

Jan. 31, 1950

R. E. SCHOCK
LOCKING AND CONTROL CIRCUIT IN A DIVERSITY
TELEGRAPHY RECEIVER

2,495,826

Filed Sept. 18, 1946

3 Sheets-Sheet 1

Fig. 1a.

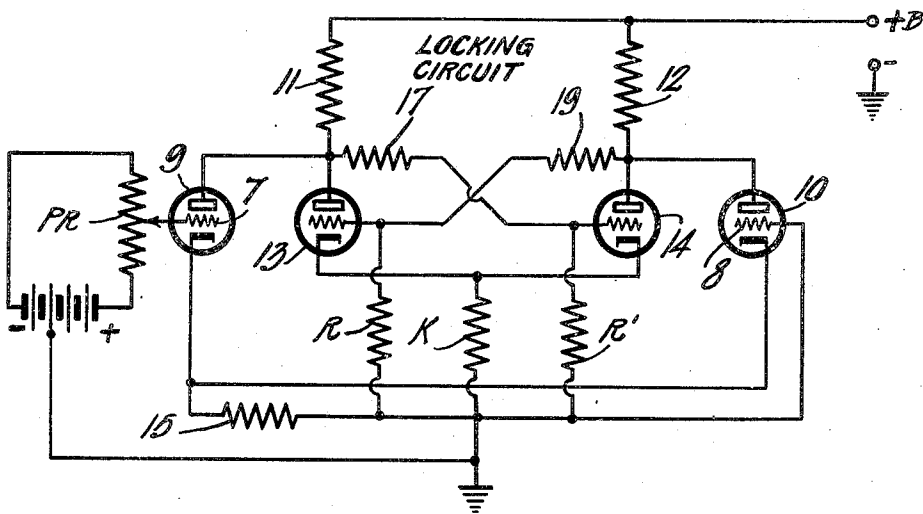
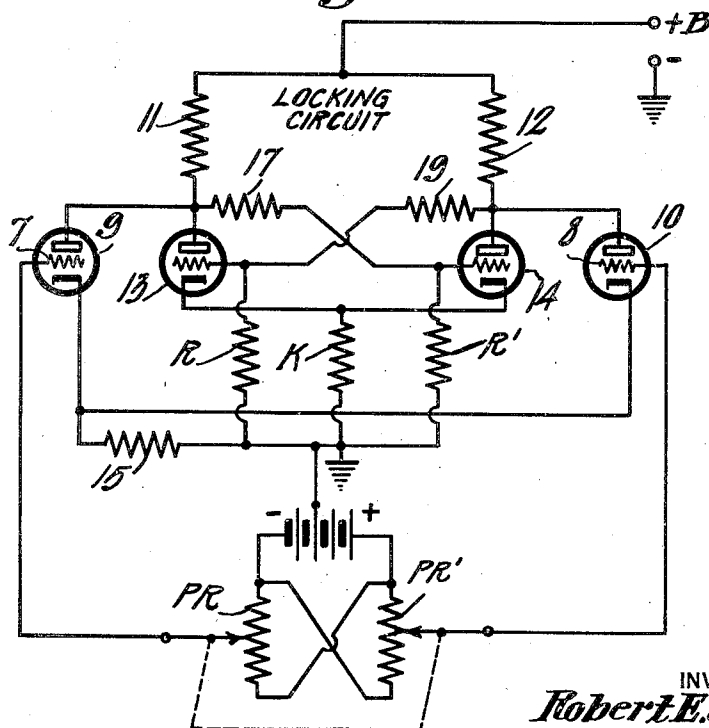


Fig. 1b.



