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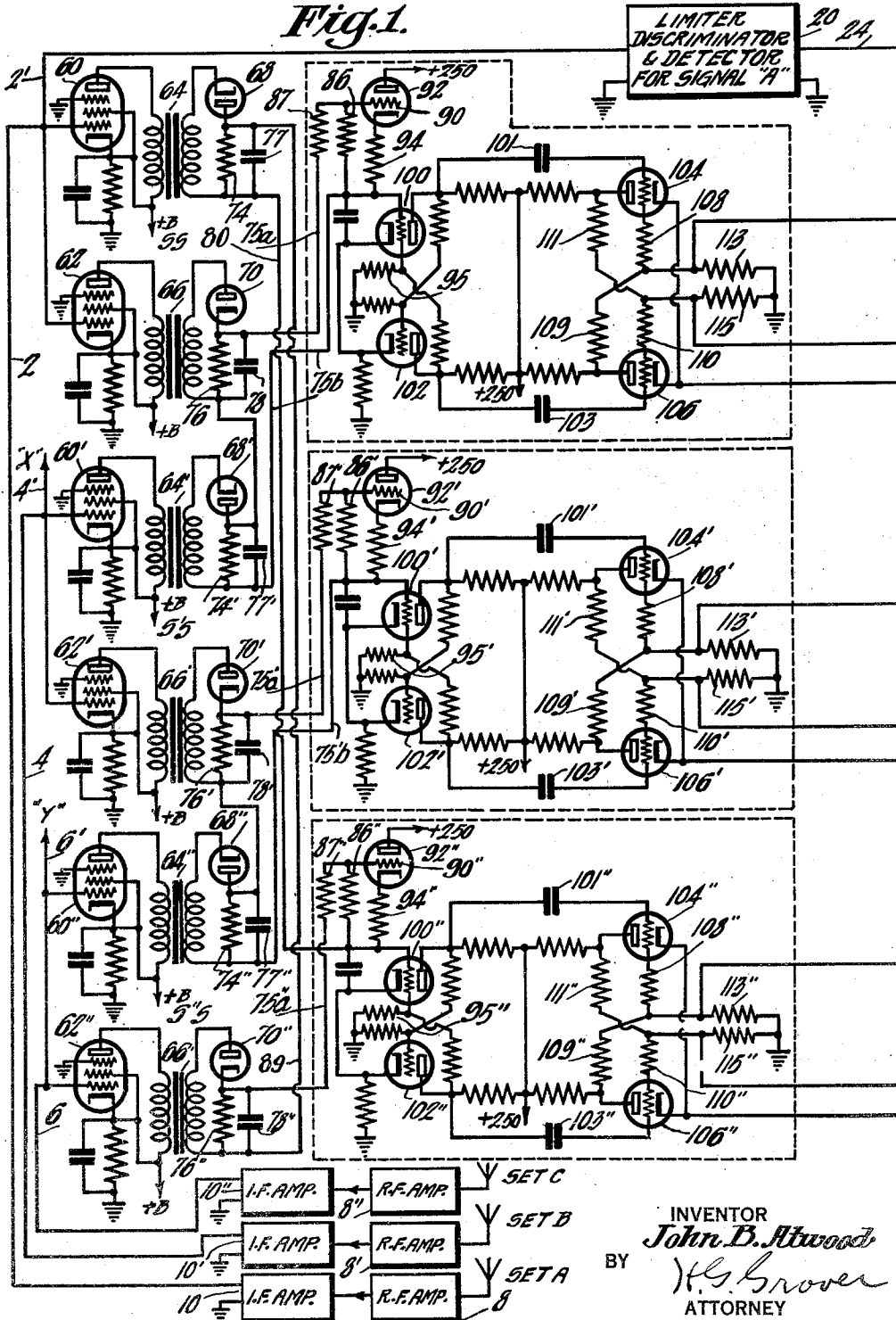
J. B. ATWOOD
ELECTRONIC SWITCHING SYSTEM IN A
DIVERSITY RECEIVING SYSTEM

