

Jan. 28, 1941.

P. J. LARSEN
ELECTRICAL TRANSLATION CIRCUITS

2,229,702

Filed Jan. 3, 1938

3 Sheets-Sheet 1

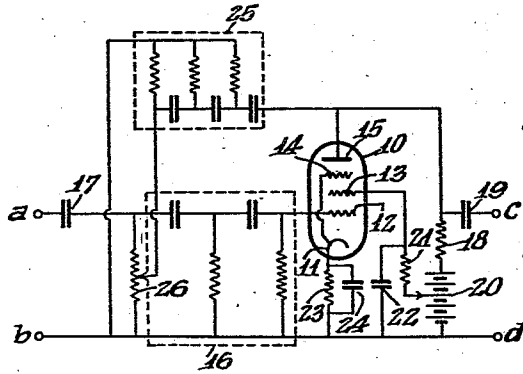


Fig. 1

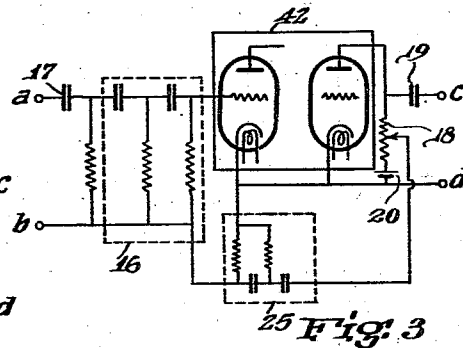


Fig. 3

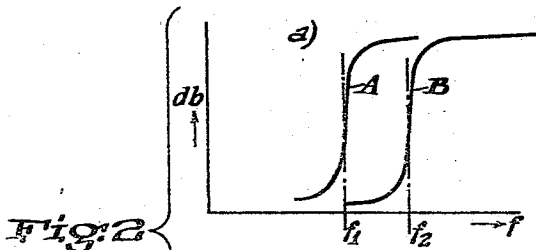


Fig. 2

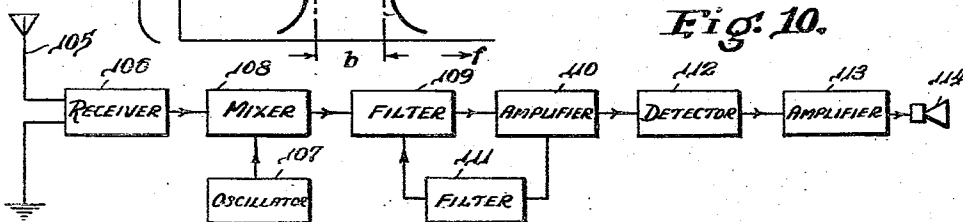


Fig. 10.

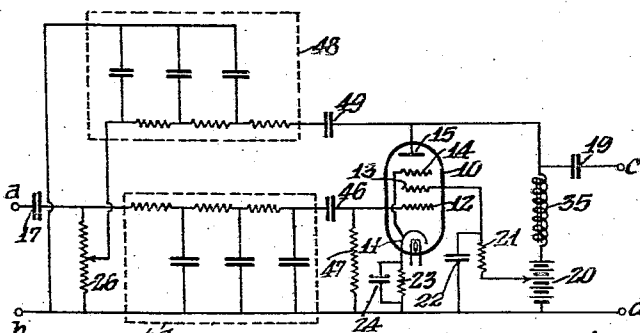


Fig. 4

INVENTOR.
Paul J. Larsen
BY
H. W. R. N. A.
ATTORNEY

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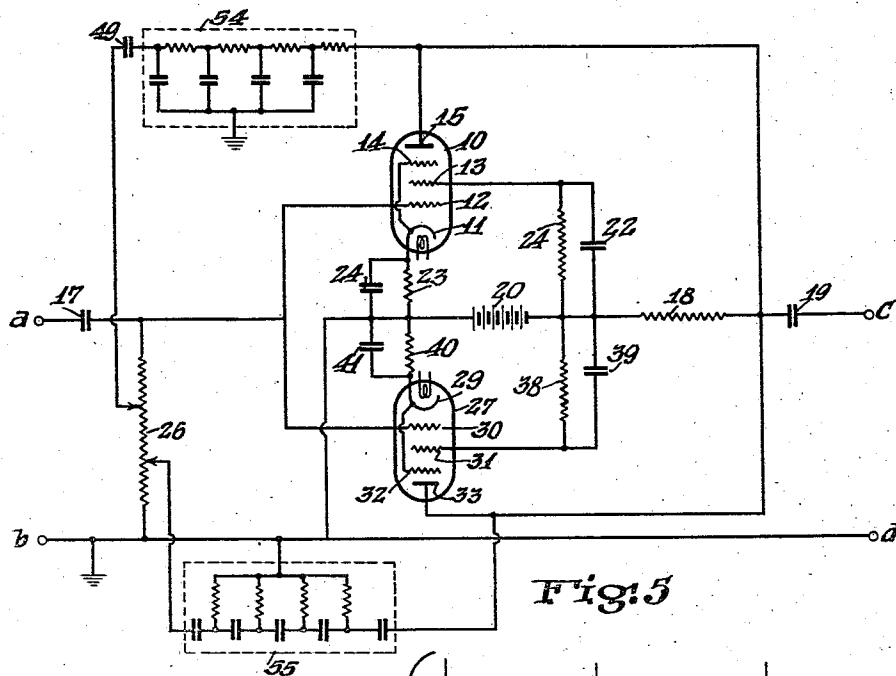


