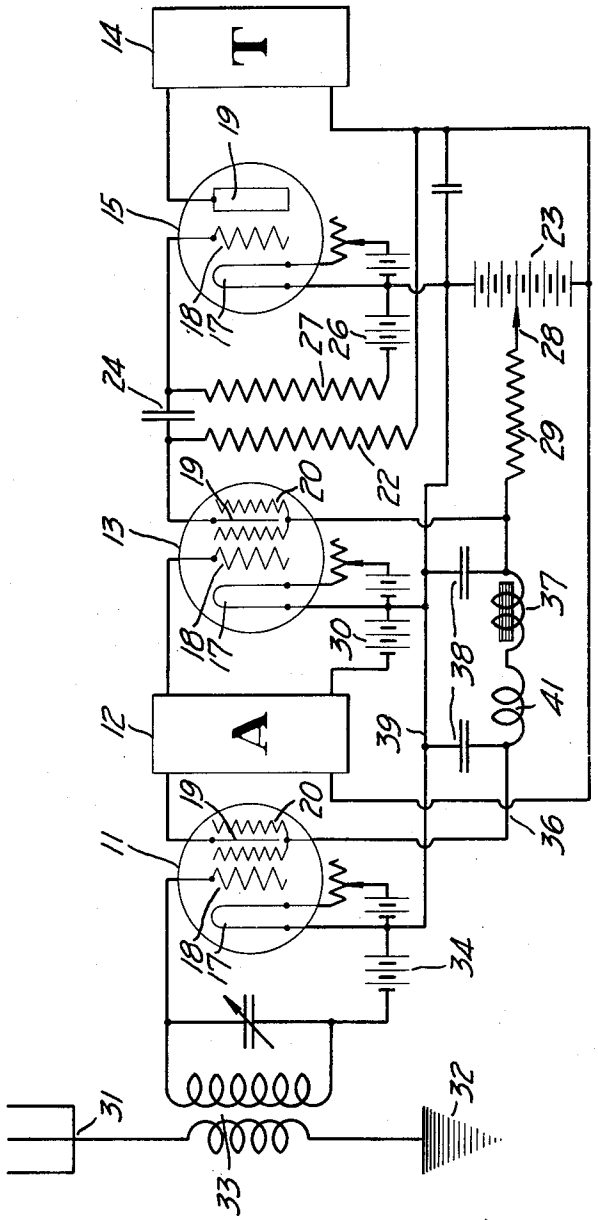
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RELAY SYSTEM

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RELAY SYSTEM

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This invention relates generally to systems for repeating current impulses. It is particularly adapted to be used with systems employing vacuum tube relays of the electron emission type.

It is an object of this invention to devise an electron relay system having means for securing automatic compensation in the output of an electron relay to offset the effect of applied impulses of different intensities.

It is a further object of this invention to devise a radio receiving system and method of operating the same which will make possible a response in the translator of substantially uniform intensity irrespective of a wide variation in the intensities of applied signals.

It is a further object of this invention to devise an improved method of detecting radio signals.

It is another object of the invention to devise a radio receiving system having improved detecting means which will permit elimination of one or more audiofrequency amplifiers.

Further objects of this invention will appear from the following description in which I have set forth the preferred embodiment of my invention. It is to be understood that the appended claims are to be accorded a range of equivalents consistent with the state of the prior art.

Referring to the drawing:

I have shown a circuit diagram illustrating one embodiment of my invention.

Radio receiving systems are generally constructed so as to be selectively tunable over a wide range of radio frequencies whereby radio signals originating from different stations may be selected out and received. Because the power output of the different transmitting stations is usually un-uniform, and since they are generally located at different distances from the receiver, the translator response will generally vary in volume or intensity depending upon the particular station from which the signals are being received. When radio signals of great intensity are being received, it is necessary with present forms of apparatus to make a manual compensating adjustment in order that the translation response may not be of undue volume. Manual compensation is accomplished for example by reducing the "A" battery current for one or more of the electron relays of the system, by detuning the receiver with respect to the incoming signals, or by reducing the electrical coupling between two or more of the relays.

In my invention I compensate automatically for signals of different intensities. This compensation is effected in such a way that the audiofrequency response of the translator is not thereby distorted, and therefore the system is applicable for the reception of voice modulated frequencies.

While certain features of the invention are applicable broadly to electron relays for amplifying current variations, in the drawing I have illustrated the invention as embodied in a receiver of signal energy. Systems of this kind generally utilize one or more electron relays for receiving and detecting the signal energy, and the integrated output of the detector is then suitably translated. As a means for receiving and detecting signal energy I have shown an electron relay or vacuum tube 11, the output of which may be repeated through a radio frequency amplifier 12, or may be applied directly to a further electron relay 13, adapted to function as a detector. The output of relay 13 is caused to effect a response in the translator 14, preferably after having been repeated through an amplifying relay 15.