2,492,780

Filed May 8, 1946

2 Sheets-Sheet 1

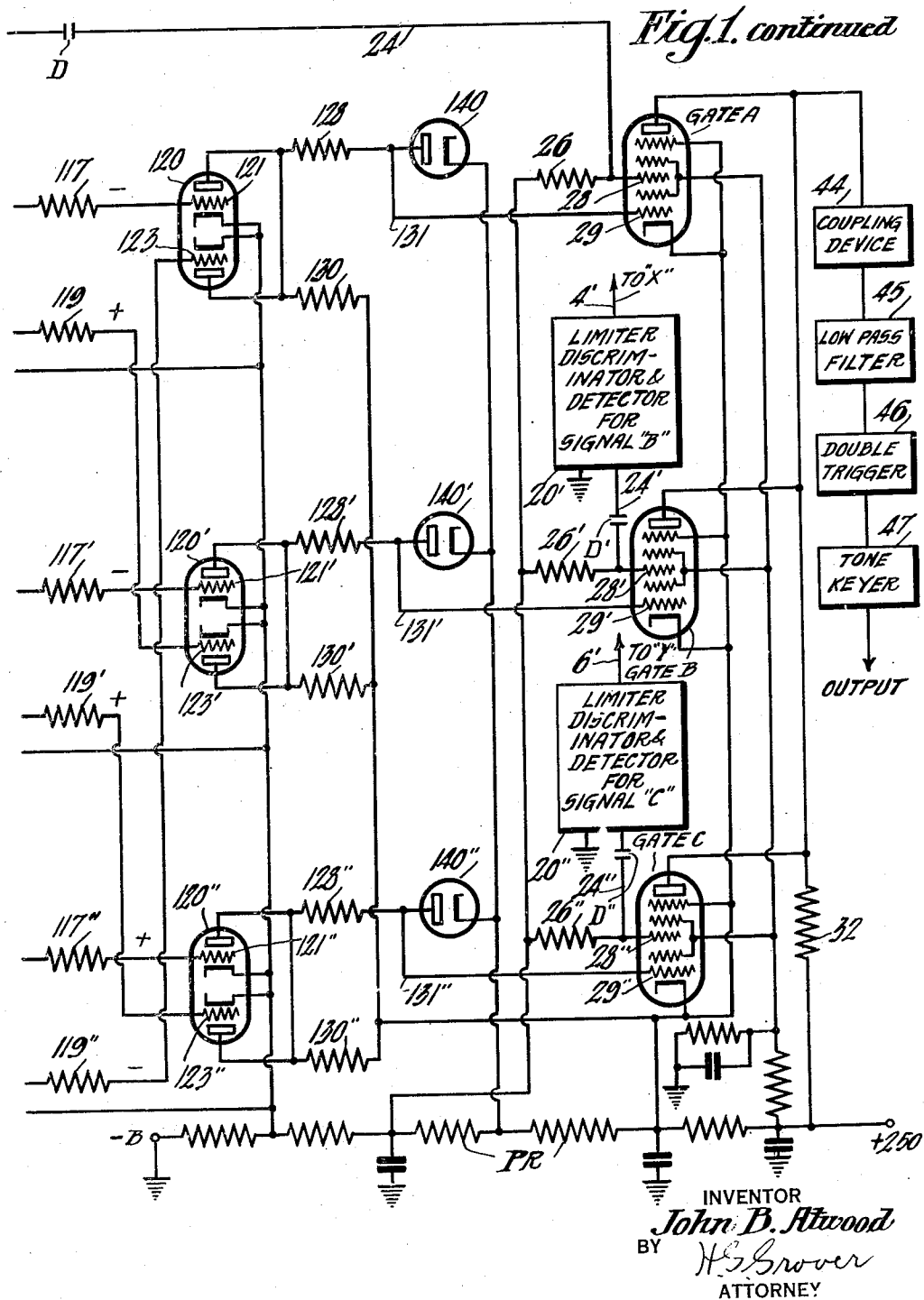
Fig. 1.



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UNITED STATES PATENT OFFICE

2,492,780

ELECTRONIC SWITCHING SYSTEM IN A
DIVERSITY RECEIVING SYSTEMJohn B. Atwood, Riverhead, N. Y., assignor to
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Application May 8, 1946, Serial No. 668,109

7 Claims. (Cl. 250—8)

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This application relates to telegraphy and the like signalling systems and more in particular to frequency shift telegraphy or facsimile receivers in space diversity.

Telegraphy and facsimile systems making use of the frequency shift type of modulation are known in the art. In these systems alternating current has its frequency shifted from a first value which might represent "mark" in telegraphy or "white" in facsimile to a second value which might represent "space" in telegraphy or "black" in facsimile. At the receivers, this current is subject to a demodulation process to derive other current; for example, current having a strong direct current component which shifts in magnitude between two values one of which represents "mark" or "white" and the other of which represents "space" or "black." These currents then are used to operate directly or indirectly (in many cases by way of tone keyers) recording apparatus of some type; for example, teletypewriters. Arrangements of this nature are shown in Schock et al. U. S. application #632,978 filed December 5, 1945 and in Schock U. S. application Serial #630,429 filed November 23, 1945, now abandoned. In these disclosures, two receivers are included in the diversity systems. Two receivers in diversity usually provide better signals for recording purposes than a single receiver. Three receivers in space diversity give still better results and an object of the present invention is to provide triple diversity in frequency shift systems of the type outlined briefly hereinbefore.

