Nov. 25, 1941. A. V. LOUGHREN 2,263,825

SIGNAL TRANSLATING STAGE

Filed May 15, 1940 2 Sheets-Sheet 1

FIG. 1.

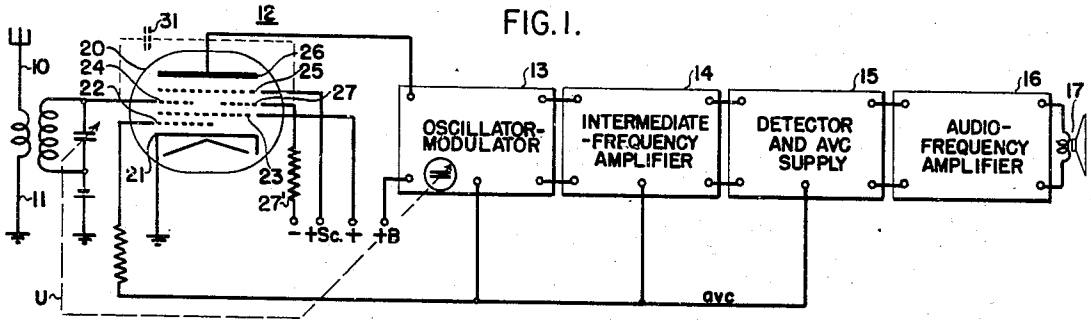


FIG. 2.

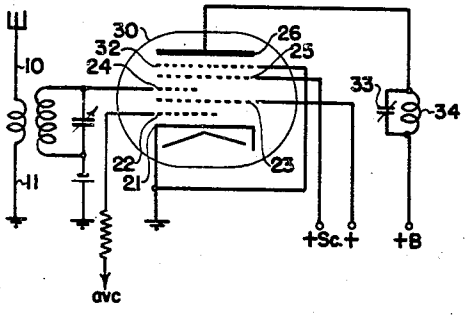


FIG. 3.

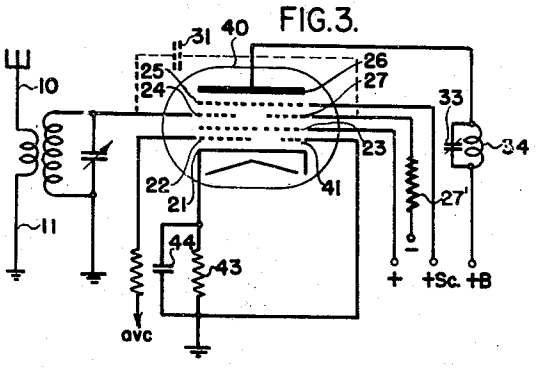


FIG. 4.

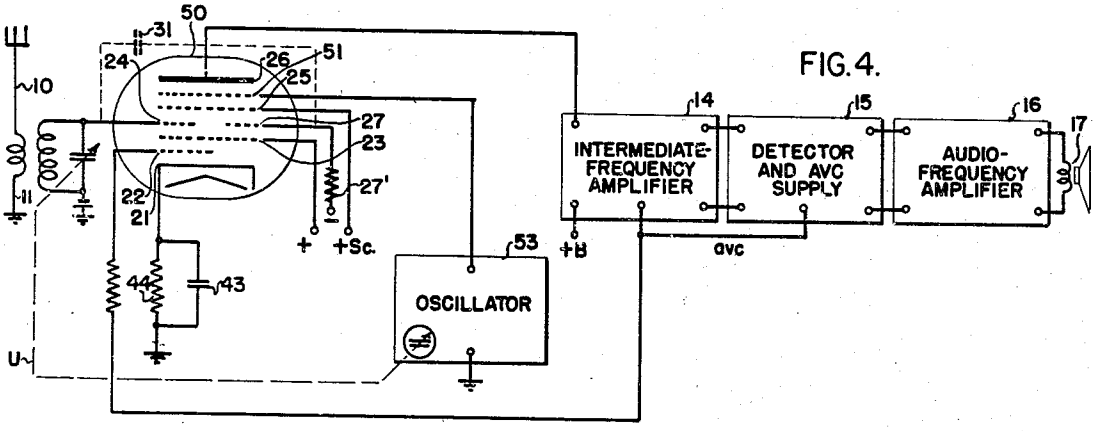
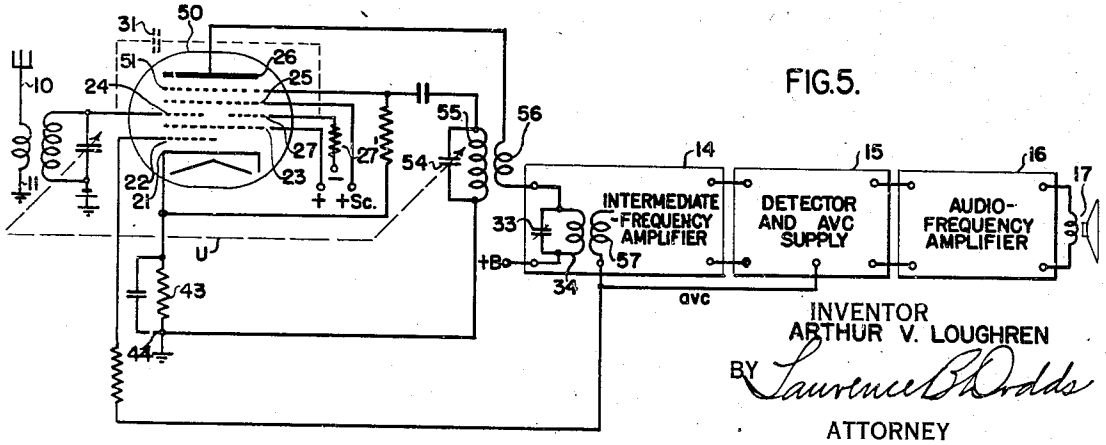