INVENTOR
Robert E. Scock
BY *H. S. Snover*
ATTORNEY

Jan. 31, 1950

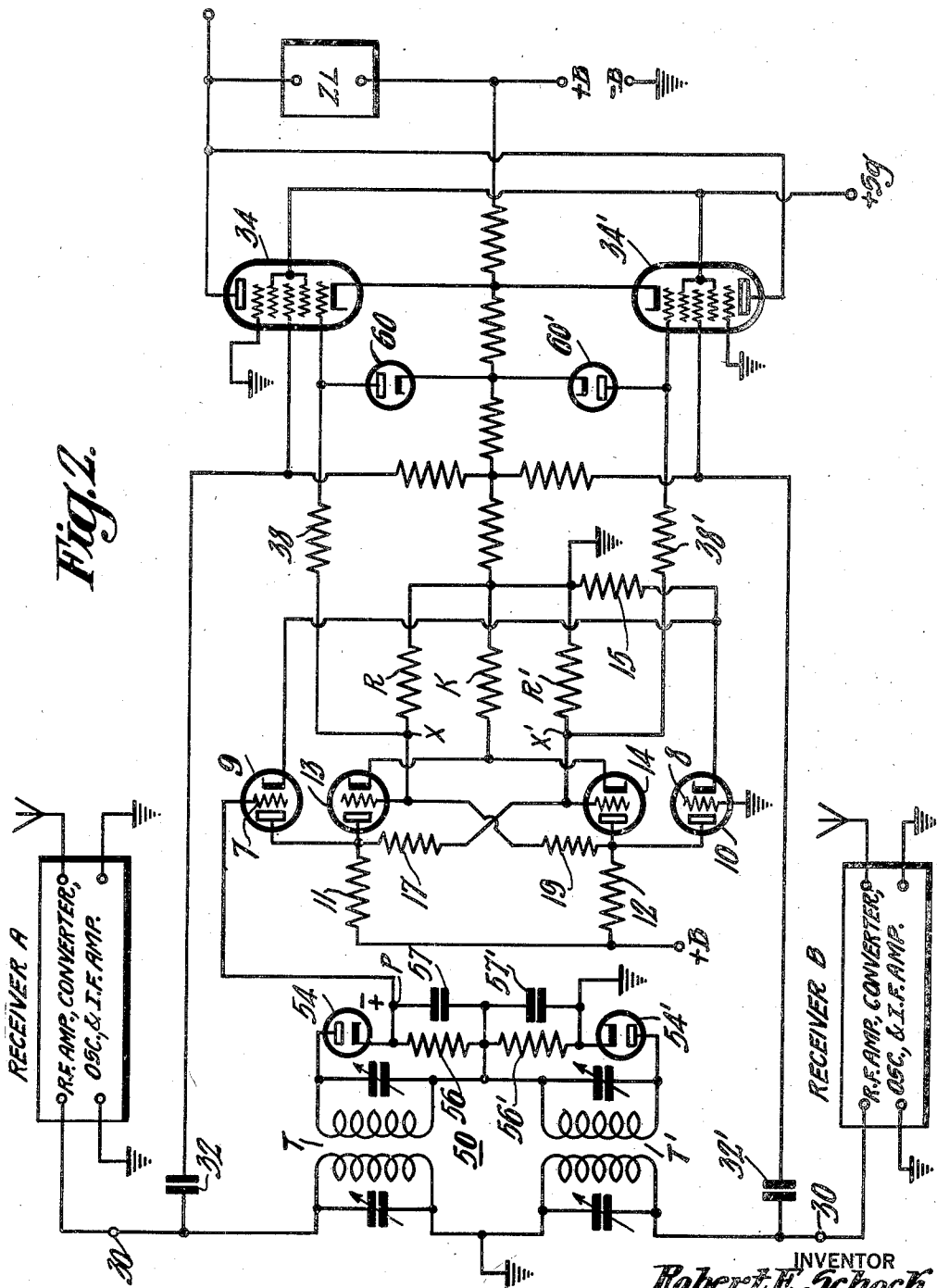
R. E. SCHOCK
LOCKING AND CONTROL CIRCUIT IN A DIVERSITY
TELEGRAPHY RECEIVER

2,495,826

Filed Sept. 18, 1946

3 Sheets-Sheet 2

Fig. 2.



