Jan. 9, 1940. H. F. DALPAYRAT 2,186,195

INVERSE FEEDBACK CIRCUITS

Filed Dec. 24, 1937 4 Sheets-Sheet 1

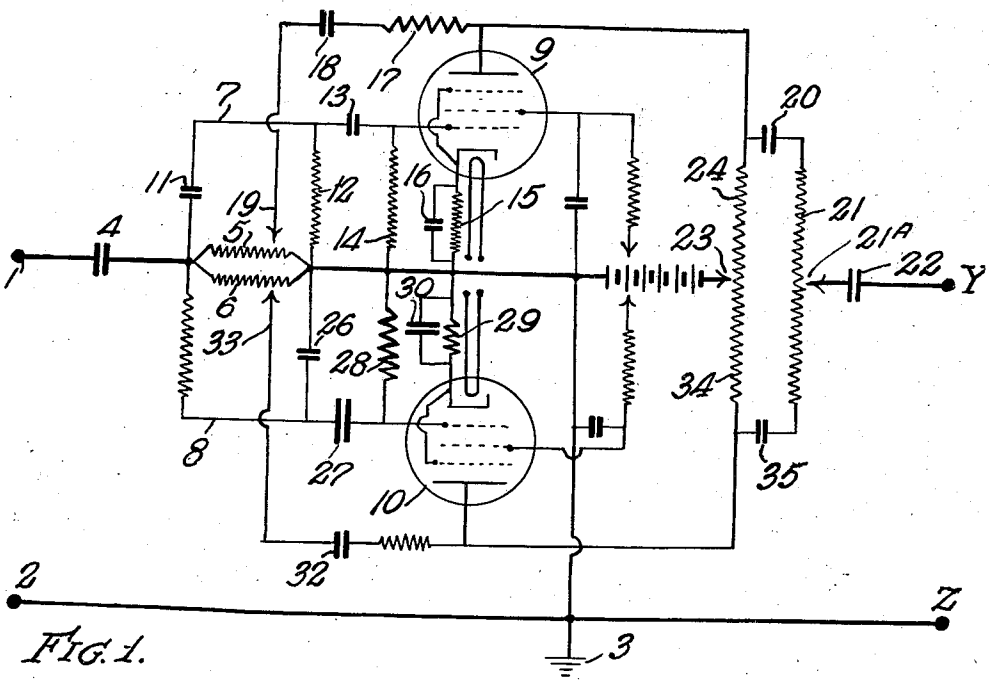

FIG. 1.

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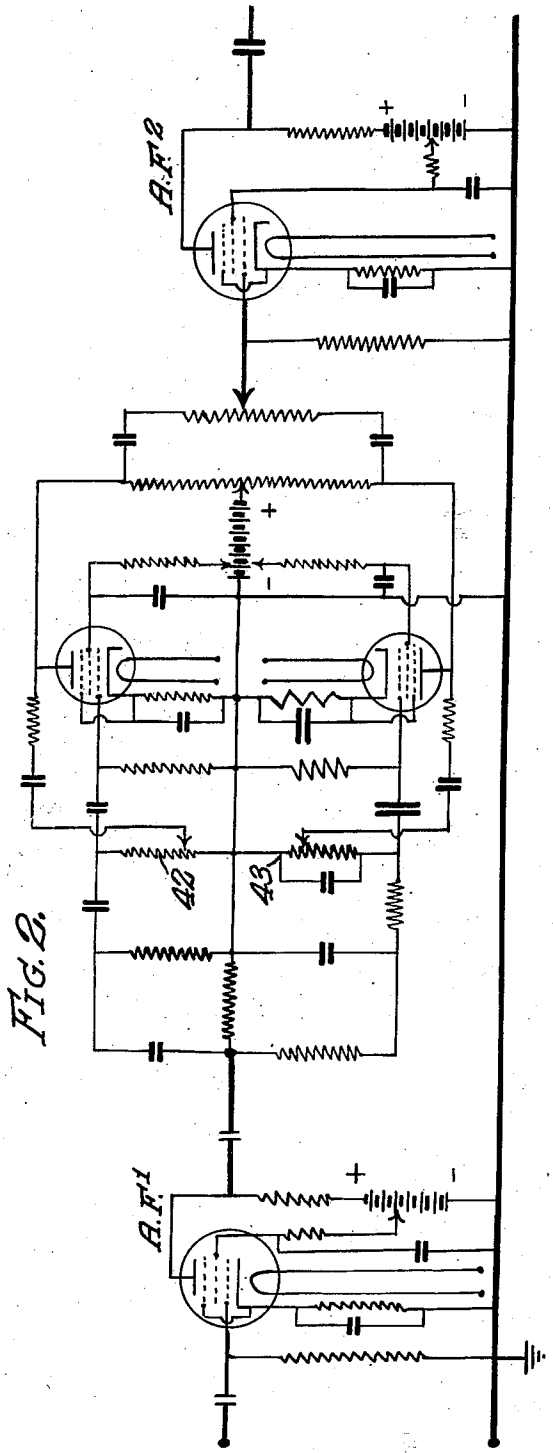

