July 9, 1935. C. O. BROWNE 2,007,594

TELEVISION

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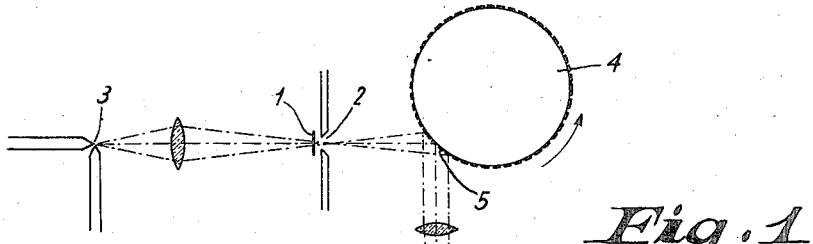


Fig. 1

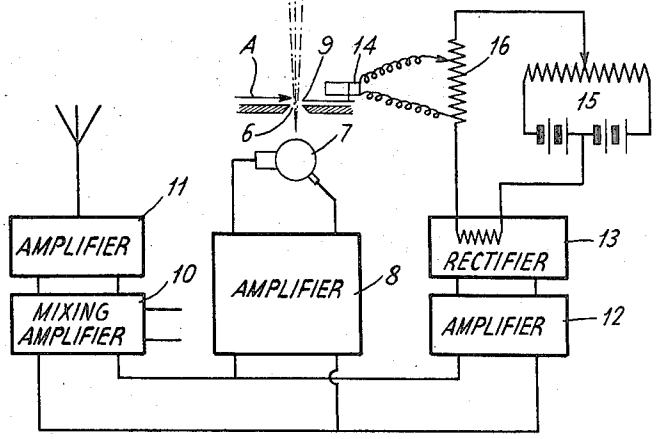
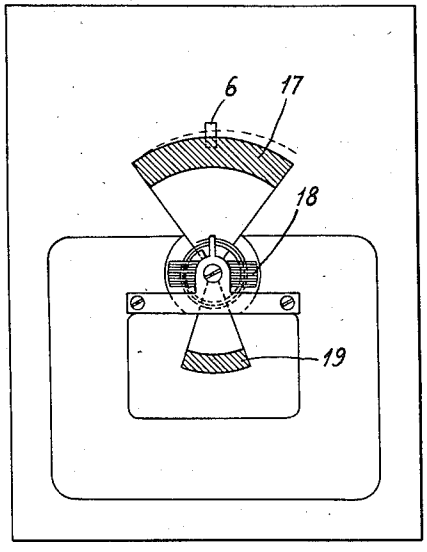


Fig. 2



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TELEVISION

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1 Claim. (Cl. 178—6)

The present invention relates to television.

A fundamental feature of all television scanning systems is the production of relative motion between an object and a scanning aperture.

The terms "object" and "scanning aperture" should be given broad meanings. In the case of transmitting systems, for example, the object may be either the actual object of which electrical images are to be transmitted or may be an optical image of a real object, whilst in the case of reception the object is usually a viewing screen. Similarly the aperture may be either a real aperture or an optical image of a real aperture, such as is used in so-called spot scanning.

In most known systems, light which passes through the scanning aperture at the transmitter is utilized to generate picture signals in a photo-electric device, the signals so generated being amplified and transmitted to a distant receiver where they are again amplified and used to control the amount of light which passes through a receiver scanning aperture on to a screen.

The fineness with which the object is scanned at either end is determined by the ratio of the size of the object to the size of the scanning aperture, and it is clearly desirable that this ratio should be maintained as high as possible.

If, however, it be desired to make any change in this ratio it is clearly more convenient both at the transmitter and the receiver to alter the area of the scanning aperture rather than to alter the area of the object, a diminution of the aperture size effecting an increase in fineness and an enlargement of the aperture effecting a decrease in fineness.