INVENTOR
Robert E. Scock
BY *H. S. Snover*
ATTORNEY

Jan. 31, 1950

R. E. SCHOCK
LOCKING AND CONTROL CIRCUIT IN A DIVERSITY
TELEGRAPHY RECEIVER

2,495,826

Filed Sept. 18, 1946

3 Sheets-Sheet 3

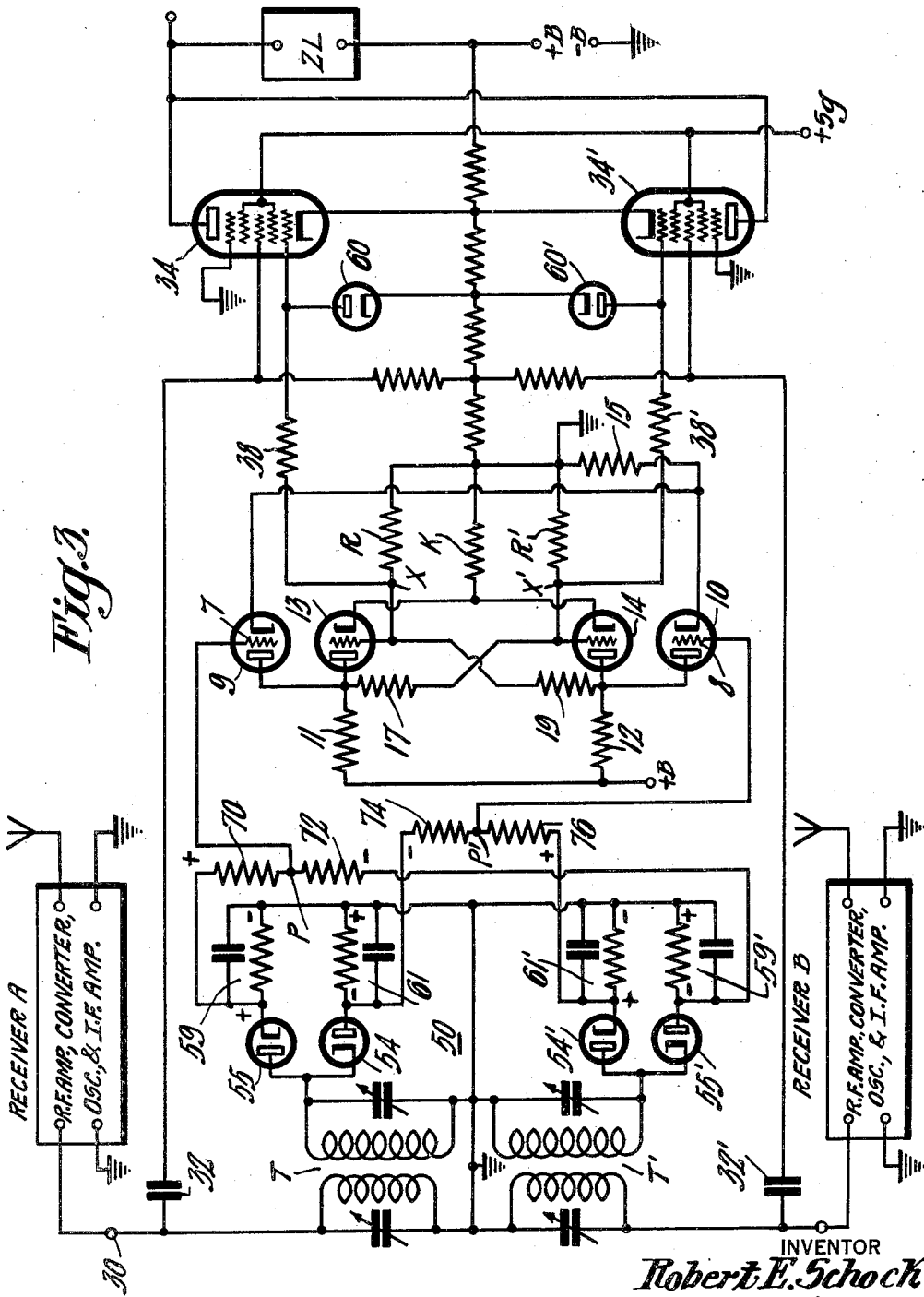


Fig. 3.

