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CURRENT LIMITING DEVICE

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Fig. 1.

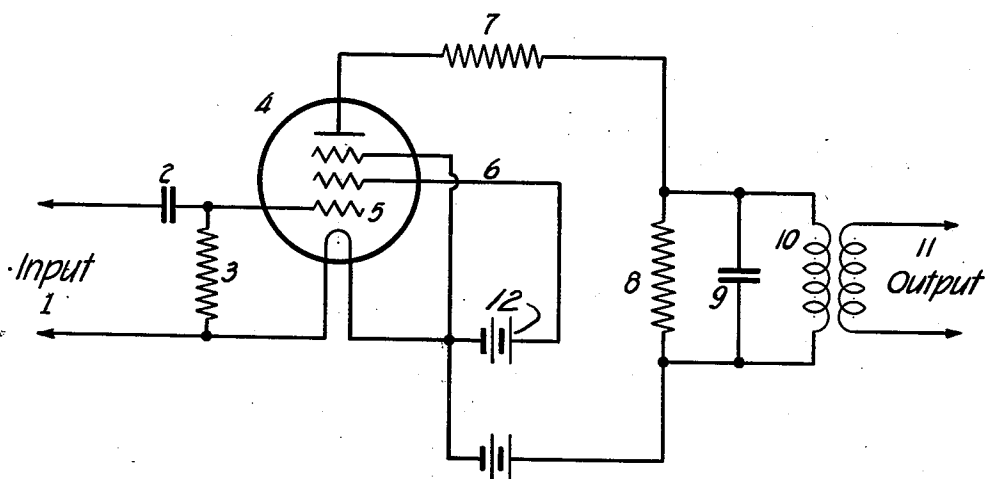
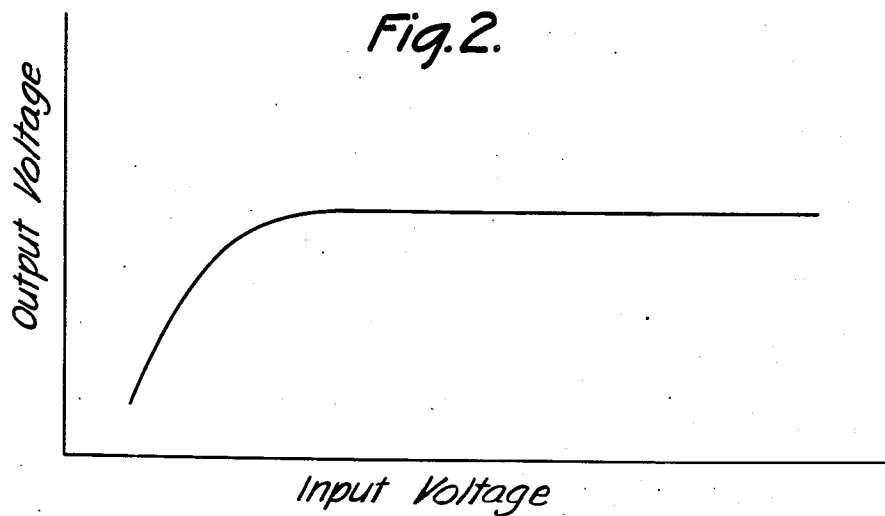


Fig. 2.



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CURRENT LIMITING DEVICE

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7 Claims. (Cl. 178-44)

This invention relates to improvements in current limiters for use in radio signaling particularly adapted for use in systems employing frequency modulation.

The object of the invention is to provide more effective limiting action in frequency modulation receivers, particularly those employed in the broadcast service, wherein the limiter is subjected to a variety of types of disturbances, having differing electrical characteristics.

Fig. I illustrates the arrangement of the limiter circuit; and

Fig. II shows the characteristic for various applied voltages.

These figures will be referred to hereinafter.

One of the essential steps in the process of receiving frequency modulation signals is the effective removal of changes in amplitude of the radio frequency current before undertaking the conversion of the changes in frequency which carry the signaling intelligence into changes in amplitude which may then be detected in the usual way. The changes in amplitude which must be removed may have had their origin in the transmitter circuits, in the propagation through the intervening medium, in the receiving circuits prior to the limiter, or they may be caused by the superposition of electrical disturbances of all sorts, varying in character from the continuous wave of another frequency modulated station to the extremely intermittent and isolated pulses caused by the ignition systems of automobiles or the sparking contacts of electric razors.

The limiter characteristics which are desirable are that it shall reach its maximum output with a minimum applied voltage, and that the output shall remain constant thereafter regardless of the input voltage applied. It must also have the characteristic that if subjected to disturbances of the impulse type of greater strength than the signal, so that the output of the limiter for the signaling current is blocked thereby, that the period of recovery from the paralysis shall be a minimum.

