Dec. 5, 1939. W. VAN B. ROBERTS 2,182,322

WAVE LIMITER CIRCUIT

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Fig. 1

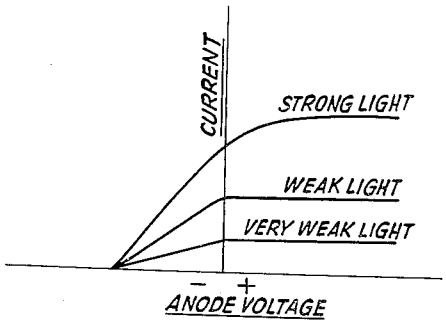
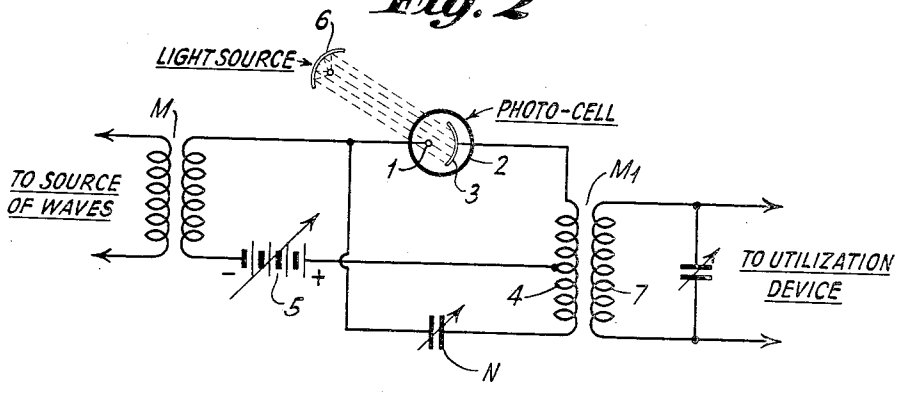


Fig. 2



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WAVE LIMITER CIRCUIT

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11 Claims. (Cl. 250—41.5)

My present invention relates to electric wave limiters, and more particularly to a wave transmission network employing a novel limiter device.

The main object of my present invention is to provide a wave translating device possessing sharply defined limiting action.

A more particular object of my invention is to provide such a device especially for alternating voltages which are filtered by passage through resonant circuits after passing the limiting device.

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.

Fig. 1 shows a family of anode voltage-current curves characteristic of the limiter device.

Fig. 2 schematically represents a wave transmission circuit employing the invention.

The limiter device itself is based upon known properties of a high vacuum photocell. If the current through such a cell is plotted against the voltage across the cell, it is known that for very weak illumination of the cell by monochromatic light the current is zero for a small negative potential of the anode with respect to the cathode. The current is constant for anode voltages in excess of a small value which may be taken as substantially zero. Thus, the characteristic is sharply limited at both ends as shown in the lowest curve of Fig. 1. If the light is very strong there may be sufficient space charge effect inside the photocell to require more voltage on the anode to insure saturation current as shown in the upper curve of Fig. 1, thus reducing the sharpness of the top knee of the curve. On the other hand, the sharpness of the lower knee is diminished if a wide range of light frequencies is used instead of the monochromatic light assumed above. This is because the amount of negative potential required on the anode completely to shut off the current through the cell depends upon the frequency of the light, and not at all upon its intensity.

The limiter device of this invention may be used as a distorting device, or to pass alternating currents without appreciable distortion, according to the adjustment of the operating bias on the cell. If the bias is adjusted to bring the operating point upon the most linear part of the characteristic, weak currents will be passed without appreciable distortion.

Fig. 2 shows a wave transmission circuit employing the limiter device. The wave source, which may be a signal collector (antenna circuit) or a tuned radio frequency amplifier, is coupled at M to the anode 1 of the high vacuum photocell 2. The electron emitter element 3 is connected to the primary of the coupling transformer M_1. The anode 1 is connected to the midpoint of the primary winding 4, through a path including the secondary winding of coupling transformer M and the adjustable negative biasing voltage source 5. The anode is further connected, for a reason to be given later, to the opposite side of coil 4 through a condenser N. A light source 6 provides light for exciting the emitter 3. The tuned circuit 7 follows the limiter device, and it is to be understood that the circuit 7 may feed amplifiers, or other utilization devices.

If the impressed voltage is sufficient to overshoot the linear part of the curve, the current peaks are limited as to amplitude and distortion occurs. However, in the case of high frequency currents a subsequent filtering out of the resulting harmonics may be employed to reduce the effect of such distortion. It can be shown that in the case of perfect limiting, such as would be obtained if the curves of Fig. 1 were straight lines running from zero current to a constant saturation value, the fundamental component of output current reaches substantially a saturation value about 27 percent higher in amplitude than the saturation value of the limiting device; and reaches this value when the input to the device is about twice the voltage required to reach the saturation current of the device.

The limiter device of the present invention may also be used as a distorting device, such as a detector, by adjusting the operating bias, for example, to bring the operating point to the bottom of the curve. In this case ordinary rectification will take place for voltages less than the value required to reach the upper knee of the curve, while for greater voltages the rectified output approaches a definite limit equal to one-half the saturation current. This characteristic in a detector is a safeguard against abnormally high voltages in an audio system, such as are often produced during severe static disturbances, or the like.