FIG. 2.

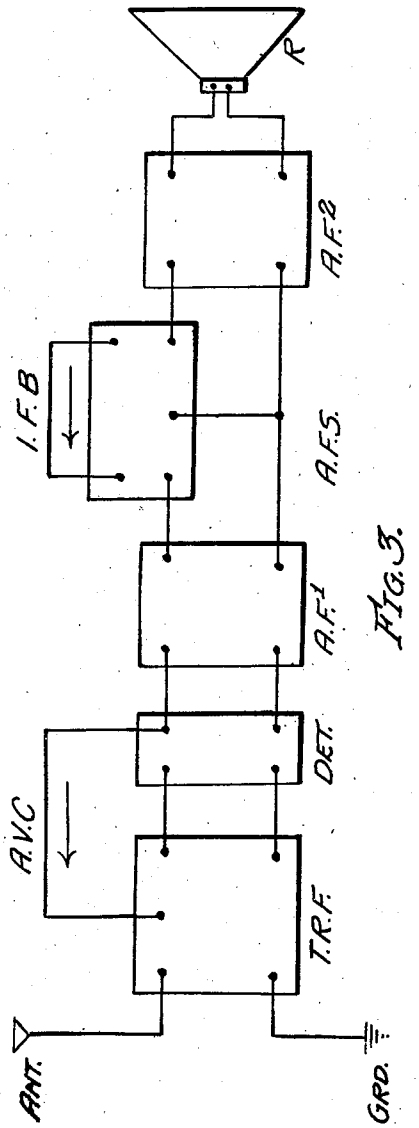

FIG. 3.

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INVERSE FEEDBACK CIRCUITS

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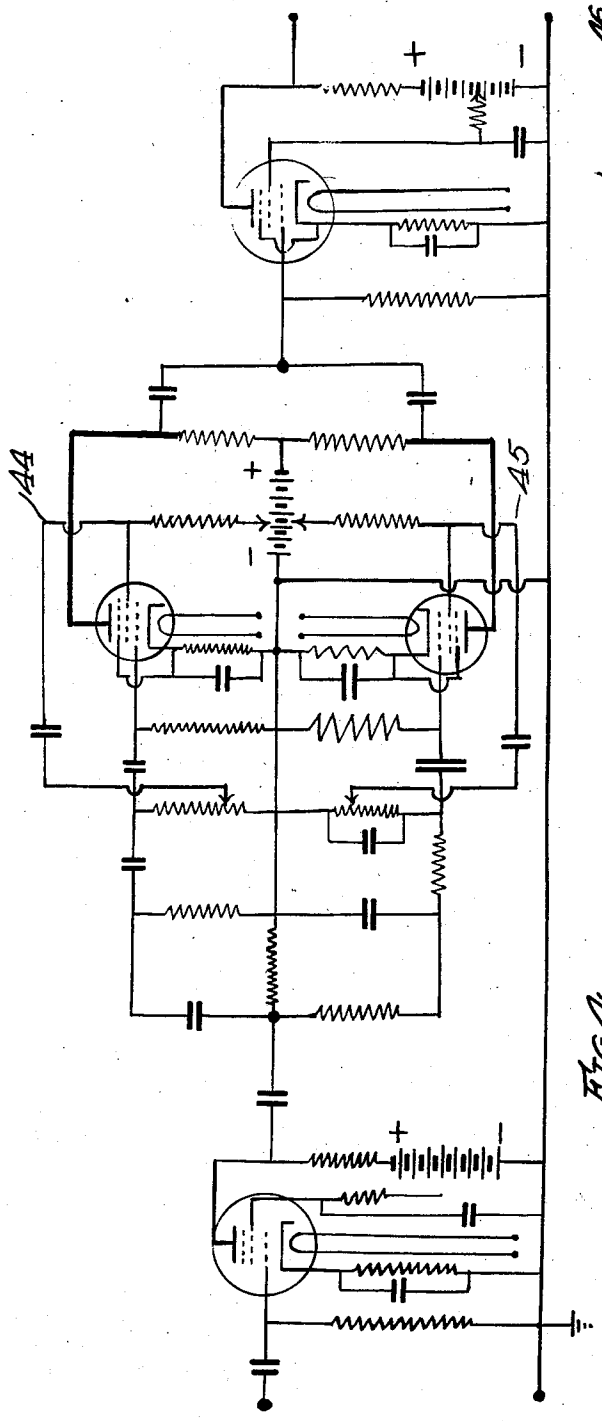

