March 28, 1939. C. O. BROWNE 2,152,464

TELEVISION AND THE LIKE SYSTEM

Filed Oct. 10, 1934 2 Sheets-Sheet 1

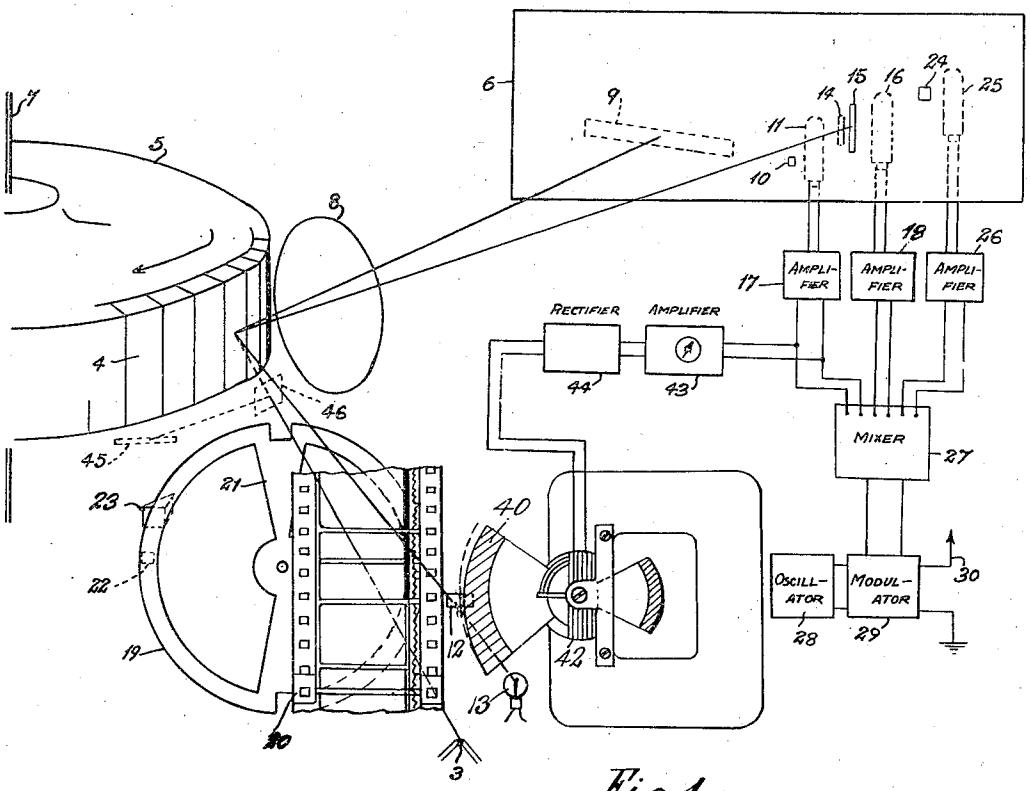
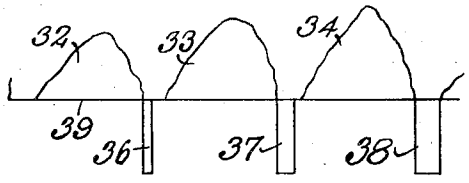
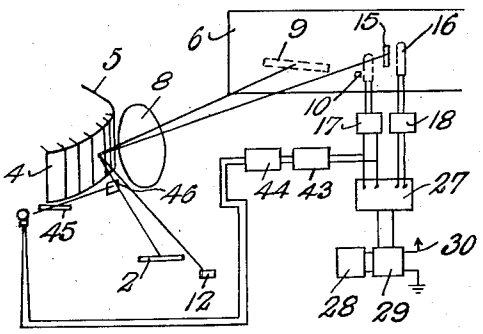


Fig. 1.

Fig. 1a

Fig. 3.





Inventor:
Cecil O. BROWNE
By: J. Oppenheimer
Atty.

