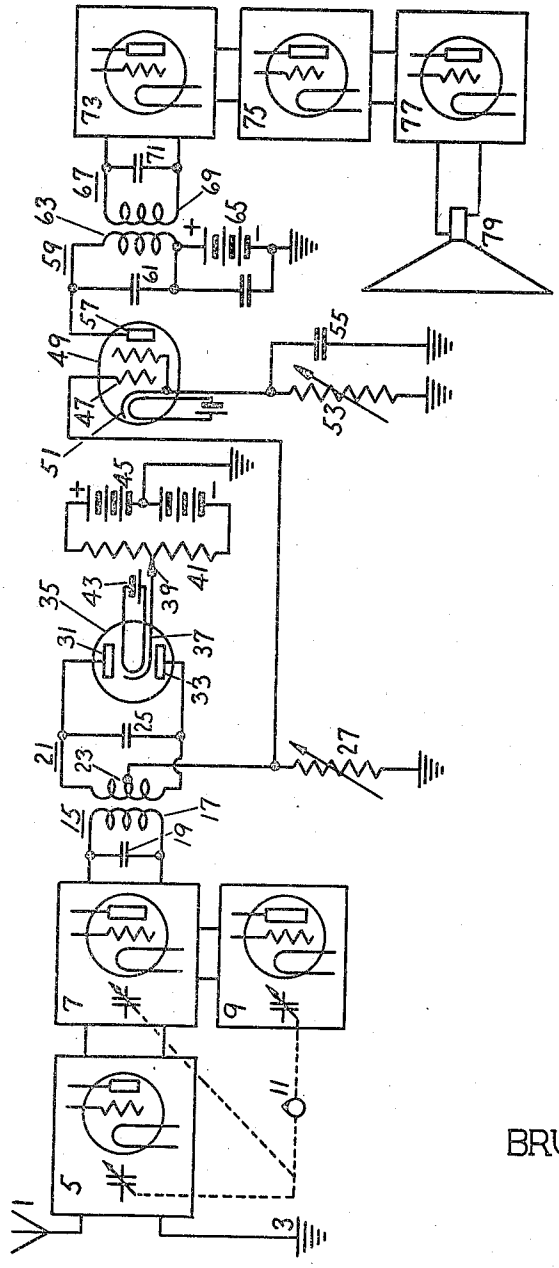
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RADIO SYSTEM

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RADIO SYSTEM

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Our invention broadly relates to radio systems. More specifically it relates to a radio receiving or transmitting system which may be limited in response to impressed voltages which lie outside of certain predetermined limits.

We are aware of thermionic tube limiters which operate on the anode bend of the anode current characteristic curve. Our invention employs a linear rectifier, and is further distinguished by a frequency doubling characteristic which may or may not be utilized. Our invention may be used to limit either the lower, or upper, or both lower and upper limits of response of a radio system.

One of the objects of our invention is to limit the response of a radio system to input voltages within a certain range and to eliminate the response for voltages exceeding this range. Another object is to establish an upper response limit. A further object is to establish a lower response limit. A still further object is to limit the response of a radio receiving system to normally desired signals and to greatly diminish the response to excessive interfering signals or atmospheric impulses.

The accompanying diagram illustrates our invention applied to a superheterodyne receiving system. While this example has been chosen by way of illustration, the invention is not limited to any particular system, but may be applied to tuned or untuned radio frequency receivers, radio transmitters and the like.

Referring to the accompanying figure an antenna 1 and ground 3 are connected to a tunable radio frequency amplifier 5. The output of the amplifier 5 is connected to the input of a first detector 7. The output of a local oscillator 9 is coupled to the first detector 7. The tuning controls may be unified as indicated by reference numeral 11. The output of the first detector is an intermediate frequency current which is established in accordance with the accepted theory of operation of a superheterodyne receiver.

The intermediate frequency currents flow in the resonant output circuit 15 which is connected to the first detector 7. The circuit 15 is composed of an inductor 17 and a capacitor 19 which is resonant to currents of intermediate frequency which may be designated as a radio frequency equalling f. The resonant circuit 15 is suitably coupled to a second resonant circuit 21. This circuit 21 is composed of an inductor 23 and a capacitor 25 resonant to currents of frequency f. A resistor 27 is connected from a center tap 29 on the inductor 23 to ground.

The anode electrodes 31, 33 of a full-wave rectifier 35 are connected to the terminals of the inductor 23. The cathode 37 is connected to the slider 39 of a potentiometer 41. The cathode may be of the filament type or of the heater type as shown. The cathode may be energized by a battery 43 or any suitable power source. The potentiometer 39 is connected to a biasing battery 45. A point intermediate the terminals of battery 45 is grounded.