FIG. 4.

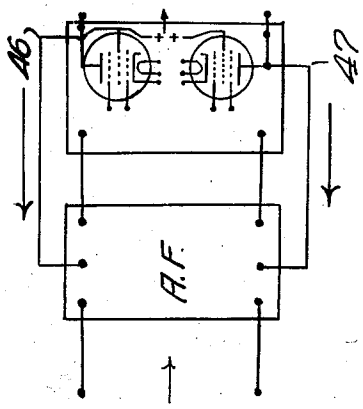

FIG. 5.

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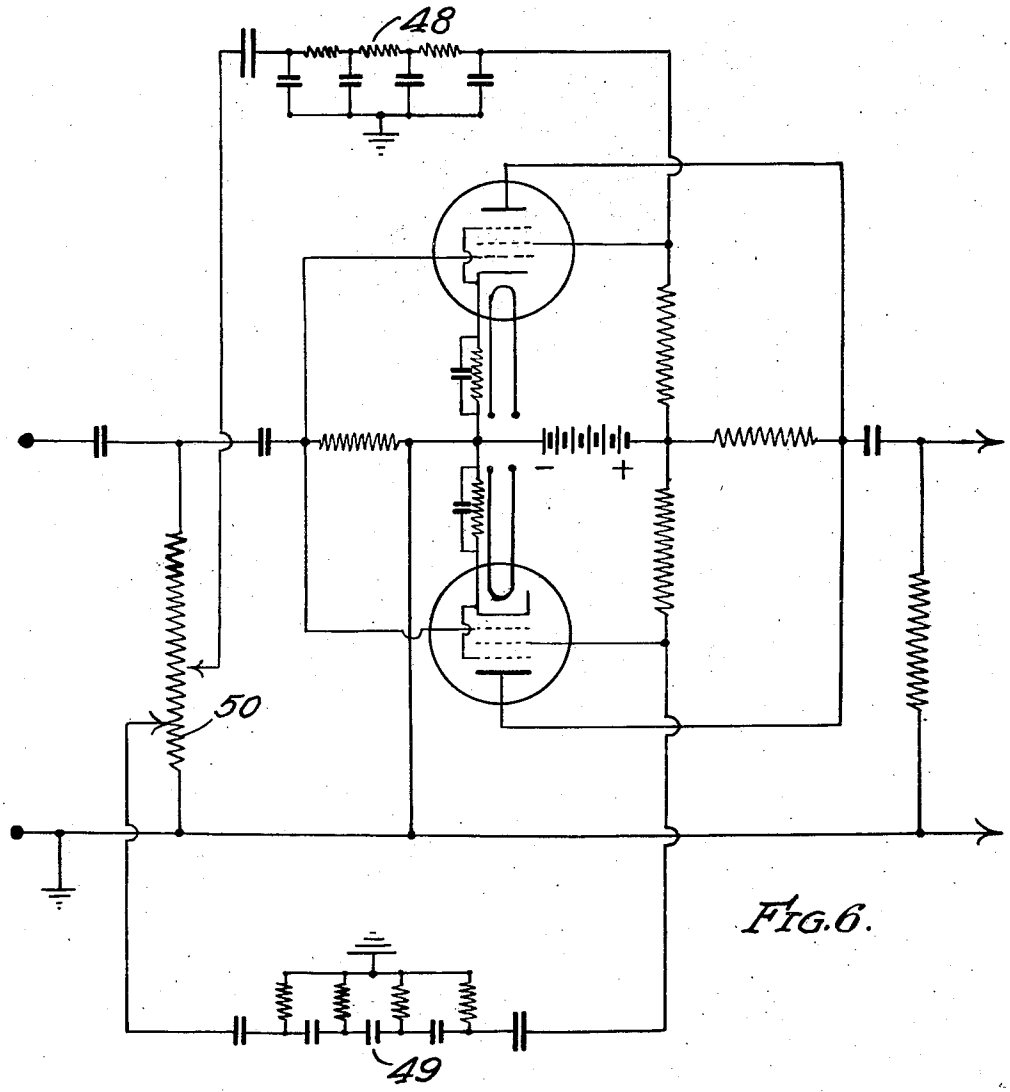

FIG. 6.