March 28, 1939. C. O. BROWNE 2,152,464

TELEVISION AND THE LIKE SYSTEM

Filed Oct. 10, 1934 2 Sheets-Sheet 2

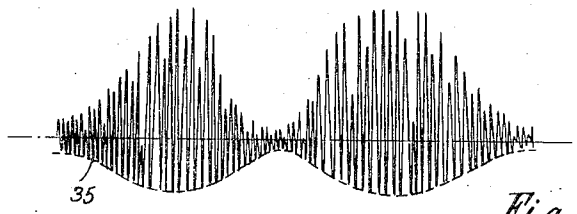


Fig. 4.

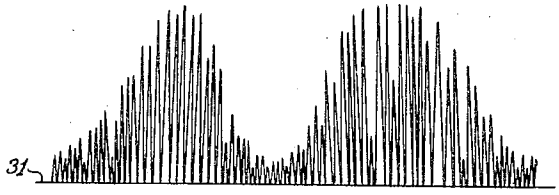


Fig. 2.

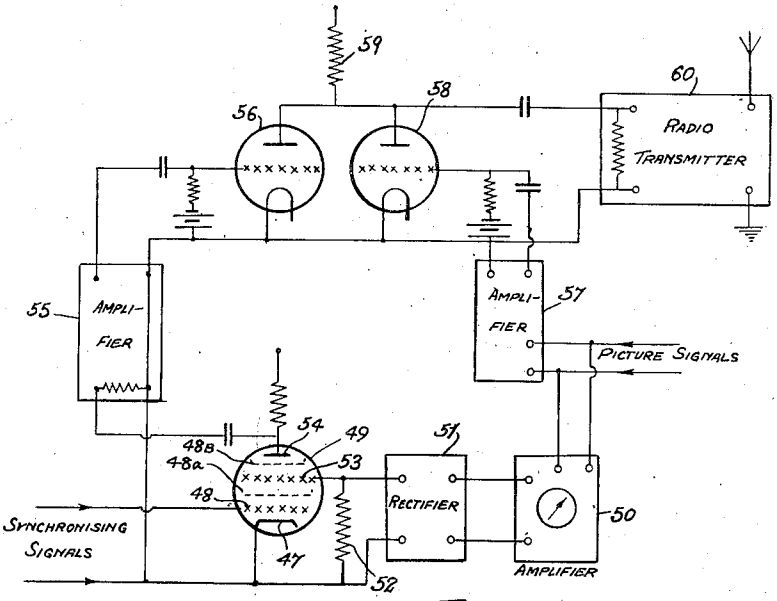


Fig. 5.

Inventor:
Cecil O. BROWNE
By: J. Oppenheimer
Atty.

Patented Mar. 28, 1939 2,152,464

UNITED STATES PATENT OFFICE

2,152,464

TELEVISION AND THE LIKE SYSTEM

Cecil Oswald Browne, West Acton, London, England, assignor to Electric and Musical Industries Limited, Hayes, England, a company of Great Britain

Application October 10, 1934, Serial No. 747,738
In Great Britain October 12, 1933

12 Claims. (Cl. 178—7.1)

The present invention relates to television and the like systems.

In most systems of television slow changes in average brightness of the whole object are not transmitted owing to the fact that during transmission the electric picture signals are passed through elements such as condensers and transformers which are incapable of passing direct current and low frequency signals.

In one known system it has been proposed to overcome this difficulty by injecting into the transmission channel, at the end of each line scanned, an auxiliary signal which corrects any unbalance in the light and dark portions of the line last scanned with respect to an electrical datum line corresponding to grey in the object. The duration of the auxiliary pulses is constant and their amplitude is varied in accordance with changes in average brightness of the object. The auxiliary signals may be injected into the channel in either sense with respect to the datum line (corresponding to grey) according as to whether the average brightness of a line is above or below the datum grey.