Fig. 5

Fig. 6

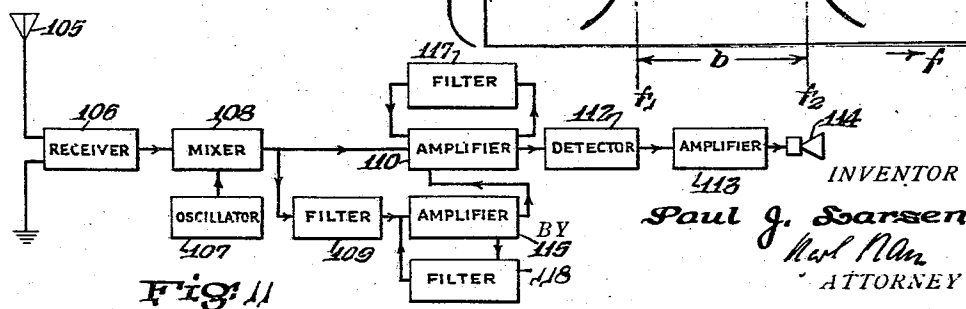
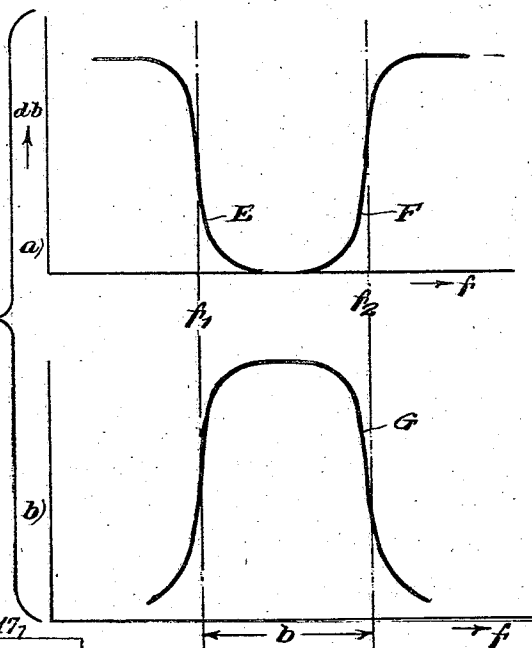


