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R. ANDRIEU

2,204,061

MODULATOR CIRCUIT

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Fig. 1

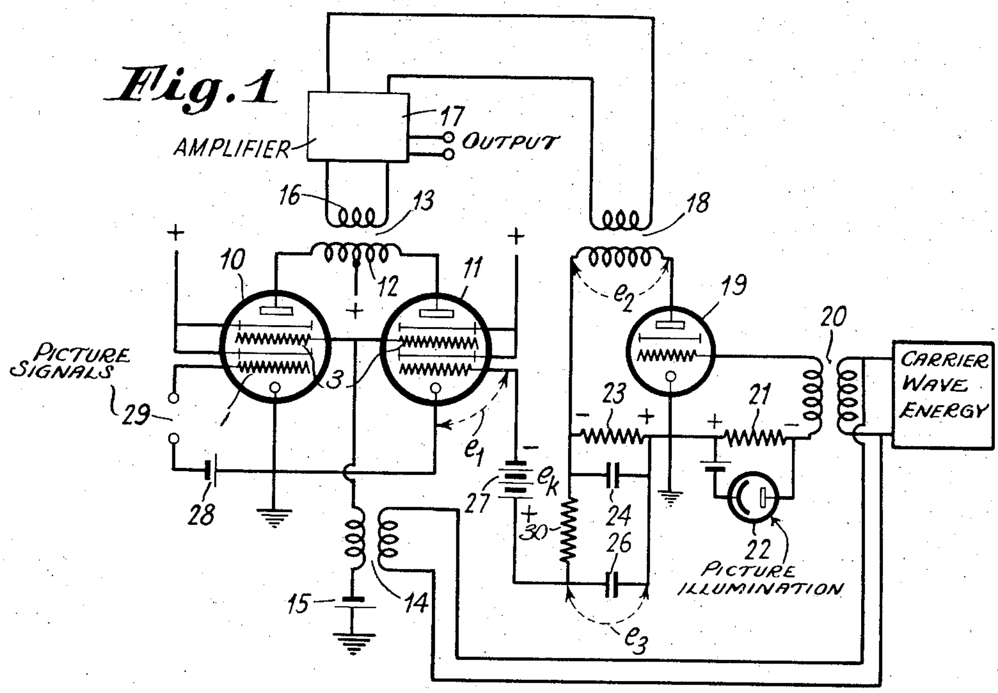
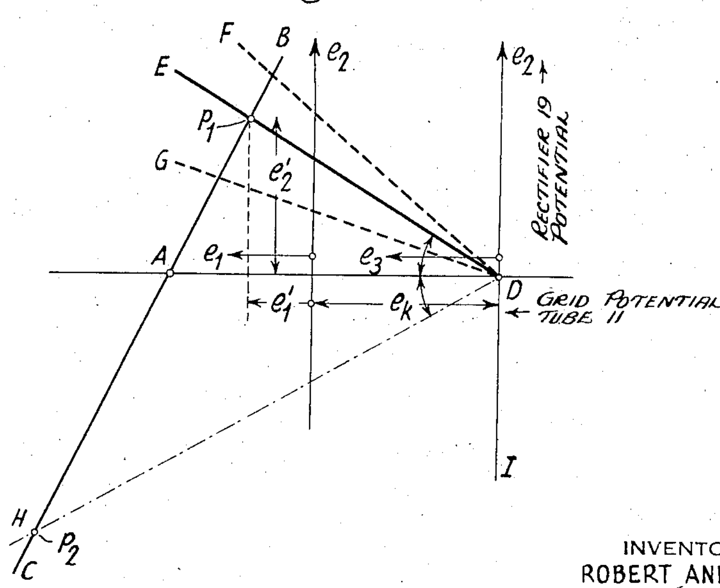


Fig. 2



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2,204,061

MODULATOR CIRCUIT

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In Germany November 30, 1935

8 Claims. (Cl. 178—7.1)

This invention relates to transmitters, and more particularly, to balanced modulators particularly adapted for variable carrier control transmission systems such as are used in television transmission. It is an improvement upon copending application Serial No. 95,519, filed August 12, 1936 by Rudolf Urtel and entitled "Arrangement for amplitude modulation."