When occurring on one side of the datum line the auxiliary signals give rise to a white spot at the end of each line reconstituted at the receiver unless special precautions are taken to remove the auxiliary signals after transmission. Furthermore, the auxiliary signals occupy the position (in time) in the transmission which is usually taken by synchronising signals and since the auxiliary signals may be either positive or negative with respect to the electrical datum line it has not been found possible to use these auxiliary signals themselves for purposes of synchronising.

It is an object of the present invention to provide, in a television or the like system, improved means for controlling from the transmitter the average brightness of the reconstituted picture at the receiver either arbitrarily under the control of an operator or in accordance with the average changes in brightness of the object.

It is another object of the present invention to provide transmitting apparatus including means for generating and transmitting auxiliary signals which may be utilised both as synchronising signals and for controlling the average brightness of the reconstituted picture.

It is another object of the present invention to provide television transmitting apparatus comprising a scanning device for generating from an object to be transmitted trains of picture signals having intervals between successive trains, an amplifier for amplifying only those components of said signals which have a frequency exceeding a predetermined value, means for utilising the components of said signal having frequencies below said predetermined value to generate a series of pulses, each of said pulses occurring in one of said intervals and having an energy corresponding to the average energy of at least one of said trains of picture signals, and means for combining the first named components of said signal with said pulses in opposite senses with respect to a datum line fixedly related to black in said object.

The average energy contained by the pulses is varied by altering either the duration or the amplitude of the pulses, or both.

The invention will now be described, by way of example, with reference to the accompanying diagrammatic drawings, in which

Fig. 1 illustrates television transmitting apparatus arranged and adapted to operate in accordance with the present invention.

Fig. 1*a* illustrates a modification of the apparatus according to Fig. 1,

Fig. 2 shows the wave form of trains of picture signals generated with the aid of the apparatus shown in Fig. 1 and before amplification,

Fig. 3 shows, in greater detail, the wave form of trains of picture signals interspersed with synchronising signals generated with the aid of apparatus shown in Fig. 1,

Fig. 4 shows the wave form which is taken up by the picture signals of Fig. 2 after they have been amplified in an amplifier incapable of amplifying direct current and low frequency signals, and

Fig. 5 shows apparatus for modulating synchronising signals generated with the aid of the apparatus of Fig. 1 and for mixing the modulated synchronising signals with trains of picture signals.

In Figs. 2, 3 and 4, ordinates represent current and abscissae time, and signals extending above the horizontal zero lines in these figures give rise to bright spots in the reconstituted picture whilst signals extending below the zero lines produce complete blackness in the reconstituted picture.

It will be assumed that a motion picture film is to be transmitted in a manner suitable for reception with the aid of a cathode ray tube and that the deflections of the cathode ray are to be controlled by means of two sets of synchronising signals sent from the transmitter.

Referring now to Fig. 1, at the transmitter a motion picture film 1 is moved uniformly and

vertically downwards past a horizontally disposed scanning or "picture" slit or gate 2, the length of which is equal to the width of the pictures on the film 1. The strip of film which at any instant lies in the gate 2 is illuminated by light from a suitably disposed arc 3 and light which passes through the film 1 and picture gate 2 is reflected, from one of ninety plane mirrors (one of which is indicated at 4) disposed upon a rotating mirror drum 5, on to a plane vertical scanning screen 6 situated about six feet from the mirror drum 5. The mirrors 4 are all mounted tangentially about the surface of the drum 5 and the latter rotates about a vertical axis 7. The film and the mirror drum may be either geared together or driven independently. Close to the drum 5 is placed a spherical lens 8 adapted to focus an image of the film strip in the picture gate 2 on to the scanning screen 6. One such image is shown at 9. In the screen 6 is a small square aperture 10 behind which is disposed a photo-electric cell 11 and, as the mirror drum 5 rotates, images of successive strips of the film 1 which appear in the picture gate 2 are translated over this square "picture" aperture 10, corresponding electric "picture" signals being generated in the "picture" photo-electric cell 11. A short interval occurs between the scanning of a line by one mirror and the scanning of the next line by the next mirror. During this interval the picture cell 11 is unilluminated and there is therefore produced in the picture cell a pulse corresponding to substantially complete black.