FIG. 5.



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FIG. 6.

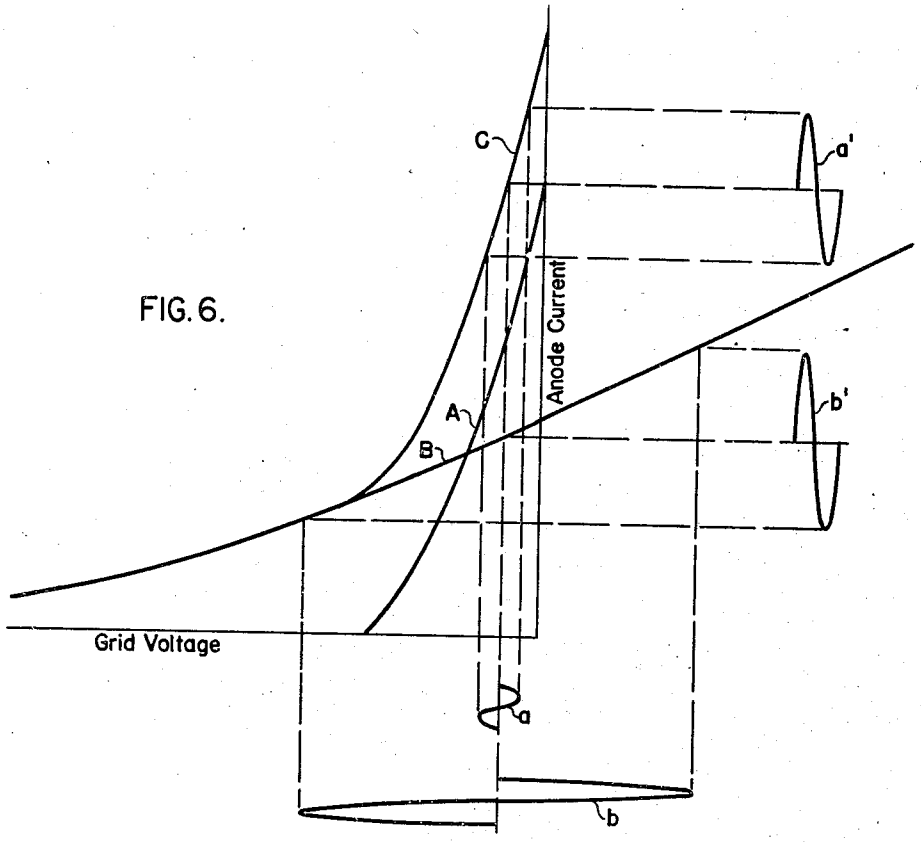
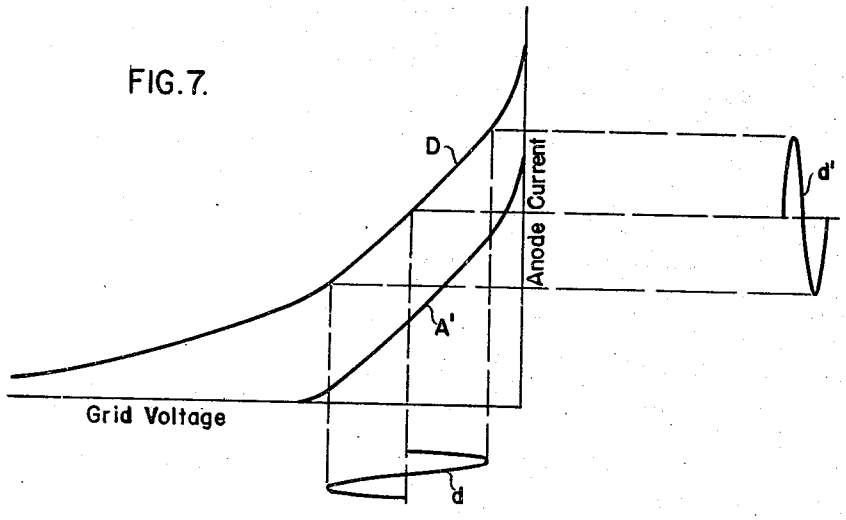


FIG. 7.



