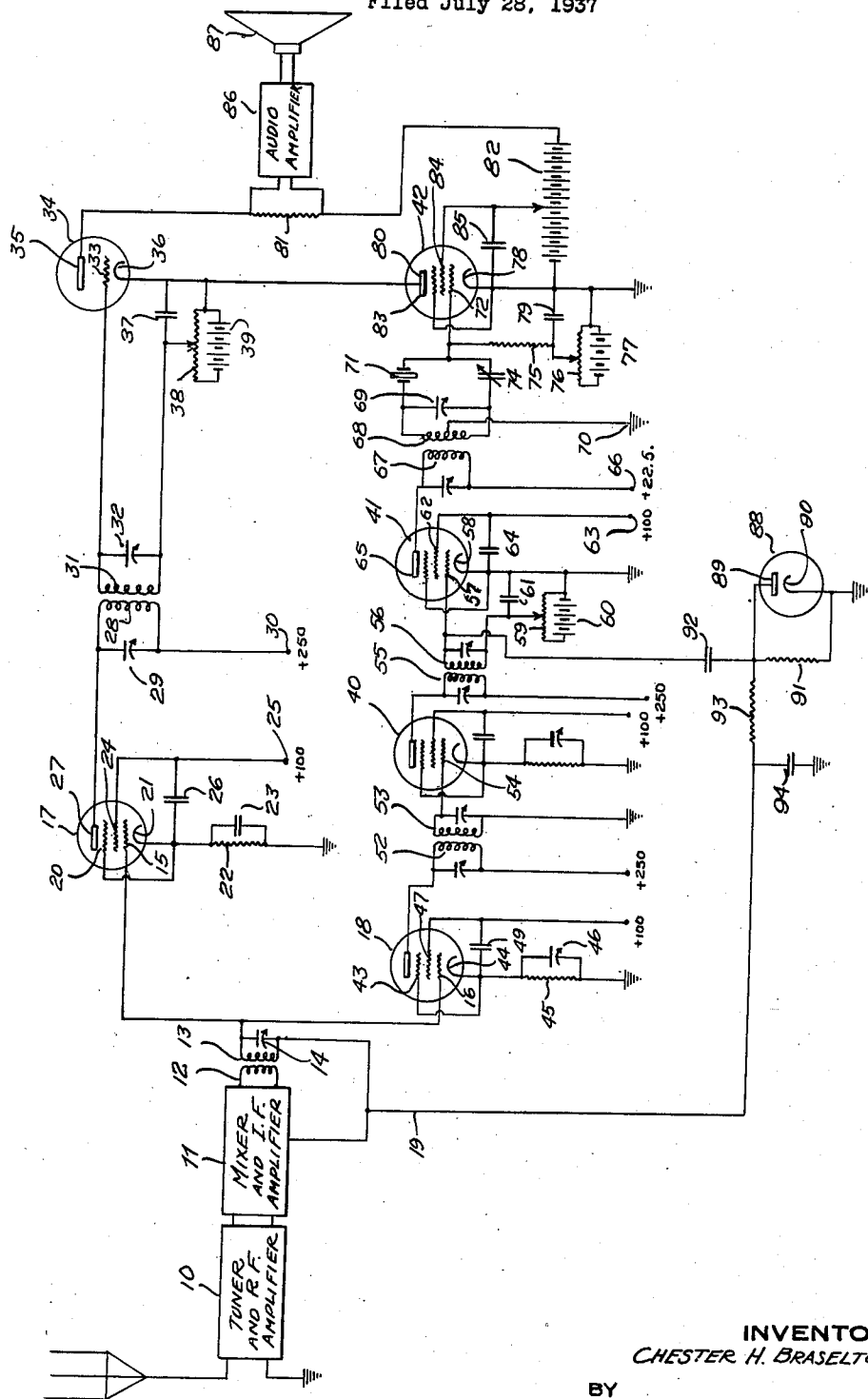


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C. H. BRASELTON
RECEIVING APPARATUS

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2,206,010

RECEIVING APPARATUS

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This invention relates to radio receiving apparatus and has, for its principal object, to provide an apparatus which is highly selective and at the same time will faithfully reproduce substantially all of the desired signal frequencies with little or no attenuation.

Another object of the invention is to provide a radio receiver in which interference from stations on either side of the selected station is reduced to a minimum.

Another object of the invention is to provide a receiver in which the signal frequencies are reproduced by the beats between the incoming radio frequency oscillations and an independently controlled oscillation corresponding to the carrier frequency.