INVENTOR
Robert E. Scock

BY *H. S. Snover*

ATTORNEY

UNITED STATES PATENT OFFICE

2,495,826

LOCKING AND CONTROL CIRCUIT IN A
DIVERSITY TELEGRAPHY RECEIVERRobert E. Schock, Riverhead, N. Y., assignor to
Radio Corporation of America, a corporation of
Delaware

Application September 18, 1946, Serial No. 697,669

2 Claims. (Cl. 250—8)

1

This application concerns a new and improved locking circuit having two positions of stability.

This application also concerns new and improved tube means for controlling the state of stability of the said locking circuit. The locking circuit per se is of the general type disclosed in Finch U. S. Patent 1,844,950.

Trigger or locking circuits are of wide use in the radio art, being used, for example, to a considerable extent in connection with pulse systems where they are driven by pulses of one form or another fed to the trigger circuit through one or more condensers. When it is desired to use a trigger circuit for something other than the transfer of or the shaping of pulses, it may be desirable to drive said circuit from what may be called a slow varying direct current potential. In such a case, a problem is presented in finding a satisfactory method of applying the varying direct current potential to the locking circuit without destroying its triggering or locking properties.

It is an object of the present invention to improve unidirectional potential drivers for triggering or locking circuits.

This object is attained in accordance with my invention by the use of a control or driver tube, the anode circuit of which includes a resistor, also included in the anode circuit of one of the locking circuit tubes. The driver tube is controlled by the unidirectional potential and the condition of stability of the trigger or locking circuit is controlled by the magnitude of potential drop in the common resistor.

Since the locking circuit is by necessity controlled by a driver tube connected therewith, the driver tube per se unbalances the trigger circuit to a certain extent to cause its switching action to be non-symmetrical or unbalanced.

A further object of my invention is to provide means for compensating or correcting this unbalanced condition. This object is attained by provision of a second tube connected to the other locking circuit tube substantially in the same manner in which the driving tube is connected to the first locking circuit tube. The compensating tube is then held at a selected bias so that complete balance is attained when a selected unidirectional control potential is applied to the driving tube.

In a modification of my invention as described above, two driver tubes are used, one connected with each locking circuit tube so that the driver tubes balance each other in the locking circuit. Differential unidirectional potentials are then

2

used in a novel manner to control the driver tubes which in turn control the condition of stability of the locking circuit.

As indicated above, the improvements disclosed herein are of wide application in the signaling art and use thereof is so intended. However, a particular use I find for the same, is in control of gating tubes in diversity receiver systems, such as for example, frequency shift or "on-off" diversity telegraph systems, disclosed, for example, in Shock et al. U. S. application Serial #632,978, filed December 5, 1945.

In diversity systems of the type disclosed in said Shock et al. application, space or propagation intercepting diversity effects are used to obtain several versions of the same signal. These versions are then compared as to quality so that the best signal may be selected for recording purposes.

A further object of my invention is to provide improved means for sensing which signal is best and improved means for controlling a locking circuit by a potential derived from the signal strength sensing means.

In a modification of the means described hereinbefore, differential control potentials are to be applied to the balanced driving tubes for the locking circuits and a further object of my invention is to provide an improved signal sensing means for deriving differentially varying control potentials which positively flip the locking circuit to a condition of stability at which it is to be when a certain one of the signal versions is of the greatest magnitude. It will be noted that when differential potentials are used for controlling the trigger circuit, a more positive action is obtained.

In describing my invention, reference will be made to the attached drawings wherein:

Figs. 1a and 1b each illustrate one embodiment of my improved trigger or locking circuit and improved control means therefor;

Figs. 2 and 3 illustrate novel signal strength sensing means and locking circuit driving tube control means for the locking circuits illustrated in Figs. 1a and 1b respectively.