In the diversity systems referred to hereinbefore, the transmitted currents are compared as to strength or signal quality and are subject to a sensing operation wherein the best of the two signals is sensed and used for recording purposes. A further object of the present invention is to provide an improved method of and means for comparing three versions of the transmitted signals and sensing the best thereof to use for recording purposes.

In the receiver of U. S. application Serial #632,978 gating tubes are used to make available for recording the best signal only and for blocking off the remaining signals. In the said application, the gating stages are in a sense differential and are differentially controlled by a locking circuit arrangement set into operation by a potential which represents the difference in magnitude of the two versions of the signals. An object of the present invention is an improved gating tube controlling circuit including three

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locking circuit arrangements with their inputs controlled by the potentials derived by the three-way comparison of the quality of the three signal versions and their outputs interconnected in such a manner as to accomplish three-way summation of the locking circuit outputs to derive three resultant potentials the magnitude of one of which is distinctive as compared to the magnitudes of the others thereof and indicates which of the three versions of the signal is best. This summation of the locking circuit outputs takes place in what I have designated coincidence tube pairs which in turn control the gating tubes.

Since the common output of the gating tubes is connected directly, or by way of auxiliary equipment which may include a tone keyer, to recording apparatus, it is essential that only that gating tube be opened which will allow the best signal to pass. A gating tube bias clamping arrangement is provided wherein diodes are connected in shunt to a portion of the control grid to cathode impedance of each gating tube and so poled as to drain off or eliminate all potentials applied thereto which exceed a critical value.

In describing my invention in detail reference will be made to the attached drawings wherein the single figure illustrates by circuit element and circuit element connections a frequency shift system including receivers in triple diversity arranged in accordance with my invention.

In the drawing, I have shown three receivers labeled set A, set B, and set C connected by leads 2, 4, and 6 to pairs of signal quality sensing amplifiers and detectors labeled generally SS, S'S and S''S.

The receiver sets A, B, and C may each comprise radio frequency amplifiers 8, 8' and 8'' and if desired a first heterodyne detector and local oscillator. Output of intermediate frequency is fed to intermediate frequency amplifiers 10, 10' and 10''. In these amplifiers a second heterodyning process may be carried out if desired so that at the output I derive frequency shifted oscillatory energy of low intermediate frequency. The oscillatory energy may be of say about 50 kilocycles mean frequency and may be shifted several hundred cycles, for example from 49.6 kilocycles to 50.4 kilocycles. I may use as receivers here my assignee's standard radio frequency amplifier and converter and intermediate frequency amplifier etc. or any other type receiver having the desired characteristics. The receivers include common automatic gain control circuits. The AGC circuits per se are not shown or described

herein but may be conventional in make up and operation.

The receivers A, B and C have two outputs one of which goes to the signal sensing amplifiers and detectors SS, S'S, S''S and the other of which goes by leads 2', 4' and 6' to intermediate frequency amplifiers, limiters, frequency discriminators and detectors and so forth in units 20, 20', 20''. In these units 20, 20', and 20'' the frequency shifted signals are amplified and the frequency shifts due to modulation thereon converted to corresponding variations in amplitude or magnitude and these variations are detected to derive at the discriminator detector outputs demodulation currents having a strong direct current component which changes in polarity, the polarity of the direct current component representing different signalling conditions. The output is filtered in units 20, 20', 20'' to remove the intermediate frequency and is then coupled through condensers D, D' and D'' so that on the leads 24, 24', and 24'' I provide an alternating current signal potential which appears across resistors 26, 26' and 26'' and on the injector grids 28, 28' and 28'' of three tubes of the pentagrid type designated gate A, gate B, and gate C; the letters of the said designations correspond to the set letter applied to the three receivers. Moreover these potentials appearing across the resistors 26, 26' and 26'' are of a polarity which varies in accordance with the signal modulations. These potentials might vary between a potential which produces about zero potential on the grid of the gate tube (with respect to its cathode) representing one signalling condition and say a potential which produces a high negative value on the grid of the gate tube (with respect to its cathode) representing another signalling condition so that the tubes gate A, gate B or gate C being supplied with this potential act as amplifiers when the signal swings from zero potential to the said negative potential. In this respect note that the cathodes of the gate tubes are held positive relative to ground by their connections to a positive point on potentiometer resistance PR but the grids are still negative with respect to the cathodes because they are connected by resistors 26, 26' and 26'' to a less positive point on the potentiometer PR. The biases on the grids 29, 29' and 29'' are modified by gating tube control potentials supplied from the coincidence tube pairs 120, 120' and 120'', described hereinafter, in such a manner as to make that gate tube operative which is supplied with the best version of the signal.