Fig. 11

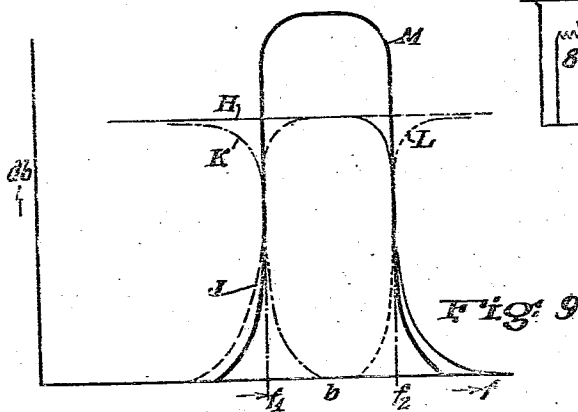
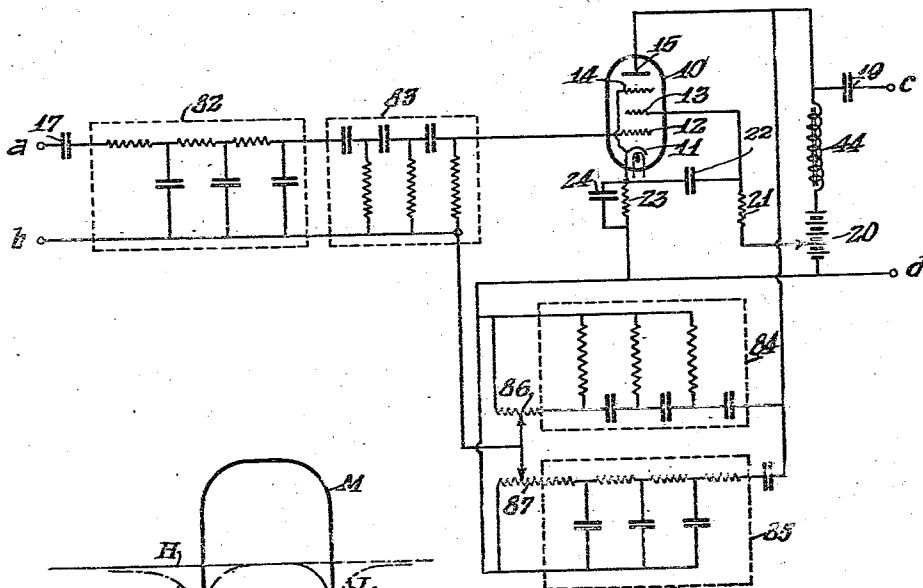
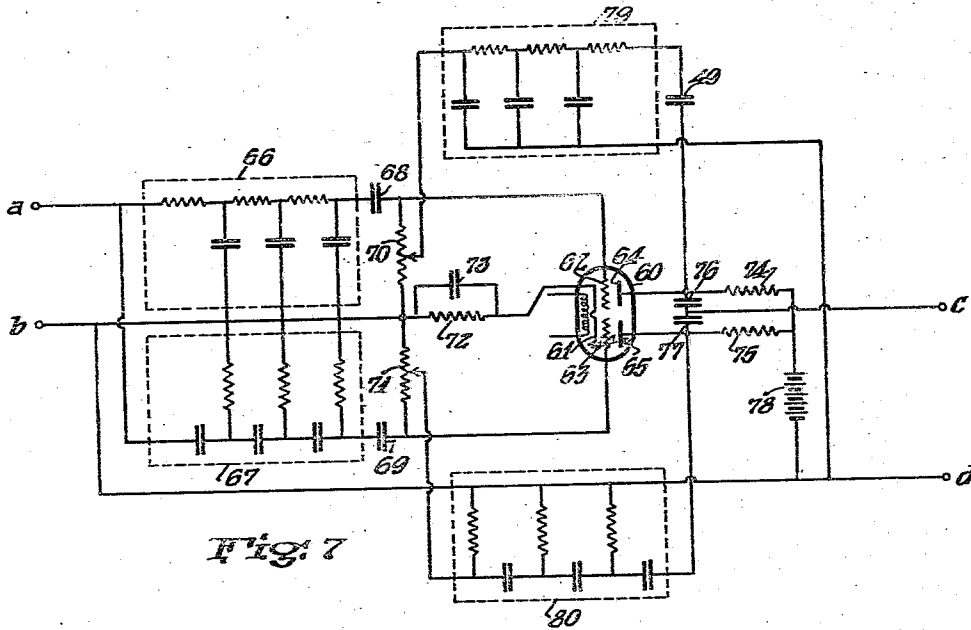
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3 Sheets-Sheet 3



INVENTOR
Paul J. Larsen
BY
H. H. H. H.
ATTORNEY

UNITED STATES PATENT OFFICE

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ELECTRICAL TRANSLATION CIRCUITS

Paul J. Larsen, East Orange, N. J., assignor to
Radio Patents Corporation, New York, N. Y.,
a corporation of New York

Application January 3, 1938, Serial No. 183,154

13 Claims. (Cl. 179-171)

The present invention relates to improvements in and a method of amplifying variable electric currents as used in the high frequency and low frequency arts such as in radio, telephone, telegraph, talking picture, sound systems and the like. More particularly, the invention is concerned with amplifiers embodying one or more inverse feedback arrangements for stabilizing the operation, preventing distortion and to obtain other advantages well known.

The object of the present invention is to obtain a frequency discrimination by utilizing the effect of inverse feedback in an amplifier, more particularly to provide an amplifier with a more or less "square top" or band-pass or band suppression frequency characteristic in a simple manner and substantially without the use of resonating elements or circuits with their inherent drawbacks such as due to mutual coupling effects both internal and external requiring careful screening and/or shielding and which are liable to produce distortion, instability conditions and other defects well known.

Another object is the provision of an amplifier having a predetermined frequency response characteristic or band width suitable for amplifying and/or translating both low frequency (audio), intermediate frequency and high signal frequency bands of any desired frequency range or band width and comprising coupling and transmission networks consisting substantially of resistance and capacity elements.

A further object is to combine capacity and resistance elements as coupling networks in an amplifier circuit in such a manner as to obtain a desired frequency band amplification or transmission above or below a first predetermined cut-off frequency and to balance or neutralize by inverse feedback all the currents having frequencies above or below another predetermined frequency thereby to obtain a frequency response characteristic of the band-pass or band suppression type positioned at any desired point on the frequency scale extending from zero frequency to the low (audio), intermediate and high frequency ranges employed in practice.

These and further objects and advantages of the invention will become more apparent as the following detailed description proceeds taken with reference to the accompanying drawings illustrating several embodiments of the invention and wherein

Figure 1 shows a simple amplifying circuit having a band-pass type frequency discriminating amplifying or transmission characteristic con-

structed in accordance with the invention, Figure 2 shows frequency response curves illustrative of the function and operation of the circuit according to Figure 1, Figure 3 shows a modification of an amplifying circuit with band-pass characteristics of the type shown by Figure 1, Figure 4 is a further modification of a circuit according to the invention, Figure 5 illustrates another modification of an amplifying circuit constructed in accordance with the principle of the invention, Figure 6 shows frequency response curves explanatory of the function of the circuit shown in Figure 5, Figures 7 and 8 illustrate amplifying circuits according to a still further improved embodiment of the invention adapted to increase the sharpness or cut-off effect of the band-pass characteristic, Figure 9 is a diagram illustrating the function of the circuits according to Figures 7 and 8, and Figures 10 and 11 are block diagrams illustrating the employment of the invention in the intermediate section of a superheterodyne radio receiver or the like.