In Fig. 1a, tubes 13 and 14 are the locking circuit tubes. The anodes of these tubes are connected by resistors 11 and 12 to the positive terminal of a direct current source, the negative terminal of which is grounded, being thereby connected through common cathode resistor K to the cathodes of tubes 13 and 14. The anodes and control grids of tubes 13 and 14 are cross coupled by resistors 17 and 19. The grid direct

current biasing circuits for the tubes 13 and 14 are completed by resistors R and R'. This locking circuit as described hereinbefore operates as follows:

Assume that current is caused to start flowing in tube 13. The potential drop in the resistor 11 increases to apply a less positive or more negative potential by resistor 17 to the control grid of tube 14 to reduce current flow in tube 14. When current flow decreases in tube 14, the potential drop in anode resistor 12 becomes less so that resistor 19 applies a more positive potential to the control grid of 13 to increase current flow in tube 13. The action is cumulative and carried to a point at which tube 13 draws full current and tube 14 is cut off. The locking circuits stay in this position until for some reason, current flow is increased in tube 14 or reduced in tube 13 to start a new tripping action which switches the current through 14 and cuts off current flow in tube 13.

The driver tube 9 has its anode connected to the direct current source by the resistor 11 and has its cathode connected directly to the cathode of a balancing tube 10. Both cathodes are connected to ground by a common resistor 15. The direct current control potential is applied to the grid 7 of tube 9 and for the sake of simplicity, this potential is shown as being derived from a potentiometer resistor PR, a point which may be moved up and down to vary the potential on the grid 7. The trigger driver tube 9 drives the trigger circuit. The balancing tube 10 is of the same type as tube 9 and operates to effect a balanced trigger circuit when the grid 7 of tube 9 has zero potential or volts applied thereto. The driver tube 9 is able to actuate the trigger circuit because its plate is connected to the plate of the trigger circuit 13, and to the source through the common plate resistor 11. The compensating or balancing tube 10 draws current through a resistor 12 which is also in the plate circuit of the tube 14.

In operation, if trigger tube 13 is cut off and trigger tube 14 is conducting, this status may be reversed by applying positive potential to the grid of tube 9. This causes tube 9 to draw more current through resistor 11 and drop the voltage on the grid of tube 14, by way of the cross coupling resistor 17, to a point where tube 14 is cut off and the circuit flips to the reversed status with tube 13 conducting. Actually tube 10 aids somewhat in driving the trigger to reverse because the positive potential applied to tube 9 not only increases the plate current flow through resistor 11, but also the cathode current flow through resistor 15. Since this resistor is common to both tubes 9 and 10, the increased positive potential across this cathode resistor tends to bias tube 10 to draw less current. This decrease in current through resistor 12 increases the positive potential, supplied by way of the cross coupling resistor 19, to the grid of tube 13 and helps to render it conducting.

In Fig. 1b, the circuit is the same as 1a except that now the grids of both tubes 9 and 10 are driven by control potentials. The grid of tube 9 is driven positive and the grid of tube 10 negative to render tube 13 conducting and tube 14 non-conducting. Reversing these potentials will cause the trigger to flip to its other position.

Use of the triggering circuit of Fig. 1a in a frequency shift diversity system is illustrated in

Fig. 2. In this diversity system, it is assumed that there are two receivers, one of which is designated receiver A and the other of which is designated receiver B. These receivers are excited by spaced antenna systems for diversity effects and may comprise radio frequency amplifiers, frequency changers or converters including a detector and local oscillator and an intermediate frequency amplifier supplying output to terminals 30 and 30'. The intermediate frequency output which is shifted in frequency in accordance with signals is supplied by coupling condensers 32 and 32' to the third grid electrodes in gating tubes 34 and 34'. The gating tubes operate as disclosed in Schock et al. application, Serial #632,978, filed December 5, 1945, to supply output from one receiver or the other to a common load ZL for use as described in said application. The gating tubes are controlled by the trigger circuit. The trigger circuit per se is as illustrated in Fig. 1a and the description thereof will not be repeated here. It will be noted that the potentials at the points X and X' vary differentially as the trigger circuit is tripped between its two states of stability and that these potentials at X and X' vary from say about zero potential to some negative value sufficiently high to cut off the tubes 34 and 34' controlled thereby. The points X and X' are coupled by resistors 38 and 38' to controlling electrodes in the gate tubes 34 and 34' to differentially control the operation of the gating tubes as described above.