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Patented Jan. 9, 1940 2,186,195

UNITED STATES PATENT OFFICE

2,186,195

INVERSE FEEDBACK CIRCUITS

Henri F. Dalpayrat, New York, N. Y., assignor to Radio Patents Corporation, New York, N. Y., a corporation of New York

Application December 24, 1937, Serial No. 181,696

7 Claims. (Cl. 179—171)

My invention relates to improvements in, and methods of operating amplifying circuits, for radio, telephone, telegraph, and other purposes, and more particularly to inverse feedback systems reacting upon high-pass and low-pass filter circuits in audio frequency amplifiers.

The main object of my invention is to provide a novel method to suppress, limit, or expand, selected ranges of frequencies forming part of a signal, in order to correct distortions of the signal, and for altering the signal being amplified in such a way as to improve the quality of the reproduced signal, and improve the apparent selectivity of the tuning apparatus transmitting or receiving the signaling frequencies.

Inverse or negative feedback circuits as known in the art using discharge devices, such as electronic relays, usually comprise a feedback arrangement whereby a portion of the amplified output energy is fed back into the input circuit to limit excessive signal amplitudes or suppress undesirable frequencies, resulting in a substantial reduction of noises and distortion.

A disadvantage of inverse feedback circuits of this type known in the art, is the fact that while the excessive amplitudes are reduced, and the higher frequencies, usually composed of noises, are suppressed, various parts of the desired signal are also reduced or suppressed, introducing a new type of distortion and preventing the reproduction of a high-fidelity signal.

Accordingly it is an object of my invention to provide a new type of inverse feedback circuit capable of altering in various ways the selected ranges of frequencies chosen through the adjustment of a simple controlling device.

Another disadvantage of inverse feedback circuits, and particularly, inverse feedback circuits comprising frequency selective means such as bandpass filters, is the fact that the loss of energy in these filters is very high, necessitating high voltage variations in their input and consequently a larger number of filter sections, usually connected between different stages of amplification. This method is complicated, expensive and not reliable as the filters and all their connecting wires must be carefully shielded to prevent interstage electromagnetic couplings and undesirable local oscillation noises and whistling noises which may result therefrom.

Accordingly it is a further object of my invention to decrease the number of filter sections to a minimum while obtaining a high degree of efficiency without feeding back from one stage to another, and without causing objectionable oscillations.

Another disadvantage of selective inverse feedback circuits, when designed for uses such as tone control or for limiting the range of frequencies reproduced, in order to increase the apparent selectivity of the tuned apparatus transferring or selecting the signal, is the fact that it is usually very difficult to alter both the high frequency portions of a signal and the low-frequency range of that signal without impairing or destroying the original quality of the signal.

Accordingly another object of my invention is to provide a method whereby my amplifying circuit may be used as a tone control, a volume control, a low or high-frequency booster or suppressor, or as a means to obtain indirectly tuning characteristics comparable to the ideal flat top resonance curve well known in the art, without decreasing the amplification of the tuned radio or intermediate frequency stages, as provided in a radio receiving apparatus.

Still a further object of my invention consists in the provision of an efficient and simple circuit arrangement for manually adjusting the quality and the selectivity of a received radio broadcast signal as desired to suit the personal taste or requirements of the listener.

The invention has further objects and aspects in view which will appear hereafter in a detailed description thereof in connection with the accompanying drawings in which I have shown by way of example several circuits embodying the novel features of the invention.

In the drawings, Figure 1 shows one embodiment of a translation system for electric wave energy comprising amplifying means with inverse feedback constructed according to the invention to obtain a desired frequency discrimination between an input and an output circuit,

Figure 2 is a circuit showing a modification of the system according to Figure 1,

Figure 3 illustrates in block diagram form the previous circuit embodied in a radio receiving system,

Figure 4 shows a further embodiment of the inventive circuit utilizing the screen grid of an amplifying valve for deriving inverse feedback energy,

Figure 5 is a schematic diagram illustrating the use of inverse feedback derived from both the plate and screen grid of separate amplifying valves,

Figure 6 illustrates another modification of the invention for obtaining frequency discrimination

by means of filter networks associated with the inverse feedback paths.