Similar reference characters identify similar parts throughout the different views of the drawings.

Referring to Figure 1 wherein is shown a simple inverse feedback amplifying circuit having a predetermined frequency discriminating characteristic of the band-pass type positioned at any desired point of the frequency scale including the audio, intermediate and high frequency ranges, numeral 10 represents an amplifying valve of standard construction, in the example shown a valve of the pentode type, having a cathode 11, an input or control grid 12, a screen grid 13, a suppressor grid 14 and a plate or anode 15. The suppressor grid 14 is directly internally connected with the cathode in a manner well known. Item 16 represents a network comprising a plurality of capacity units connected in series and resistance elements in shunt. The input of network 16 is connected to terminals a, b forming the input for the amplifier through a coupling condenser 17 which may form part of the network 16 in combination with shunt resistance 26. The output of the network 16 is connected across the grid cathode path of the valve 10. As is known, networks of this type are effective in preferentially passing currents of higher frequency above a predetermined cut-off frequency and of suppressing currents of lower frequency below said cut-off frequency, by reason of the fact that the high frequency currents are easily directly transmitted through the capacity

units while the low frequency currents are shunted or by-passed through the resistance units of the system. Arrangements of this type with capacity units in series and shunted by resistance elements are also known as high-pass resistance capacity filters or networks.

In this manner, current variations beyond a predetermined frequency known as the cut-off frequency of the network or filter 16 impressed upon the input terminals *a, b* which may be of low frequency (audio), intermediate or high frequency are transmitted and amplified in the output circuit of the valve 10. This is further illustrated in Figure 2a of the drawings, wherein A represents the response characteristic—output current or signal response in suitable units such as in decibel units as shown vs. frequency—of the high-pass filter or network 16 having a cut-off frequency f_1 .

The amplified current variations produced in the output or plate circuit of valve 10 may be impressed in the known manner through a load resistance 18 and coupling capacity 19 to a further amplifying or utilization circuit to be connected to the output terminals *c, d* of the system. Numeral 20 represents the high tension source for supplying anode current to the valve 10. The screen grid 13 is shown connected in a known manner to a suitable tap point of the high tension source 20 through a voltage drop resistance 21 and is by-passed to cathode or ground by a capacity 22 in a known manner. There is further provided a biasing resistance 23 inserted in the cathode return lead of the valve shunted by a by-pass condenser 24 to provide suitable grid biasing potential and to cause the valve 10 to operate at a favorable point of its operating characteristic.

There is provided in accordance with the improvements of the invention a further resistance capacity type high-pass filter or network 25 in shunt to the anode cathode path of the valve 10 on the one hand and having its output connected to a variable tap point of the first or input shunt resistance 26 of the filter or network 16 in the grid circuit. The filter or network 25 is designed to have a characteristic such as shown at B in Figure 2a with a cut-off frequency f_2 differing from the cut-off frequency f_1 of the network 16 by a predetermined frequency range equal to the desired band width or transmission characteristic of the system. Since, as is well known, the anode potential in an amplifying valve of the type disclosed varies inversely to the controlling potential variations impressed upon the grid of the valve, it is seen that the potential impressed upon the grid circuit through the filter or network 25 is substantially 180° out of phase with the potential impressed upon the grid from an input circuit through the network 16. Both the input control potential and the inverse feedback potential are thus superimposed in parallel and impressed upon the grid of the valve. Since the network 25 has a characteristic as shown at B in Figure 2a with a higher cut-off frequency f_2 than the network 16, it is readily seen that the inverse feedback as described will have the effect of suppressing or neutralizing all frequencies above f_2 in such a manner that a resultant band-pass type response characteristic is obtained having a width b equal to the frequency range between f_1 and f_2 as shown at C in Figure 2b.

The filters or networks 16 and 25 may be designed to have the requisite critical or cut-off

frequencies f_1, f_2 in a known manner by proper dimensioning of the capacity and resistance units in relation to each other and to the impedance of the associate circuits connected to the input output terminals of the networks or filters.

The coupling resistance 18 in the plate circuit of the valve 10 may be replaced by an inductance which latter has the advantage of obtaining increased controlling potential applied to the next amplifying stage or utilization circuit while in no way interfering with the function and frequency discriminating action of the inverse feedback system. In this manner, the inherent loss in gain or amplification of the system due to the effect of the inverse feedback may be compensated to a certain extent.

