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C. A. BROKAW ET AL

2,245,383

RADIO RECEIVING SYSTEM

Filed Feb. 6, 1940

2 Sheets-Sheet 1

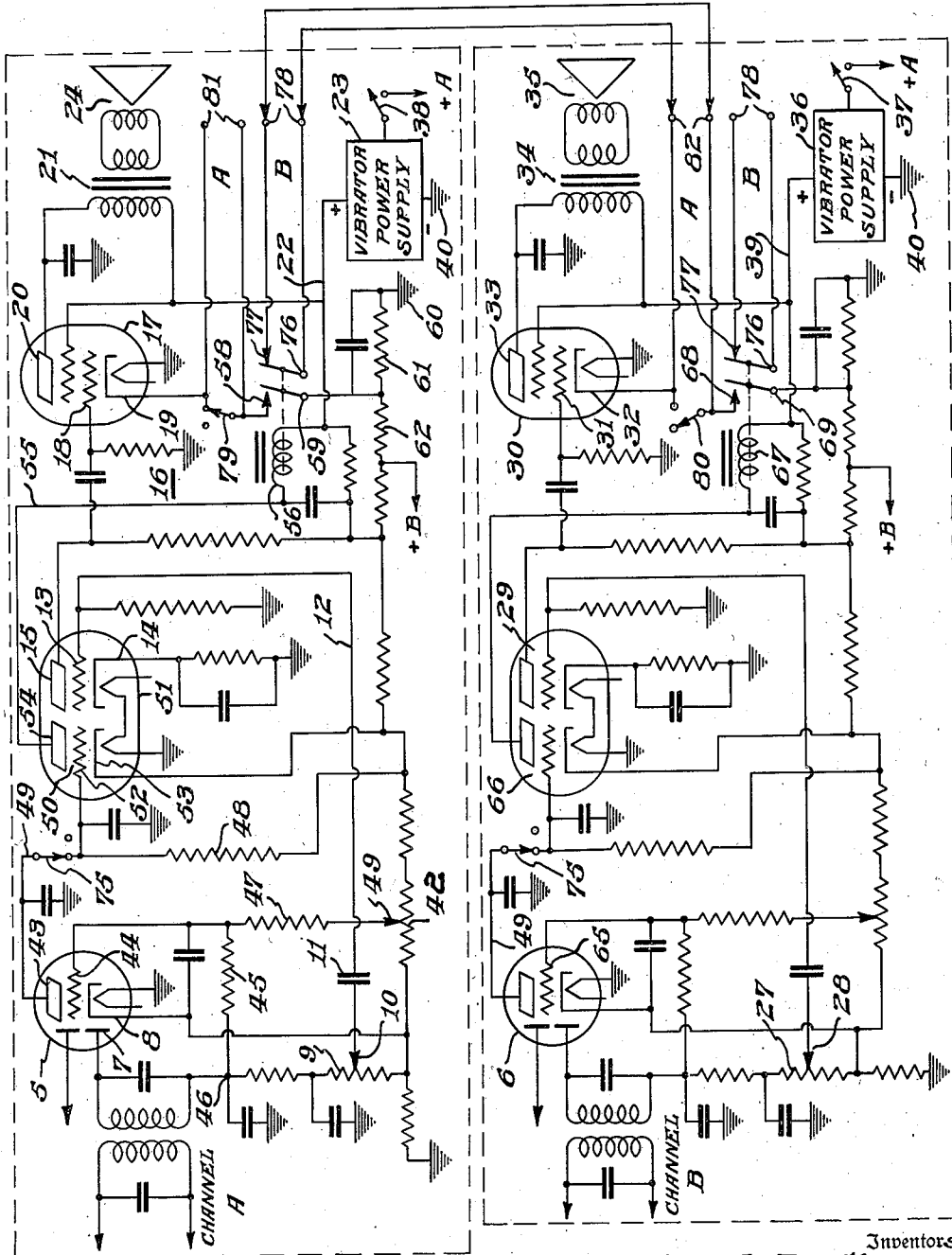


FIG. 1.