In order to continue the description of the manner of using the useful signal, assume that one of the tubes gate A, gate B or gate C is made conductive by the control bias on its first grid so that it amplifies the signal supplied to its second control grid. The anodes of the tubes gate A, gate B and gate C are tied in parallel and connected by load impedance 32 to the positive terminal of a direct current source the negative terminal of which is grounded. The high signal potential end of this load impedance 32 is connected to an amplifying coupling tube in unit 44 which feeds the signal modulations passed by the conductive gate tube through a low pass filter in unit 45 and through a double triggering circuit in unit 46 to a tone keyer in unit 47 from which the output may be supplied to recording means such as a teletypewriter. The limiter, discriminator and detector in each of the units

20, 20' and 20'' per se are not claimed in this application as being novel and in order not to unnecessarily lengthen this disclosure, will not be described in detail herein. The tone keyer may be conventional and no description thereof will be given here.

As brought out hereinbefore one of the purposes of my invention is to take advantage of space diversity effects and for these reasons I have provided means for selecting signal from that one of three receivers having the best signal. This means for sensing which signal is best and for supplying a control potential for opening the appropriate gate tube will now be described. Signals at intermediate frequency from the amplifier 10 are supplied by lead 2 in parallel to the grids of two amplifiers 60 and 62. The cathodes of these amplifiers are grounded through self bias resistors bypassed for the intermediate frequency and the other side of the output of amplifier 10 is grounded so that intermediate frequency energy modulated in frequency by the signals is impressed on the input electrodes of tubes 60 and 62. The anodes of these tubes are connected to the primary windings of output transformers 64 and 66. The secondary winding of transformer 64 is connected to diode rectifier 68 while the secondary winding of transformer 66 is connected to a diode rectifier 70. The rectifier 68 circuit has as a load impedance a load resistor 74 between the anode and the secondary winding of transformer 64. The rectifier 70 has as a load impedance a resistor 76 connected between the cathode and the end of the secondary winding of transformer 66. Note that the polarities of the rectifiers in each of the signal strength sensing units SS etc. are reversed. Signal strength sensing unit S'S is similarly connected by transformers 64' and 66' in the output circuits of amplifier tubes 60' and 62'. The secondary windings of these transformers are similarly connected to rectifier 68' in a circuit including load resistors 74', and to rectifier 70' in a circuit including a load impedance 76'. Tubes 60'' and 62'' with transformers 64'' and 66'' are similarly connected with rectifiers 68'' and 70'' in circuits including load impedances 74'' and 76''. The load impedances are shunted by bypassing condensers 77, 77', 77'', 78, 78', and 78'' which filter out or bypass all potential variations of signal frequency and higher. Potential variations which represent the mean or average carrier strength and lower are not filtered out.

The problem is to compare the strengths of three signals and sense which signal is the strongest. To do so each signal must be compared with the other signal. This is accomplished in my system by the units SS, S'S and S''S and the rectifiers associated therewith. A rectifier say 68 excited by the output of receiver set A is connected in series with a rectifier say 70' excited by the output of receiver set C. This series circuit includes rectifier load impedance 74, lead 80, grid resistor 85'', voltage dropping resistor 87'', rectifier load impedance 76'', lead 89 and load impedance 74. The output impedance 76 of rectifier 70, excited by output from set A, is similarly connected in series, by lead 75a, resistor 87, resistor 86 and lead 75b, with the output impedance 74' of rectifier 68', which is excited by output from the receiver set B. The output impedance 76' of rectifier 70', excited by output from set B, is connected in series with the output impedance 74'' of rectifier 68'' excited from the output of set C by lead 75a, resistor 87', resistor 86' and lead

75'b. The load impedance and rectifier arrangements are such that the outputs of the rectifiers having their loads in series are opposed so that in each of the series rectifier output circuits potentials representing the magnitudes of the signals from two receiver sets are opposed to leave a differential resultant potential the polarity of which depends on which of the two compared signals is the stronger.