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Patented Nov. 25, 1941 2,263,825

UNITED STATES PATENT OFFICE

2,263,825

SIGNAL TRANSLATING STAGE

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Application May 15, 1940, Serial No. 335,238

17 Claims. (Cl. 250—20)

This invention relates generally to signal-translating stages for the translation of signals within a wide amplitude range and particularly to such stages in which the gain is controlled inversely in accordance with the amplitude of the signal input to the stage.

Under normal operating conditions, a modulated-carrier signal receiver is utilized for the reception of signals of amplitudes varying within very wide limits. As a result, the signal input to the first repeater stage of the receiver normally has a correspondingly wide range of amplitude variations. For weak signals, it is desirable to maintain the transmission characteristics or the response of the preselector between the antenna and the first repeater stage of the receiver at a maximum in order to raise the received signals substantially above the noise level, thus to procure maximum useful sensitivity of the receiver. However, with a high gain in the preselector, as the strength of desired received signals increases to such an extent that the grid swing of the first repeater stage includes a substantial nonlinear portion of the characteristic curve of the repeater, distortion of the desired signal-modulation envelope and cross modulation of the desired signal-carrier wave by strong undesired signals may result. This is particularly true in the case of receivers provided with automatic amplification control by which strong signals cause the grid of the first repeater stage to be biased toward that portion of its characteristic which is most nonlinear. The undesired signals, as well as desired signals, which reach the grid of the first repeater stage of the receiver have the effect of causing the grid to swing over such a range that these disturbing effects result. It is well known that such envelope distortion and cross modulation are effects which cannot be filtered out by succeeding selective circuits of the receiver.

In general, the preselector of a receiver, that is, the selector circuit between the antenna and the input circuit of the first vacuum-tube repeater in the signal-translating channel, should be selective to pass a band of desired modulation frequencies sufficiently wide to provide the desired fidelity of reproduction. Generally speaking, if an attempt is made to decrease the total desired and undesired signal input of the first repeater stage by discriminating against the undesired signals passed by the selector by adjusting its band width, the fidelity of reproduction is impaired to an undesirable degree. Furthermore, this does not remove the envelope distortion of abnormally strong desired signals.

Various expedients have heretofore been proposed for automatically and adjustably attenuating the input to the first repeater stage of a modulated-carrier receiver in order to eliminate the disturbing effects described above. In certain of these arrangements, adjustable impedance elements such as vacuum tubes have been connected in circuit with the preselector circuit of the receiver adjustably to damp such circuit, thereby adjustably to attenuate the signal input to the first repeater stage. Other proposed arrangements for this purpose comprise two feed-forward coupling paths between the antenna and the first vacuum-tube repeater of the signal-translating channel so arranged as to apply signal voltages of opposite phase to the input circuit of the first repeater, the transmission characteristics of one of the coupling paths being adjustable. While such arrangements provide generally satisfactory operation, they have generally required the use of one or more additional vacuum tubes or other circuit complexities that tended to increase the cost of the receiver.

It is an object of the invention, therefore, effectively to provide an improved, simple, and economical signal-translating stage which may be easily adjusted to control the sensitivity of a modulated-carrier signal receiver in such manner as to eliminate the undesired effects described above.

It is another object of the invention effectively to provide a signal-translating stage which secures the desired characteristics described without affecting the selectivity of a radio-frequency selector with which it is associated.

It is still another object of the invention to provide a signal-translating stage adapted for the translation of a signal input which varies over a wide amplitude range, which provides an output signal which varies over a relatively narrow amplitude range, and which is substantially free from cross-modulation or envelope distortion effects.

In accordance with the invention, a signal-translating stage comprises a vacuum tube including a source of electrons, an anode, a control electrode, and a signal-input electrode between said control electrode and said anode effective to control the electron stream from the source to the anode and having a greater effect on the electron stream over one cross-sectional portion of the electron path than on that over another portion so that, normally, the trans-

conductance from the control electrode to the anode is primarily determined by the control of the electron stream through one portion of the electron path. Means are also provided for applying a unidirectional potential to said control electrode for increasing the ratio of the average density of the electron stream over the other portion of the electron path to that over the one portion, whereby the portion of the transconductance of the tube determined by the electron stream through the other portion is materially increased.

As used in this specification, the term "transconductance" is intended to include the parameter "conversion transconductance" as conventionally applied to modulator or converter tubes.

For a better understanding of the invention, together with other and further objects thereof, reference is had to the following description taken in connection with the accompanying drawings, and its scope will be pointed out in the appended claims.

