Dec. 5, 1939. G. W. WALTON 2,182,043

TELEVISION AND LIKE SYSTEM

Filed Aug. 1, 1936

Fig. 1.

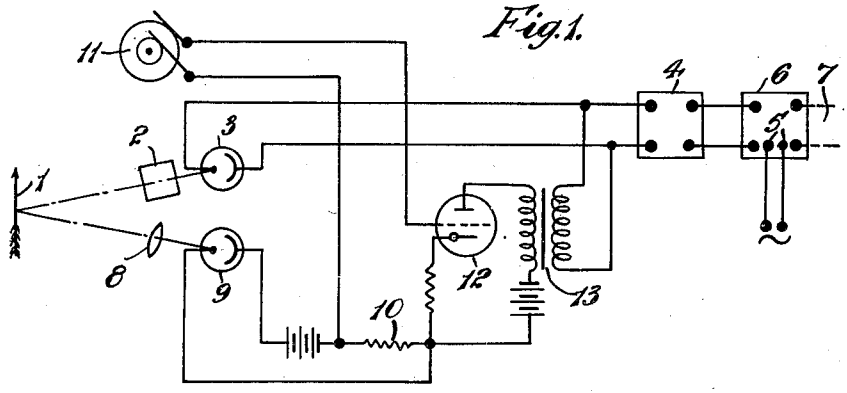


Fig. 2.

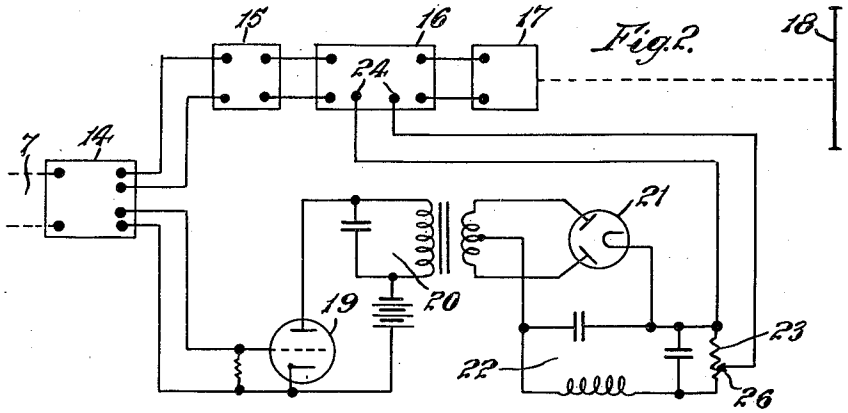
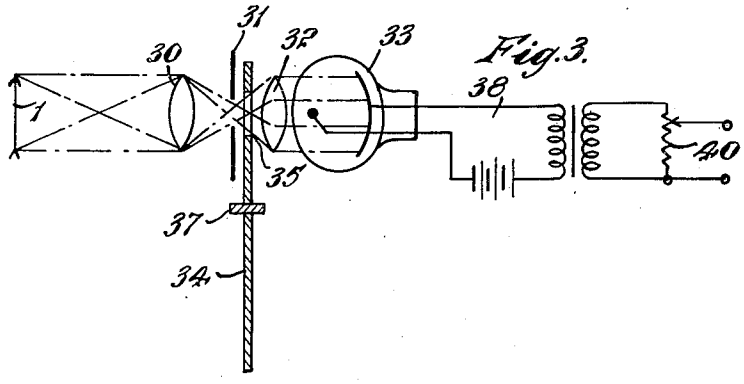


Fig. 3.



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TELEVISION AND LIKE SYSTEM

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In Great Britain August 7, 1935

7 Claims. (Cl. 178—7.1)

The present invention relates to television and like systems.