These potentials are across the grid to cathode input impedances of trigger driver tubes 92, 92' and 92''. The potentials are supplied over potential dropping resistors 87, 87', and 87'' and appear across grid bias resistors 86, 86', and 86''. The grids 90, 90', and 90'' have bias voltages due to cathode resistors 94, 94', and 94'' respectively. These bias voltages are modified by the voltages appearing across resistors 86, 86', and 86'' respectively. The latter voltages are in turn the resultant voltages produced respectively, across resistors 74' and 76 by rectifiers 68' and 70, and resistors 74'' and 76'' by rectifiers 68'' and 70'', and resistors 74 and 76'' by rectifiers 68 and 70''. The cathodes of the trigger driver tubes 92, 92', and 92'' are each connected by resistors 94, 94', and 94'' respectively to the control grid of tubes 100, 100' and 100'' of double locking or triggering circuits including second tubes 102, 102' and 102''. The potential at the grid of tube 100 is always positive with respect to ground, but is positive or negative with respect to the cathode of tube 100 depending upon whether grid 90 of tube 92 is positive or negative. The grids of tubes 100' and 100'' are biased in a like manner. There is a triggering or locking circuit for each of the rectifier pairs described above. The tubes 100 and 102 of each locking stage have their anodes and control grids cross coupled by impedances and their grids biased and their anodes connected by resistances to direct current potential sources in a well known manner. The anodes of the first stages comprising tubes 100, 102, etc. are coupled by condensers 101 and 103 to the control grids of the second locking circuits comprising the additional tubes 104, 106, 104', 106' and 104'', 106'' in a second locking circuit stage. The arrangement of the double locking circuit is such that when tube 100 is conductive tube 102 is non conductive and vice versa. When tube 100 becomes conductive its anode potential drops and this drop of potential is applied by condenser 101 to the control grid of locking tube 104 so that this tube becomes non conductive. The electrodes of tubes 104 and 106 are cross coupled in a conventional manner so that when tube 104 is non-conductive tube 106 is conductive and vice versa. Moreover since when tube 100 became conductive its anode potential dropped, the anode potential of the other tube 102 of this locking circuit rises and this rise in potential is applied by capacitor 103 to the control grid of the tube 106 to make the same conductive. The application of the potentials through the condensers 101 and 103 operates to make the triggering action very abrupt especially on the ends of the potential variations at the anodes of tubes 100 and 102 so that in the double trigger arrangement quick action is obtained. As a matter of fact the action is so fast that as pointed out in application Serial No. 632,978 the gating tubes may be turned on and off at a rate higher than the keying rate so that marks may be accepted from one receiver and spaces from another receiver.

Corresponding locking circuit arrangements including tubes 100', 102' and 100'', 102'' and so

forth driven by driving tubes 92', 92'' are supplied and the locking circuits respond to the resultants derived in units SS, S'S, and S''S by comparison of the strength of the signals from two of the receiver sets.

The output from the second locking circuit including tubes 104 and 106 is supplied by resistors 113 and 115 connected between adjacent terminals of resistors 108 and 109 and adjacent terminals of resistors 110 and 111 respectively and ground. The differential potential variations at the said junction points between resistors 108 and 109 and 110 and 111 are large as compared to the variations of the driving potentials at the grid of tube 92. The voltage say between resistors 108 and 109 is always positive with respect to ground, but may be positive or negative with respect to the cathode of tube 104 depending upon whether tube 104 is conducting or non conducting. This is pointed out in detail in Schock et al. application #632,978 filed December 5, 1945 and in Atwood U. S. application Serial #618,761 filed September 26, 1945, now abandoned. These potentials which vary differentially are applied by resistors 117 and 119 etc. to the control grids of coincidence tube pairs 120, 120' and 120''. The pairs of coincidence discharge devices are shown as being included in common envelopes but obviously separate tube envelopes may be used. The control grid 121 of one of the electron discharge systems of tube 120 is connected to the junction point between resistors 108 and 109. The control grid 123 of the other electron discharge tube system in this envelope is coupled to the junction point between resistors 110'' and 111'' of the locking or double trigger circuit controlled by driver tube 92''. The two electron discharge devices in tube 120' are correspondingly excited one by the output appearing between resistors 108' and 109' the other by output appearing between the resistors 110 and 111. The control grids of the electron discharge devices in envelope 120'' are connected one to the junction point between resistors 108'' and 109'' the other to the junction point between resistors 110' and 111'.

The tubes 120, 120' and 120'' each operate to compare the state of stability of a different pair of the differentially operating triggering circuits. The triggering circuits are in turn driven by potentials derived by opposing the outputs of two of the amplifier and detector systems in the paired rectifier circuits. The tube pair 120 is called a coincidence tube pair since the state of conductivity of each tube depends on the state of stability of the two locking circuits connected to each tube and a particular coincidence of the state of stability of the two locking circuits is required in order that the coincidence tube pair may make the gate tube controlled by it conductive. The coincidence tube pairs have their anodes tied together and connected by resistors to the control grids 29, 29' and 29'' of the gating tubes gate A, gate B and gate C so that the sum of the potentials at the anodes of the tubes at 120 is applied by bias limiting resistor 128 to the control grid 29 of the tube gate A. The anodes of the tubes at 120' are tied together and connected by bias limiting resistor 128' to the control grid 29' of the tube gate B. The anodes of the tube at 120'' are tied together and connected by bias limiting resistor 128'' to the control grid 29'' of the tube gate C. The cathodes of the double triode tubes 120, 120' and 120'' are tied together and connected to a point on potentiometer PR which

is positive relative to ground. This puts the potential variations at the anodes of these tubes across the input impedances of the gate tubes. The potential or voltage at the control grid 29 is always positive with respect to ground, but it may be positive or negative with respect to the cathode of tube gate A depending upon whether both halves of tube 120 are cut off or not. The same remarks apply to the bias voltages on the grids 29' and 29''. The anodes of the tubes at 120, 120' and 120'' are connected by resistors 130, 130' and 130'' to a point on PR which is positive relative to the potential on the cathodes of these tubes.