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

Figure 1 in the drawings shows terminals 1 and 2 receiving a signal and preferably a signal delivered by an amplifier comprising automatic volume control features, which are well known in the art, and need no special description here. The incoming signal causes voltage variations across two relatively high ohmic impedances 5 and 6 linking a filter 7 designed to transfer the high frequencies to another filter 8 designed to transfer the low frequencies.

The high frequencies are transferred by filter 7 through small condensers 11 and 13 while the lower frequencies leak to ground through resistance 12. Tube 9 thus amplifies mostly high frequencies of the incoming signal, and its efficiency for this purpose is further increased by a high cathode resistor 15 shunted by a small condenser 16. The amplified signal causes voltage variations in a resistor 24 connected in the anode circuit. The signal is delivered through a condenser 20. The tone or volume of the signal may be adjusted by varying a potentiometer resistance 21 by moving the contact 21A. The respective amplifications of tubes 9 and 10 may be varied by increasing or decreasing the impedance of their output circuit resistors 24 and 34 through an adjustable contact 23. The low frequencies are preferably transferred to tube 10 through a high resistance 25 and a relatively large capacity 27 while the higher frequencies leak to ground through a small capacity 26 and a low resistance 28. The efficiency of tube 10 is also further increased for the amplification of lower frequencies through a cathode resistor 29 which is of lower value than that of cathode resistor 15. Resistor 29 is shunted by a relatively large condenser 30.

A part of the amplified energy of tube 9 is feedback through a de-coupling resistor 17 and a condenser 18. Resistor 17 is needed to introduce damping in the feedback circuit and facilitate the adjustment of potentiometer 5 through contact 19. According to the setting of contact 19, the higher frequencies may be automatically reduced in intensity or if desired totally neutralized.

The operation of tube 10 is similar to that of tube 9 except that the input circuit of tube 10 is filtered to favor the transfer of lower frequencies as explained before. A portion of the amplified energy of tube 10 is fed-back through resistor 31 and condenser 32 and neutralizes in various amounts the low frequencies developed across resistor 6 according to the setting of potentiometer contact 33.

From this description it may be understood that either a given range of high frequencies or a range of low frequencies may be reduced or neutralized. It is also evident that the reduction in intensity of all frequencies may be utilized to achieve a distortion-free volume control action. The reduction of certain frequencies provides an efficient tone control, while a sharp reduction of the higher frequencies, with a lesser reduction of the lower frequencies will substantially offset the effect of broadly tuned radio frequency circuits, thus causing a desirable improvement in the apparent selectivity of the tuned circuits.

While testing and perfecting this invention it has been found that resistors 24 and 34 could have fixed values, and be separate resistors instead of being branches of a potentiometer.

Potentiometer 21 and its sliding contact 21A can also be eliminated and replaced by a conductor connecting condensers 20 and 35 to the output terminals Y—Z which may include a condenser 22.

When the contacts 19 and 33 are grounded to the cathode connection the complete system operates in a manner similar to two tubes connected in parallel amplifying equally all incoming frequencies. Displacing contact 19 along 5 reduces the intensity of the high frequencies, while displacing contact 33 along 6 reduces the intensity of the lower frequencies.

Figure 2 in the drawings, shows a circuit according to the invention connected between the output of an amplifier A. F. 1 and the input of another amplifier A. F. 2.

The circuit shown in Figure 2 is substantially the same as the circuit of Figure 1, but is further characterized by the inverse feedback circuits being connected to potentiometers 42 and 43 which form a part of the frequency selective filter networks, respectively.

The improvement in Figure 2 consists in the separated positions of the inverse feedback potentiometers which are easier to adjust than in Figure 1, and are capable of a finer degree of frequency selection due to their greater distances from the first input impedance of the filters.

Figure 3 shows the position of a circuit according to the invention in an amplifying system, such as a radio receiver where the signals received by an antenna (Ant.) and ground (Grd.) system are tuned and amplified by a tuned radio frequency system (T. R. F.) and demodulated by a detector (Det.) from which is also derived in a known manner a bias regulating voltage for automatic volume control action or (A. V. C.). The detected signal is amplified at audio frequency by an audio frequency amplifier (A. F. 1) and then passed through a circuit according to the invention or audio frequency selector (A. F. S.).