It is known that in a moving picture, in addition to the changes in light intensity of the picture details, the average light intensity of the whole picture also charges. In order to reproduce faithfully such a picture it is essential that both the light intensity of the details and the average light intensity of the whole reproduced picture should have substantially the same values, at any instant, as the corresponding intensities in the original. In television and like systems this has been hitherto difficult to achieve for the following reasons:

During the translation of the light intensities of the original picture into electric currents, the varying light intensities of the details give rise to alternating currents, the lowest frequency of which is in the neighbourhood of ⅔ of the picture repetition frequency, when a moving picture is being reproduced. Changes in the average light intensity of the picture give rise to currents having frequencies of a much lower order. Thus the most rapid of these changes that is visible to the human eye gives rise to a current having a frequency of the order of ⅓ of the picture repetition frequency, whilst the majority of the changes have periods of the order of several seconds. The resulting current thus may be regarded as a direct current having a slowly changing amplitude. Such a direct current is usually lost during the process of transmission, owing to the fact that the amplifiers and other electrical currents employed in the transmission of the currents are not usually designed to transmit it. Owing to the extreme difficulty and expense of designing amplifiers that will transmit satisfactorily not only the direct current component, but also all the frequencies necessary to reproduce faithfully the picture details, it has hitherto been usual to ignore the direct current component although, with the result that, in the reproduced picture, the degree of contrast between the tones of the picture is falsified, since this degree of contrast is dependent upon a correct rendering of the average light intensity of the picture as well as of the light intensity of the details of the picture.

In order to overcome this difficulty it has been proposed to derive a separate current which is representative of these slow changes in the average intensity of illumination of the picture, and to transmit this current over a channel which is separate from the channel employed to transmit the picture currents. This method has the obvious disadvantage of necessitating the use of an extra transmission channel.

An object of the present invention is to provide a television or like system in which the average light intensity of the reproduced picture can be made to correspond to that of the original at any instant of time, and in which the employment of special amplifiers designed to amplify down to zero frequency and extra transmission channels is avoided.

In achieving this object, use is made of the fact that there exist certain frequencies which, when transmitted and received in a normal fashion, produce no visible image at a receiver. Such frequencies can thus be mixed with the picture currents without in any way affecting the quality of the received picture. This matter is more fully dealt with in the specification of G. W. Walton's application Serial No. 572,138, filed on October 30, 1931, in which it is shown, for example, that frequencies which are in the neighbourhood of a whole multiple plus one-half of the picture frequency, or more generally, equal to

$$A \times \frac{B}{C}$$

where A is the picture frequency and B and C are whole numbers such that B is not a multiple of C, do not produce a visible image at the receiver.

According to the invention an alternating current of such a frequency that it does not produce a visible image at a receiver, is modulated in amplitude in accordance with the changes in the average light intensity of the picture to be transmitted, and is then mixed with the picture currents and transmitted with them. At the receiver a portion of this alternating current is separated from the picture currents and is rectified, the resulting voltages being employed to control the average light intensity of the reproduced picture. It is important to note that it is not necessary to remove the whole of the modulated alternating current from the picture currents, since any residue cannot possibly affect the reproduced image in any way.

The invention will now be described by way of example with reference to the accompanying drawing in which:

Fig. 1 is a diagram showing a television transmitter employing the features of the present invention,

Fig. 2 is a diagram showing a receiver for use in connection with the transmitter of Fig. 1, and

Fig. 3 illustrates an optical method of obtaining the alternating current modulated in accordance with the changes in intensity of the average illumination of the picture to be transmitted.

Referring to Fig. 1, the object 1 is scanned by any known form of scanning apparatus (shown diagrammatically at 2) and picture currents are thus produced in the output circuit of the photo-electric cell 3, which are amplified at 4. A carrier wave is applied to terminals 5 of the modulating device 6, and this wave, after being modulated with the picture currents from amplifier 4 is transmitted over the channel 7. The amplifier 4 is so designed that the lower limit of the frequency band that it can handle is not below ⅔ of the picture frequency, i. e., 16⅔ cycles per second, assuming that the picture is scanned 25 times per second. Hence in the output of this amplifier there will normally exist no frequencies which are representative of the changes in intensity of the average illumination of the object, since the frequency of the most rapid of such changes that can be observed by the human eye is situated at about ⅓ of the picture frequency.