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2 Sheets-Sheet 2

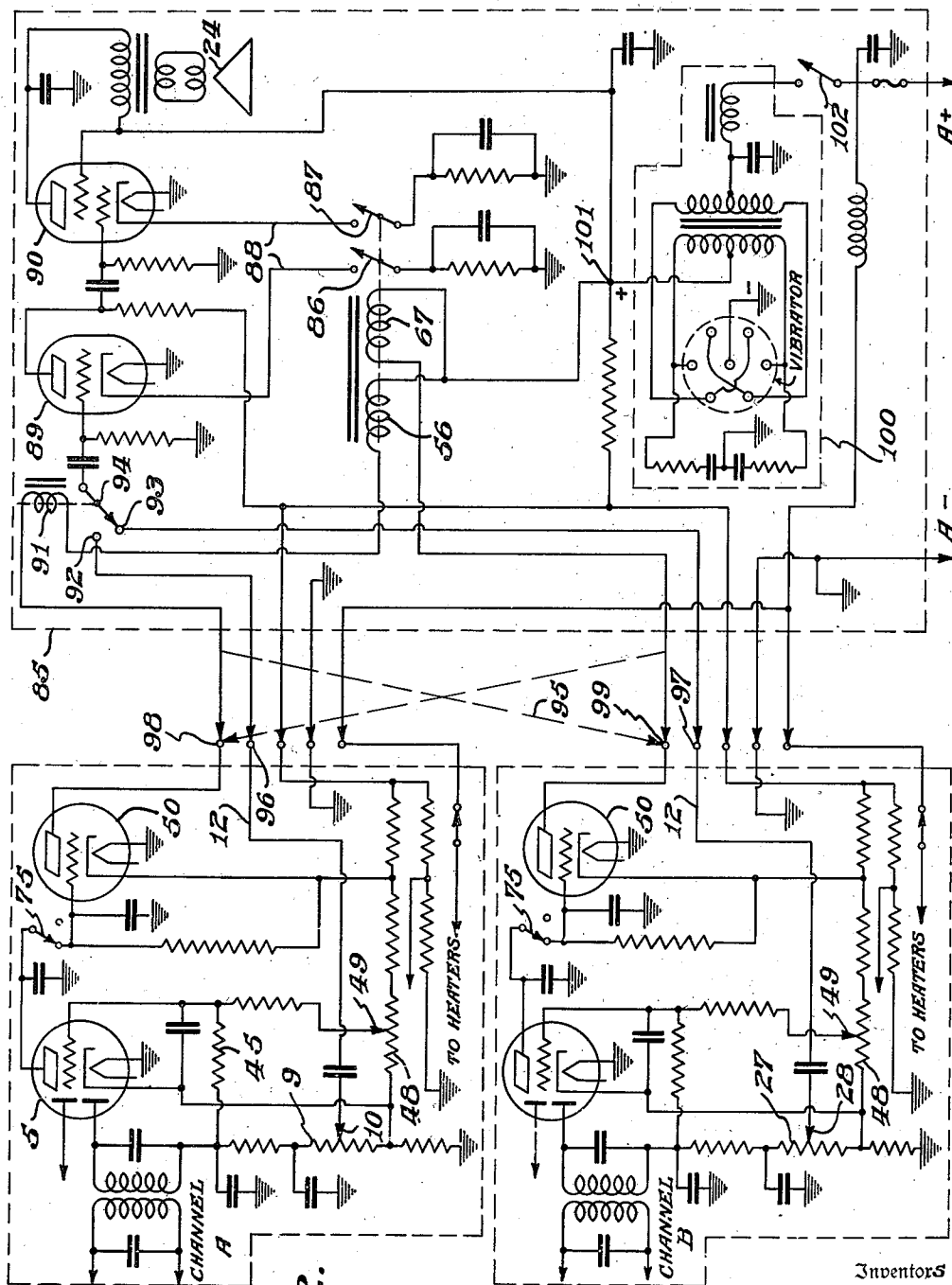


FIG. 2.