Receiver A and receiver B outputs are compared as to strength in a signal strength sensing means designated generally at 50. This means comprises transformers T and T' having band pass characteristics sufficiently wide to pass without material attenuation all of the frequency components in a frequency shift signal of intermediate frequency such as supplied at the output of receivers A and B. These transformers T and T' each have secondary windings connected in a separate rectifier circuit including in series with the secondary winding of transformer T a rectifier diode 54, a load resistor 56 and a bypass condenser 57. The secondary winding of transformer T' is similarly connected in a rectifier circuit, elements of which are designated by numerals or letters corresponding to the numerals or letters used in the preceding sentence adding prime. It will be noted that the rectifier load resistors 56 and 56' are so connected that the potential drops produced therein oppose. Thus, when the signals are of like strength, the potential at the point P should be and is substantially zero. In this respect, note that the cathode of the rectifier 54' is grounded. This potential at P will become positive when the signal at receiver A is stronger than the signal at receiver B and will become negative when the signal at receiver A is weaker than the signal at receiver B. This will be apparent by an inspection of the polarities in which the rectifiers are connected to the load impedances. The potential at P then varies $\pm$ with respect to zero potential and is supplied to the control grid 7 of the driver tube 9. If we assume that this potential swings negative which it would if the signal in receiver A is the weakest, the tube 9 would become less conductive to draw less current through resistor 11 and the anode potential of tube 13 would rise or become more positive as would the grid potential of tube 14. This would operate as described hereinbefore to switch the

5

current through tube 14 and make the potential at the point X' more positive. This potential is applied by the resistor 38' to the controlling grid of the gate tube 34' to make this tube operative to supply signal to the load ZL and this signal is supplied from receiver B wherein the signal is the strongest. When the potential at the point P becomes positive, a second tripping action takes place as described before to switch the current through the tube 13 to make more positive the potential at the point X and more negative the potential at the point X', to make tube 34 operative, to pass signal from receiver A and to cut off tube 34' to block signal from receiver B.

The voltage peak limiting tubes 60 and 60' and their purpose and operation in the triggering circuit have been described in Schock et al. application, Serial #630,429, filed November 23, 1945, now abandoned, and the description thereof will not be repeated herein.

The novel compensated triggering circuit of Fig. 1b is used in the diversity receiver system of Fig. 3. The arrangement here is as described hereinbefore in connection with Fig. 1b and Fig. 2 except for the following differences:

The signal sensing circuit is now to provide differentially acting control potentials, one for the grid 7 of the driver tube 9 and the other for the grid 8 of the driver tube 10. The signal strength sensing or comparing circuit designated generally at 50, now comprises, connected with the secondary of transformer T, diodes 54 and 55 arranged in opposed polarity with rectifier loads 59 and 61. The secondary of transformer T' is similarly connected in rectifier circuits including rectifier tubes 54' and 55' similarly connected in opposed polarity with load 59' and load 61'. The load 59 is connected in a series circuit including said load, the potential (combiner) divider including resistors 70 and 72 and the rectifier load 59'. The rectifier load 61 is in a series circuit with the potential (combiner) divider comprising resistors 74 and 76 and the rectifier load 61'. It will be further noted that the diodes 55 and 55' are of opposed polarity and are excited by a signal from each receiver. Their loads 59 and 59' are in series with the potential (combiner) divider including resistors 70 and 72 to provide at point P a potential which varies above say zero potential in a negative direction when the signal at the receiver A is the weakest. This potential is applied to the grid of driver tube 9. The rectifiers 54 and 54' likewise excited by energy from receivers A and B respectively, are of opposed polarity with loads 61 and 61' in a series circuit grounded at a point between loads 61 and 61' which series circuit includes resistors 74 and 76 adjacent terminals of which at point P' are connected to the control grid 8 of tube 10. This rectifier arrangement is such that when the signal at the receiver A is the strongest, the potential at point P becomes more positive and the potential at point P' less positive or more negative. Then the potential on the grid 8 of tube 10 becomes more negative to assist in switching current through tube 13 to make the potential at point X more positive and the potential at point X' more negative to cut-off gating tube 34' and turn on gating tube 34 to pass the signal supplied by receiver A. When the signal from the output of receiver A is weaker than the signal from the output of receiver B, the potential at the point P becomes more negative while the

6

potential at the point P' becomes more positive to cut off current in the tube 13 and pass full current through the tube 14 to make more positive the potential at the point X' to turn on tube 34' and turn off tube 34.

