10 both paths in parallel, and means, including a winding in the common portion of the circuit, for affecting the impedance of the device in accordance with pulsations in the constant current, to reduce the effect of these
15 pulsations.

10. The combination as set forth in claim 9, in which the impedance affecting means further includes a secondary coil coupled to the coil, and a connection from said secondary coil to the electronic emission device.
20

11. In an amplifier system, a pair of devices the impedances of which can be varied in accordance with signaling impulses, means
25 for varying the impedance of one of said devices in accordance with the signaling impulses to be amplified, a source of constant current for supplying current to both devices in parallel, a coil part of which is in circuit
30 with one device, and part in another, and a resistance paralleling said coil.

12. The combination as set forth in claim 11, with the limitation that the devices are electronic emission devices.

35 13. The combination as set forth in claim 11, with the addition of means responsive to the action of one device, for reversely varying the impedance of the other device.

40 14. The combination as set forth in claim 11, with the addition of means responsive to the action of one device, for reversely varying the impedance of the other device, including a link circuit coupling said devices.

45 In testimony whereof I have hereunto set my hand.

PHILIP JOHN WALSH.

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