Another object of the invention is to provide a radio receiver with means to independently control the level of the carrier frequency with respect to that of the side bands.

Other objects of the invention will be apparent as the description thereof proceeds.

The invention is illustrated in the accompanying drawing, the single figure of which represents a circuit diagram of a receiver embodying the invention.

In transmitting intelligence by radio a carrier wave with its accompanying side bands is selected at the receiver by means of resonant circuits which tend to increase the carrier frequency and attenuate those frequencies farthest away from the carrier. The greater the selectivity the more this attenuation is carried out, with the result that a highly selective receiver may tend to completely cut off high frequency notes of the signal.

This invention comprehends the reception of a band of frequencies wide enough to include the carrier and all necessary side band frequencies, the division of this received energy into two paths, the elimination of substantially all frequencies in one of said paths except the carrier frequency, the combination of the paths again in a single circuit to cause the separated carrier frequency to coact with the transmitted frequencies in the other path to reproduce the audio signal. I prefer to provide the single circuit with two thermionic tubes with their plate circuits in series and to connect one of said paths to the grid of one tube, while the other path is connected to the grid of the other tube.

Referring to the figure, I have shown the circuit in connection with a super-heterodyne in which the tuner and radio frequency amplifier unit 10 may be used to select the desired band

of frequencies in accordance with the usual practice and to amplify them prior to introducing them to the mixer tube, which is contained in the unit 11, together with the local oscillator and intermediate frequency amplifier stages. The output circuit for the unit 11 may contain a coil 12 which may be coupled to a coil 13, tuned by a variable condenser 14. One end of this coil and condenser combination may be connected to the control grids 15 and 16 of pentode tubes 17 and 18, respectively, while the other end of the coil and condenser may be connected to an automatic volume control circuit 19, to be subsequently described, for supplying a controlled bias to the grids of the tubes. The units 10 and 11 may differ from ordinary units of this nature solely by virtue of the fact that they are both preferably tuned sufficiently broad to pass as uniformly as possible the entire band of frequencies necessary to produce the maximum signal frequency desired. In other words, if 16,000 cycles is the maximum signal frequency which is to be used with the carrier, then the units 10 and 11 should preferably be designed to pass 16,000 cycles on each side of the carrier, or, where single side band transmission is to be used, on one side of the carrier.

The tubes 17 and 18 represent the first tubes in the two paths for dividing the signal, the former being in the broadly tuned path, while the latter is in the sharply tuned path. The tube 17 may have its suppressor grid 20 connected to the cathode 21, which may be grounded through a resistance 22 shunted by a condenser 23, while the screen grid 24 may be given a positive potential, indicated at 25. A condenser 26 may be connected between the screen grid and the cathode. The anode 27 of the tube 17 may be connected to a coil 28 and condenser 29, forming a resonant circuit, the other end of which may be connected to a source of positive potential, indicated at 30. A coil 31, tuned by a variable condenser 32, may be inductively coupled to the coil 28 and may have one end connected to the control grid 33 of a tube 34.

This tube 34 may preferably be of the three element type having an anode 35 and a cathode 36, and may form one of the two series connected tubes used for combining the two signal paths. The control grid 33 may be given a negative potential by means of a potentiometer 38 and battery 39, which may be connected between the cathode 36 of the tube and the opposite ends of the coil 31 and condenser 32. Inasmuch as the tube is maintained above ground,

there should preferably be provided a separate source of heating current for the tube.

The tuned circuits formed by the coils 28 and 31 and condensers 29 and 32 are preferably broad enough to permit all of the signal to pass without attenuation, as has already been stated in connection with the circuits of the units 10 and 11. Hence, the grid 33 has applied to it a variable voltage corresponding to the entire signal together, perhaps, with some side band frequencies of neighboring stations.

The sharp circuit, starting with the tube 18, is preferably provided with a plurality of additional stages including tubes 40 and 41 and tube 42 which forms the other tube in the series circuit. The tube 18 may be of the pentode type with the suppressor grid 43 connected directly to the cathode 44 which may be given a definite potential above ground by means of the resistance 45 shunted by the condenser 46. The screen grid 47 may be given a positive potential 48 and a by-pass condenser 49 may be connected between the screen grid and the cathode. The anode 50 of the tube may be given a positive potential, indicated at 51, through a resonant circuit 52, which may be coupled to a resonant circuit 53 connected to the grid 54 of the tube 40. This tube 40 may also be of the pentode type with the connections made exactly the same as those just described for the tube 18.