In copending patent application Ser No. 95,519, filed Aug. 12, 1936, by Rudolf Urtel there is described a circuit arrangement for amplitude modulation whereby the difference is formed of two alternating currents of the carrier frequency and one or both alternating currents are besides subjected, due to the slow variation of the properties of the modulation arrangement, to a regulation depending on the size of the output amplitude of the modulation arrangement. For this purpose a rectifier is provided at output end of the modulation arrangement and the direct potential produced by it is connected in opposition to a compensation potential which latter itself may be caused to be a function of the average density of a picture to be transmitted for television purposes. The state of balance of the modulation arrangement may be adjusted in this case either by the amplitude of the compensation potential or by the amplitude of the potential furnished by rectifier at the modulation potential.

In accordance with the invention the average density of a television picture is to be televised in an arrangement of this type by influencing the sensitiveness of the rectifier, in contrast to the proposal made in parent patent to vary the amplitude of the compensation potential by means of the average density. By sensitiveness of the rectifier is understood in this connection the ratio of output potential of rectifier to its input potential, that is the proportion of direct potential value on rectifier output side to effective value of the alternating potential at its input side.

An embodiment of invention is illustrated in Fig. 1 of the drawing, while Fig. 2 shows graphically the potential relationships as an aid in explaining the principle of operation of my invention.

10 and **11** therein designate two hexodes whose anodes are connected to the two terminals of the primary **12** of a transformer **13**, the midpoint of primary being connected to the positive pole of anode potential source. Grids **3** of both hexodes are interconnected and grounded through the secondary of a transformer **14** as well as a negative biasing potential source **15**. Secondary **16** of transformer **13** is connected to the plate circuit of a rectifier tube **19** through an alternating current amplifier **17** and a further transformer **18**. In the control grid circuit of tube **19** is connected another transformer **20** and a resistance **21** which is fed by a photocell **22**. The plate circuit of tube **19** contains a resistance **23** and in parallel thereto a condenser **24** as well as further filter members **25**, **26** and **30**. The left coating of condenser **26** is connected with grid **1** of tube **11** through a constant compensation potential source **27**, while grid **1** of tube **10**, being besides impressed with a negative grid biasing potential **28**, receives the modulation potential at terminals **29**.

The mode of operation of arrangement according to Fig. 1 is as follows: Primary of transformer **14** is impressed with a potential of carrier frequency resulting in the flow of an anode alternating current in the two tubes **10** and **11** of carrier frequency in the manner that the plate alternating current of tube **10** is modulated by modulation potential **29** while the one of tube **11** is of constant size as long as the potential e_1 at its grid **1** is constant. In primary **12** both plate alternating currents, of equal phase, act in opposition to one another, with the result that the difference of the two plate alternating potentials appears at secondary **16**, that is an alternating potential which is modulated to a much higher degree than the plate alternating current of tube **10**. This potential is fed through amplifier **17** and transformer **18** to rectifier **19**, a direct potential being thus formed at resistance **23** corresponding to the prevailing carrier amplitude. The height of this direct potential depends however, no attention being paid for the time being to transformer **20**, on the size of the negative grid biasing potential at resistance **21**. In consequence, potential e_1 at grid **1** of tube **11** depends likewise on the potential at resistance **21**. Hence, rectifier tube **19** furnishes, with a definite pre-given value of the alternating potential transmitted through transformer **18**, a direct potential that is the smaller the greater the potential drop at resistance **21**, that is the greater the average density of the television picture measured by photocell **22**.