Referring now to the drawings, Fig. 1 is a circuit diagram, partly schematic, of a modulated-carrier signal receiver of the superheterodyne type including a signal-translating stage in accordance with the invention; Figs. 2 and 3 are circuit diagrams of modifications of the signal-translating stage of Fig. 1; Fig. 4 is a circuit diagram, partly schematic, of a receiver of the superheterodyne type including a signal-translating stage in accordance with the invention and of the frequency-converter type; Fig. 5 is a circuit diagram, partly schematic, of a receiver of the superheterodyne type including a signal-translating stage in accordance with the invention and of the oscillator-modulator type; and Figs. 6 and 7 comprise graphs utilized to explain the operation of the circuit of Fig. 1.

Referring now particularly to Fig. 1 of the drawings, there is shown a circuit diagram, partly schematic, of a complete modulated-carrier signal receiver of the superheterodyne type employing the invention. This receiver comprises, coupled in cascade with an antenna-ground circuit 10, 11, a radio-frequency amplifier 12, a frequency changer or oscillator-modulator 13, an intermediate-frequency amplifier 14 of one or more stages, a detector and automatic amplification control or A. V. C. supply 15, an audio-frequency amplifier 16 of one or more stages, and a sound reproducer 17. Automatic amplification control is secured in a well-known manner by applying a unidirectional voltage derived from the A. V. C. supply 15 to the control electrodes of oscillator-modulator 13 and one or more of the tubes included in the intermediate-frequency amplifier 14. Automatic amplification control potentials are also applied to radio-frequency amplifier 12 in a manner to be hereinafter fully described.

Neglecting for the present the details of operation of signal-translating stage 12 of the present invention, the apparatus described constitutes, in general, a conventional superheterodyne wave-signal receiver, the operation of which is well-understood in the art. In brief, signals intercepted by antenna-ground circuit 10, 11 are translated to the input circuit of radio-frequency amplifier 12, are amplified therein and translated to oscillator-modulator 13 wherein they are converted to an intermediate-frequency signal. The intermediate-frequency signal is amplified in intermediate-frequency amplifier 14 and delivered to detector 15 wherein the audio-frequency signals and the A. V. C. biasing potentials are derived. The audio-frequency signals are, in turn, amplified by the audio-frequency amplifier 16 and supplied to sound reproducer 17 for reproduction. The automatic amplification control bias derived from unit 15 is effective to maintain the signal input to detector 15 within relatively narrow limits for a wide range of received signal intensities.

Referring now more particularly to the signal-translating stage 12 of the invention, this stage comprises a vacuum tube 20 including, in the order named, a source of electrons such as a cathode 21, a first or control electrode 22, a second electrode 23, a third or signal-input electrode 24, a screen electrode 25, and an anode 26. The signal-input electrode 24 is effective primarily to control the variations in electron stream from cathode 21 to anode 26 at signal-input frequencies and is so designed as effectively to extend over only a portion of the cross-sectional area of the electron path from cathode 21 to anode 26. An additional or auxiliary electrode 27 is provided which extends over another portion of the cross-sectional area of the electron path between cathode 21 and anode 26 and is generally complementary to the signal-input electrode 24. Electrode 24 is loosely coupled to electrode 27 by means of capacitance 31 shown in dotted lines for the reason that it may be comprised in whole or in part of the interelectrode capacitance between these electrodes. Electrode 27 is also designed so as to extend over only a portion of the entire cross-sectional area of the electron path. Positive operating potentials are supplied to electrodes 23 and 25 and anode 26 from suitable sources, while negative operating potentials are supplied to electrodes 24 and 27, the operating potential applied to electrode 27 being applied through an impedance 27'. A negative voltage, variable in accordance with the amplitude of received signals, is applied to electrode 22 from the A. V. C. supply source 15.

In considering the operation of the signal-translating stage of Fig. 1, it will be seen that signal-input electrode 24 has more effect on one portion, which may be called portion A, of the cross-sectional area of the cathode-anode electron path than on another portion, that is, the portion over which electrode 27 extends, which may be called portion B, so that, normally, that is, in the absence of an appreciable negative potential applied to electrode 22 from the A. V. C. source 15, the transconductance between control electrode 24 and anode 26 is determined primarily by the electron stream through the portion A. Due to the loose or incidental coupling provided by capacitance 31 and impedance 27', which effectively form an impedance attenuator, between signal-input electrode 24 and electrode 27, potentials applied to electrode 24 also additionally affect the transconductance between electrode 24 and anode 26, but only to a relatively small degree, due to the action of electrode 27 on the portion B of the electron stream.