The output circuit of the tube 40 may comprise the resonant circuit 55 which may be coupled to a resonant circuit 56 connected between the control grid 57 of the tube 41, and the cathode 58 of that tube through a potentiometer 59 shunted by a battery 60, so as to give an adjustable negative potential to the grid 57. A condenser 61 may be connected between the cathode and the potentiometer end of the resonant circuit 56. The screen grid 62 of the tube 41 may be given a positive potential as indicated at 63, while a condenser 64 may be connected between the screen grid and the cathode.

The tube 41 preferably acts as a limiting tube to maintain the voltage delivered to the subsequent part of the circuit below a certain maximum under all conditions, and hence I prefer to give the anode 65 a low potential of 22.5 volts, as indicated at 66, while the screen has a voltage of approximately 100 volts. The anode circuit contains resonant circuit 67 which may be inductively coupled to a coil 68. The coil 68 may be shunted by a variable condenser 69 and the midpoint of the coil grounded, as indicated at 70.

One side of the coil 68 and condenser 69 may be connected through a piezo electric crystal 71 to the grid 72 of the tube 42. The other end of the coil 68 and condenser 69 may be connected through a variable condenser 74 to the grid 72, so that the coil 68 and condenser 69, crystal 71 and condenser 74 form a bridge circuit, one terminal of which is the ground connection at 79, while the other terminal is the grid 72, the crystal 71 and condenser 74 being in opposite legs of the bridge, and the latter having sufficient value to balance the capacity of the former. The grid 72 of the tube 42 is also connected through a resistance 75 and a potentiometer 76 and battery 77 to the cathode 78 of the tube and to ground, there being a condenser 79 across the battery and potentiometer.

This circuit is intended to feed to the grid 72 of the tube 42 a variable voltage corresponding to the carrier frequency only of the intercepted signal without any of the side band fre-

quencies. Accordingly, the resonant circuits 52, 53, 55, 56, 67, and 68 are preferably made as sharp as possible. By means of the crystal 71, which, in the present instance, may be cut to respond to the intermediate frequency only, all frequencies, save this particular frequency, will be eliminated from this sharp circuit, and the grid 72 will therefore receive oscillating voltage only when the receiver is tuned exactly on a carrier so that the signal will be present in the sharp circuit.

The tubes 34 and 42 are arranged with their plate circuits in series, as has already been stated, and to this end the plate 80 of the tube 42 may be connected directly to the cathode 40 of the tube 34, while the plate 35 of this tube may be connected through a load resistance 81 and plate potential battery 82 to the cathode 78 of the tube 42. The suppressor grid 83 of the tube 42 may be connected to the cathode 78 and the screen grid 84 may be given a positive potential on the battery 82. A condenser 85 may be connected between this screen grid and cathode 78. I may prefer to connect an audio amplifier 86 across the resistance 81, while the output of the amplifier may be connected to any translating device, such as the speaker 87.

The tube 34 is provided with a suitable bias for its grid circuit by means of the potentiometer 38 and battery 39 so that this tube acts as nearly as possible as an R. F. amplifier, reducing detection in the tube 34 to a minimum. The plate voltage of the tube 34 is dependent not only upon the battery 82, but also upon the plate current of the tube 42, which is controlled by the carrier oscillation delivered to its grid. The tube 42 is also adjusted as to grid bias by means of the potentiometer 76 and battery 77 so as to have a minimum of detector action, and inasmuch as this is operated as a pentode, variation in plate potential caused by the action of the tube 34 has little or no effect on the plate current of this tube. The tube 34, however, connected to operate as a triode, is sensitive to plate voltage variation, and hence its plate-cathode current will vary not only in accordance with the grid voltage variation, but also in accordance with the plate cathode current of the tube 42, and there will be beats produced between the carrier oscillation introduced into the series circuit by the tube 42 and the complete broad band of oscillations introduced into the circuit by the tube 34. These beats result in the audio signal which may be transferred to the audio amplifier 86 by means of the drop in potential across the resistance 81.

I have found that with my improved circuit the relation of the levels of the broad and sharp signals is important, and I therefore preferably provide an automatic volume control to maintain a substantially constant level for all signals intercepted by the receiver. To this end the diode tube 88, having an anode 89 and a cathode 90 may be used. The anode 89 may be connected to the grounded cathode 90 through a high resistance 91, and signal potential may be supplied to the tube by connecting the anode 89 to the grid 57 of the tube 41 through a large capacity condenser 92. The anode 89 may also be connected through a large resistance 93 to the automatic volume control circuit 19 while a by-pass condenser 94 may be connected between this circuit and ground. The drop in potential across the resistance 91 as controlled by the diode tube 88 changes the potential on the grids of the tubes

17 and 18 and of the tubes in the unit 11, as will be understood.