In the past it has been customary to employ three element electron relays for detecting radio signal energy. These relays were usually employed with a grid condenser and grid leak, or with a negative bias applied to the grid by means of a "C" battery. Both of these arrangements are limited as to the intensity of the signal energy which they can receive and effectively integrate. The grid leak arrangement for example is subject to an increase in the internal tube resistance with an increase in the applied signal intensity, thus impairing operation of the tube as an amplifier. Furthermore the relay departs from the general square law on strong input signals thus causing distortion of the current variations in the output circuit. The use of a "C" battery for detection is furthermore objectionable because of low sensitivity and high internal resistance.

Because of the limitations of the grid leak and "C" bias methods of detection, it has been formerly necessary to use two or more vacuum tubes connected in cascade in order to sufficiently amplify the detected current for proper operation of the translator. In my efforts to secure a detector which would handle strong signals without distortion and which would effect efficient amplification so as to provide relatively strong detected impulses, I discovered that under proper operating conditions a vacuum tube relay of the four element type will operate efficiently as a detector. The particular type of tube which

I have successfully employed for this purpose is available upon the open market and is commonly known as the screened grid vacuum tube. It corresponds generally to the vacuum tube disclosed in the patent to Stottky No. 1,537,708.

In the drawing the relay 13 has been indicated as being of the four element type and in practice the usual cathode or filament 17, control grid or element 18, plate or anode 19, and a plate screen grid or fourth element 20. Screen 20 is positioned so as to prevent the plate 19 from capacitatively reacting upon the grid 18. The grid 20 is maintained at a positive potential with respect to cathode 17 and control grid 18, as by means of a connection to be presently described. A relay of this kind provides much higher voltage amplification than a relay of the usual three element type.

With a four element screened plate vacuum tube having a mutual conductance of about 300 and a plate resistance of about 10^6 ohms, I have secured efficient detecting action when employing a plate potential of from 90 to 180 volts, a control grid bias of about —7.5 volts and a positive screen grid potential of about 45 volts. When operated with these voltage values I have found that signal currents of relatively high intensity may be applied to the input circuit without causing distortion of the integrated current variations. The tube effects a marked amplifying action and integrated currents may be secured of greater intensity than may be secured from former types of detectors. Furthermore such an arrangement is comparatively sensitive to radio signals.

Because of the peculiar characteristics of the detector which I employ I am enabled to construct a satisfactory broadcast receiver which utilizes a single power amplifier tube between the detector and the translator or loud speaker. Thus not only have I simplified the apparatus by elimination of amplifier tubes, but the system which I have devised will reproduce voice modulations at any point within the voice frequency range without distortion. Since only one audio frequency coupling device is necessary, and since this coupling device need not be a magnetic step-up transformer, it may be designed so as to efficiently pass all voice frequencies. Tube distortion is minimized both because of the reduction in the number of tubes necessary, and because the detector operates more effectively.

Referring to the drawing I have shown the power amplifier tube 15 as being of the usual three element type having its input resistively coupled to the output circuit of detector relay 13. For example a coupling resistance 22 is shown as having one of its terminals connected to the plate 19 of detector 13, and its other terminal connected to a positive source of plate potential, such as a "B" battery 23. The usual blocking condenser 24 is inserted between the plate 19 and grid of tube 15, and this grid is provided with a negative bias by means of "C" battery 26 and leak resistance 27. The output circuit of amplifier tube 15 is likewise supplied with a suitable source of plate potential, such as the "B" battery 23. The screen grid 20 of detector 13 is connected to a suitable source of positive potential indicated for example by the "B" battery tap 28 and control grid 18 is biased negatively as by means of "C" battery 30. A resistance 29 has been shown as inserted between the source of positive potential and the screen grid 20, for a purpose which will later be described.

For supplying radio signal energy of carrier frequency to the detector 13, I employ radio frequency amplifying means as has been previously explained, and this amplifying means preferably includes one or more relays 11 which are of the four element type, or which are otherwise constructed so that their efficiency may be readily controlled. In the drawing I have illustrated a relay similar to the detector relay 13, and which likewise employs a screen grid 20 which eliminates the reactance of the plate upon the grid. The input of relay 11 is shown as associated with a suitable source of signal energy such as the antenna 31 and ground connection 32, preferably through the use of a selectively tunable coupling device 33. Instead of directly coupling the input of relay 13 to the output of relay 11, it is obvious that the radio signal energy may be repeated through one or more relays. The output of relay 11 is associated with a suitable source of plate potential, such as the "B" battery 23, the control grid 18 is preferably maintained under negative bias by means of "C" battery 34, while the screen grid 20 is preferably connected to an independent source of positive potential such as the "B" battery tap 28. A tube of this kind when employed for amplifying radio frequency currents, has a high value of mutual conductance and a relatively high amplification ratio. I have found that this amplification ratio may be varied between certain limits by varying the value of the positive potential upon grid 20. This phenomenon is made use of to provide means for limiting the intensity of radio signals repeated in the output circuit of relay 11, whereby for radio signals or carrier frequency of different strengths received from the signal source, the intensities of impulses repeated to the input of relay 13 will tend to remain substantially uniform. Assuming that the potential upon grid 20 is of correct value to secure high mutual conductance, then a decrease in the potential will cause a corresponding decrease in the mutual conductance.