Close to the horizontal picture gate 2 is disposed a vertical slit or gate 12, which will be called the "line gate", illuminated uniformly by means of a small electric lamp 13 placed behind it. The components of the apparatus are thus shown in perspective. Nearest the observer are placed the light sources 3 and 13. Beyond them are the film 1, the gate 2, aperture 12 and the vane 40 of the galvanometer 41. Behind the film 1 is the disc 19, and beyond that the mirror drum 5. Light from the mirror drum 5 is reflected away from the observer and to the right, and the screen 6 lies perpendicular to this direction. Two rays of light are shown, one from the slit 2 falling on the aperture 9, and a second from the aperture 12, falling on the aperture 15. The conjugate focal points of the lens 8 lie in the plane containing the apertures 2 and 12 and on the screen 6. Images (one of which is shown at 14) of the line gate 12 are translated, by means of the rotating mirror drum 5, over a "line" aperture 15 disposed in the scanning screen 6 above and to one side of the picture aperture 10. The line aperture 15 is not square but is in the form of a vertical slit and behind it is placed a "line" photo-electric cell 16.

Trains of picture signals generated in the cell 11 are amplified in an amplifier 17 and line synchronising signals generated in cell 16 are amplified in a "line" amplifier 18.

One edge of the line gate 12 is adjustable in position so that the width of the gate may be controlled during the transmission and as the image 14 of the line gate 12 passes over the line aperture 15 there is generated in the line cell 16 a line synchronising signal the duration of which may be controlled by adjusting the width of the line gate 12.

It is preferable to vary the position of that edge of the line gate 12 which determines the ending of a synchronising signal, keeping the commencing edge of the line gate 12 fixed. The fixed edge should preferably coincide with the end of the scanning of a line of the film.

The dispositions of the picture and line gates and apertures relative to the mirror drum are such that each mirror 4 of the drum 5 first sweeps an image 14 of the line gate 12 over the line aperture 15 and immediately afterwards sweeps an image 9 of the picture gate 2 over the picture aperture 10. A line signal thus commence immediately on completion of the generation of a train of picture signals and successive line signals occur in the intervals between the scanning of lines of the film.

The picture gate 2 is covered whilst the frame signals are being generated. This may be achieved with the aid of a suitably apertured disc 19 rotating in front of the gate 2 about an axis normal to the plane of the film. The disc 19, which may be geared to a sprocket 20 serving to drive the film 1, carries two arms (one of which is shown at 21) which obscure the picture gate 2 twice for every revolution of the disc. The gearing between the sprocket 20 and disc 19 is such that this gate 2 is obscured at the end of each complete picture, that is to say, the picture gate 2 is obscured whilst the region dividing two whole pictures passes across the picture gate. The width of the arm 21 is such that each obscuring lasts for a time about equal to that taken to scan five lines.

Frame synchronising signals may be generated in the following manner: Roughly in the plane of the film 1, but on the other side of the film from the line gate 12 is disposed a third illuminated gate 22 which will be called the "frame" gate. The frame gate 22 remains covered by the rotating disc 19 except when the picture gate 2 is covered, that is to say, when the picture gate 2 is covered the frame gate 22 is uncovered and vice versa.

Light proceeding from the frame gate 22 is reflected from a stationary reflecting prism 23 on to a third, or "frame", aperture 24 in the scanning screen 6 behind which is a "frame" photo-electric cell 25. Signals generated in the frame cell 25 are amplified in an amplifier 26.

On account of the action of the arm 21 above referred to, during the generation of each frame signal there is generated in the picture cell 11 a pulse corresponding to substantially complete black.