I have also found that best results are obtained when the level of the sharp circuit is not permitted to exceed a certain maximum which permits operation continually on the straight portion of the grid-voltage plate-current curve of the tube. Hence, I use the tube 41 as a voltage limiting tube for the tube 42. By making the plate voltage on the tube 41 much lower than the screen voltage, the plate current will never exceed a certain maximum regardless of the strength of the signal, and adjustments may be made so that this maximum plate current falls within the range determined by the straight portion of the grid-voltage plate-current curve of the tube 42.

When there is no signal on the grid of the tube 42 there is no variable current flowing in the series circuit except the amplified radio frequencies of the tube 34, and hence no beats are produced in the tube 34, and there will be no audio output from the circuit. Inasmuch as the crystal 71 is ground to respond only to the intermediate frequency, which may be in the neighborhood of 470 kilocycles, no signal will be applied to the grid of the tube 42 unless the receiver is tuned to a carrier which will produce the proper oscillation to affect the crystal. Hence, the set must be tuned exactly on the desired carrier before there is any sound produced by the speaker, and the instant the set is tuned to one side or the other of the carrier the strength of the carrier oscillation falls off sufficiently in the sharp circuit to immediately stop the circuit from operating. The effect of the circuit, therefore, is extremely sharp tuning while at the same time all of the desired signal frequencies may be received without attenuation owing to the broad flat topped resonance curve of the broad circuit including the tubes 17 and 34.

While the invention has been shown with a superheterodyne receiver, it will be evident that other types of receivers may be used embodying the same principle, although the use of an intermediate frequency makes the construction and operation simpler, inasmuch as the tuning of broad and sharp stages does not have to be changed but may be fixed at the intermediate frequency, and the crystal may be ground to that one frequency.

While a crystal has been shown for eliminating all but the carrier frequency in the sharp circuit, other methods may be used, if desired; also under certain conditions it may not be necessary to sharpen the circuit to such a degree, and coupled resonant circuits may be found satisfactory for this purpose. However, as it is very difficult, with tubes of present construction to entirely eliminate rectification, owing to the difficulty of producing a tube with a straight line characteristic curve, better results may be obtained if the sharp circuit produces the carrier frequency alone.

Precautions should preferably be taken to shield the various circuits from each other to prevent undesired interaction of circuits which might greatly interfere with the successful operation of the set.

Various changes may be made in the arrangement as shown and described without departing from the spirit of the invention, such as providing automatic volume control by other well known methods, and I therefore desire to claim

the invention broadly, limited only by the scope of the appended claims.

What I claim is:

1. A receiving apparatus comprising frequency-selecting means capable of passing a wide band of frequencies equal to at least the maximum signal frequency to be received, means to separate the signal received by said means into two paths, one of said paths being arranged to pass substantially the entire selected band of frequencies, means associated with the other path to limit the frequency therein to substantially a single frequency, a pair of thermionic tubes each having input and output circuits and with their output circuits connected in series, means to apply voltage from one of said paths to the input circuit of one of said tubes, means to apply voltage from the other of said paths to the input circuit of the other of said tubes, and means to translate the output current of said tubes into an intelligible signal.

2. A receiving apparatus comprising frequency-selecting means capable of passing a wide band of frequencies equal to at least the maximum signal frequency to be received, means to separate the signal received by said means into two paths, one of said paths being arranged to pass substantially the entire selected band of frequencies, means associated with the other path to limit the frequency therein to substantially a single frequency, a pair of thermionic tubes each having input and output circuits and with their output circuits connected in series, means to apply voltage from one of said paths to the input circuit of one of said tubes, means to apply voltage from the other of said paths to the input circuit of the other of said tubes, means to translate the output current of said tubes into an intelligible signal, and means to maintain a substantially constant level of signals in both paths regardless of the strength of the intercepted signal.

3. A receiving apparatus comprising frequency-selecting means capable of passing a wide band of frequencies equal to at least the maximum signal frequency to be received, means to separate the signal received by said means into two paths, one of said paths being arranged to pass substantially the entire selected band of frequencies, means associated with the other path to limit the frequency therein to substantially a single frequency, a pair of thermionic tubes each having input and output circuits and with their output circuits connected in series, means to apply voltage from one of said paths to the input circuit of one of said tubes, means to apply voltage from the other of said paths to the input circuit of the other of said tubes, means to translate the output current of said tubes into an intelligible signal, and means to limit the voltage delivered by said single frequency path to a predetermined maximum.