A graphical explanation of the mode of operation of arrangement according to Fig. 1 may be explained with aid of Fig. 2. In this diagram the line BC shows the relationship between the actual potential between the grid of tube **11** and the cathode represented by e_1 and the voltage induced across the secondary of the transformer 18 represented by e_2. It will be noted that the line BC intersects the abscissa at the point A and this represents the point where the potential difference between the grid and cathode of tube 11 is identical with the potential difference between the grid and cathode of tube 10. Under these conditions, the output of the plate circuit across the primary 12 is, of course, zero, since the amplitudes of the plate current are identical and in phase opposition. Consequently, the magnitude of the voltage e_2 is zero, since no voltage is fed to the amplifier 17. However, when the potential e_1 decreases, the balance is destroyed and the output of the tube 11 predominates over the output of the tube 10 to produce a magnitude of voltage e_2 which lies above the abscissa. Conversely when the magnitude of the voltage e_1 increases beyond that value indicated by the point A, then the output of the tube 10 predominates over tube 11, and since this is in anti-phase relationship with the output previously, the magnitude of the voltage e_2 is negative compared to its previous value. The slope of the line BC, therefore, is determined by the amplification factor of tubes 10 and 11 and the amplifier 17. However, when the voltage e_2 is impressed across the detector 19 a rectified potential appears across the resistance 23 and this potential, after being suitably filtered, appears across the condenser 26 as a voltage e_3. This voltage is added in series to the bias battery e_k and the sum of these two voltages, of course, is equal to e_1, that is to say, the potential difference between the grid and cathode of tube 11. It will be noted, therefore, that the voltage e_3 is proportional to the voltage e_2 as is well known. That is to say that the rectified filtered voltage e_3 will be proportional to the impressed alternating voltage e_2 and as e_2 increases, e_3 likewise will increase and the proportionality factor will depend on the circuit constants 23 and the internal plate impedance of the tube 19. Since the internal plate impedance of the tube 19 is determined by the bias across the resistor 21 in the grid circuit of tube 19, it will be evident that the proportionality factor between e_2 and e_3 will be determined by the potential across the resistor 21. In the diagram, therefore, the line DE represents the proportionality between e_2 and e_3 for a given potential difference across the resistor 21. The slope of this line will assume the position DG or DF in accordance with whether the potential across the resistor 21 increases or decreases. It will thus be noted that by placing the origin of the line DE on the abscissa spaced a distance equal to the potential e_k of the bias battery 27 the intersection of the line DE with BC will give the operating point of the balanced bridge modulator comprising the two tubes 10 and 11. Accordingly, since the amplitude of the carrier is determined by this intersection point P_1, it will readily be perceived that the amplitude of the carrier will vary in accordance with the potential drop across the resistor 21. Where the potential across this resistor is such as to reduce the sensitivity of the rectifier 19, then the operating point is determined by the inter-section of the line DG and BC and accordingly, gives a lower amplitude of the carrier, while when the potential across the resistor 21 is such as to increase the sensitivity of the rectifier 19, then the intersection of the line DF or BC determines the carrier amplitude, and it will be noted that this carrier amplitude is greater than that provided at the operating point P_1 or the intersection of DG. Since the potential across the resistor 21 is dependent upon the illumination falling across the photocell 22 and this illumination in turn depending upon the average density of the film, it is clear that the amplitude of the carrier is determined in accordance with the average value of the film.

Transformer 20 whose primary is supplied by the same potential as the primary of transformer 14, a phase changer being connected under given conditions in series with one or both transformers, has the purpose to open rectifier 19 only with that phase position of potential e_2 that corresponds to arm A—B in Fig. 2. As such, rectifier 19 can actually supply a direct potential with the predominance of the current of tube 11 as with that of tube 10. But this means nothing else but that with predominance of the current of tube 10, corresponding as above explained to arm A—C, a direct potential is furnished according to the dash-dotted line D—H. The angles formed with horizontal axis in Fig. 2 by line D—E on the one hand, and by line D—H on the other hand, are here equal. Now, the condition of equilibrium for the modulation arrangement would now be sufficed also for point of intersection P_2 but a closer observation shows that point of intersection P_2 is unstable but P_1 stable. It will be appreciated that the reason why an intersection below the abscissa is unstable is due to the fact that as the slope of the line ED decreases, the amplitude also decreases until it becomes zero. Any further decrease would immediately cause the amplitude to increase again and to avoid this, an alternating potential of carrier frequency is introduced through transformer 20 in the control grid circuit of tube 19 so that characteristic I—D—E is valid for the rectifier and not characteristic H—D—E with positive and negative alternating potentials e_2.