Light from the object 1 is collected by the optical system 8 and falls on the photo-electric cell 9. Thus there will be developed across the impedance 10 in the output circuit of the photo-electric cell 9 slowly varying voltages corresponding to the slow changes in average illumination of the object 1. These are caused to modulate the amplitude of an alternating current generated by the alternating current generator 11, which current, together with the varying voltages across the impedance 10 are applied to the control grid of a variable mu tube 12, which also serves as an amplifier for the alternating current. The modulated current is then transmitted via the transformer 13 to the input of the amplifier 4 where it is mixed with the picture currents and is transmitted with them as a modulation of the carrier wave over the channel 7. The frequency of the alternating current generated at 11 is chosen, as described above, so that it will not produce a visible image at the receiver. A very suitable frequency for this purpose is 1½ times the picture frequency. The generator 11 is adapted to run in synchronism with the scanning means 2, and is preferably mechanically coupled thereto, so as to ensure the correct relationship between the frequency of the alternating current generated thereby and the picture frequency.

At the receiver, illustrated in Fig. 2, the modulated carrier wave is received over the channel 7 and is amplified at 14. The output of this amplifier is divided into two parts, one part being taken via the carrier wave rectifier 15, and the picture current amplifier 16 to the receiving apparatus 17. This latter comprises a suitable light control device and scanning apparatus, running in synchronism with the scanning apparatus 2, so that there is formed on the viewing screen 18 an image of the object 1. It is convenient at this stage to consider the character of this image, assuming that the remainder of the apparatus illustrated in Fig. 2 is omitted. It is clear that the currents applied to the input of the receiving apparatus 17 will comprise the original picture currents existing in the output of the amplifier 4, together with the modulated alternating current existing in the output circuit of the tube 12. Now this alternating current is incapable of producing a visible image on the screen 18, so that only the original picture currents are effective. The result will be an image which is a faithful copy of the original as regards detail but which does not correspond to the original at any instant of time as regards general overall illumination.

The second portion of the output of amplifier 14 is taken to the input circuit of the tube 19, which acts as a rectifier and may also act as an amplifier, and which has in its output circuit the filter 20. In the output circuit of this tube there will appear the picture currents and the modulated alternating current, which latter is selected by the filter 20 and rectified by the rectifier 21, the output of this rectifier being smoothed by the circuit 22. Thus there will be developed across the impedance 23 a varying voltage corresponding in frequency to the voltage developed across the impedance 10. A portion of this voltage is tapped off and is applied via the terminals 24 to the amplifier 16, where it is applied to the grid of a valve, preferably the output valve, so as to vary the amplification applied to the picture currents. Consequently the average illumination of the image on the screen 18 will depend at any instant upon the voltage developed across the impedance 23, and by suitably choosing the degree of amplification effected by the tubes 12 and 19 and the position of the tapping point 26, this average illumination can be made to correspond exactly with that of the original picture.

In Fig. 3 is shown an alternative method of producing at the transmitter the modulated alternating current. The lens 30 forms an image of the object 1 in the plane of the apertured screen 31, and the light passing through the aperture in this screen is collected by the lens 32 and falls on the cathode of the photo-electric cell 33. Immediately behind the screen 31 is placed a revolving disc 34 provided with apertures arranged circumferentially, one of which is indicated at 35. The disc is rotated about the axis 37 at such a speed that the light falling on the photo-electric cell is interrupted at the desired frequency, this frequency, of course, corresponding to that generated by the generator 11 of Fig. 1. Thus in the output circuit 38 of the photo-electric cell 33 there will be developed an alternating current modulated in amplitude in accordance with the changes in intensity of the average illumination of the object 1. This current is then transmitted via the transformer 39 and the output impedance 40 to the input of the picture current amplifier 4 of Fig. 1.

It has been assumed in the foregoing description that the currents corresponding to the changes in average light intensity of the picture, which are produced together with the picture currents in the output circuit of the photo-electric cell 3, have been lost during transmission, and this is normally the case. If desired, however, these currents can be deliberately suppressed. Thus a portion of the output of the photo-electric cell 9 can be fed into the output of the photo-electric cell 3 in phase opposition thereto, in which case these currents will cancel out if their amplitudes have been made equal.

