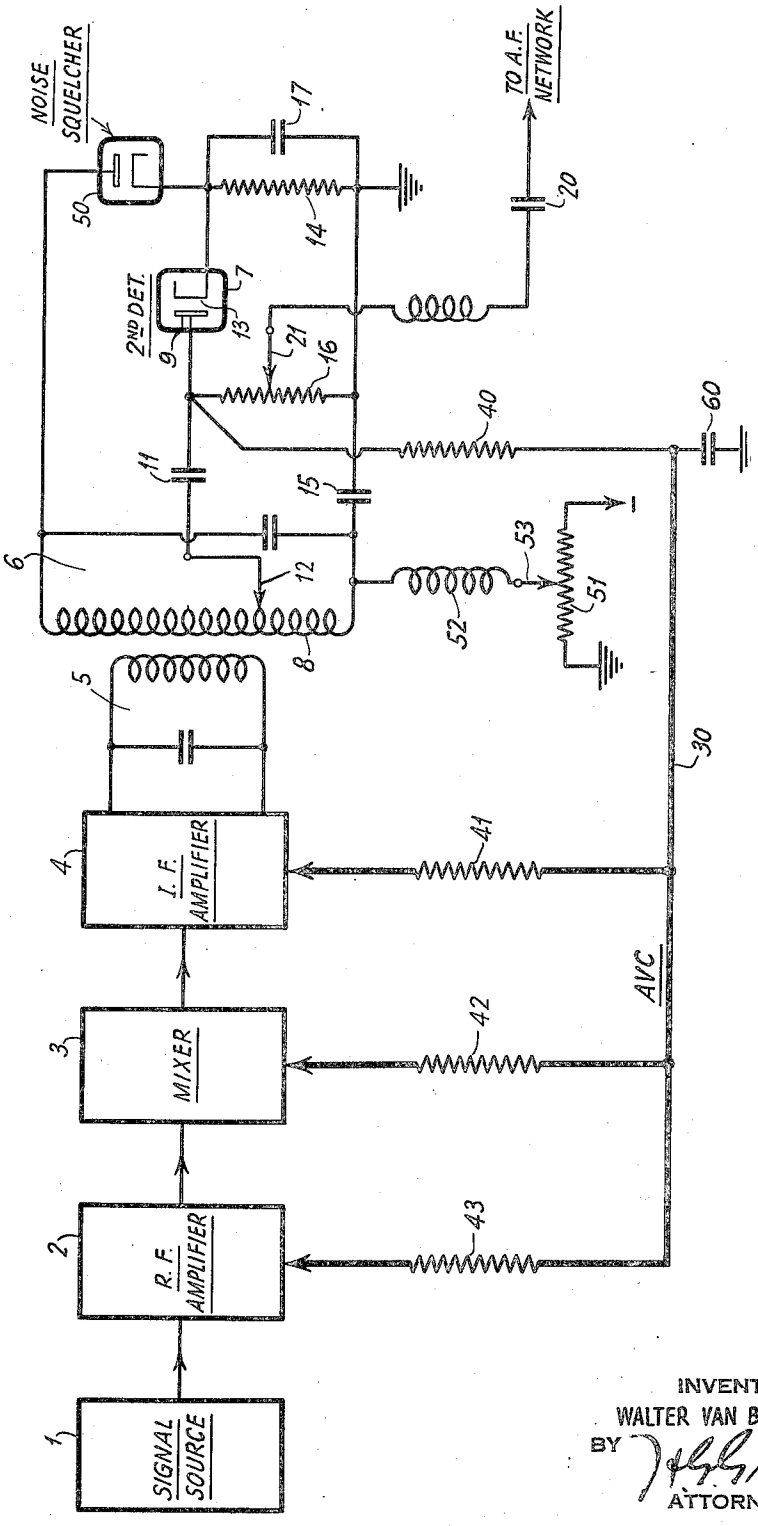
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RECEIVER NOISE LIMITING CIRCUIT

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RECEIVER NOISE LIMITING CIRCUIT

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My present invention relates to transmission control arrangements for radio receivers, and more particularly to automatic noise suppression devices for use in connection with radio receivers.