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RADIO RECEIVING SYSTEM

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8 Claims. (Cl. 250—20)

The present invention relates to radio receiving systems of the type having two or more signal receiving channels, and has for its primary object to provide an improved radio receiving system of the character referred to, wherein either or any one of the signal channels may be put into effective operation in response to signals, giving one channel a preference if desired, and providing silent standby operation in the absence of signals with low current consumption.

The invention relates particularly to radio signal receiving systems adapted for simultaneous response to a plurality of differing signals or signals in differing frequency bands as utilized in police work in patrol cars and the like. Such systems must be operated from battery power either through a motor-generated or other rotary converting apparatus, or from vibrator power supply means involving a vibrator device for interrupting the primary current and rectifying the secondary voltage of a step-up transformer.

The use of vibrator power supply devices is preferable because of simplicity and low cost, but this involves a distinct disadvantage in connection with multiple channel receivers of the type referred to for the reason that in order to carry the various receiving channels for standby operation, the steady operation of the vibrator elements of the power supply means with the relatively heavy load currents involved, greatly reduces the vibrator contact life.

It is, therefore, a further object of the present invention to provide an improved radio receiving system of the multiple signal channel type, which causes a minimum current load during standby periods with silent operation during such periods, while providing full signal output from any one of the several channels in response to signals, whereby the life of the vibrator contacts is prolonged, and which is responsive to signals from a selected one of the channels regardless of the condition of operation of any of the other channels.

It is also an object of the present invention to provide in a multiple channel radio receiving system, for the independent operation of any signal channel to the exclusion of the others, together with control of the power output and current consumption, thereby to provide silent operation and a prolonged vibrator life in a mobile installation.

In the operation of a police radio receiving system, it is desirable to provide at least two signal receiving channels, one of which may be tuned to a local police signal network, for ex-

ample, while the other is tuned to the State police network, both channels being silent during standby periods and caused to consume relatively low anode current.

It is, therefore, a still further object of the present invention not only to provide in a radio receiving system a major reduction in the anode current load in the absence of signals on either of the two signal receiving channels, but also to provide in said receiving system means for rendering the system responsive to emergency signals, whether the receiving system is standing by or in operation in response to signals from any other source.

The invention will, however, be better understood from the following description when considered in connection with the accompanying drawings and its scope is pointed out in the appended claims.

In the drawings,

Figure 1 is a schematic circuit diagram of a two-channel radio signal receiving system illustrating one embodiment of the invention, and

Figure 2 is a similar schematic circuit diagram showing a modification of the circuit of Fig. 1 also embodying the invention.

Referring to Fig. 1, the signal receiving system shown provides two signal channels, A and B, comprising a second detector 5 in channel A, and a second detector 6 in channel B, the preceding signal-conveying circuits of each channel not involving the invention being omitted for the sake of simplicity. Any suitable receiving means may be provided, such as the usual first detector and intermediate frequency amplifier in each channel, terminating as shown in the second detector for each channel.

Each detector is preferably of the diode type comprising an anode 7 and a cathode 8 provided with a signal output impedance 9 from which audio frequency signals are taken through a volume control contact 10 and a coupling capacitor 11. The coupling capacitor is connected through a lead 12 to a signal input grid 13 of an audio amplifier tube, the cathode of which is indicated at 14 and the anode at 15. The latter is coupled through a suitable coupling means 16 to the output stage represented in the present example by an audio frequency amplifier power output tube 17 having a signal input grid 18, a cathode 19 and an output anode 20. The anode is connected through an output transformer 21 with a positive anode current supply lead 22 from a vibrator power supply device 23. A loudspeak-

er 24 is coupled to the output transformer 21 as indicated.

The same amplifier arrangement, representing any suitable audio frequency amplifier, is provided in the second channel B, comprising the detector 6, volume control output potentiometer 27—28, the first stage amplifier tube 29 coupled to the power output stage 30 having a signal input grid 31, a cathode 32 and an output anode 33, the latter being coupled through an output transformer 34 to a second loudspeaker device 35.