A difficulty which is common to most systems of television is that of passing sufficient light through the scanning aperture to give rise to an adequate picture signal in the scanning photo-electric cell, and on account of this difficulty it has been found desirable to set the amplifier at a certain fixed maximum level of amplification and to ensure that the picture signal supplied to the amplifier is always of sufficient strength to override any parasitic background effect analogous to valve noise or to the well-known Johnson noise encountered in audio-frequency amplifiers and which is due to the resistances incorporated in the amplifying circuit.

In general the picture signal supplied to the amplifier is that generated in the scanning photo-electric cell and this in turn is a true representation of the fluctuations in the light falling on the cell.

If the amplifier associated with the scanning photo-cell is capable of amplifying alternating current only, then, in order to override the background effect, it is necessary to control only the alternating component of the picture signal supplied to the amplifier so that it remains at a substantially constant level and control of the direct component is unnecessary. On the other hand if the amplifier is capable of amplifying both alternating and direct current then both the alternating and direct components of the picture signal supplied to the amplifier must be controlled in such manner that the average peak value, in other words, the average value of the envelope of the picture signal current, taken over a few picture frames, is maintained at a substantially constant level.

Thus, if an alternating current amplifier be used, only the average amplitude of the picture signal supplied to the amplifier need be maintained constant and, if a direct current amplifier be used, the average peak value of the picture signal supplied to the amplifier must be maintained substantially constant.

Now, assuming that the scanning system operates in a constant manner, a change in the average amplitude or of the average peak value of the picture signal can only occur as a result of a comparatively slow change, that is to say a change taking place over a few picture frames, in the nature of the object.

A change in the average amplitude of the picture signal, or of the alternating component of the light falling upon the scanning cell, is due to a change in the contrast or, more accurately, the amplitude of black to white in the object (which of course may be due to a change in the intensity of the light illuminating the object) and a change in the average peak value of the picture signal or of the light falling upon the cell is due to a change in the average peak value of the object, that is to say to a change in either the average brightness or the average amplitude of black to white in the picture or in both. A change in the average peak value of the object occurs when the intensity of the light projected upon the object for the purposes of scanning changes in intensity and also when the average opacity of the film changes.

According to the present invention there is provided a method of transmitting images of an object to a distance in which light modulated in accordance with the tone value of the object is

passed into a light sensitive device, wherein changes in average amplitude or of average peak value of the light falling upon the device, due to changes in the nature of the object, are diminished.

Other features of the invention will appear from the following description and the appended claims.

A constructional embodiment of the invention will be described by way of example, reference being made to the accompanying drawing in which Fig. 1 illustrates diagrammatically a scanning system arranged in accordance with the present invention and adapted for use at a transmitting station, and Fig. 2 illustrates, also diagrammatically, a scanning aperture of adjustable size such as may be used in the system illustrated in Fig. 1.

It will be assumed for convenience that two motion picture films are to be transmitted, the first being of high average transparency or brightness and high average amplitude of black to white, that is to say, of high average peak value, and the second film being of comparatively low average brightness and low average amplitude of black to white. It will be assumed also that in both cases the picture signals are to be amplified by means of an amplifier capable of amplifying both alternating and direct current.

A conception of the difference between the two films may be obtained by supposing that in place of the two films mentioned above, one film is scanned twice in succession, the first time by means of a scanning beam of high intensity and the second time by means of a beam of low intensity. In the first case the object scanned is of high average brightness and high average amplitude of black to white and in the second case the object is of comparatively low average brightness and low average amplitude of black to white.

The two scannings, whether of the same or of different films, are effected by means of the same apparatus.