A part of the filtered and amplified energy is reduced or neutralized by inverse feedback (I. F. B.); only one feedback section being shown here for simplicity of illustration. (A. F. 2) is the final amplifier and (R) is the reproducer.

Although I have described my invention as a circuit utilizing two thermionic discharge devices it should be understood that a single discharge device can also be used provided that it contains the number of electrodes necessary for the connections to and the operation of my circuit.

I have also shown in my drawings, opposition feedback circuits connected to the anode output of the discharge devices, but I do not wish to be limited in this respect, as it is evident that for example, the opposition feedback circuits could be connected to the screen-grids while the amplified and desired currents could be obtained from the anodes, thus separating the opposition circuits from the output circuits, without departing from the spirit and scope of my invention.

An arrangement of this type is illustrated in Figure 4 wherein the inverse feedback circuits 44 and 45 are each connected to a positively charged grid in each electronic device.

The circuit in Figure 4 is similar in appearance and in operation to Figure 2, except that I have found that feedback from screen grids or positive grids had the advantage of efficiently

reducing unwanted frequencies without decreasing appreciably the desired frequencies that are amplified and delivered in the anode circuits, and without decreasing beyond practical limits the amplification of the electronic devices.

Figure 5 shows a combination of grid feedback and of anode feedback, which further assist in selecting various ranges of frequencies. An inverse feedback circuit **46** is connected between a positive grid and the preceding amplifier (A. F.) whereby **46** is mostly effective in reducing or correcting the high frequencies, and an anode feedback circuit **47** is mostly efficient in correcting or reducing the low frequencies.

Figure 6 shows another form of a circuit according to the invention, wherein two filter circuits **48** and **49** are each connected between a postively charged grid and an input controlled grid, whereby the undesirable frequencies transferred by the filters are fed back in opposite phase into the input circuit through a common resistor **50**, thereby reducing or neutralizing the ranges of frequencies selected by filters **48** and **49**.

While I have illustrated and described my invention with specific reference to the embodiment according to the drawings it is obvious from the above that various modifications and variations may be made from the circuit as shown, coming within the broader spirit and scope of the invention, as pointed out in the following claims.

I claim:

1. An electrical circuit comprising two discharge devices having their input circuits linked together by a common input impedance, each input circuit being filtered for different ranges of frequencies, and inverse feedback means in the output of each discharge device reacting upon the common input impedance to reduce the intensity of various ranges of signaling frequencies as selected by the filters connected in the input circuits of both discharge devices.

2. An electric translation system comprising an input circuit, a plurality of amplifiers, separate filter networks having different frequency response characteristics connected between said input circuit and each of said amplifiers, a common output circuit for said amplifiers, and adjustable inverse feedback means between points at a higher and lower oscillation level in at least one of said amplifiers.

3. An electric translation system comprising an input circuit, a plurality of amplifiers, separate filter networks having different frequency response characteristics connected between said input circuit and each of said amplifiers, a common output circuit for said amplifiers, and individual adjustable inverse feedback means between points at a higher and lower oscillation level associated with each of said amplifiers.

4. An electric translation system comprising an input and an output, a plurality of parallel amplifying channels connected between said input and said output, electric filter means effective in passing predetermined partial ranges of component frequencies of electric wave energy to be transferred from said input to said output arranged in each of said channels, and adjustable inverse feedback means between points at a higher and lower oscillation level operatively associated with at least one of said amplifying channels.

5. An electric translation system comprising an input and an output, a plurality of parallel amplifying channels connected between said input and said output, electric filter means effective in passing predetermined partial ranges of component frequencies of electric wave energy to be transmitted from said input to said output, and individual adjustable inverse feedback means between points at a higher and lower oscillation level operatively associated with each of said amplification channels.

6. A system as claimed in claim 4, wherein said channels comprise at least one amplifying valve having a cathode, an anode, a control grid and a screen grid, said inverse feed-back being directly derived from said screen grid.

7. An electric translation system comprising an input and an output, a plurality of parallel amplifying channels connecting the input with the output, adjustable inverse feed-back means connected between points at higher and lower oscillation level in each of said amplified channels, electric filter means connected in each feedback path, said filter means being effective in passing predetermined partial ranges of component frequencies of electric wave energy to be transferred from said input to said output.

HENRI F. DALPAYRAT.