As the negative bias applied to electrode 22 is increased, due to an increased signal-input amplitude and an increased A. V. C. bias, the ratio of the density of the electron stream over portion B to that over portion A is increased, whereby the portion of the transconductance between signal-input grid 24 and anode 26 contributed by the electron stream over portion B is materially increased. Stated in another way, with a small A. V. C. voltage applied to control electrode 22, the path directly through grid 24 is mainly ef-

fective in determining the transconductance between signal-input electrode 24 and anode 26. As a larger A. V. C. bias is applied to electrode 22, the transconductance of this path may be gradually decreased to complete cutoff and the resultant transconductance from signal-input electrode 24 to anode 26 is then only that due to the electron stream through grid 27. The means for applying the unidirectional A. V. C. control potential to control electrode 22 is thus effective to increase the average density of the electron stream over portion B relative to that over portion A, whereby the portion of the transconductance of the tube determined by the electron stream through portion B is materially increased. Also, it is preferable that the electrode structure of the tube is so related to its operating potentials that screen electrode 23, to which a positive potential is applied, is effective, together with the negative operating potentials applied to grids 24 and 27, to develop a virtual cathode between grids 24 and 27 and screen electrode 23, that is, a mass of slowly or random moving electrons from which the electron current to anode 26 may be controlled by the signal voltages on electrodes 24 and 27.

Reference is made to the graphs of Figs. 6 and 7 for a further explanation of the operating characteristics of the signal-translating stage 12. The curve A of Fig. 6 represents the grid voltage-anode current characteristic of portion A of tube 20, while curve B represents the corresponding characteristic for portion B. If an input signal of small amplitude is applied to control electrode 24 of tube 20, the resultant grid voltage-anode current characteristic of the tube is that represented by the sum of curves A and B, which is represented by curve C. Thus, for a small signal input, as indicated by curve *a*, a relatively large signal output, as indicated by the curve *a'*, is obtained. Similarly, if the input signal is very large, as indicated by the curve *b*, the effective or over-all input voltage-output current characteristic of the tube is that of curve B and an output signal represented by the curve *b'* is obtained from the stage. If now an input signal of intermediate amplitude value is applied to the signal-translating stage, it is seen that an A. V. C. bias is developed and applied to electrode 22 effectively changing the transconductance characteristic of portion A of the tube and the changed characteristic may be as represented by curve A' of Fig. 7. The characteristic of portion B is not materially changed, so that the over-all characteristic of the tube is that represented by the sum of curve A' of Fig. 7 and curve B of Fig. 6, which over-all characteristic is illustrated by the curve D. Therefore, for an input signal of intermediate amplitude such as represented by curve *d* an output signal is obtained which is represented by the curve *d'*. Thus, it is seen that for signal-input amplitudes of a wide amplitude range, represented by curves *a*, *b*, and *d*, the signal-translating stage 12 is effective to provide output signals of a relatively narrow amplitude range, as represented by curves *a'*, *b'*, and *d'*.

The signal-translating stage of Fig. 2 is generally similar to the signal-translating stage 12 of Fig. 1 and similar circuit elements have identical reference numerals. The tube 30 of Fig. 2 is generally similar to the tube 20 of Fig. 1 except that electrode 27 has been omitted and there is included a suppressor electrode 32 disposed between screen grid 25 and anode 26 and connected to cathode 21. A resonant circuit 33, 34 is included in the anode circuit of tube 30 and it will be understood that the remainder of the circuit of Fig. 2 may be identical with that shown in Fig. 1, the resonant circuit 33, 34 being included in the input circuit of oscillator-modulator 13.

The operation of the circuit of Fig. 2 is generally similar to that of Fig. 1. Signal-input electrode 24 is primarily effective on the portion of the cross-sectional area of the electron path over which the control electrode actually extends, but is also incidentally effective to control to a lesser extent the electron flow through the remainder of the cross-sectional area of the electron stream by virtue of its electrostatic field which extends somewhat over the remaining portion of the electron path. Suppressor electrode 32 has the same purpose in the tube 30 as the suppressor electrodes of conventional tubes, which purpose is well understood by those skilled in the art.

In Fig. 3, there is shown a signal-translating stage generally similar to that of Fig. 2 and circuit elements which are similar to those of Figs. 1 and 2 have identical reference numerals. The signal-translating stage of Fig. 3 comprises a vacuum tube 40 generally similar to vacuum tube 20 of Fig. 1 but including an additional electrode 41 extending over a portion of the cross-sectional area of the electron path between cathode 21 and screen electrode 23 which is not occupied by control electrode 22. A cathode-biasing resistor 43, by-passed for signal-frequency currents by condenser 44, is provided for tube 40, electrode 41 being grounded.

In considering the operation of the signal-translating stage of Fig. 3 it will be seen that, for received signal amplitudes of low value, for which maximum gain is required from tube 40, substantially no current flows through grid 27 due to the effect of negatively biased electrode 41 and the electron stream through the signal-input grid 24 is mainly effective to determine transconductance between control electrode 24 and anode 26. As the amplitude of received signals increases, the bias applied to electrode 22 from the A. V. C. source gradually increases, ultimately cutting off the electron stream through control electrode 24 and reducing the negative bias on grid 41 so that an electron path is open through grid 41 to anode 26. That is, sufficient bias voltage is developed across resistor 43 to cut off the electron stream through grid 41 when a small A. V. C. bias is applied to grid 22 and, as the A. V. C. bias to grid 22 increases, the bias voltage developed in resistor 43 for grid 41 is decreased, thereby permitting the electron stream to flow through grid 41 and grid 27 in a path which is controlled to a much lesser extent by the potential of signal-input electrode 24. It is, therefore, seen that the transconductance of portion B of the tube of Fig. 3 increases from a negligible value to some value as represented by the curve B of Fig. 6 while the transconductance of portion A of the tubes falls from a value as represented by curve A of Fig. 6 to zero.