Referring to Figure 3, there is shown a similar system to that illustrated in Figure 1. According to this modification, a multi-stage amplifier 42 indicated schematically is provided with the input of the network 25 in the inverse feedback circuit connected across a variable portion of an anode load resistance 18 in the plate circuit of the last valve—in which case an odd number of amplifying valves must be employed—on the one hand, and with the output of the network 25 connected in the cathode lead from the input filter or network 16 on the other hand. The arrangement according to Figure 3 further differs from Figure 1 in that the output from the filter 25 is impressed serially with the network 16.

While in the previous figures high-pass filters or networks are provided in both the input and feedback circuit paths, it is understood that substantially the same effect will be obtained by using low-pass filters of the resistance capacity type in the input and feedback circuits. Filters or networks of the latter type comprise a number of resistance elements in series and capacity elements in shunt and are effective in passing the frequencies below and suppressing frequencies above their cut-off frequency. In this manner, by properly choosing the cut-off frequencies of the networks in the input and inverse feedback circuits, respectively, a resultant band-pass characteristic or response curve as shown at C in Figure 2a may be obtained in substantially a similar manner as described hereinbefore.

An arrangement of this type is shown in Figure 4. In the latter, a low-pass resistance capacity network 45 is connected between the input terminals *a, b* and the grid cathode path of the valve 10 through further coupling capacities 17 and 46, respectively, and grid leak resistance 47. Similarly, a low pass resistance capacity network 48 is inserted in the negative feedback path in series with a coupling capacity 49 connected to the anode 15 on the one hand, and having an output terminal connected to a variable tap point of the input resistance 26 connected across the network 45. If the latter has a characteristic cut-off at frequency f_2 and the network 45 has a characteristic cut-off at frequency f_1 a resultant input-output band-pass characteristic will be obtained as shown at C in Figure 2b. There is furthermore shown a coupling inductance coil 35 in place of a resistance in the plate circuit for the purpose and with the advantage as pointed out hereinabove.

As previously pointed out, in inverse feedback circuits the amplification or gain is reduced due to the negative feedback so that more amplifying stages are required to produce output potentials or currents of desired strength compared with ordinary amplifiers without inverse or negative

feedback arrangements. In accordance with a further improvement of the invention, this loss or decrease in gain may be compensated by an additional direct feedback providing regeneration of the limited band characteristic obtained.

Instead of inversely feeding back energy from separate valves to the input circuit of a single preceding valve through high-pass and low-pass networks, respectively, to obtain a band-pass characteristic the same results may be obtained by employing two valves connected in parallel with common input and output circuits and by inverse feedback circuit paths from the anodes of both valves to the common input circuit through high and low pass networks, respectively. An arrangement of this type is shown in Figure 5. In the latter, the valves 10 and 27 are connected to a common input circuit comprising coupling capacity 17 and input impedance 26. The anodes are connected in parallel through plate resistance or impedance 18 to the plate supply 20 and to a common output circuit through a coupling capacity 19. A first inverse feedback circuit comprising a low-pass resistance capacity network 54 having a characteristic E according to Figure 6a is connected between the anode of valve 10 and a variable tap point of the input resistance 26, while a further inverse feedback circuit including a high-pass resistance capacity network 55 having a characteristic as shown at F in Figure 6a is connected between the anode of valve 27 and another tap point of the input resistance 26. The common input circuit 17 and 26 should have a substantially constant or broad frequency response for the frequency band desired whereby through the effect of the inverse feedback circuits a resultant band-pass response characteristic is obtained as shown at G in Figure 6b. The valve 27 has a cathode 29, control grid 30, screen grid 31, suppressor 32, and a plate 33. The screen grid 31 is connected to the high potential terminal of the plate potential source 20 through a resistance 38 by-passed by a condenser 39.

Referring to Figure 7 there is shown a system comprising a multiple section amplifying valve having high and low-pass resistance capacity networks in the input circuits thereof cooperating with low and high-pass networks in the inverse feedback circuits having cut-off characteristics different from the others by a frequency difference of the band desired in such a manner that each amplifier circuit provides the desired band-pass characteristic, however conjointly obtaining an improved resultant cut-off effect as well as increased efficiency and output signal strength. There is shown in Figure 7 a composite amplifying valve 60 equivalent to two amplifying valves arranged in a common envelope and having a cathode 61, a pair of control grids 62 and 63, and a pair of anodes 64 and 65, thus forming two separate and independent discharge or amplifying paths. The grid circuit of the amplifying path or section 61, 62, 64 is connected to the input terminals a, b through a low-pass resistance capacity network 66 by the aid of a coupling capacity 68 with associate coupling or grid-leak resistance 70. The grid or control circuit of the amplifying path or section 61, 63, 65 is similarly connected to input terminals a, b through a high-pass network and a coupling capacity 69 with associate grid-leak or coupling resistance 71. 72 represents a grid biasing resistance inserted in the common cathode return lead shunted by by-pass capacity 73. The an-

odes 64 and 65 are connected in parallel to the common output terminal c through anode load resistances 74, 75 and associate coupling condensers 76, 77. Item 78 represents a common high tension source for supplying the anode current. Both anodes 64 and 65 are further shunted to the cathode through low-pass and high-pass resistance capacity networks, respectively, shown at 79 and 80 and having their output terminals connected to suitable tap points of the respective coupling resistances 70 and 71 in the grid circuits. The operation of this system is illustrated in Figure 9. In the latter, H represents the response characteristic of the network 66, J represents the response characteristic of the network 67, both networks being designed to overlap with cut-off frequencies f_2 , f_1 , respectively, spaced by a predetermined frequency range equal to the desired band width b of the system. Furthermore, K represents the characteristic of the network 79 and L represents the characteristic of the network 80 in Figure 7.