The anode current for channel B is derived from a separate vibrator power supply device 36, each channel being independently energized by closure of switches indicated at 37 and 38 to supply the anode and screen grid current thereto. The positive anode output lead from the power supply device for channel B is indicated at 39, and as in channel A, the negative connection is made to ground or chassis 40 or other suitable common return circuit for the respective channels.

Each of the channels includes a control amplifier in addition to the signal amplifier. The control amplifier is responsive to received signals to control the anode current of the output stages as the major load on the vibrator power supply device and the operating contacts thereof.

Referring to the control amplifier of channel A, an amplifier tube having an anode 43 and a control grid 44 is provided with a common cathode 8 in the same envelope with the second detector. The grid 44 is connected through a filter resistor 45 with the negative terminal 46 of the detector output circuits and also through a limiting resistor 47 with a potential source 42 providing an adjustable potential at terminal 49 which is positive with respect to the cathode 8. In the absence of signals, the terminal 49 may be adjusted to provide a predetermined positive bias on the control grid 44, sufficient to establish a relatively high anode current in the output resistor 48 in the anode circuit 49.

In the presence of signals, the positive bias in the grid 44 is overcome by the increasing negative bias provided by the detector resulting in a reduction of the anode current in the output resistor 48 when the signal strength is above the predetermined value referred to.

This change in anode current is utilized to provide a variable bias which increases in a positive direction with signal increase and which is applied to a control amplifier 50 provided in the same envelope 51 with the signal amplifier. This amplifier is provided with a control grid 52 connected with the negative end of the resistor 48 while the cathode 53 is connected with a positive end thereof, as shown.

The output anode 54 is connected through the anode circuit 55 with a relay coil 56 which is energized as the grid 52 becomes less negative in response to signals above the predetermined signal level referred to. In the arrangement shown, the anode circuit 55 is connected through the relay coil 56 to the positive supply lead 22 from the vibrator power supply device. In the absence of signals, it will be seen that the anode current load provided by the tube 50 is reduced. Likewise in the absence of signals, the anode circuit of the output stage 17 is opened by providing a pair of relay contacts 58 and 59 in circuit between the cathode 19 and a negative anode supply connection provided by the chassis 60, this connection including a bias resistor 61 in the bleeder network 62 of the channel.

The relay contacts 58 and 59 are arranged to open when the coil 56 is de-energized or when the current is reduced to a sufficiently low value, as in the absence of signals above a predetermined strength. The operation of the system, thus far described, is as follows:

In the absence of signals, the positive bias on the first stage of the direct current amplifier constituted by the tube 5 is adjusted by means of the contact 49 until the negative bias derived from the output resistor 48 is such that current through the relay coil 56 is reduced to a sufficiently low value to permit the relay to open the contacts 58 and 59 thereby reducing the anode current load on the vibrator power supply device 23, caused by the output tube 17. In this manner also the loudspeaker is rendered inoperative and the output from the channel A is prevented.

In any case, the bias potential applied to the first direct current amplifier stage is such that it determines the level at which signals are to be received through the channel and in the presence of such signals above that level, increasing negative bias is applied to the grid 44 causing a decrease in the anode current through the resistor 48 and an increase, in a positive direction, of the bias potential applied between the cathode 53 and the control grid 52 of the second direct current amplifier or relay control stage 50. The resulting increase in anode current through the anode circuit 55 and the relay coil 56 causes the contacts 58 and 59 to close, thereby energizing the anode circuit of the output stage and permitting the output from the channel to be delivered to the output device 24.

As soon as the signals received through channel A cease or fall to a relatively low amplitude, the relay contacts open because of a reduction in the anode current from the control tube following an increase in negative bias to such control tube from the first stage as a result of the restoration of the positive bias from the source 42.