Having described my invention, what I claim is:

1. In a balanced bridge modulator, the method of varying the sensitivity of the bridge which comprises deriving from the bridge carrier wave energy modulated by signalling energy representative of an optical image to be transmitted, rectifying a portion of the derived carrier wave energy, controlling the rectification in accordance with the average value of illumination of the optical image to be transmitted, and varying the balance of the bridge in accordance with the rectified portion of the derived carrier wave energy.

2. A variable sensitivity balanced bridge modulator comprising means for deriving from the bridge carrier wave energy modulated by signalling energy representative of an optical image to be transmitted, means for rectifying a portion of the derived carrier wave energy, means for controlling the rectification in accordance with the average value of illumination of the optical image to be transmitted, and means for varying the balance of the bridge in accordance with the rectified portion of the derived carrier wave energy.

3. In a balanced bridge modulator, the method of varying the sensitivity of the bridge which comprises deriving from the bridge carrier wave energy modulated by signalling energy representative of an optical image to be transmitted, rectifying a portion of the derived carrier wave

energy, controlling the rectification in accordance with the average value of illumination of the optical image to be transmitted, and feeding the rectified portion of the energy in series with a constant source of energy to the bridge to vary the balance point of said bridge in accordance with the average value of illumination of the optical image to be transmitted.

4. A variable sensitivity balanced bridge modulator comprising means for deriving from the bridge carrier wave energy modulated by signalling energy representative of an optical image to be transmitted, means for rectifying a portion of the derived carrier wave energy, means for controlling the rectification in accordance with the average value of illumination of the optical image to be transmitted, and means for feeding the rectified portion of the energy in series with a constant source of energy to the bridge to vary the balance point of said bridge in accordance with the average value of illumination of the optical image to be transmitted.

5. In a balanced bridge modulator, the method of varying the sensitivity of the bridge which comprises deriving from the bridge carrier wave energy modulated by signalling energy representative of an optical image to be transmitted, rectifying a portion of the derived carrier wave energy, photoelectrically controlling the rectification in accordance with the average value of illumination of the optical image to be transmitted, and varying the balance of the bridge in accordance with the rectified portion of the derived carrier wave energy.

6. A variable sensitivity balanced bridge modulator comprising means for deriving from the bridge carrier wave energy modulated by signalling energy representative of an optical image to be transmitted, means for rectifying a portion of the derived carrier wave energy, means for photoelectrically controlling the rectification in accordance with the average value of illumination of the optical image to be transmitted, and means for varying the balance of the bridge in accordance with the rectified portion of the derived carrier wave energy.

7. In a balanced bridge modulator, the method of varying the sensitivity of the bridge which comprises deriving from the bridge carrier wave energy modulated by signalling energy representative of an optical image to be transmitted, rectifying a portion of the derived carrier wave energy, photoelectrically controlling the rectification in accordance with the average value of illumination of the optical image to be transmitted, and feeding the rectified portion of the energy in series with a constant source of energy to the bridge to vary the balance point of said bridge in accordance with the average value of illumination of the optical image to be transmitted.

8. A variable sensitivity balanced bridge modulator comprising means for deriving from the bridge carrier wave energy modulated by signalling energy representative of an optical image to be transmitted, means for rectifying a portion of the derived carrier wave energy, means for photoelectrically controlling the rectification in accordance with the average value of illumination of the optical image to be transmitted, and means for feeding the rectified portion of the energy in series with a constant source of energy to the bridge to vary the balance point of said bridge in accordance with the average value of illumination of the optical image to be transmitted.

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