As will be seen from Figure 9, the result of the combined action of all four networks in the input and inverse feedback circuits will be a curve as shown at M in Figure 9 representing a band-pass characteristic having a desired width b with improved cut-off effect and increased gain or output signal strength.

A similar combined effect of a plurality of low and high-pass networks in the input and inverse feedback circuits may be obtained by a circuit of the type shown in Figure 8. The latter differs from Figure 7 in that a pair of low-pass and high-pass networks 82 and 83 having cut-off characteristics as shown at H and J in Figure 9 are connected in series across the input circuit of a single valve 10 arranged and connected as shown at previous figures. There are further shown a pair of inverse feedback circuits with low-pass and high-pass networks 85 and 84 having their inputs connected across the anode cathode path of the valve and having a variable portion of their output potentials obtained from resistances 86 and 87 serially inserted between one output terminal of the network 83 and the cathode or negative potential point of the system. If the characteristic of the network 84 is similar to that shown at L and the characteristic of the network 85 equal to the characteristic as shown at K in Figure 9, it is understood that a combined resultant band-pass effect is obtained in a substantially similar manner as described hereinabove.

It is evident from the above that the novel amplifying circuit arrangement according to the invention may be used and embodied in various systems where it is desired to obtain a frequency discriminating amplifying or transmission characteristic comprising a definite frequency range or band width at any point of the frequency scale and zero frequency to the highest commercial frequencies employed in signal and other transmission systems. The invention has special use as a band-pass or selector circuit embodied in the intermediate section of a superheterodyne radio receiver or the like to selectively amplify a sharply defined frequency band of about 10 to 15 kc. To illustrate this further, there is shown in Figure 10 in block diagram form a radio receiver of the superheterodyne type embodying selective intermediate frequency stages of the type constructed according to the invention.

Referring to Figure 10, the receiver of conventional construction comprises an antenna 105, a 75

RF or high frequency signal amplifier 106 connected to a frequency converting device or mixer 108 wherein the high frequency signals are changed into intermediate frequency signals by combination with locally produced oscillations obtained from an oscillator 107. The intermediate frequency signals are passed through a resistance capacity filter 109 having definite cut-off characteristics and applied to an amplifier 110. From the latter, a portion of the amplified energy is inversely fed back through a resistance capacity filter of specific construction and cut-off characteristics and applied to the filter 109 or input of the amplifier 110 in accordance with any one of the modifications or combinations thereof disclosed and described hereinbefore. After the intermediate frequency signals have been selectively amplified to a desired degree, they are impressed in a known manner upon a rectifier or detector 112 for conversion into low or audio frequency signals which latter after further amplification by an audio amplifier 113 serve to operate a suitable translating device such as a loud speaker shown at 114. It is naturally obvious that in the audio frequency amplifier similar inverse feedback systems may be employed to give a desired band width of from about 70 to about 7000 cycles as an example thereby eliminating any possible 60 cycle hum or hiss from the carrier or tubes from the loud speaker circuit.

Referring to Figure 11, there is shown a similar receiver of the superheterodyne type with an intermediate frequency section comprising two amplifiers 110 and 115 in parallel each amplifier having associated therewith an inverse feedback system including resistance capacity networks 117 and 118 in the manner described hereinbefore.

In the embodiment of the invention illustrated, resistance capacity type networks have been shown to obtain high-pass and low-pass transmission characteristics.

It is understood that any other type of network or filter for producing the above effect such as low and high-pass filters comprising capacity and inductance elements may be employed with equal advantage and without departing from the spirit of the invention. It is further understood that the invention may be equally employed for translating or amplifying both low frequency and high frequency signal waves such as audio or speech currents as well as intermediate frequency or high frequency waves or current. In the former case the coupling impedances, or if desired the inductance units when employing a resistance inductance type filter preferably consists of iron cored inductances or choke coils, while in the latter case inductance coils either without iron core or with cores of the known high frequency type may be employed.

While I have shown a particular combination of elements to illustrate one way of carrying out the invention, I want it clearly understood that any one of the elements can be used by itself or with any other element besides those shown and illustrated without departing from the scope of the invention.

It will further be evident from the above that the invention is not limited to the specific arrangements of parts and circuits shown and methods disclosed herein for illustration, but that the novel thought and underlying principle of the invention is susceptible of numerous variations and modifications coming within the broad scope and spirit of the invention as defined in the appended claims.

The specification and drawings are accordingly intended to be regarded in an illustrative rather than a limiting sense.