Channel B is provided with the same type of direct-current amplifier and relay control as channel A and the operation is the same as described for channel A. The first stage D. C. amplifier is indicated at 65 and is coupled to the second stage D. C. amplifier 66 in the output circuit of which is located the relay winding 67 operative to close contacts 68 and 69 in circuit with the cathode 32 of the power output amplifier 33 in the signal channel.

It will be noted that a switch 75 is included in each of the control amplifier circuits between the first amplifier and second amplifier stages. By opening either of the switches, the biasing potential is removed from the control amplifier stage, causing the relay in connection with the particular channel to close the cathode circuit of the output amplifier stage regardless of the signal strength or the presence of signals in the channel, whereby either channel may be placed in operation any time in a normal manner.

It will also be noted that each of the relays is provided with an additional pair of contacts 76 and 77 connected with terminals 73 to which an additional control circuit may be connected for applying selective control in case it is desired to have one signal channel operate in preference to the other or others.

In one embodiment of the invention as shown herein, the contacts 76 and 77 are arranged to be opened when the relay is energized to place either channel in operation, and are connected in circuit with the cathode of the other channel to

open the cathode circuit thereof and to maintain the cathode circuit open regardless of whether the control relay for that channel is operating in response to signals or not.

To provide for connecting the contacts 76 and 77 in the cathode circuit of the output amplifier of either channel, the cathode circuits for the cathodes 19 and 32 are further provided with switches 79 and 80 across which terminals 81 and 82 are connected, respectively.

In the present example, the terminals 78 of channel A are connected with the terminals 82 of channel B, thereby placing the relay 56 in channel A in control of the cathode circuit of the power output stage of channel B. Therefore, when the relay 56 in channel A is energized in response to signals and the channel is in operation, channel B is maintained in an inoperative condition by reason of the fact that, whether the relay 67 operates or not, the cathode circuit of the output stage 39 cannot be completed in response to signals through channel B. However, should signals be applied to channel B, as soon as signals cease in channel A and the relay 56 is deenergized, the channel B output will be restored when the contacts 76 and 77 return to the closed position by operation of the relay 56. It will be seen that, by opening the switch 79 and closing the switch 80, connection may be made between the terminals 78 of channel B to terminals 81 of channel A, in which case preference will be given to the signals from channel B over those of channel A.

From the foregoing description, it will be seen that the audio frequency, or second detector of a radio receiver in each of a plurality of signal channels may supply a controlling D. C. bias potential to a D. C. amplifier the output circuit of which includes means for closing and opening the cathode circuit of the power amplifier, thereby reducing the current drain during standby periods by removing the major portion of the plate load from a vibrator power supply device, the contact life of which is appreciably prolonged.

In addition, the relay circuits are made selectively responsive to either one of two signals to the exclusion of signals in the other channel, so that the standby system may be made responsive to one signal, such as an emergency signal, in preference to any others regardless of whether such other signals are being impressed upon the receiving system or not.

Furthermore, silencing of the output of either or both channels is effected without the operation of short-circuiting means for the signal channel or for the loudspeaker device, as is the ordinary practice where silencing is desired.

It will also be noted that the switching means for silencing and cutting off the major portion of the plate load from the vibrator and the switching means for providing selective control of one channel in preference to the other, are provided by simple series switching connections in the cathode lead of each of the output amplifier stages, thereby greatly simplifying the circuit arrangement and maintaining the switching at low potential or substantially ground potential.

In certain classes of receiving apparatus providing a plurality of signal receiving channels, it may be desirable to provide a single output amplifier and a single vibrator power supply device for the plurality of channels, particularly where it is desired to operate but one of the two or more channels at any time.

In the circuit arrangement of Fig. 2, to which attention is now directed and in which the same reference numerals are used to designate like parts as in Fig. 1, a single audio frequency amplifier and vibrator power supply device is provided for both channels A and B. The operation and adjustment of the two channels for signal reception is the same as described in connection with Fig. 1.