The film **1** of high average peak value is first moved, in a direction perpendicular to the plane of the paper, past a scanning gate **2** at uniform speed whilst it is illuminated by light from an arc **3**. The arc is adapted to emit light of constant intensity. The gate **2** is in the form of a slit disposed perpendicularly to the direction of motion of the film. A drum **4**, which is adapted to rotate about an axis parallel to the direction of motion of a film **1**, carries a plurality of plane mirrors **5** all of which are arranged symmetrically and tangentially upon its surface. Each mirror **5** on the drum **4** reflects an image of a strip of the film in the gate **2** over a single rectangular scanning aperture **6** behind which is disposed a photo-electric cell **7** associated with an amplifier **8**. As the film **1** moves past the gate **2** and the drum rotates, images of successive strips of the film are translated over the aperture **6** and corresponding electric picture signals are generated in the cell **7**.

The arc **3** is adjusted to give its maximum output of light and the amplifier **8** is adjusted to give maximum amplification without there arising an appreciable parasitic background effect due either to noise generated by valves or to the Johnson noise referred to above.

The picture signals generated in this way are transmitted, together with synchronizing impulses, by means of apparatus which will be described later, and at the receiving station the picture signals are reformed into images of the picture film in any known or suitable manner.

Images of the film are also reconstituted at the transmitting station; this is achieved by means of scanning apparatus which is not shown but which may be similar to that above described working in the inverse manner. The fineness and average peak value of the transmitted images may be judged by eye or may be measured from this reconstituted image and alterations of these features of the image are effected by altering the size of the scanning aperture **6** by means of a shutter **9** which forms one boundary of the aperture **6**.

Measurements of the average peak value of the transmitted images may be made by applying the picture signals to a peak voltmeter. Alternatively the picture signals may be analyzed by applying them to one pair of deflecting plates of a cathode ray oscillograph, a comparatively low frequency saw-tooth wave being applied to the usual second pair of deflecting plates of the oscillograph.

Alterations in the area of the scanning aperture in the transmitting apparatus vary, in effect, the number of elemental areas into which each picture is divided for transmission. If this number is too few the fineness of scanning is too low and the definition of the reconstituted image is poor, although the amplitude of the signals generated in the photo-cell is high; if the number is too great there is a greater detail in the reconstituted image than the eye can appreciate, and the probability is that the transmission channel cannot handle such high detail without serious distortion.

Furthermore, if the fineness of scanning is increased unduly and the scanning aperture made too small, the picture signal supplied to the amplifier would be too weak to override the parasitic background effect mentioned above. In general, therefore, the detail and average peak value of the picture provide a good indication of the nature of the signal supplied to the amplifier. Initial setting of the picture signal amplitude can thus be made from an inspection of the picture and adjustments subsequently made by reference to the peak voltmeter or cathode ray oscillograph.

The film of comparatively low average peak value is now passed through the scanning apparatus. Compensation for its low average peak value cannot be achieved by altering the arc **3** or the amplifier **8** since these are already giving their maximum outputs, but in accordance with the present invention compensation is achieved by increasing the area of the scanning aperture **6**. The increase in area serves to decrease the fineness of scanning and also to increase the average brightness and amplitude of the light falling upon the cell **7** and is adjusted until the picture signals developed in the photo-electric cell **7** are roughly the same as for the first film.

The second film is thus also transmitted under the best possible conditions of average brightness and fineness of scanning, whilst the amplifiers have for the whole transmission been working at their maximum amplification. The frequency and phase characteristics of the amplifiers thus remain constant although variations of both average brightness and fineness of scanning are achieved.

If the amplifier **8** is capable of amplifying both alternating and direct currents, as has been assumed so far, then the amplified signal provides

a true representation of the average peak value of the light falling upon the cell 7; instead, therefore, of varying the aperture size manually, the amplified current may be used to control automatically the amount of light falling upon the cell so that its average peak value is maintained substantially constant.

This may also be done if the amplifier 8 is capable of amplifying alternating current only because in this case it is only the alternating component of the light falling upon the cell 7 which need be maintained constant.

In either case, therefore, the amplified picture signal may be used to control automatically the size of the scanning aperture.