1. An electric wave band translation system comprising an input and an output and an amplifier connecting said input and output, the frequency response range of said system substantially exceeding on both sides the frequency range of the wave band to be transmitted, a first stop filter network associated with said input circuit, and a feed-back path from said output to said input arranged to feed back amplified wave energy substantially in phase opposition to the incoming wave energy and including a second stop filter network, said first network with its pass-range embracing said wave band and with its stop-range substantially covering said frequency response range outside one limit frequency of said wave band, said second network with its stop range embracing said wave band and with its pass-range substantially covering said frequency response range outside the other limit frequency of said band range.

2. An electric wave band translation system comprising an input and an output and an amplifier connecting said input and output, the frequency response range of said system substantially exceeding on both sides the frequency range of the wave band to be transmitted, a first stop filter network associated with said input circuit, and a feed-back path from said output to said input arranged to feed back amplified wave energy substantially in phase opposition to the incoming wave energy and including a second stop filter network, said first and second network being of the same type blocking substantially all frequencies on one side and passing substantially all frequencies on the other side of a predetermined frequency, said first network with its pass-range including said wave band and with its stop range substantially covering said frequency response range outside one limit frequency of said wave band, said second network with its stop range embracing said wave band and with its pass-range substantially covering said frequency response range outside the other limit frequency of said wave band.

3. In an electric wave translation system, an amplifier having an input and an output and a main amplifying path connecting said input with said output, a plurality of circuit paths between points of higher and lower oscillation levels of said amplifier for inversely feeding back energy so as to reduce the gain of said amplifier, band-pass filters connected in both said main amplifying and feedback paths, part of said filters having an equal cut-off frequency and the remaining filters also having equal cut-off frequencies differing from said first cut-off frequency by a predetermined amount, to obtain a resultant input-output band-pass characteristic of said system with improved cut-off effects and embracing the range between said first and second cut-off frequency, respectively.

4. An electric wave translation system comprising an input and an output and an amplifier connecting said input and output, the frequency response range of said system substantially exceeding on both sides the frequency range of the wave band to be transmitted, a path for feeding back amplified wave energy from said output to said input substantially in phase opposition to the incoming wave energy, a pair of high-pass networks comprising a plurality of capacity elements in series each shunted by resistance ele-

ments and having cut-off frequencies differing from each other by a predetermined range substantially equalling the frequency range of the wave band to be transmitted, one of said networks being inserted in said main path of said amplifier and the other of said networks being arranged in said feedback path, the cut-off frequency of said first mentioned network substantially coinciding with the lower limit frequency and the cut-off frequency of said latter network substantially coinciding with the upper limit frequency of said wave band.

5. An electric wave translation system comprising an input and an output and an amplifier connecting said input and output, the frequency response range of said system substantially exceeding on both sides the frequency range of the wave band to be transmitted, a path for feeding back amplified wave energy from said output to said input substantially in phase opposition to the incoming wave energy, a pair of low-pass filter networks comprising a plurality of resistance elements in series each shunted by capacity elements and having cut-off frequencies differing from each other by a predetermined range substantially equalling the frequency range of the wave band to be transmitted, one of said networks being inserted in the main amplifying path between said input and output and the other network being arranged in said feedback path, the cut-off frequency of said first mentioned network substantially coinciding with the upper limit frequency and the cut-off frequency of said latter network substantially coinciding with the lower limit frequency of said wave band.

6. An electrical system for transmitting a wave band of desired frequency range comprising an electron valve amplifier having an input and an output, the frequency response range of said system including and substantially exceeding on both sides the frequency band to be transmitted, a low-pass network having a predetermined cut-off frequency substantially coinciding with the upper limit frequency of said wave band connected to said input to produce amplified current variations in said output circuit below said cut-off frequency, a further low-pass network having a cut-off frequency substantially coinciding with the lower limit frequency of said wave band, said further network being connected to said output, and connections from said further network to said input for feeding back amplified energy in inverse phase relation to the input energy and with such amplitude as to reduce the gain of said amplifier, to obtain a resultant band-pass type input-output frequency response characteristic embracing the range between said cut-off frequencies and substantially suppressing frequencies outside said band to be transmitted.

7. An electrical system for transmitting a wave band of desired frequency range comprising an electron valve amplifier having an input and an output, the frequency response range of said system substantially exceeding on both sides the frequency band to be transmitted, a high-pass network comprising a plurality of capacity elements in series each shunted by a resistance element and having a predetermined cut-off frequency substantially coinciding with the lower limit frequency of said wave band, said high-pass network being connected to said input to produce amplified current variations in said output above said cut-off frequency, a further high pass network comprising a plurality of capacity elements in series each shunted by a resistance element and having

a cut-off frequency substantially coinciding with the upper limit frequency of said wave band, said further high pass network being connected to said output, and connections from said further network to said input for feeding back amplified energy in inverse phase relation to the input energy and with such amplitude as to reduce the gain of said amplifier, to obtain a resultant band-pass type input-output frequency response characteristic embracing the range between said cut-off frequencies and substantially suppressing frequencies outside said wave band to be transmitted.