However, since a common amplifier and vibrator power supply device as enclosed in the dotted rectangle 85 is provided, the second stage 50 of the D. C. control amplifier is included in a separate envelope from the first stage audio frequency amplifier. Furthermore, the relay coil 56 for channel A and the relay coil 67 for channel B are included in the same relay device to actuate contacts 86 and 87 in the cathode circuits 88 of the first and second stage audio frequency amplifiers 89 and 90 so that, when either or both of the channels are receiving signals of the desired or predetermined signal strength, the audio frequency amplifier will be operative to supply the output to the loudspeaker device 24.

To provide for selecting the signal output from a preferred channel, a selector relay having an operating winding 91 and selector contacts 92, 93 and 94 is connected in the input circuit of the first audio frequency amplifier 89, and the winding 91 is placed under control of either of the control amplifiers in the two channels.

As shown, the winding 91 is in circuit with the amplifier 50 of channel A, and the audio frequency output lead 12 for channel A is connected to the contact 92, while the corresponding lead 12 of channel B is connected to the contact 93. The movable contact 94 actuated by the relay coil is connected to the input circuit of the amplifier stage 89 providing for selecting the output of channel A in response to signals in channel A.

Channel B may be given a preference, however, by changing the connections as indicated by the dotted leads 95 to connect the relay coil 91 in circuit with the control amplifier of channel B. In a similar manner, the connections for terminals 92 and 93 are reversed on terminals indicated at 96 and 97 for channels A and B, respectively, the terminals 98 and 99 being provided for the purpose of switching the output circuits for the control amplifiers, as above mentioned.

The selector relay coil 91 may be placed in circuit with either of the relay coils 56 or 67 but, in the present example, is placed in series with the coil 56.

The modification shown in Fig. 2 involves the use of a single relay for controlling the cathode circuits of a single audio frequency amplifier, the relay having actuating coils for each channel control amplifier, and an additional selector relay connected in circuit with one of the relay coils to provide predetermined selection of one channel in preference to the other, when signals are received on both channels, for purposes hereinafter referred to.

Either channel may be made operative in a normal manner by opening the first stage D. C. control amplifier plate circuit by means of the switches 75 and, in the case of the circuit modification of Fig. 2, opening both switches 75 causes the preselected channel to take preference by operation of the selector relay 91. In the circuit shown, this will be channel A.

Heretofore, the vibrator life in a police radio installation for multiple-channel operation has

been only a few hundred hours, whereas the system may be required to operate in the order of 700 hours a month. With ordinary vibrator devices commercially available, a system in accordance with the invention may provide a vibrator-operating life of several thousand hours. Thus, the system provides a great advantage in police work in that maintenance and service costs are greatly reduced, as well as the interruption of the service with low cost commercial vibrator devices.

We claim as our invention:

1. In a radio signal transmission system, the combination with a pair of signal conveying channels of signal rectifier means connected with each of said channels having output circuits providing signal variable biasing potentials, direct current amplifier means having control circuits connected with said output circuits providing control currents responsive to variations in said biasing potentials, an output load circuit for said system, relay means connected in circuit with said direct current amplifier means for response to the output current of said amplifiers, means connected with and controlled by said relay means for energizing said load circuit in response to received signals in at least one channel, and a vibrator power supply device connected with said load circuit to supply energy thereto through said last named means.

2. In a multiple channel radio signal transmission system, a signal rectifier connected with each channel, means connected with each rectifier for deriving therefrom a modulation signal component and a signal variable biasing potential, a direct current amplifier having a control grid circuit connected with said last named means in each channel whereby it is responsive to variations in biasing potential to provide a variable output anode current, an output anode circuit for each direct current amplifier, relay means in each of said last named output circuits responsive to anode current variations therein, an output amplifier for said system including a power amplifier tube having an anode-cathode circuit, means in said power amplifier anode-cathode circuit actuated by said relay means for closing said last-named circuit in response to signals above a predetermined amplitude, and a vibrator power supply device connected with said power amplifier anode-cathode circuit to energize the same.