There is a type of interference encountered in radio receiver operation which can not be effectively eliminated by the ordinary sharp tuning means employed heretofore in reducing interference.

This type of interference consists of voltage impulses of very short duration but of amplitude often many times greater than that of the desired signals, such as produced by spark plugs of automobile engines. These impulses shock-excite the sharply tuned resonant circuits of the receiver to produce relatively slowly dying out trains of oscillations which upon rectification produce large pulses of current in the loud speaker. The initial impulse by itself is of too short duration to produce an impulse in the speaker of sufficient energy content to be objectionable. According to the present invention, the objectionable pulses of current in the loud speaker are substantially reduced by automatically rendering the detector inoperative to rectify applied voltages less than the peak value of an interfering impulse from a time immediately subsequent to the receipt of such an impulse until a time sufficiently later so that transient oscillation produced by said impulse will have had time to die out. This of course interrupts the receipt of the desired signals also, but the necessary length of this interruption is so short that the interruption is not nearly so detrimental to the receipt of the desired signals as would have been the large impulse that would have been superposed on the desired signals if the detector had not been momentarily paralyzed.

Accordingly, it may be stated that it is one of the main objects of my present invention to provide in a radio receiver a quick acting automatic transmission control circuit, the control becoming effective immediately when an interfering voltage substantially exceeds the voltage of the desired signal but the control persisting only for a short time after the cessation of the interfering voltage, and functioning to paralyze the receiver during a short time subsequent to the receipt of an interfering noise voltage pulse which is relatively high in peak value as compared to the desired signals.

Another important object of the present invention may be stated to reside in the provision of a noise suppression, or squelching, circuit for the detection network, the squelch device being normally biased in such a manner that the relation between detector output voltage and detector input voltage increases substantially linearly with detector input up to a predetermined voltage input, and after which it falls rapidly to zero for further increase in input voltage.

Another object of the invention is to provide a diode detector network for a radio receiver wherein the tuned input circuit is so arranged with respect to the diode that only a predetermined portion of the signal input voltage is impressed upon the diode, and a second diode, functioning as a squelch device, being connected to the said input circuit and diode detector in such a manner, and operating with such normal bias, that normally no current flows through the squelch diode, but when the voltage across the input circuit is sufficient to produce a peak voltage on the squelch diode substantially greater than its bias, the detector diode is rendered inoperative by the current flowing through the squelch diode.

Still other objects of the invention are to improve generally the operating efficiency of radio receiver circuits, and more especially to provide receivers which are not only reliable and simple in operation, but include noise limiter devices simple in construction and operation, and readily assembled in a radio receiver.

The novel features which I believe to be characteristic of my invention are set forth in particularity in the appended claims; the invention itself, however, as to both its organization and method of operation will best be understood by reference to the following description taken in connection with the drawing in which I have indicated diagrammatically a circuit organization whereby my invention may be carried into effect.

Referring now to the accompanying drawing there is shown a conventional type of superheterodyne receiving system, and it will be understood that this receiver is composed of the usual and well known networks that are ordinarily encountered in such types of receivers. For example, the receiving system shown in the drawing comprises the signal source 1 which feeds collected signals to the tunable radio frequency amplifier 2. The signal source, or collector, may be the usual grounded antenna circuit; a radio frequency distribution line; or even the collector used on constructions such as automobiles. The amplifier 2 is tunable, and will enploy the usual variable tuning condenser. The amplified signals are fed to the tuned input circuit of the first detector, or mixer, 3. The mixer may be of the combined local oscillator-first detector type

employing a pentagrid converter tube of the 2A7 type; or separate first detector and local oscillator tubes may be used. In any case, it will be clear that the tunable circuits of the radio frequency amplifier, the first detector and the local oscillator will have the rotors of their variable tuning condensers mechanically arranged for uni-control.