Of course, where the photocell 2 acts as a detector, the output circuit will be an audio network.

In order to avoid the passage of currents through the inherent capacity of the photocell, a bridge circuit may be used as shown in Fig. 2. Here the neutralizing condenser N is adjusted to balance out the effect of the tube capacity so that the output current to the utilization device is solely the current that passes through the cell by virtue of its illumination. It should be noted in passing that the amount of current passed, other things being equal, may be adjusted, or controlled, by the intensity of illumination of the

cell. The photocell 2 may be of any well known type. Since the high vacuum photocell, and the properties thereof, are well known to those skilled in the art, it is believed the present general description is sufficient.

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. An electric wave limiter circuit comprising a photoelectric emission vacuum cell and a load circuit, means for impressing electric wave energy modulated in accordance with signals upon said cell and load circuit in series, means for neutralizing with respect to said load circuit the flow of wave energy through the distributed capacity of said cell and connections thereto, a source of direct current in series with said load and cell, a source of steady intensity illumination for producing a predetermined saturation emission current from an electrode of said cell, said direct current source being adjusted to produce across said cell a voltage approximately equal to the maximum peak voltage produced by said modulated waves while said illumination is adjusted to provide a saturation emission current of substantially twice the current produced by said direct source alone.

2. A source of modulated wave energy subject to additional interfering energy peaks of relatively large amplitude, a photoelectric cell and a utilization circuit in series, and a source of steady intensity illumination for said cell, said illumination being so adjusted that voltages in excess of the maximum peak amplitude of said waves produce saturation current through said cell, whereby said utilization circuit is protected from current impulses, resulting from said interfering energy, substantially in excess of the current amplitude produced by said modulated waves.

3. In a circuit for the transmission of high frequency signal-modulated oscillations, input and output circuits, means interposed between said circuits to limit the amplitude of said signal modulated oscillations, comprising a photo-electric cell of the type having only two electrodes, an anode and a cathode, and which requires relatively low anode potentials for producing saturation current, a source of illumination of constant intensity for said cell, means to adjust the anode potential of the cell, and means to neutralize the effect of capacity in shunt to said cell.

4. In a wave transmission system, a source of high frequency signal-modulated waves, a wave utilization circuit, means coupling the source and circuit comprising a photocell of the type having only two electrodes, an anode and a cathode, and which requires relatively low anode potentials for producing saturation current, a source of illumination of constant intensity for said cell, and means for adjusting the anode potential of the cell to a predetermined operating point on its characteristic.

5. In a wave transmission system, a source of high frequency signal-modulated waves, a wave utilization circuit, means coupling the source and circuit comprising a photocell of the type having only two electrodes, an anode and a cathode, and which requires relatively low anode potentials for producing saturation current, a source of illumination of constant intensity for said cell, a variable source of anode potential whereby the cell may be operated at a predetermined point on its characteristic, and means to neutralize the inherent capacity of the cell.

6. In a wave transmission system, a source of high frequency signal-modulated waves, a wave utilization circuit, means coupling the source and circuit comprising a photocell of the type having only two electrodes, an anode and a cathode, and which requires relatively low anode potentials for producing saturation current, a source of illumination of constant intensity for said cell, means for biasing the anode the cell to a predetermined point on its characteristic, and said coupling means comprising a bridge circuit in which the photocell is included.

7. In combination with a source of high frequency signal-modulated electric waves, a load circuit, a limiter device to limit the amplitude of current variations passing to the load circuit, said device comprising a photo-electric cell of the type having only two electrodes, an anode and a cathode, and having an input voltage-output current characteristic wherein the difference between the voltages of zero current and saturation current is relatively small.

8. In combination with a source of high frequency signal-modulated electric waves, a load circuit, a limiter device to limit the amplitude of current variations passing to the load circuit, said device comprising a photo-electric cell of the type having only two electrodes, an anode and a cathode, and having an input voltage-output current characteristic wherein the difference between the voltages of zero current and saturation current is relatively small, and means for initially biasing the anode of the cell negative.

9. In combination with a source of high frequency signal-modulated electric waves, a load circuit, a limiter device to limit the amplitude of current variations passing to the load circuit, said device comprising a photo-electric cell of the type having only two electrodes, an anode and a cathode, and having an input voltage-output current characteristic wherein the difference between the voltages of zero current and saturation current is relatively small, and means for neutralizing the inherent capacity of the cell.

10. In combination with a source of high frequency signal-modulated electric waves, a load circuit, a limiter device to limit the amplitude of current variations passing to the load circuit, said device comprising a photo-electric cell of the type having only two electrodes, an anode and a cathode, and having an input voltage-output current characteristic wherein the difference between the voltages of zero current and saturation current is relatively small, and means for biasing said cell to a point on its characteristic such that it operates as a detector.

11. In a wave transmission system, a source of high frequency signal-modulated waves, a wave utilization circuit, means coupling the source and circuit comprising a photocell of the type having only two electrodes, an anode and a cathode, and which requires relatively low anode potentials for producing saturation current, a source of illumination of constant intensity for said cell, means for biasing the cell to a predetermined point on its characteristic, said predetermined point being chosen to permit the cell to transmit waves without distortion.

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