3. In a multiple channel radio signal transmission system, a signal rectifier connected with each channel, means connected with each rectifier for deriving therefrom a modulation signal component and a signal variable biasing potential, a direct current amplifier having a control grid circuit connected with said last named means in each channel whereby it is responsive to variations in biasing potential to provide a variable output anode current, an output anode circuit for each direct current amplifier, relay means in each of said last-named output circuits responsive to anode current variations therein, an output amplifier for said system including a power amplifier tube having an anode-cathode circuit, means in said power amplifier anode-cathode circuit actuated by said relay means for closing said last-named circuit in response to signals above a predetermined amplitude, a vibrator power supply device connected with said power amplifier anode-cathode circuit to energize the same, and means for selectively energizing

said power amplifier tube in response to signals in one of said channels.

4. In a multiple channel radio signal transmission system, a signal rectifier connected with each channel, means connected with each rectifier for deriving therefrom a modulation signal component and a signal variable biasing potential, a direct current amplifier in each channel having a control grid circuit connected with said last named means to receive said variable biasing potential therefrom, and having an output circuit including current responsive relay means, a power amplifier having an anode-cathode circuit providing a relatively heavy load current, a vibrator power supply device connected in said last named circuit for energizing said circuit, means for opening said last-named circuit under the control of said relay means, and circuit means providing connections for said relay means with said anode-cathode circuits for preferentially selecting the signal output from one of said channels while suppressing the signal output from another of said channels.

5. In a radio signal receiving system, the combination of means providing a pair of signal conveying channels, a signal rectifier connected in each channel and having a rectified signal output circuit, a direct current amplifier for each channel having a control grid connection with one of said output circuits whereby it is controllable in accordance with the rectified signal output from each channel to provide a variable output controlling current, an output circuit for each amplifier, a power amplifier for said system having an anode-cathode circuit providing a relatively heavy load current, a vibrator power supply device for said power amplifier connected in said anode cathode circuit, means connected in each direct current amplifier output circuit for opening said anode-cathode circuit in response to variations in said controlling current in the absence of signals, and for closing said anode-cathode circuit and for preferentially selecting the output of one of said channels in response to signals.

6. In a radio signal receiving system, the combination of means providing a pair of signal conveying channels, a signal rectifier connected in each channel and having a rectified signal output circuit, a direct current amplifier for each channel having a control grid connection with one of said output circuits whereby it is controllable in accordance with the rectified signal output from each channel to provide a variable output controlling current, adjustable means for limiting the response of said amplifier to signals above a predetermined level, an output circuit for each amplifier, a power amplifier for said system having an anode-cathode circuit providing a relatively heavy load current, a translating device connected therewith, a vibrator power supply device for said power amplifier connected in said anode-cathode circuit, means connected in each direct current amplifier output circuit for opening said anode-cathode circuit in response to variations in said controlling current in the absence of signals, and for closing said anode-cathode circuit and for preferentially selecting the output of one of said channels in response to signals.

7. In a radio signal receiving system, the combination of means providing two signal receiving channels each including a signal rectifier, means in each channel for deriving from the signal rectifier therein a controlling potential which

varies with signal strength, a direct current amplifier for each channel having a control grid circuit connected with said potential deriving means and having an output anode circuit, relay means connected in each of said circuits for operation in response to received signals through said channels, vibrator power supply means for said system, a power output amplifier having an output anode circuit providing a relatively heavy load current, and means responsive to operation of said relay means for connecting said last named output anode circuit with said vibrator power supply means.

8. In a radio signal receiving system, the combination of means providing two signal receiving channels each including a signal rectifier, means in each channel for deriving from the signal rec-

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tifier therein a controlling potential which varies with signal strength, a direct current amplifier for each channel having a control grid circuit connected with said potential deriving means and having an output anode circuit, relay means connected in each of said circuits for operation in response to received signals through said channels, vibrator power supply means for said system, power output amplifier means having output anode circuits providing relatively heavy load currents, and means responsive to operation of said relay means for selectively connecting one of said last named output anode circuits with said vibrator power supply means.

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