The signal receiver represented in Fig. 4 is generally similar to that of Fig. 1 and similar circuit elements have identical reference numerals. The circuit of Fig. 4 differs from that of Fig. 1 primarily in that it contains no stage of radio-frequency amplification, the signal-translating stage of the invention being included in the circuit of the receiver as a converter stage

for developing an intermediate-frequency signal for intermediate-frequency amplifier 14. The signal-translating stage of Fig. 4 includes a vacuum tube 50 having between screen electrode 27 and anode 26 an electrode 51 supplied with oscillations from a conventional local oscillator 53. It is believed that the operation of the circuit of Fig. 4 will be readily apparent from the description of the circuits of the preceding figures; that is, the action of grid 24 is generally similar and the oscillation voltage supplied to grid 51 is also effective to vary or modulate at the frequency of local oscillator 53, the resultant electron stream to anode 26. Therefore, for a received signal of low amplitude, the conversion transconductance from signal-input electrode 24 to anode 26 is primarily determined by the electron stream through the grid 24. For strong signals, however, the conversion transconductance from signal-input electrode 24 to anode 26 is primarily determined by the electron stream through grid 27, the potential applied to signal-input electrode 24 having a lesser effect upon this portion of the electron stream.

The receiver of Fig. 5 is generally similar to that of Fig. 4 and similar circuit elements have identical reference numerals. The receiver of Fig. 5 differs from that of Fig. 4 in that the signal-translating stage embodying the invention is an oscillator-modulator, there being included in such signal-translating stage means for developing sustained oscillations which are applied to electrode 51. This means comprises a frequency-determining circuit 54, 55 and a feedback circuit including an inductance 56 in the anode circuit of tube 50 and inductively coupled to inductance 55. The condenser 54 is uncontrolled with that of the preselector circuit of the receiver in a conventional manner as indicated by the dashed line U. In order to complete the anode circuit of tube 50 to the unidirectional source of operating potential +B, there is shown included in intermediate-frequency amplifier 14 an anode load impedance for intermediate frequencies which comprises tuned circuit 33, 34 to which is inductively coupled an inductance 57. It will be understood that the remaining portions of intermediate-frequency amplifier 14 which are not shown may be of conventional construction and operation.

While there have been described what are at present considered to be the preferred embodiments of this invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and it is, therefore, aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. A signal-translating stage comprising, a vacuum tube including a source of electrons, an anode, a control electrode, and a signal-input electrode between said control electrode and said anode effective to control the electron stream from said source to said anode and having a greater effect on the electron stream over one cross-sectional portion of the electron path than on that over another portion so that normally the transconductance from said signal-input electrode to said anode is primarily determined by the control of the electron stream through said one portion, and means for applying a unidirectional potential to said control electrode for increasing the ratio of the average density of the electron stream over said other of said portions to that over said one of said portions, whereby the portion of said transconductance determined by the electron stream through said other of said portions is materially increased.

2. A signal-translating stage comprising, a vacuum tube including a source of electrons, an anode, a control electrode, and a signal-input electrode between said control electrode and said anode effective to control the electron stream from said source to said anode and extending over only a portion of the cross-sectional area of the electron path whereby it has a greater effect on the electron stream over said portion than on that over another portion so that normally the transconductance from said signal-input electrode to said anode is primarily determined by the control of the electron stream through said one portion, and means for applying a unidirectional potential to said control electrode for increasing the ratio of the average density of the electron stream over said other of said portions to that over said one of said portions, whereby the portion of said transconductance determined by the electron stream through said other of said portions is materially increased.

3. A signal-translating stage comprising, a vacuum tube including a source of electrons, an anode, a control electrode, a signal-input electrode between said control electrode and said anode effective to control the electron stream from said source to said anode and effectively extending over only a portion of the cross-sectional area of the electron path, whereby it has a greater effect on the electron stream over one cross-sectional portion of the electron path than on that over another portion, an auxiliary signal-input electrode effective to control the electron stream from said source to said anode extending over said other portion and normally being less effective than said signal-input electrode so that normally the transconductance from said signal-input electrode to said anode is primarily determined by the control of the electron stream through said one portion, and means for applying a unidirectional potential to said control electrode for increasing the ratio of the average density of the electron stream over said other of said portions to that over said one of said portions, whereby the portion of said transconductance determined by the stream through said other of said portions is materially increased.