The picture signals and the line and frame synchronising signals are injected into a common transmission channel with the aid of a mixing circuit 27, the picture and synchronising signals being inserted into the channel on opposite sides of an electric datum line which corresponds to black in the object or which corresponds to a value differing from black by a fixed amount. The combined signals in the output circuit of the mixer 27 thus consist of trains of picture signals in the "bright" sense relative to complete black alternating with synchronising signals of the opposite, or "blacker than black" sense relative to black.

The combined signals are superimposed upon a carrier wave generated in an oscillation generator 28 by means of a modulator 29 and the modulated carrier wave is radiated from an aerial 30.

The wave form of a multiplicity of trains of picture signals generated in the photo-cell 11 is shown in Fig. 2, the datum line 31 corresponding to black in the object being straight. A magnified view of several of these picture trains (each train corresponding to a line on the ob-

ject) is also shown in Fig. 3 at 32, 33 and 34. Now if the picture signal amplifier 17 contains a condenser or transformer (through which the picture signals are passed), the wave form of the amplified signals is as shown in Fig. 4. Whereas in Fig. 2 the zero of potential is represented by the line 31, which corresponds to black in the picture, and lies at the bottom of the troughs of the waves representing the picture signals, the line corresponding to zero potential is now the "centre of gravity" of the wave system, when these signals are passed through a circuit containing a condenser (as is usually done in ordinary valve amplifying circuits). This line is represented by the straight line in Fig. 4, the areas enclosed by the curve above this line being equal to the areas enclosed by the curve below the line. The potential corresponding to black in the picture is still at the bottom of the troughs of the waves, and is therefore now in the position shown by the dotted datum line 35 of Fig. 4 which differs from rectilinearity by amounts dependent upon the average amplitude of the picture signals.

Changes in the direct component of the picture signals, that is to say, that component of the signals which determines the average brightness of the reconstituted image, are thus not faithfully transmitted.

Similarly if the combined picture and synchronising signals are passed through a condenser or transformer, the direct current and low frequency components of the picture signal are lost.

In order to preserve the direct current and low frequency components of the picture signal therefore, the width of the line gate 12 (Fig. 1) at the transmitter (and therefore the duration of the line synchronising signals) is varied in accordance with the changes in average brightness of the object. Thus, for example (referring to Fig. 3), an increase in average brightness of the object is recorded in the combined picture and synchronising signals as an increase in the direct component of successive trains of picture signals 32, 33 and 34 together with an increase in the duration of the intervening line synchronising signals (three of which are shown at 36, 37 and 38). Preferably the increase in duration of the line signals is made such that the energy in each line signal is equal to the energy in the preceding train of picture signals so that the electrical datum line (39 of Fig. 3) of the combined signals remains unchanged in position and corresponds to substantially complete blackness in the object. Signals of the kind shown in Fig. 3 may be amplified in apparatus incapable of amplifying direct current and low frequency signals without loss of these direct and low frequency signals.

Rectified current derived from the picture signals may conveniently be used to control the width of the line gate 12 shown in Fig 1. In this case the movable boundary of the gate 12 is constituted by a vane 40 mounted upon a moving coil galvanometer 41 in place of the usual indicating pointer and the vane 40 is arranged to obscure the gate 12 in accordance with the movement of its coil 42 which in turn is controlled by rectified current derived from the picture signals. The restoring force of the coil, usually provided by means of a pair of springs, is such that the vane 40 has a high natural frequency.

A portion of the picture signals amplified in amplifier 17 is tapped off and further amplified in an amplifier 43 which is provided with a volume control. The output of amplifier 43 is rectified in a rectifier 44 and the rectified picture signals are passed through the coil of the galvanometer 41.

In practice the volume control of amplifier 43 is varied until the level corresponding to black in the object is maintained constant in the mixed picture and synchronising signals.

If desired the movable boundary of the line gate 12 may be obscured by means of a light valve comprising a conducting ribbon carrying the rectified picture current and situated in a magnetic field.