The picture signals derived from either of the films are therefore divided into two channels. One of the two sets of signals is fed to a mixing amplifier 10 where the picture signals are mixed with synchronizing signals prior to amplification in the amplifier 11 and transmission over a single channel, and the second set is fed, if necessary after further amplification in the amplifier 12, into a rectifier 13. The rectified impulses are then arranged to operate, for example by means of an electromagnetic device 14, the shutter 9 which constitutes one boundary of the scanning aperture 6.

The electromagnetically operated shutter 9 is illustrated in greater detail in Fig. 2. It comprises a moving coil galvanometer with a vane 17 substituted for the usual indicating pointer, the vane being arranged to obscure the scanning aperture 6 in accordance with the movement of the coil 18. The vane 17 is counterbalanced by a weight 19 and the restoring force of the coil, usually provided by means of a pair of springs, is adjusted so that the shutter has a natural frequency somewhat lower than the frequency with which successive complete pictures on the film are scanned. The natural frequency may be, for example, about 8 cycles per second. Changes in average amplitude or peak value of successive whole pictures of the film are thus faithfully reproduced in the photo-electric cell currents, because the shutter does not respond to changes of frequency as high as the frequency with which successive complete scans are effected, but all changes in average amplitude or peak value of the light falling upon the cell, which are due to changes in the nature of the object, of frequency as low as or lower than the natural frequency of the shutter are automatically eliminated or at least diminished. Differences in average opacity of two films are for example compensated for in this way.

Damping means may be provided in order to prevent trains of oscillations being set up.

If desired the shutter may comprise a moving coil loudspeaker movement in which the coil operates the shutter. In this case the diaphragm of the speaker may be conveniently retained for damping purposes and if desired may be arranged to work in a dash-pot in order to increase the damping effect.

Alternatively two of the boundaries of the scanning aperture may be obscured by means of a light valve comprising a loop of conducting ribbon carrying the rectified picture current impulses and situated in a magnetic field. Variations in size of the scanning aperture may then be effected by passing direct current of strength depending upon the amplitude of the picture impulses, through the conducting loop of ribbon.

In the case when the amplifier associated with the scanning photo-electric cell is capable of amplifying only alternating current, then compensation has to be effected only for fluctuations in the alternating component of the light falling upon the cell, and in order that the vane 17 may obscure correctly an increasing proportion of the scanning aperture 6 with increasing picture signal amplitude, two preliminary adjustments are necessary. In the first place the correct size of aperture for a given average amplitude of the amplified picture signals is obtained by adjusting the zero of the electromagnetically operated shutter my means of the potentiometer 15, and in the second place the sensitivity of the movement of the vane 17 is adjusted by varying the resistance 16 in shunt with the coils of the electromagnetic device operating the vane, until a given change in the amplified picture signal amplitude produces a correct change in aperture area.

Having once adjusted the apparatus in this way variations in the average amplitude of black to white of two films or in different parts of one film, or in any object which may be scanned, are automatically allowed for, and the amount of light reaching the photo-electric cell is varied, at frequencies lower than the frequency with which the object to be transmitted is completely scanned, inversely, although not necessarily linearly, with the changes in average amplitude of the object.

As shown in Fig. 1, as the drum 4 rotates about its axis, images of strips of the film are translated over the aperture 6 in the direction indicated by the arrow A. The shutter 9 is thus controlled in motion in the direction of scanning only, and the width of each line scanned therefore remains constant. If desired, however, two perpendicular sides of the aperture 6 may be constituted by shutters, the motion of one of them being controlled in the direction of scanning and the motion of the other being controlled in a direction perpendicular thereto. This is of particular advantage where the changes occurring in the object are very considerable. Alternatively the rectifier 13 shown in Fig. 1 may be biased back so that the shutter is operated only if the picture signals exceed a predetermined average amplitude or average peak value. This method of working is convenient if it is required to control the picture signal amplitude to fill to any desired extent, but not overload, the radio transmitter.