The choice of the frequency of the alternating current is, as stated above, governed generally by the expression

$$\frac{A \times B}{C}$$

Nevertheless it is found preferable to limit the choice to frequencies near the lower end of the frequency band covered by the picture frequencies, i. e., to choose a frequency in the neigh-

bourhood of the picture repetition frequency or of the lower harmonics thereof. If this is done it is found that there exists on either side of a frequency given by the expression

$$\frac{A \times B}{C}$$

a narrow band of frequencies, any one of which satisfies the essential condition of being incapable of producing a visible image at the receiver, thus giving a greater tolerance to the choice of frequency. It is also desirable, to avoid flicker effects, to ensure that the amplitude of the alternating current, when mixed with the picture currents, does not exceed 40% of the amplitude of the picture currents.

When employing the optical method of producing the modulated alternating current illustrated in Fig. 2, it is desirable that the slits in the rotating disc should be so formed that their transparency should vary sinusoidally in the direction of rotation of the disc, i. e., their transparency should be greatest at the centre and less at the edges. In this manner the production of unwanted high frequencies is avoided.

I claim:

1. A television transmitting system comprising means for periodically scanning an object, a first light sensitive device for receiving light from said scanning means, an amplifier for amplifying the currents produced by said first light sensitive device, a second light sensitive device for receiving light from the whole of said object, a generator for producing an alternating current having a frequency equal to a multiple of the scanning period plus one half, modulating means for modulating the amplitude of said alternating current in accordance with the currents produced by said second light sensitive device, an output circuit for said modulating means and an input circuit for said amplifier and means for coupling together said circuits.

2. A television transmitting system comprising means for periodically scanning an object, a first light sensitive device for receiving light from said scanning means, an amplifier for amplifying the currents produced by said first light sensitive device, a second light sensitive device, optical means for collecting the whole of the light from said object so that it falls on said second light sensitive device, means for periodically interrupting the light incident upon said second light sensitive device, the period of said interruptions being equal to a multiple of the scanning period plus one-half, an output circuit for said second light sensitive device and an input circuit for said amplifier and means for coupling together said circuits.

3. A method of television which comprises deriving from an object picture currents representative of the details of said object, producing an alternating current modulated in amplitude in accordance with the changes in the average light intensity of said object, mixing said alternating current with said picture currents and transmitting them to a receiver, the frequency of said alternating current being such that it is incapable of producing a visible image at said receiver, utilizing a portion of the received currents to produce an image of said object, rectifying a further portion of said received currents and utilizing the rectified current to control the average light intensity of said image.

4. A method according to claim 3 wherein the frequency of said alternating current is given by the expression

$$\frac{A \times B}{C}$$

where A is the picture repetition frequency, and B and C are whole numbers such that B is not a multiple of C.

5. A method of television which comprises deriving from an object picture currents representative of the details of said object, separately deriving from said object varying currents representative of the average light intensity of said object, generating an alternating current, modulating the amplitude of said current in accordance with said varying currents, mixing said alternating current with said picture currents and transmitting them to a receiver, the frequency of said alternating current being such that it is incapable of producing a visible image at said receiver, utilizing a portion of the received currents to produce an image of said object, rectifying a further portion of said receiver currents, and utilizing the rectified current to control the average light intensity of said image.

6. A television transmitting system comprising means for deriving from an object picture currents representative of the details of said object, means for deriving from said object varying currents representative of the average light intensity of said object, an alternating current generator, modulating means for modulating the amplitude of the alternating current derived from said generator in accordance with said varying currents and means for mixing the said alternating current with said picture currents and for transmitting them to a receiver, the frequency of said alternating current generator being given by the expression

$$\frac{A \times B}{C}$$

where A is the picture repetition frequency, and B and C are whole numbers such that B is not a multiple of C, whereby no visible image is produced by said alternating current at said receiver.

7. A television transmitting system comprising means for deriving from an object picture currents representative of the details of said object, a light sensitive device, optical means for collecting the whole of the light from said object so that it falls on said light sensitive device, means for periodically interrupting the light falling on said device, and means for mixing the resultant alternating current derived from said light sensitive device with the picture currents, and for transmitting both currents over a common channel to a receiver, the period of the interruptions being such as to produce an alternating current having a frequency given by the expression

$$\frac{A \times B}{C}$$

where A is the picture repetition frequency, and B and C are whole numbers such that B is not a multiple of C, whereby no visible image is produced by said alternating currents at said receiver.

GEORGE WILLIAM WALTON.