Normally in Fig. 3, the two transformers T and T' would be identical and so would all of the diode load resistors 59, 61, 59' and 61'. Normally also resistors 70 and 72 would be identical to each other in value and may be equal to or several times greater in value than the load resistors. The same may be said of resistors 74 and 76. Perhaps I may best explain the function of resistors 70 and 72 by referring to Fig. 1a. In Fig. 3 the center tapped battery of Fig. 1a may be said to have been replaced by the diode load resistors 59 and 59'. Now in Fig. 1a the two halves of the battery gave an unvarying potential supply so the potentiometer PR was used to supply voltage variations to the grid of tube 9. But in Fig. 3, where the center tapped battery is replaced by load resistors 59 and 59', there are varying potentials across these load resistors, the differential of which is applied to the grid of tube 9. So the potentiometer of Fig. 1a becomes a fixed divider in Fig. 3 embodying resistors 70 and 72 of equal value. The value of these resistors is kept high with respect to the load resistors 59 and 59' in order not to shunt these load resistors down unnecessarily.

What is claimed is:

1. In means for comparing the relative strengths of two currents which are representative of diversified versions of the same signal and for deriving potentials which vary differentially when the relative strengths of said currents vary, a first pair of rectifier systems including an alternating current path having a common portion excited by one of said currents and two direct current branch portions each including a load impedance and a rectifier device with the devices in opposed relation so that the potential drops across said loads are of opposed polarity, a second pair of rectifier systems having an alternating current path including a common portion excited by the other of said currents and two direct current branch portions each including a load impedance and a rectifier device with the last mentioned devices in opposed relation so that the potential drops across said last two load impedances are of opposed polarity, a connection between adjacent terminals of said first-mentioned load impedances and adjacent terminals of said second-mentioned load impedances, a circuit including adjacent series output impedances for adding in series the potential drops across a load impedance of said first-mentioned two load impedances and a load impedance of said second-mentioned two load impedances, a second circuit including adjacent series output impedances for adding in series the potential drops across the remaining load impedances, and means for deriving said differentially varying potentials from adjacent terminals of said output impedances.

2. In a diversity system, two radio receivers responsive to signal energy, a gate device coupled to each receiver, a common output circuit coupled to the gate devices, a locking circuit including a pair of electron flow devices each having a pair of output electrodes and a control electrode with one output electrode of each flow device coupled by a separate resistor to the positive terminal of a source of potential, a connection including a common resistor between the negative terminal

of said source and the other output electrodes of the flow devices, means cross coupling the positive output electrodes and control electrodes of the flow devices so that when current starts to flow in one device, it is cut off in the other device and vice versa, a pair of control devices each having a positive output electrode coupled to the positive output electrode of a different one of said locking circuit devices and each having another output electrode with a common resistor coupling the last-named output electrodes to the negative terminal of said source, each of said control devices having a control electrode, and means for applying control potentials differentially to said control device control electrodes including a first full wave rectifier circuit including series load impedances excited by signals from both of said receivers, a connection between said load impedances and the control electrode of one control device, a second full wave rectifier circuit including series load impedances excited by signals from both of said receivers, and a connection between

the load impedances of said second rectifier circuit and the control electrode of the other control device.

ROBERT E. SCHOCK.

REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
2,154,492	Clough	Apr. 18, 1939
2,253,832	Whitaker	Aug. 26, 1941
2,324,314	Michel	July 13, 1943
2,348,016	Michel	May 2, 1944
2,364,952	Crosby	Dec. 12, 1944
2,366,357	Schlesinger	Jan. 2, 1945
2,375,126	Mathes	May 1, 1945
2,384,456	Davy	Sept. 11, 1945
2,405,237	Ruhlig	Aug. 6, 1946
2,411,598	Smith	Nov. 26, 1946
2,433,667	Hollingsworth	Dec. 30, 1947