In either case control of the width of the line gate may be obtained, as described, by means of rectified current derived from the picture or, alternatively, by means of the amplified current generated in an auxiliary photo-electric cell which receives light simultaneously from all points of one picture of the film.

If the whole of one line of the picture is black no signal is generated in the picture cell and the following line synchronising signal causes a very small shift of the electrical datum line in the blacker than black direction. Thus each cycle of the transmitter signal voltage under these conditions comprises a long steady voltage of low value in the bright direction followed by a short pulse in the opposite direction. The energy in the line signal in this case, however, is a minimum and the shift af the datum line is so small (about $\frac{1}{50}$ of the maximum picture signal amplitude) as to be negligible. If the strength of the signal output from the picture signal amplifier 17 corresponding to black in the intervals between lines is not adequately defined, there would be inadequate changes of rectified current for operating the vane 40. This may be avoided by passing a small constant amount of light into the picture photo-cell 11 during the generation of lines.

In operation, the device 40—41—42 is supplied with rectified current derived from the picture signals which are rectified in the device 44, so that it cannot respond instantly to all variations in the picture current. The aperture 12 is fixed, and its size is varied by the vane 40, which alters its position according to the rectified picture current, and therefore to the average brightness of the picture. Furthermore, it has a certain inertia, so that substantially no effect is recorded if different parts of each frame have different brightness. Changes in the size of the aperture 12 will occur in general at a rate of about 1 to 10 cycles per second.

In a modification of the above described method the duration of the line signals is maintained constant and the amplitude varied in such manner that the electrical datum line of the combined picture and synchronising signals remains substantially constant in position and preferably at a level corresponding to substantially complete black in the film. This is achieved by varying the intensity with which the line gate 12 of Fig. 1 is illuminated in accordance with changes in average brightness of the film, the size of the gate being, of course, maintained constant. Rectified picture signals such as those supplied by the rectifier 44 may be used for example to control the supply of current to the light source 13 which is used to illuminate the line gate 12.

In a further method of generating line signals of constant duration and variable amplitude there is provided at the transmitter an auxiliary gate 45 (Fig. 1a) an image of which is in optical coincidence with the image of the picture gate 2.

For example, a half-silvered mirror 46 is placed in the light beam between the picture gate 2 and the mirror drum 5, and an image of the auxiliary gate 45 is formed, by reflection in the mirror drum 5, in coincidence with the image 9 of the picture gate 2 on the scanning screen 6. Suitable means (not shown) are provided for shuttering the gate 45 at the frame frequency. The intensity with which the auxiliary gate 45 is illuminated is varied in accordance with, but to a much greater extent than, the changes in average brightness of the film in such manner that the transmitted signals contain the desired changes in the direct component of the picture signals.

Owing to the half-silvered mirror 46, light is lost from both gates 2 and 45 in the above arrangement so that, if desired, an image of the auxiliary gate 45 may be formed upon the screen 6 by means of a separate optical system using another portion of the mirror drum 5. In this case also the auxiliary gate must be shuttered at the same frequency and in phase with the shuttering of the picture gate 2.

In a further modification the line signals may be made of constant amplitude but lasting for only a fraction of the interval between picture lines, the rest of the interval being occupied by a signal of which the amplitude varies in accordance with the general intensity it is required to transmit.

This may be achieved with the aid of the galvanometer movement 41 described above, the width of a part only of the line gate 12 being varied by the vane 40, whilst the remaining portion is left at full width to develop the line signals.

Displacements of the datum line (corresponding to black in the object) of the mixed signals may also be prevented by altering the amplitude of the line synchronising signals in the following way.