I have discovered experimentally that the arrangement shown in Fig. I meets these requirements. Referring now to this figure, 1 represents the input to the limiter which would ordinarily be the last intermediate frequency amplifier of a superheterodyne receiver, 2 represents a small series capacity of the order of 100 micro-microfarads; and 3 a grid to cathode resistor having a resistance of about 10,000 ohms. 4 is a pentode amplifier tube having in

its plate circuit a series resistance 7 which may vary from the order of 10,000 ohms to a considerably higher value depending on the characteristics of the tube and the plate voltage used.

9, 10 represent the tuned plate load circuit with the loading resistance 8 in parallel thereto, and 11 represents the limiter output circuit. The screen grid 6 is preferably maintained at a relatively low voltage—of the order of 45 volts, as by a battery 12. The plate voltage depends to a considerable extent on characteristics of the tube, but by proper selection of the series resistance 7 and the plate voltage the output of the limiter may be maintained constant over wide ranges of input voltage, as shown by the curve of Fig. II.

The operation of the limiter device is as follows. On the negative excursions of the grid potential, the decrease in the plate current is limited by zero value, i. e., complete cutoff. On the positive excursions of the grid potential, the increase in the plate current is limited by the voltage drop across the resistance 7, which reduces the plate potential to the order of the screen voltage or less. By proper selection of screen and plate voltages and the series resistance 7, the limiting action on the positive side may be maintained constant over a wide range of input voltages. So long as the peak value of the disturbances does not exceed approximately 50% of the peak signal voltage, the limiter will operate in accordance with the characteristic of Fig. II.

When the peak value of the disturbances exceeds the signal level, the effect is to cause the disturbances to become the current which is limited and the signal to be the current which is wiped out. The peak value of ignition disturbances may be large compared to the signal level, although the relative amounts of energy may be small compared to the signal in any given time interval, since the duration of an oscillation set up by the individual ignition spark is short. Wherever a condenser is connected in series with the grid of a vacuum tube and such type of oscillation applied to the grid circuit, the rectified current which charges the condenser may remain in the condenser to affect the operation of the tube as a limiter for a period much in excess of the duration of the disturbance. It is important, therefore, to make the time constant of the discharge path low, which is effected by making the condenser 2 small and the shunt resistance 3 much lower than the value of an ordinary grid leak.

The low shunt resistance has the additional

effect of keeping the input impedance substantially constant regardless of the changes in the input voltage.

I have described what I believe to be the best embodiments of my invention. I do not wish, however, to be confined to the embodiments shown, but what I desire to cover by Letters Patent is set forth in the appended claims.

I claim:

1. In a receiver for receiving frequency modulated signal currents of radio frequency, in combination, an electron discharge limiter tube having a cathode, a control grid and a plate, means for applying a band of the frequency modulated signal currents between the control grid and cathode of the tube, said means comprising a condenser having a small capacity value connected in series with the grid of the tube and a conductive connection between the grid and cathode of the tube; and means associated with the plate circuit of the limiter tube for limiting the amplitude of the plate current impulses in the positive direction to a desired maximum value.
2. The combination as set forth in claim 1 in which the conductive connection comprises a resistor, the time constant of said condenser and resistor having a small value.
3. The combination as set forth in claim 1 in which the conductive connection consists of a resistor having a small resistance value, whereby the input impedance across the grid and cathode of the tube remains substantially constant throughout a wide range of variations in the applied input voltage.
4. In a receiver for frequency modulated signal currents of radio frequency, means for limiting the amplitude of the radio frequency signal currents, said means comprising the combination of an electron discharge limiter tube having a cathode, a control grid, a screen grid and a plate, means for applying a band of the frequency modulated signal currents between the control grid and cathode of the tube, means for applying a substantially steady positive potential to the screen grid, and an output circuit connected between the plate and cathode, said output circuit comprising the series connection of a resistor, a coupling reactor and a source of positive plate potential said resistor being arranged to limit the amplitude of the plate current impulses in the positive direction to a desired maximum value.
5. The combination as set forth in claim 4 in which the value of said resistor is such as to reduce the value of the plate voltage to substantially that of the screen grid for maximum values of the plate current.
6. The combination as set forth in claim 4 in which the means for applying a band of signal currents between the control grid and cathode comprises a circuit having a small time constant, and in which the coupling reactor in the output circuit forms a portion of a parallel resonant circuit.
7. In a device for limiting frequency modulated radio frequency signal currents, the combination of a screen grid tube having input and output circuits for said currents, a series condenser and a grid to cathode resistor in said input circuit, the capacity of said condenser and the resistance of said resistor being so related to each other as to provide a time constant of such low value that the period of recovery of the limiting device from paralysis due to disturbances of the impulse type of greater strength than the signal is reduced substantially to a minimum, the output circuit of the tube having a resistor in series with the plate, means for applying positive potentials to the screen grid and the plate, the resistance of said plate resistor being so proportioned with reference to the screen and plate voltages that the output voltage of the tube remains substantially constant for a wide range of applied signal voltages.

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