4. A signal-translating stage comprising, a vacuum tube including a source of electrons, an anode, a signal-input electrode effective to control the electron stream from said source to said anode effectively extending over only a portion of the cross-sectional area of the electron path, whereby it has a greater effect on the electron stream over one cross-sectional portion of the electron path than on that over another portion, an auxiliary control electrode effective to control the electron stream from said source to said anode extending over said other portion so that normally the transconductance from said signal-input electrode to said anode is primarily determined by the control of the electron stream through said one portion, means for applying a signal input to said signal-input electrode and for applying a small fraction of said signal input to said auxiliary electrode, and means for increasing the ratio of the average density of the electron stream over said other of said portions to that over said one of said portions, whereby the portion of said transconductance determined

by the stream through said other of said portions is materially increased.

5. A signal-translating stage comprising, a vacuum tube including a source of electrons, an anode, a control electrode, a signal-input electrode between said control electrode and said anode effective to control the electron stream from said source to said anode and having a greater effect on the electron stream over one cross-sectional portion of the electron path than on that over another portion, and an auxiliary control electrode effective to control the electron stream from said source to said anode and having a greater effect on said other portion than on said one portion, said stage including means loosely coupling said signal-input electrode and said additional control electrode so that normally the transconductance between said signal-input electrode and said anode is primarily determined by the control of the electron stream through said one portion, and means for applying a unidirectional potential to said control electrode for increasing the ratio of the average density of the electron stream over said other of said portions to that over said one of said portions, whereby the portion of said transconductance determined by the electron stream through said other of said portions is materially increased.

6. A signal-translating stage comprising, a vacuum tube including a source of electrons, an anode, a control electrode, a signal-input electrode between said control electrode and said anode effective to control the electron stream from said source to said anode and having a greater effect on the electron stream over one cross-sectional portion of the electron path than on that over another portion, and an auxiliary control electrode effective to control the electron stream from said source to said anode and having a greater effect on the electron stream over said other portion than on that over said one portion, said stage including means incidentally coupling said signal-input electrode and said auxiliary electrode and including the interelectrode capacitance between said electrodes so that normally the transconductance from said signal-input electrode to said anode is primarily determined by the control of the electron stream through said one portion, and means for applying a unidirectional potential to said control electrode for increasing the ratio of the average density of the electron stream over said other of said portions to that over said one of said portions, whereby the portion of said transconductance determined by the electron stream through said other of said portions is materially increased.

7. A signal-translating stage comprising, a vacuum tube including means for forming a virtual cathode, an anode, and a signal-input electrode effective to control the electron stream from said virtual cathode to said anode and having a greater effect on the electron stream over one cross-sectional portion of the electron path than on that over another portion so that normally the transconductance from said signal-input electrode to said anode is primarily determined by the control of the electron stream through said one portion, and means for increasing the ratio of the average density of the electron stream over said other of said portions to that over said one of said portions, whereby the portion of said transconductance determined by the electron stream through said other of said portions is materially increased.

8. A signal-translating stage comprising, a vacuum tube including a source of electrons, an anode, a control electrode, and a signal-input electrode between said control electrode and said anode effective to control the electron stream from said source to said anode and having a greater effect on the electron stream over one cross-sectional portion of the electron path than on that over another portion so that normally the transconductance from said signal-input electrode to said anode is primarily determined by the control of the electron stream through said one portion, and means for applying a variable negative potential to said control electrode for increasing the ratio of the average density of the electron stream over said other of said portions to that over said one of said portions, whereby the portion of said transconductance determined by the electron stream through said other of said portions is materially increased.

9. In a modulated-carrier signal receiver including an antenna and a signal-translating channel, a first signal-translating stage in said signal-translating channel comprising, a vacuum tube including a source of electrons, an anode, a control electrode, and a signal-input electrode between said control electrode and said anode effective to control the electron stream from said source to said anode and having a greater effect on the electron stream over one cross-sectional portion of the electron path than on that over another portion so that the transconductance from said signal-input electrode to said anode is primarily determined by the control of the electron stream through said one portion, means for coupling said signal-input electrode to said antenna, and means for applying a unidirectional potential to said control electrode for increasing the ratio of the average density of the electron stream over said other of said portions to that over said one of said portions, whereby the portion of said transconductance determined by the electron stream through said other of said portions is materially increased.

10. In a modulated-carrier wave-signal receiver including an antenna, a signal-translating channel, and a source of automatic amplification control voltage, a first signal-translating stage in said signal-translating channel comprising, a vacuum tube including a source of electrons, an anode, a control electrode, and a signal-input electrode between said control electrode and said anode effective to control the electron stream from said source to said anode and having a greater effect on the electron stream over one cross-sectional portion of the electron path than on that over another portion so that normally the transconductance from said signal-input electrode to said anode is primarily determined by the control of the electron stream through said one portion, means for coupling said signal-input electrode to said antenna, and means for applying a potential from said source of automatic amplification control voltage to said control electrode for increasing the ratio of the average density of the electron stream over said other of said portions to that over said one of said portions, whereby the portion of said transconductance determined by the electron stream through said other of said portions is materially increased for received signal amplitudes of large value.