4. A receiving apparatus comprising frequency-selecting means capable of passing a wide band of frequencies equal to at least the maximum signal frequency to be received, means to separate the energy selected by said selecting means into two paths, one of said paths being arranged to pass substantially the entire selected band of frequencies, means associated with said other path to limit the frequency therein to substantially a single frequency, a pair of thermionic tubes each having an input circuit and an output circuit with the output circuits of said tubes connected in series, means to apply voltage

from one path to the input circuit of one of said tubes, means to apply voltage from said other path to the input circuit of said other tube, means to operate said tubes with a minimum of detector action, and means to translate output currents from said tubes into intelligible signals.

5. A receiving apparatus comprising frequency-selecting means capable of passing a wide band of frequencies equal to at least the maximum signal frequency to be received, means to separate the energy selected by said selecting means into two paths, one of said paths being arranged to pass substantially the entire selected band of frequencies, means associated with said other path to limit the frequency therein to substantially a single frequency, a pair of thermionic tubes each having an input circuit and an output circuit with the output circuits of said tubes connected in series, means to apply voltage from one path to the input circuit of one of said tubes, means to apply voltage from said other path to the input circuit of said other tube, means to operate said tubes with a minimum of detector action, means to translate output currents from said tubes into intelligible signals, and means to maintain a substantially constant level in both said paths for any intercepted signal.

6. A receiving apparatus comprising frequency-selecting means capable of passing a wide band of frequencies equal to at least the maximum signal frequency to be received, means to separate the energy selected by said selecting means into two paths, one of said paths being arranged to pass substantially the entire selected band of frequencies, means associated with said other path to limit the frequency therein to substantially a single frequency, a pair of thermionic tubes each having an input and an output circuit with the output circuits of said tubes connected in series, means to apply voltage from one path to the input circuit of one of said tubes, means to apply voltage from said other path to the input circuit of said other tube, means to operate said tubes with a minimum of detector action, means to translate output currents from said tubes into intelligible signals, and means to limit the amplitude of oscillations produced by the said single frequency path below a predetermined maximum.

7. A receiving apparatus comprising frequency-selecting means capable of passing a wide band of frequencies equal to at least the maximum signal frequency to be received, means to separate the signals received by said means into two paths, one of said paths being arranged to pass substantially the entire selected band of frequencies, means associated with the other path to limit the frequency therein to substantially a single frequency, a pair of thermionic tubes each having input and output circuits and with their output circuits connected in series, means to apply voltage from one of said paths to the input circuit of one of said tubes, means to apply voltage from the other of said paths to the input circuit of the other of said tubes, means to translate the output current of said tubes into an intelligible signal, means to maintain a substantially constant level in said paths, and means to limit the voltage delivered by said single frequency path to a predetermined maximum.

8. A receiving apparatus comprising frequency-selecting means capable of passing a wide band of frequencies equal to at least the maximum signal frequency to be received, means to

separate the signal received by said means into two paths, one of said paths being arranged to pass substantially the entire selected band of frequencies, means associated with the other path to limit the frequency therein to substantially a single frequency, a pair of thermionic tubes each having input and output circuits and with their output circuits connected in series, means to apply voltage from one of said paths to the input circuit of one of said tubes, means to apply voltage from the other of said paths to the input circuit of the other of said tubes, means to operate said tubes with a minimum of detector action, means to translate the output current of said tubes into intelligible signals, means to maintain a substantially constant level in both said paths for any intercepted signal, and means to limit the amplitude of oscillations produced by the said single frequency path below a predetermined maximum.

9. A receiving apparatus comprising frequency-selecting means capable of passing a wide band of frequencies equal to at least the maximum signal frequency to be received, means to separate the energy received by said frequency-selecting means into two paths, one of said paths being arranged to pass substantially the entire selected band of frequencies, means associated with said other path to limit the frequency therein to substantially a single frequency, a thermionic tube having an anode, a cathode and a control electrode, means to apply voltage from said broad path between said control electrode and cathode of said tube, means to bias said control electrode so that said tube will operate with a minimum of detection, a second thermionic tube having a cathode, a control electrode and an anode, means to effectively shield the control electrode of said second tube from the anode thereof, means to apply voltage from said single frequency path between the control electrode and cathode of said second tube, means to connect the anode circuits of said tubes in series, a source of anode potential included in said series circuit, and a load circuit associated with said series circuit.