The ungrounded terminal of the resistor 27 is connected to the control grid 47 of a radio or intermediate frequency amplifier tube 49. The amplifier tube may be of any conventional type but we prefer a tube having a sharp cut-off. The cathode 51 of tube 49 may be grounded through an adjustable self-bias resistor 53. A separate source of bias voltage may be used to advantage in some tubes. The resistor 53 is by-passed for high frequency currents by a capacitor 55. The anode 57 is connected to a resonant circuit 59 which is composed of a capacitor 61 and an inductor 63. This circuit 59 may be resonant to currents of frequency f or $2f$ as will be explained below. The inductor 63 is connected to the positive terminal of a B battery 65. The negative terminal of the B battery is grounded. The battery may be by-passed. It should be understood that either batteries or any conventional power source may be used to energize tubes 35 and 49 as well as the several parts of the receiver indicated by block diagrams.

The tuned circuit 59 is suitably coupled to another tuned circuit 67 composed of inductor 69 and capacitor 71. The tuned circuit 67 is preferably resonant to the frequency chosen for the preceeding circuit 59. The tuned circuit 67 is connected to an intermediate or radio frequency amplifier 73 which is in turn coupled to a second detector 75. The output of the second detector may be further amplified by an audio amplifier 77 and the amplified signals reproduced by a loudspeaker 79 or other signal indicator.

In the operation of the system illustrated by the foregoing description, it is first assumed that no bias is applied on the cathode 37 with respect to the anodes 31, 33 of the rectifier 35. It is further assumed that no signal currents are being received. Under the assumed conditions the steady voltage applied to the control grid 47 of tube 49 will be that developed across the self-bias resistor 53. This voltage is preferably adjusted so that the grid is established on the characteristic curve at a point where negative voltage

swings of desired signals will operate toward cut-off but will fall just short of that point.

Assuming desired signal currents start to flow in circuit **15** after the above described adjustment, currents of frequency *f* will be induced in resonant circuit **21**. These currents, being of alternating wave form, will be fully and substantially linearly rectified by the rectifier **35**. That is electrons from the cathode **37** will flow to the instantaneously positive anode, through half the inductor, through the resistor **27** to ground and returning through ground to the cathode **37**. The currents flowing through the resistor **27** will be pulsating at a frequency equal to 2*f*. The grounded terminal of the resistor **27** being of positive polarity and the opposite terminal being negative when current flows.

Thus the control grid **47** connected to the upper terminal of the resistor **27** can be driven from zero or ground to increasingly negative potentials but never more positive than ground. Thus currents of frequency *f* or 2*f* may be created in the output circuit of the amplifier **49**. If an excessive current impulse, which may be derived from atmospheric or man-made static, is received, the current impulse will be rectified. The rectified currents will establish voltages which will drive the control grid so negative that the anode current will be cut-off and no signal or atmospheric disturbances will be created or received in the final signal indicator. With the foregoing adjustments weak and normally desired signals will be received but excessive impulses will block the system.

Since the currents of frequency 2*f* are applied to the control grid, the resonant circuit **59** connected to the anode **57** may be tuned to currents of either *f* or 2*f*. Because of certain advantages in preventing shock excitation, over all transfer, and in increasing selectivity, we prefer to employ circuits resonant to currents of frequency 2*f*. If a single frequency *f* is to be used a half wave rectifier may be substituted for the full-wave rectifier **35**.

If the slider **39** is adjusted to bias the cathode **37** slightly positive with respect to the anodes **31**, **33**, signals or impulses whose voltage peaks do not exceed the bias will produce no rectified current. Thus a lower limit of response is established. Desired signals whose voltage exceed the bias will be reproduced up to the upper response limit which is determined as before. Thus by biasing the rectifier so that it will be inoperative for voltages below a predetermined limit and by adjusting the high frequency amplifier cut-off characteristic, lower and upper response characteristics may be determined for the system. Signals or impulses inside these limits will be reproduced and those outside the predetermined limits will be eliminated.

It should be understood that the rectifier may be biased so that its anodes are positive with respect to cathode by an appropriate adjustment of the slider **39** on the potentiometer **41**. With positively biased anodes and a full wave rectifier, incoming voltages below the bias will increase the current in one half the rectifier and decrease the current in the other half of the rectifier. These effects balance each other.

Therefore, no signals are impressed on the high frequency amplifier until the incoming voltages exceed the bias when the balancing will no longer hold true. The desired signals will be reproduced in the output circuit of the amplifier when the signal potentials exceed the bias. If excessive signals or impulses are applied, the rectified currents will establish pulsating voltages which will drive the amplifier to cut-off and prevent the establishment of alternating currents in the amplifier output circuit.