To effect automatic control of the mutual conductance of relay 11 I provide means for effecting automatic variation of the positive potential applied to the screen 20 of relay 11, in accordance with intensity or strength of integrated current impulses. Before describing the preferred manner of accomplishing this result, it may be explained that I have found that the screen grid current of a detector tube such as previously described will vary in accordance with a variation in the detector plate current. For example for an increase in the input signal potential of the detector, there is a corresponding increase in the detector plate current, and this increase is accompanied by a marked increase in the screen grid current. Therefore for a change in the intensity or strength of a carrier frequency current being imposed upon the input of the detector, there is a corresponding increase in the screen grid current. This fact is utilized to effect an automatic control of the efficiency of tube 11. Thus I make the series resistance 29 of relatively high value so that proportional changes in potential of grid 20 of detector 13, will occur with variations in the screen grid current. The screen grids 20 of both tubes 11 and 13 are then interconnected as by means of conductor 36, so that a decrease in potential of the screen grid of tube 13 will effect a corresponding decrease in the potential impressed upon the screen grid of tube 11.

With a direct electrical connection between the screen grids 20, it is obvious that the potential

upon the screen grid of tube 11 might be varied in accordance with the audiofrequency currents in the output of detector 13, thus introducing distortion. To prevent audiofrequency impulses from reacting upon tube 11, I preferably utilize suitable filter means, such as an audible frequency choke 37 of high inductance inserted in series with conductor 36, and one or more condensers 38 are connected between conductor 36 and a source of neutral potential such as the negative "B" battery lead 39. A radio frequency choke 41 is also provided in order to prevent radio frequency currents reacting upon tube 11.

The operation of the above system may be briefly reviewed as follows: The system is adjusted so that for a signal of fair intensity, an adequate response will be produced in the translator. If signals of greater intensity are received, the screen grid current of relay 13 will tend to increase and thus cause the potential of the grid 20 of this tube to tend to decrease accordingly. Decrease in potential upon grid 20 of tube 13 effects a decrease in the potential upon grid 20 of tube 11, thus effecting a compensating reduction in the mutual conductance or the efficiency of tube 11. By proper proportioning of the parts, this compensation may be made such that there will be practically no increase in the response secured at the translator for an increase in the intensity of applied signals. The decrease in the efficiency of tube 11 does not cause distortion of repeated currents, since decrease in the potential upon grid 20 still permits the tube to operate on that portion of its characteristic curve which will not cause distortion. In a broadcast receiver the same magnitude of reproduction in the loud speaker may be secured for all stations whose signals are above a given minimum strength. Thus the power amplifier 15 and loud speaker may always be operated with current values which will be conducive to the best quality of tone production. Furthermore the only adjustment necessary for an operator is to tune the apparatus from one station to another. If it is desired to reduce the magnitude of reproduction for all stations, such an adjustment may be secured by varying the resistance value of resistor 29, or by inserting a battery in series in lead 36, or by any other adjustment which will not disturb the compensating action. It is of course understood that if the signals are very weak, the volume of reproduction will not be the same as for signals within the intensity range for which the system is designed to receive.

While tube 11 has been shown as being of the four element shielded plate type, it is obvious that I may employ any type of relay which is provided with means for readily varying its operating efficiency. For example I may employ a four element electron relay in which one element is employed as a means for minimizing the space charge. It is also possible to vary the efficiency of tube 11 by variation in the current flow in the output of detector 13, rather than by the variation in potential upon the screen grid 20 of this detector tube. Furthermore while I prefer to employ a detector tube of the four element type, it is possible to arrange a compensating system such as described above when utilizing an ordinary three element electron relay for detecting purposes.

I claim:

1. In a relay system, a source of varying currents, an electron relay having control, cathode and anode elements, an input circuit associated with the control and cathode elements and arranged to receive current variations corresponding to the variations of said source, an output circuit associated with the anode and cathode elements, and means including another conductive element cooperably associated with said first named elements for changing the mutual conductance of the relay inversely in response to a change in the intensity of current variations in said input circuit.

2. In a signal receiving system, a source of signal energy of carrier frequency, an electron relay having control, cathode and anode elements, an input circuit associated with said control and cathode elements and arranged to receive current variations corresponding to current variations of said source, an output circuit associated with the cathode and anode elements, another conductive element associated with said first named element for controlling the mutual conductance of the relay, a second relay having an input circuit arranged to receive current variations corresponding to the variations repeated in the output of the first named relay, and means cooperably associated with the second relay for impressing a potential upon said other conductive element, said means serving to decrease said potential in accordance with an increase in the intensity of signal energy received from said source.

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