8. An electrical system for transmitting a wave band of desired frequency range comprising an electron valve amplifier having an input and an output, the frequency response range of said system substantially exceeding on both sides the frequency range of the wave band to be transmitted, a low-pass network comprising a plurality of resistance elements in series shunted by capacity elements and having a predetermined cut-off frequency substantially coinciding with the upper limit frequency of said wave band, said low-pass network being connected to said input to produce amplified current variations in said output circuit below said cut-off frequency, a further low-pass network comprising a plurality of resistance elements in series shunted by capacity elements and having a cut-off frequency substantially coinciding with the lower limit frequency of said wave band, said further low-pass network being connected to said output, and connections from said further network to said input circuit for feeding back amplified energy in inverse phase relation to the input energy and with such amplitude as to reduce the gain of said amplifier, to obtain a resultant band-pass type input-output frequency response characteristic embracing the range between said cut-off frequencies and substantially suppressing frequencies outside said wave band to be transmitted.

9. In an electric wave translation system, an electron valve amplifier having a normally broad frequency response characteristic, at least two paths for feeding back amplified output energy from a point of higher oscillation level to a point at a lower oscillation level of said amplifier in inverse phase relation and with such amplitude as to reduce the gain of said amplifier, a low-pass network inserted in one of the feedback paths and a high-pass network inserted in the other feedback path, said networks having cut-off frequencies differing from each other by a predetermined amount to cancel by negative feedback the response of said amplifier to frequencies below the cut-off frequency of said low pass network and above the cut-off frequency of said high pass network, respectively.

10. An electric system for translating a wave band of desired frequency range comprising an input and an output and an amplifier connecting said input and output forming a main amplifying channel, the frequency response range of said system substantially exceeding on both sides the frequency range of the wave band to be transmitted, a pair of high-pass and low-pass networks serially associated with said input circuit, the pass ranges of said networks overlapping each other and embracing the frequency range of said wave band so that the cut-off frequency of said high-pass network substantially coincides with the lower limit frequency and the cut-off frequency of said low-pass network substantially coincides with the upper limit frequency of said wave band, and a pair of feedback paths from said output to

said input circuit arranged to feed back amplified wave energy substantially in phase opposition to the incoming wave energy, one of said feedback paths including a high-pass network and the other feedback path including a low-pass network, the stop ranges of said latter networks overlapping each other to an extent substantially equalling said wave band so that the cut-off frequency of said latter high-pass network substantially coincides with the upper limit frequency and the cut-off frequency of said latter low-pass network substantially coincides with the lower limit frequency of said wave band, thereby obtaining a resultant band-pass type input-output-frequency range of the system embracing said wave band.

11. An electric wave translation system comprising a pair of amplifiers having input and output circuits, feedback means associated with each amplifier for feeding back amplified energy to the input circuits in inverse phase relation to the input waves and with such amplitude as to reduce the gains of said amplifiers, means for impressing a common signal wave upon both input circuits of said amplifiers, further means for combining the outputs of said amplifiers, a first high-pass type selective network associated with the feed-back means of one amplifier, a second low-pass type selective network associated with the feedback means of the other amplifier, the cut-off frequencies of said networks differing from each other by a predetermined amount to obtain a resultant input-output band-pass type frequency response characteristic embracing the range between said cut-off frequencies.

12. In an electric wave translation system, a first amplifier, a second amplifier, each of said amplifiers having an input and an output, feedback means associated with each amplifier for feeding back amplified wave energy in inverse relation to the input energies and with such amplitude as to reduce the amplifying gain, means for

impressing a common signal wave upon the inputs of both of said amplifiers, further means for combining the outputs of said amplifiers, a high-pass filter connected in the feedback circuit of the first amplifier, a low-pass filter connected in the feedback of the other amplifier, the cut-off frequencies of said filters differing from each other by a predetermined amount, a further high-pass filter connected in the input of said first amplifier and having a cut-off frequency equal to the cut-off frequency of said first low-pass filter, and a further low-pass filter connected in the input of said second amplifier and having a cut-off frequency equal to the cut-off frequency of said first high-pass filter.

13. An electric wave band translation system comprising an input and an output and an amplifier connecting said input and output, the frequency response range of said system substantially exceeding on both sides the frequency range of the wave band to be transmitted, a first stop filter network associated with said input, and a feedback path from said output to said input arranged to feed back amplified wave energy substantially in phase opposition to the incoming wave energy and including a second stop filter network, said first network with its pass-range embracing said wave band and with its stop-range substantially covering said frequency response range outside one limit frequency of said wave band so that the cut-off frequency of said first network substantially coincides with said limit frequency, said second network with its stop-range embracing said wave band and substantially the stop range of said first network and with its pass-range substantially covering said frequency response range outside the other limit frequency of said band range so that the cut-off frequency of said second network substantially coincides with said other limit frequency.

PAUL J. LARSEN.