11. A signal-translating stage comprising, a vacuum tube including, in the order named, a cathode, a first electrode, a second electrode, a signal-input electrode, and an anode, means for applying a positive unidirectional operating po-

tential to said second electrode, said signal-input electrode being effective to control the electron stream from said source to said anode and having a greater effect on the electron stream over one cross-sectional portion of the electron path than on that over another portion so that normally the transconductance from said signal-input electrode to said anode is primarily determined by the control of the electron stream through said one portion, and means for applying a variable negative potential to said first electrode for increasing the ratio of the average density of the electron stream over said other of said portions to that over said one of said portions, whereby the portion of said transconductance determined by the electron stream through said other of said portions is materially increased.

12. A signal-translating stage comprising, a vacuum tube including a source of electrons, an anode, a control electrode, and a signal-input electrode between said control electrode and said anode effective to control the electron stream from said source to said anode and having a greater effect on the electron stream over one cross-sectional portion of the electron path than on that over another portion so that normally the transconductance from said signal-input electrode to said anode is primarily determined by the control of the electron stream through said one portion, and means effective primarily on said one of said portions for applying a unidirectional potential to said control electrode for decreasing the density of the electron stream over said one portion, whereby the portion of said transconductance determined by the electron stream passing through said other of said portions is materially increased.

13. A signal-translating stage adapted to translate signal inputs within a wide amplitude range comprising, a vacuum tube including a source of electrons, an anode, a control electrode, and a signal-input electrode between said control electrode and said anode effective to control the electron stream from said source to said anode and having a greater effect on the electron stream over one cross-sectional portion of the electron path than on that over another portion so that normally the transconductance from said signal-input electrode to said anode is primarily determined by the control of the electron stream through said one portion, and means responsive to the amplitude of said signal input for applying a unidirectional potential to said control electrode for increasing the ratio of the average density of the electron stream over said other of said portions to that over said one of said portions, whereby the portion of said transconductance determined by the electron stream through said other of said portions is materially increased.

14. A signal-translating stage comprising, a vacuum tube including a source of electrons, an anode, a signal-input electrode effective to control the electron stream from said source to said anode and having a greater effect on the electron stream over one cross-sectional portion of the electron path than on that over another portion so that normally the conversion transconductance from said signal-input electrode to said anode is primarily determined by control of the electron stream through said one portion, an additional means for varying at a preselected frequency the electron stream from said source to said anode, and means for increasing the ratio of the average density of the electron stream over said other of said portions to that over said one of said portions, whereby the portion of said transconductance determined by the electron stream through said other of said portions is materially increased.

15. A signal-translating stage comprising, a control electrode including, in the order named, a source of electrons, a signal-input electrode, a screen grid, an additional electrode, and an anode, said signal-input electrode being effective to control the electron stream from said source to said anode and having a greater effect on the electron stream over one cross-sectional portion of the electron path than on that over another portion, means comprising said additional electrode for varying the electron stream to said anode at a preselected frequency, whereby the normal conversion transconductance from said signal-input electrode to said anode is primarily determined by the control of the electron stream through said one portion, and means for increasing the ratio of the average density of the electron stream over said other of said portions to that over said one of said portions, whereby the portion of said transconductance determined by the electron stream through said other of said portions is materially increased.

16. A signal-translating stage comprising, a vacuum tube including a source of electrons, an anode, and a signal-input electrode effective to control the electron stream from said source to said anode and having a greater effect on the electron stream over one cross-sectional portion of the electron path than on that over another portion so that normally the conversion transconductance from said signal-input electrode to said anode is primarily determined by the control of the electron stream through said one portion, means included in said vacuum tube for providing sustained oscillations and for utilizing said oscillations to vary the electron stream to said anode, and means for increasing the ratio of the average density of the electron stream over said other of said portions to that over said one of said portions, whereby the portion of said transconductance determined by the electron stream through said other of said portions is materially increased.

17. A signal-translating stage comprising, a vacuum tube including, in the order named, a source of electrons, a signal-input electrode, a screen electrode, an additional electrode, and an anode, means including said additional electrode for providing sustained oscillations and for utilizing said oscillations to control the electron stream to said anode, said signal-input electrode being effective to control the electron stream from said source to said anode and having a greater effect on the electron stream over one cross-sectional portion of the electron path than on that over another portion so that normally the conversion transconductance from said signal-input electrode to said anode is primarily determined by the control of the electron stream through said one portion, and means for increasing the ratio of the average density of the electron stream over said other of said portions to that over said one of said portions, whereby the portion of said transconductance determined by the electron stream through said other of said portions is materially increased.

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