10. A receiving apparatus comprising frequency-selecting means capable of passing a wide band of frequencies equal to at least the maximum signal frequency to be received, means to separate the energy received by said frequency-selecting means into two paths, one of said paths being arranged to pass substantially the entire selected band of frequencies, means associated with said other path to limit the frequency therein to substantially a single frequency, a thermionic tube having an anode, a cathode and a control electrode, means to apply voltage from said broad path between said control electrode and cathode of said tube, means to bias said control electrode so that said tube will operate with a minimum of detection, a second thermionic tube having a cathode, a control electrode and an anode, means to effectively shield the control electrode of said second tube from the anode thereof, means to apply voltage from said single frequency path between the control electrode and cathode of said second tube, means to connect the anode circuits of said tubes in series, a source of anode potential included in said series circuit, a load circuit associated with said series circuit, and means to maintain a constant level for both of said paths regardless of the signal intercepted by said receiver.

11. A receiving apparatus comprising frequency-selecting means capable of passing a wide

band of frequencies equal to at least the maximum signal frequency to be received, means to separate the energy received by said frequency-selecting means into two paths, one of said paths being arranged to pass substantially the entire selected band of frequencies, means associated with said other path to limit the frequency therein to substantially a single frequency, a thermionic tube having an anode, a cathode and a control electrode, means to apply voltage from said broad path between said control electrode and cathode of said tube, means to bias said control electrode so that said tube will operate with a minimum of detection, a second thermionic tube having a cathode, a control electrode and an anode, means to effectively shield the control electrode of said second tube from the anode thereof, means to apply voltage from said single frequency path between the control electrode and cathode of said second tube, means to connect the anode circuits of said tubes in series, a source of anode potential included in said series circuit, a load circuit associated with said series circuit, and means to limit the voltage applied to the grid of said second tube to below a predetermined maximum.

12. A receiving apparatus comprising frequency-selecting means capable of passing a wide band of frequencies equal to at least the maximum signal frequency to be received, means to separate the energy received by said frequency-selecting means into two paths, one of said paths being arranged to pass substantially the entire selected band of frequencies, means associated with said other path to limit the frequency therein to substantially a single frequency, a thermionic tube having an anode, a cathode and a control electrode, means to apply voltage from said broad path between said control electrode and cathode of said tube, means to bias said control electrode so that said tube will operate with a minimum of detection, a second thermionic tube having a cathode, a control electrode and an anode, means to effectively shield the control electrode of said second tube from the anode thereof, means to apply voltage from said single frequency path between the control electrode and cathode of said second tube, means to connect the anode circuits of said tubes in series, a source of anode potential included in said series circuit, a load circuit associated with said series

circuit, means to maintain a constant level for both of said paths regardless of the signal intercepted by said receiver, and means to limit the voltage applied to the grid of said second tube to below a predetermined maximum.

13. A receiving apparatus comprising frequency-selecting means capable of passing a wide band of frequencies, means to separate the energy received by said selecting means into two paths, one of said paths being sharper than the other, a pair of thermionic tubes having input circuits and output circuits with their output circuits connected in series, means to apply voltage from one path to the input circuit of one tube, means to apply voltage from the other path to the input circuit of said other tube, and means to transmit into an intelligible signal currents flowing in said series output circuit.

14. A receiving apparatus comprising frequency-selecting means capable of passing a wide band of frequencies, means to separate the energy received by said selecting means into two paths, one of said paths being sharper than the other, a pair of thermionic tubes having input circuits and output circuits with their output circuits connected in series, means to apply voltage from one path to the input circuit of one tube, means to apply voltage from the other path to the input circuit of said other tube, means to transmit into an intelligible signal currents flowing in said series output circuit, and means to maintain a substantially constant level in said two paths for any signal received.

15. A receiving apparatus comprising frequency-selecting means capable of passing a wide band of frequencies, means to separate the energy received by said selecting means into two paths, one of said paths being sharper than the other, a pair of thermionic tubes having input circuits and output circuits with their output circuits connected in series, means to apply voltage from one path to the input circuit of one tube, means to apply voltage from the other path to the input circuit of said other tube, means to transmit into an intelligible signal currents flowing in said series output circuit, and means to limit the voltage applied to one of said tubes by said sharper path to below a predetermined maximum.

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