In other cases it may be preferable to vary the area of the aperture by controlling two or more boundaries independently. One boundary may be controlled by the mean picture signal amplitude, for example, and another by the peak picture signal amplitude.

If desired, in the case of film transmission, instead of varying the area of the scanning aperture in accordance with the variations in amplitude of black to white in the film, the area may be varied in accordance with the variations in opacity of the background of the film, that is to say, in accordance with those variations in opacity of the film due to the developing and fixing processes which the film has undergone. This may be effected by passing a beam of light of constant intensity through an edge portion of the film lying alongside the pictures, into a photo-electric cell. Alternatively, an auxiliary cell may be disposed so as to receive light from the whole of the scanned picture and thus register the changes in average brightness of the whole picture.

In either case the currents developed in the cell, if necessary after amplification, can be

utilized to control an electromagnetically operated shutter as described above.

The invention may be embodied in a television receiving station. In this case the light source and amplifiers are preferably adjusted to give their maximum output and amplification respectively. Any fall in amplitude or average peak value of the received picture signals, due for example to fading, which would produce a decrease in average amplitude of black to white or average brightness (or both) of the pictures reformed on the screen, is compensated by increasing the size of the scanning aperture. This has the effect of increasing the average amplitude and brightness of the reformed picture and correspondingly decreasing the fineness of scanning.

It will be apparent, however, that a change either in the average brightness or in the amplitude of black to white of the object at the transmitter or a change in either of these properties of the received picture currents at the receiver, may be compensated by varying the mean intensity of the scanning light source or by varying the size of any obturator inserted between the scanning light source and the cell at the transmitter, or between the scanning light source and the viewing screen at the receiver. An electromagnetic device operated in the manner described above may be used for effecting the variations in size of such an obturator. It should be noted, however, that if either of these methods be adopted, although compensation for changes in average amplitude or peak value is achieved the optimum relationship between the average brightness and the fineness of scanning is not maintained. Compensation is therefore preferably effected by varying the size of the scanning aperture.

It will be clear that varying the size of the scanning aperture or any other obturator in the path of the light between the object and the scanning cell has the effect of altering both the direct and alternating components of the light falling upon the cell. If, therefore, it be desired to compensate for changes in the alternating component only it is necessary to offset the change produced in the direct component by the change in aperture size. This may be done, for example, by projecting an auxiliary light beam upon the cell. The scanning aperture or other obturator is then varied in size so as to compensate for changes in the alternating component and the intensity of the auxiliary beam is varied so as to compensate for the changes in the direct component due to the change in aperture or obturator size.

If it be desired to compensate for changes in the direct component only, the size of the scanning aperture or obturator is maintained constant and the intensity of the auxiliary light beam varied so as to compensate for changes in the direct component.

The changes in the nature of the object may be such that the average values of the alternating and direct components of the light falling upon the cell change in opposite senses, the changes not being connected by any simple relationship. In this case it may be desirable to compensate for the two changes separately. This may be effected by using the scanning aperture or obturator to compensate for changes in the alternating component and using the auxiliary beam to compensate for changes in the direct component which are due both to changes in the nature of the object and to changes in aperture or obturator size.

In practice the aperture or obturator may be controlled in size by means of rectified currents derived from the alternating component of the picture signal and the auxiliary beam controlled in intensity by means of currents derived from the direct component of the picture signal.

I claim:

A television system which comprises means including an element for scanning a subject for television, a masking element having an aperture for dividing the subject into a plurality of elemental areas and means for converting the light intensities of the several elemental areas into electric signaling impulses, means for amplifying the produced electrical signals, a screening element arranged to cover at predetermined time intervals predetermined portions of the apertured masking element, means for selecting from the converted light values forming the electrical signals changes in the average peak values of the resulting signals, means for amplifying the selected signals, electromagnetic means operated by said selected signals for controlling the screening element to screen predetermined portions of the apertured element to maintain constant level of the resulting signals, and means for transmitting the electrical signals produced from the conversion of the optical image.

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