Bias clamping tubes 140, 140' and 140'' are connected between the control grids 29, 29' and 29'' and a positive point on the potentiometer PR shunting the direct current source. Note that the anodes of these diodes are connected to the resistors 128, 128' and 128'' respectively so that the positive potential applied to the cathodes of the diodes must be overcome by a potential applied to the anodes thereof from the coincidence tube pairs 120, 120' and 120'' before the diodes become conductive.

In operation intermediate frequency outputs from the three receivers are applied to the limiters, discriminators, and detectors in units 20, 20' and 20'' and therefrom the detected signals are applied to the controlling electrodes 28, 28' and 28'' of the gating tubes for use of one thereof as selected. The intermediate frequency outputs of sets A, B and C are also applied by amplifiers 60, 62, etc. to the differential rectifiers including tubes 68, 70, 68', 70' and so forth. The three voltages developed by these rectifiers appear across resistors 86, 86' and 86'' to operate the trigger circuit control tubes 92, 92', 92''. The three double trigger circuits in turn control the three coincidence tube pairs 120, 120' and 120'' which operate the three gate tubes to permit one thereof having the best input signal to supply output to the units 44, 45, 46 and 47. The operation is such that only one gate tube is rendered conductive at any one time and this is the one which utilizes the output from the receiver having the strongest mark or space signal at the moment.

More specifically, output of intermediate frequency from units 10, 10' and 10'' is supplied to coupling tubes 60, 62 and so forth to feed the rectifier tubes 68, 70 and so forth. Paired rectifier outputs are opposed in series so that output from rectifier 70 is balanced against output from rectifier 68' to supply a control tube operating potential which appears across resistor 86 and on the control grid 90 of locking circuit driving tube 92. Assume that signal A is stronger than signal B which in turn is stronger than signal C. Then the lead 75a to the grid 90 will have a net potential which is positive with respect to lead 75b since the rectified signal potential across resistor 76 is larger than the rectified signal potential across resistor 74' and the rectifiers supplying the potentials are of opposed polarity. This positive voltage appears on the grid 90 of tube 92 and causes current to flow therein and in cathode resistor 94 and grid resistor 95 of locking tube 100. This increased current increases the potential drop across resistor 95 and as a consequence increases or makes more positive the potential on the control grid of the locking circuit tube 100. Tube 92 in other words operates in a cathode follower type of circuit. This flips or trips the locking circuit

so that current flows in tube 100 and in tube 106 and is cut off in tube 102 and tube 104. This makes the potential at the anode end of resistor 108 fall and the potential at the anode end of resistor 110 rise and these falling and rising potentials respectively are fed by resistors 117 and 119 to the control grids 121 and 123' of coincidence tube pairs 120 and 120'. This produces a negative voltage from the grid 121 to cathode of coincidence tube pair 120 and a positive voltage from the grid 123' to the cathode of coincidence tube pair 120'. In a manner similar to that just described, voltages either plus or minus with respect to their cathodes are applied to the six grids of the coincidence tubes. For the assumed conditions, the polarities are as indicated at the coincidence tube ends of resistors 117, 119, 117' and 119' and 117'' and 119''.

This is because driver tube 92' has its grid excited by a net positive potential resulting from opposing rectified signal from set B (stronger than C) against rectified signal from set C. This makes tube 100' conductive and tubes 106' and 104' respectively conductive and non-conductive to make the potential at 117' negative and at 119' positive. However driver tube 92' has a net negative potential applied to its grid because it is the resultant of rectified output of rectifier 68 excited by the stronger signal from set A and rectified output from rectifier 70' excited by output from the weaker set C. This makes the potential at 117'' positive and at 119'' negative because tube 92'' and trigger tube 100'' are non-conductive so that the trigger circuit is tripped to its other condition of stability with tubes 104'' and 106'' respectively conductive and non-conductive.

It will be seen that the coincidence tube pair 120 has both of its grids negative, coincidence tube pair 120' has one grid negative and one grid positive and coincidence tube pair 120'' has both grids positive. Both tube sections of coincidence tube pair 120 being biased negative, it is cut off and this causes the potential at the plates thereof to increase to its maximum value since there is no drop in potential across resistor 130 which is in the direct current potential supply circuit. One tube section of coincidence tube pair 120' has a negative potential applied to its grid 121' the other section having a positive potential applied to its grid 123' so its plate potential is nearly a minimum because of the current in resistor 130' and as a consequence a large drop of potential therein. Both sections of coincidence tube pair 120'' have positive potentials applied to their grids so considerable plate current flows and their anode voltage is reduced to a minimum by the potential drop in resistor 130'' due to this current flow. The increased voltage on the plates of the tubes of coincidence tube pair 120 is applied to the first grid 29 of the gate tube A over lead 131. This makes the gate tube A conductive to let through the signal resulting at the discriminator detector output in unit 20 the input to which is supplied by signal from the receiver set A. The other two gating tubes are cut off by the negative potentials developed at the anode ends of resistor 130' and 130''.