The IF or intermediate frequency output of the mixer **3** is transmitted to one, or more, stages of IF amplification; therefore, the numeral **4** is to be understood as comprising one, or more, IF amplifier tubes, each tube having associated therewith a resonant network which is fixedly tuned to the operating IF. The last IF output circuit **5** is coupled to the IF input circuit **6** of the second detector, or audio demodulator, device **7**.

The second detector **7** is of the diode type, and has its anode **9** connected to a predetermined point on the input coil **8** through a path which includes the condenser **11** and the adjustable tap **12**. The cathode **13** of diode **7** is connected to the low alternating potential side of input circuit **6** through a path which includes the resistor **14** and condenser **15**. The detector load resistor **16** is connected in series between the anode **9** and cathode **13**, and is in series with the resistor **14**. The condenser **17** is connected in shunt with resistor **14**, and the anode side of resistor **14** is grounded. The audio component of rectified signal energy flowing through resistor **16** is transmitted to one, or more, stages of AF amplification through a path which includes the condenser **20** and the top **21** which may be adjustable for volume control. The audio network may comprise one, or more, stages of amplification, and will generally terminate in a reproducer of any desired type.

The direct current component of the rectified signal voltage appearing across resistor **16** is transmitted as an AVC bias to the stages prior to the second detector whose gains are under control. As shown in the drawing, the AVC network comprises the lead **30** connected to the anode side of resistor **16**, and the AVC bias is transmitted through filter resistors **40**, **41**, **42** and **43** in order to substantially suppress the pulsating components of the rectified IF energy. Those skilled in the art will understand that the connections from the lead **30** are made to the various grid circuits of the radio frequency amplifiers, the first detector and the IF amplifiers and that condenser **60** is chosen to give the AVC filter a suitable time constant. The AVC arrangement functions to decrease the gain of each controlled stage as the signal amplitude at the input circuit **6** increases. In this way the signal amplitude at the input circuit **6** is maintained substantially uniform regardless of variations at the source **1**. In the absence of incoming signals the sensitivity of each of the stages **2**, **3** and **4**, which are under control, will be a maximum, but under normal operating conditions the gain of each controlled stage is reduced by the AVC action from the maximum value.

A second diode **50** is electrically associated with the second detector circuit. The anode of diode **50**, which diode functions as the noise squelcher, is connected to the high alternating potential side of the input circuit **6**, while the cathode of the diode **50** is connected to the detector cathode side of resistor **14**. A biasing source is provided for the squelch diode **50** by connecting the anode of the diode to a desired point on the potential source resistor **51**, and this connection is made through a path which includes the coil **8**, the radio frequency choke **52** and the adjustable tap **53**. The potential supply resistor **51** has one side thereof grounded, and the other side thereof is at a negative direct current potential with respect to the grounded side. Of course, the voltage supply resistor **51** may be part of the general voltage supply network usually employed in a radio receiving system.

To explain the operation of the noise limiter device used in this arrangement, let it be assumed that the tap **12** has been adjusted to such a point on coil **8** that when 100 volts carrier peak are impressed across the entire circuit **6**, then only 30 volts carrier peak exist between the anode **9** and cathode **13**. In other words, the anode **9** is tapped down on coil **8** to a point such that there is a ratio of 10 : 3 between the entire input voltage and the voltage impressed across the detector diode. The squelch diode is now adjusted in bias, by proper setting of tap **53** on resistor **51**, so that the anode of diode **50** is at minus 100 volts D. C. with respect to the cathode thereof. With such a bias on the diode **50**, no current flows through the squelch diode.

When the input signal across circuit **6** increases to an extent such as to produce a peak voltage on the diode **50** substantially greater than its bias of minus 100 volts, the detector cathode **13** increases in potential, and the detector **7** ceases to function. This follows from the fact that when the input voltage impressed between the anode and cathode of diode **50** exceeds the negative bias on the anode, current flows through the diode, and renders the cathode side of resistor **14** positive with respect to ground. This means that cathode **13**, which is connected to the same point on resistor **14**, becomes positive with respect to ground, and positive with respect to anode **9** thereby preventing current from flowing through detector **7**.