Although we prefer the full wave rectifier system our invention is not limited to any particular type of rectifier. Likewise while we have illustrated tuned or resonant input and resonant output circuits, aperiodic or non-resonant circuits may be employed. In a similar manner any number of equivalent radio frequency networks may be used in place of the inductively coupled tuned circuits which we have selected merely by way of example.

We claim:

1. In a radio frequency amplifying system, an input circuit, means for impressing radio frequency currents on said input circuit, a full wave rectifier for rectifying said currents, means for deriving pulsating voltages of radio frequency from said rectified currents, means for amplifying said pulsating radio frequency voltages, an output circuit for said amplifying means, and means for adjusting said amplifying means so that said voltages establish radio frequency currents of twice the frequency of the first mentioned currents in said output circuit and currents applied to said input circuit exceeding a predetermined value will be substantially reduced in said output circuit.

2. In a device of the character of claim 1, means for tuning said output circuit to resonate to currents of double the frequency of said first mentioned currents.

3. In a device of the character of claim 1, means for tuning said output circuit to resonate to currents of the frequency of said first mentioned currents.

4. A radio frequency system comprising an input circuit, means for impressing radio frequency currents on said input circuit, means for rectifying both positive and negative phases of said radio frequency currents, means for adjusting said rectifier to prevent rectification of currents below a predetermined value, means for deriving pulsating voltages of radio frequency from said rectified currents, a thermionic amplifier having grid and anode circuits, an output circuit for such amplifier means for impressing said pulsating radio frequency voltages on said grid circuit, means for deriving radio frequency currents in said anode circuit, and means for adjusting said amplifier so that pulsating voltages within certain limits are amplified and pulsating voltages exceeding said limit cut-off the current in said anode circuit.

5. In a device of the character of claim 4, means for tuning said output circuit to resonate at the frequency of the first mentioned currents.

6. In a device of the character of claim 4, means for tuning said output circuit to resonate at double the frequency of the first mentioned currents.

7. In a radio system, an input circuit, means for impressing radio frequency currents on said input circuit, means for rectifying said currents, means for deriving pulsating voltages from said currents, means for converting said pulsating voltages into radio frequency currents of double the first mentioned frequency, and means for adjusting said converting means so that voltages in excess of predetermined limits will substantially block said converting means.

8. The method of transferring desired signal

currents and attenuating currents exceeding said desired signal currents in a radio frequency system which comprises rectifying said currents, deriving pulsating voltages from said rectified currents, converting said pulsating voltages into radio frequency currents of double the frequency of said signal currents, and substantially blocking said radio frequency system for currents exceeding said desired signal currents.

9. The method of transferring desired signal currents and attenuating currents exceeding said desired signal currents in a radio system which comprises rectifying both positive and negative phases of said currents, deriving pulsating voltages from said rectified currents, converting said pulsating voltages into radio frequency currents, and substantially blocking said radio frequency system for currents exceeding said desired signal currents.

10. The method described in claim 8 further characterized by the step of preventing the rectification of currents below a predetermined value.

11. In a radio frequency amplifying system, an input circuit, means for impressing radio frequency currents on said input circuit, a thermionic amplifier, and coupling means for transmitting such radio frequency currents to said amplifier comprising a rectifier for rectifying said currents, a load circuit associated with said rectifier comprising an impedance, said rectifier and said impedance being so constructed and arranged as to produce negative pulsating radio frequency voltages across said load circuit which are a function of the radio frequency impressed on said input circuit, means including a self-biasing resistor for applying to the grid of the amplifier a biasing potential of predetermined value relative to cut-off and for varying the value of said biasing potential means for conductively connecting the grid of the amplifier to one end of said impedance, and a conductive circuit between the other end of said impedance and said self biasing resistor for connecting said impedance with the cathode of said amplifier whereby said grid will pulsate at radio frequency in a sense negative with respect to said cathode but will not pulsate in the positive sense with respect to said cathode to make the bias of the grid less negative with respect to cut-off than that determined by the value of said biasing potential, whereby the current in the plate circuit of said amplifier will be limited between zero and a maximum which is determined by the value of said biasing potential.

12. A structure as specified in claim 11, in which said coupling means includes a half wave rectifier and a variable resistor so connected that the grid of said thermionic amplifier will pulsate at the same radio frequency as that impressed upon said input circuit.

13. A structure as specified in claim 11, in which said coupling means includes a double wave rectifier and a variable resistor so connected that the grid of said thermionic amplifier will pulsate at a radio frequency double that of the radio frequency impressed on said input circuit.

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