In a similar manner, it may be shown that if the signal supplied by receiver set B is the strongest, only gate tube B will be conductive; and if the signal supplied by receiver set C is the strongest, only gate tube C will be conductive.

Thus it is seen that in my improved system I select the best signal picked up by any one of

three receivers and translate the same for use in recording apparatus not shown. No matter which signal of the three is strongest, only the strongest is passed by the gate tubes.

Since the problem is to select the strongest of three signals it might be suggested that the three differential voltages developed by using the six rectifier tubes could be used. However these three voltages cannot be used directly to control the gate tubes because two of them may be positive at the same time, although one of the two may be more positive than the other. By using these three differential voltages to control three trigger circuits, six voltages are obtained. Each of these voltages has two possible magnitudes (depending upon which way the triggers are flipped) each of which is relatively fixed in value. There are now six voltages which change between fixed values instead of three voltages which vary over wide limits in accordance with the signal strength. By comparing these six voltages in pairs with coincidence tube pairs, three voltages are again obtained. However, of these three voltages, only one will be of appropriate magnitude to turn on the gate tube which corresponds to the strongest signal.

If the potential at the anode end of resistor 128 becomes too positive, diode tube 140 will be excited by this potential through bias limiter resistor 128 and will draw current through said resistor when its anode potential becomes more positive than its cathode potential as set by adjustment of the connections to potentiometer PR. In this manner, the bias limiter tube 140 and limiter resistance 128 in combination limits the amount that the voltage at the grid 29 can go in the positive direction and sets it to the proper voltage for the gate A tube bias for the conducting condition. Adjustment of the direct current bias on the control grid 29, the magnitude of the signal output from the detector in 20, etc., determine the minimum control potential on the grid 29 at which the tube gate A is cut off. Bias limiting resistors 128' and 128'' and bias clamp tubes 140' and 140'' are connected to the grids 29' and 29'' of gate tubes B and C for similar purposes.

What is claimed is:

1. The method of translating signals that may be subjected to fading effects which includes these steps, deriving from signals picked up at different points a plurality of currents corresponding to said signals to be translated, said derived currents being of intensities which may change relatively to each other from time to time, producing by means of each derived current two potentials each having strong direct current components the magnitudes of which depend on the intensities of the derived currents by means of which they are produced, opposing each produced potential by a potential produced by means of another of said derived currents to produce resultant potentials corresponding in number to the number of derived currents and of polarities depending on the relative magnitudes of the derived currents, two of which potentials may be of like sign, deriving from each of the said resultant potentials pairs of voltages the voltages of which vary differentially each between two substantially fixed values, and effectively summing in new pairs each voltage of each of said pairs with a different one of the voltages of the remaining of said pairs to derive resultant control potentials of different magnitudes, there being a control potential for each of said derived currents.

2. The method of translating received signals that may be subjected to fading effects which includes these steps, deriving a plurality of currents corresponding to said signal to be translated, said derived currents being of magnitudes which may change relatively to each other from time to time, producing by means of each derived current two potentials each having strong direct current components the magnitudes of which depend on the magnitudes of the derived currents by means of which they are produced, opposing each produced potential by a potential produced by means of another of said derived currents to produce resultant potentials corresponding in number to the number of derived currents and of polarities depending on the relative magnitudes of the derived currents, deriving from each of the said resultant potentials pairs of potentials of opposed polarity, the polarities of which pairs change differentially with changes in polarity of the said resultant potentials, effectively summing in new pairs each potential of each of said pairs with a different one of the potentials of the remaining of said pairs to derive resultant control potentials of different magnitudes, there being a control potential for each of said derived currents, and controlling the translation of each of said derived currents by a different one of said control potentials.

3. In a diversity system, means for deriving a plurality of voltages varying in accordance with the same signal, said voltages being of average magnitudes which may change relatively to each other from time to time, means for selecting only the best of said voltages for recording including an electronic gating device for each of said voltages, each gating device having an input excited by one only of said voltages, a common output impedance for all of the gating devices, means for deriving from each of said voltages two potentials having strong direct current components the magnitudes of which depend on the strengths of the voltages from which they are derived, means for opposing in pairs each derived potential by a potential derived from another of said voltages to produce resultant potentials corresponding in number to the number of said voltages and of polarities depending on the relative magnitudes of the opposed potentials, apparatus excited by said resultant potentials to produce for each thereof in pairs other potentials of opposite polarities the polarities of which reverse when the polarities of said resultant potentials change, apparatus for summing in new pairs each of said other potentials with a remaining other potential to provide a control potential for each of the summed pairs of potentials, and means for controlling the conductivities of said gating devices each by one of said control potentials and in such a manner as to bias all of said gating devices to cut off except that gating device excited by the best of said first mentioned voltages.