Considering a specific example, a disturbance having a peak voltage of 200 across the input circuit **6** would give a cathode potential of approximately 100, and since the corresponding detector input would be only 60 volts peak, the detector would not function. Hence, if one considers the relation between detector output voltage and input voltage, it will be seen to increase substantially linearly with signal input up to about 100 volts across the tuned circuit, after which it will fall rapidly to zero for further increase in input voltage. It should be observed that the total bias on the squelch diode **50** will be not only the bias derived from the supply resistor **51**, but, also, include bias developed on the squelch diode cathode by the rectified IF energy flowing in the detector diode.

The condenser **17** is of a magnitude such as to provide with resistor **14** a noise suppressing action which is relatively quick, but short lived. In other words, the diode **50** is part of a quick acting AVC arrangement which functions to throttle the second detector when the voltage across input circuit **6** rises considerably above a predetermined amplitude. It is to be noted that the magnitude of condenser **17** is chosen so that it will retain its charge only sufficiently long to permit the transients of the noise pulse to die down. A suitable time constant of $\frac{1}{1000}$ second would result from making resistor **14** one-tenth megohm and condenser **17** .0005 microfarad. The efficiency of detector operation is not im-

paired by tapping down on coil 8. On the contrary since the squelch diode 50 normally draws no current, this tapping down actually serves to provide a good impedance match between circuit 6 and the diode 7, and thus no loss of detector output need result except for the voltage developed across resistor 14. However, the drop across resistor 14 may be utilized for some other function in the receiver, provided it does not interfere with its quick acting AVC function.

The speed of cut-off of the detector 7 is controlled by the position of tap 12 on coil 8, as well as by the bias imposed on diode 50 from the squelch threshold adjusting means 51 and 53. The lower the tap 12 on coil 8, the greater will be the speed of cut-off; furthermore, the less bias imposed on diode 50, the faster will be the cut-off action. It is, additionally, pointed out that while diodes 7 and 50 have been shown as being separate devices, the electrodes thereof can be disposed within a single tube envelope, and a tube of the "6H6" type may be used for this purpose. Again, since the cathodes of both diodes are connected to a common point on resistor 14, a tube using a common cathode and two anodes may be employed in place of the separate diodes; and, for example, a tube of the 85 type can be used, this being a tube of the "duplex diode-triode" type, and in which case the grid and plate of the tube can be used to amplify the audio component transmitted through condenser 20.

While I have indicated and described a system for carrying my invention into effect, it will be apparent to one skilled in the art that my invention is by no means limited to the particular organization shown and described, but that many modifications may be made without departing from the scope of my invention, as set forth in the appended claims.

What I claim is:

1. In combination with a source of signals and a load circuit, a diode detector, a resonant input circuit, tuned to an operating signal frequency, coupled to said signal source, means for impressing a predetermined fraction of the voltage across said input circuit between the diode electrodes, means electrically associated with the diode electrodes for developing a rectified current from the impressed input voltage, a second diode having its electrodes connected across a greater portion of said input circuit whereby a greater voltage derived from the input circuit is impressed between the second diode electrodes, an impedance in the space current paths of both diodes, having one side thereof connected in common to the cathodes of both diodes, the other side of the impedance being connected to the detector diode anode, and means for producing an initial potential difference between the electrodes of the second diode such that the latter has no current flow in the absence of input circuit voltage above a predetermined value.

2. In combination with a source of signals and a load circuit, a diode detector, a resonant input circuit, tuned to an operating signal frequency, coupled to said signal source, means for impressing a predetermined fraction of the voltage across said input circuit between the diode electrodes, means electrically associated with the diode electrodes for developing a rectified current from the impressed input voltage, a second diode having its electrodes connected across said input circuit whereby the entire voltage across the input circuit is impressed between the second diode electrodes, an impedance in the space current paths of both diodes, having one side thereof connected in common to the cathodes of both diodes, the other side of the impedance being connected to the detector diode anode, means for producing an initial potential difference between the electrodes of the second diode such that the latter has no current flow in the absence of input circuit voltage above a predetermined value, and a condenser electrically associated with said impedance to provide a time constant network of relatively quick action.