4. In a diversity system, means for deriving a plurality of versions of a signal to be recorded, said versions being of magnitudes which may change relatively to each other from time to time, means for selecting only the strongest signal for recording including an electronic gating device for each version of said signal, a common output impedance for all of the gating devices, means for deriving from each version of the signal two potentials having strong direct current components the magnitudes of which depend on the magnitudes of the signal versions from which they are derived, means for opposing each de-

rived potential by a potential derived from another version of said signal to produce resultant potentials corresponding in number to the number of signal versions and of absolute magnitudes and polarities depending on the relative magnitudes of the opposed potentials, a locking circuit controlled by each of the resultant potentials, said locking circuits each having output impedances wherein are developed differentially varying potentials, means for producing control potentials which are of a magnitude representing the summation in pairs of each of the potentials developed by each locking circuit and a potential developed by another locking circuit, there being a control potential for each version of said signal and for each gating device, and means for applying each of said control potentials to the gating device to be controlled thereby.

5. In a diversity system, at least three signal receiver, amplifier and detector systems, an electronic gating device for each of said receivers, each device having a control electrode coupled to the output of the detector therefor, said gating devices each having output electrodes, a common utilization circuit coupled to all of said output electrodes, means for comparing the strength of signal energy from each receiver with the strength of signal energy from the others of said receivers and for deriving a resultant potential, a tripping circuit for each receiver, said tripping circuits having output impedances across which differentially varying potentials are produced, a driving electronic device for each tripping circuit, means for controlling each of the driving devices by a different one of said potentials derived by comparing the signal strengths, a pair of electronic coincidence devices for each tripping circuit, each coincidence device having a control electrode and an output electrode, a coupling between the output electrodes of each of the coincidence device pairs and a different one of said gating devices, means for applying the potential appearing across one output impedance of each tripping circuit to the control electrode of a different one of the coincidence devices of each pair, and means for applying the potential appearing across the other output impedance of each tripping circuit to the control electrode of a different one of the remaining coincidence devices of said pairs.

6. In a diversity system, at least three signal pick up amplifier and detector systems, an electronic gating device for each of said detectors, each gating device having a control electrode coupled to the output of the detector therefor, said devices each having output electrodes in a common utilization circuit coupled to all of said output electrodes, a differential detector for comparing the strength of signal energy from each pick up with the strength of signal energy from each other of said pick ups and for deriving a resultant potential, the differential detectors corresponding in number to the signal systems, a tripping circuit for each system, said tripping

circuits having output impedances across which differentially varying potentials are produced, a driving electronic device for each tripping circuit, means for controlling each of the driving devices by a different one of said potentials derived by comparing the signal strengths, a pair of electronic coincidence devices for each tripping circuit, each coincidence device having a control electrode and an output electrode, a coupling between the output electrodes of each of the coincidence device pairs and a different one of said gating devices, means for applying the potential appearing across one output impedance of each tripping circuit to the control electrode of a different one of the coincidence devices of each pair, and means for applying the potential appearing across the other output impedance of each tripping circuit to the control electrode of a different one of the remaining coincidence devices of said pairs.

7. In a diversity system, at least three receivers each including signal pick up and amplifying and translating means, an electronic gating device for each of said receivers, each device having a control electrode coupled to the translating means, said devices each having output electrodes connected to a common output circuit, apparatus for generating and opposing in pairs potentials the magnitudes of which represent the strengths of the several versions of the signals at the pick up devices, the two potentials of each pair each representing the strength of a different version of the signals, there being two potentials generated for each signal version, apparatus for deriving a resultant potential from each pair of opposed potentials, there being a resultant for each version of said signal, said resultants being of polarities depending on the relative strengths of the signal versions, apparatus for each resultant actuated by the respective resultants to provide pairs of potentials of opposed polarities which change polarity differentially as the polarity of the resultant changes, apparatus for summing, in new pairs, one potential of each of said last-named pairs of potentials with one of the potentials of another of said last-named pairs of potentials to derive a control potential for each of the summed pairs, and means for using each of said control potentials to control the operativeness of an appropriate one of said gating devices.

JOHN B. ATWOOD.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,004,126	Moore	June 11, 1935
2,249,425	Hansell	July 15, 1941
2,290,992	Peterson	July 28, 1942
2,414,111	Lyons	Jan. 14, 1947