3. In a radio receiver, a signal input circuit, a diode detector, connections from the diode electrodes to the input circuit such that a relatively small fraction of the entire signal circuit input is impressed between the diode electrodes, a load resistor connected in the space current path of the diode for developing a rectified voltage from the signal input voltage, a noise limiter diode having its anode connected to a point on the input circuit, and the cathode to the second diode being connected to the detector diode cathode, the second diode anode connection to the input circuit being such that the voltage from said input circuit impressed on the second diode is relatively great compared to that impressed on the detector diode, an impedance conductively connected between said cathodes and the detector diode anode, and means connected between the second diode electrodes for maintaining the second diode anode at a negative direct current potential with respect to its cathode when the input voltage peak is less than said negative direct current potential.

4. In a radio receiver, a signal input circuit, a diode detector, connections from the diode electrodes to the input circuit such that a relatively small fraction of the entire signal circuit input is impressed between the diode electrodes, a load resistor connected in the space current path of the diode for developing a rectified voltage from the signal input voltage, a noise limiter diode having its anode connected to a point on the input circuit, and the cathode of the second diode being connected to the detector diode cathode, the second diode anode connection to the input circuit being such that the voltage from said input circuit impressed on the second diode is relatively great compared to that impressed on the detector diode, an impedance conductively connected between said cathodes and the detector diode anode, means connected between the second diode electrodes for maintaining the second diode anode at a negative direct current potential with respect to its cathode when the input voltage peak is less than said negative direct current potential, and an automatic volume control connection to the detector load resistor, said impedance having connected in shunt therewith a condenser of a magnitude such that the impedance and condenser provide a time constant network which is quick acting.

5. In a detecting circuit for radio signals, a detector diode, means for supplying alternating voltage to said diode, a second diode and means for supplying to said second diode an alternating voltage proportional to, but greater than, the voltage applied to said detector diode, means for applying to said second diode a direct current bias voltage greater than the peak alternating voltage which is supplied to said second diode coincidentally with normal signal voltage being supplied to said detector diode, and means for biasing the anode of said detector diode negative relative to the cathode in proportion to the direct component

of current flowing through said second diode whereby the application of alternating voltage sufficiently greater than normal to said detector diode results in paralyzing said detector diode, and means for maintaining said paralysis only for a time, subsequent to the cessation of said abnormally high voltage, which is too short to cause a noticeable interruption of the output of said detector diode.

6. In a detecting circuit for radio signals, a detector diode, means for supplying alternating voltage to said diode, a second diode and means for supplying to said second diode an alternating voltage proportional to, but greater than, the voltage applied to said detector diode, means for applying to said second diode a direct current bias voltage greater than the peak alternating voltage which is supplied to said second diode coincidentally with normal signal voltage being supplied to said detector diode, and means for biasing the anode of said detector diode negative relative to the cathode in proportion to the direct component of current flowing through said second diode whereby the application of alternating voltage sufficiently greater than normal to said detector diode results in paralyzing said detector diode, means for maintaining said paralysis only for a time, subsequent to the cessation of said abnormally high voltage, which is too short to cause a noticeable interruption of the output of said detector diode, said alternating voltage supply means for the detector diode including at least one amplifier, and a gain control circuit, responsive to the direct current voltage output of the detector diode, connected to said amplifier.

7. In a rectifier network, a diode, means for supplying alternating signal voltage to the latter, a second diode, means for supplying to the second diode an alternating signal voltage proportional to, but greater than, the voltage supplied to the first diode, means for applying to said second diode a direct current bias voltage greater than the peak alternating signal voltage which is supplied to said second diode, and means for biasing the first diode anode negative with respect to its cathode in proportion to the direct current component of current flowing through the second diode in response to interfering voltage of an amplitude greater than said signal voltage peak.

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