The line gate 12 shown in Fig. 1 is maintained at constant size and shape so that the line signals generated in photo-cell 16 consist of a series of pulses of constant amplitude and duration. These pulses are amplified, as before, in amplifier 18 but are then applied (as shown in Fig. 5) between the cathode 47 and first grid 48 of a hexode thermionic valve 49, grids 48A and 48B being maintained at suitable potentials which may be positive with respect to the cathode potential. A portion of the picture signals, after amplification in amplifier 17 (Fig. 1), are tapped off and further amplified in an amplifier 50 (shown in Fig. 5) provided with a volume control. The output from amplifier 50 is rectified in a rectifier 51. The rectified picture signals are passed through a resistance 52 which is connected between the cathode 47 and third grid 53 of the thermionic valve 49 in such manner that increases of current flowing through resistance 52, corresponding to increases in the picture signal current, produce increases in current flowing to the anode 54 of the valve 49. In the anode circuit of the valve, therefore, there are generated line synchronising signals which are amplitude modulated (in the desired manner) in accordance with the changes in average brightness of the object. These modulated synchronising signals are amplified in an amplifier 55 before being applied to the input circuit of a "synchronising modulation amplifying valve" 56. The picture signals are also amplified in an amplifier 57 and applied to the input circuit of a "picture modulation amplifying valve" 58. The picture and synchronising modulation amplifying valves 56 and 58 respectively are connected in parallel so that the picture and modulated line synchronising signals are mixed in a common anode resistance 59. The mixed signals flowing in this resistance are transmitted in any known or suitable manner with the aid of a radio transmitter 60.

As the interval between the scanning of two successive lines of the object is about one-seventh of the total time taken to scan one line, the signals applied to the grid of the synchronising modulation amplifier 56 consist of excursions in the dark direction of magnitude about six times that in the bright direction with respect to the mean level of the signals. The synchronising modulation amplifier is, therefore, biased so as to operate on the bottom bend of its characteristic curve and the signals are applied in such sense that the portion of the signals which extend in the bright direction with respect to the mean level make the grid more negative and are rectified out.

By varying the volume control of amplifier 50 the average energy in the line synchronising signals may be made equal to that in the trains of picture signals, thereby re-establishing the direct current and low frequency components in the picture signals. If the radio transmitter is direct current coupled, the line synchronising signals may be condenser coupled into the radio transmitter 60 and the synchronising signals may be made once more of constant amplitude by suitably operating transmitting valves of the radio transmitter on the bottom bends of their characteristic curves.

A certain minimum amplitude of signal should always be transmitted by the double grid valve 49, however, in order that synchronising signals may be transmitted during dark portions of the film.

In the case of the apparatus illustrated in Fig. 1 the time constant of the re-establishing circuit is determined by the period of the vane 40, whilst in the case of the apparatus illustrated in Fig. 5 the time constant may be adjusted by varying the time constant of a member of the rectifier 52.

Television systems are known in which a cathode ray tube is used as reproducing device at the receiver, direct current coupling being maintained from the input of the radio transmitter right up to the cathode ray tube at the receiver, the cathode ray tube and its scanning circuits being direct current coupled to the rectifier of the radio receiver. The above described arrangement of reestablishing the direct current and low frequency components of the picture signals at the input of the radio transmitter and then transmitting the synchronising signals with constant energy content irrespective of the nature of the picture signals is clearly of particular advantage in such systems.

Although in all of the above-described embodiments of the invention the electrical datum line is maintained at a level corresponding to substantially complete black in the object, it will be apparent that it may equally well be maintained at some other suitable level fixedly related to black.

Advantages resulting from the above described methods of controlling the electrical datum line of the combined picture and synchronising signals can best be appreciated from a contemplation of a cathode ray tube receiving station.

The receiver tube is permanently biased nega-

tively so that, in the absence of picture signals (when the picture at the transmitter is black) and in the presence of synchronising signals of minimum duration applied in the blacker than black direction, the emission of electrons from the cathode of the tube to the usual fluorescent screen associated with the tube almost, but never quite, takes place and the screen remains dark. That is to say the grid of the tube is given a steady bias which is slightly more negative than the value corresponding to zero emission.

The combined picture and synchronising signals are applied between the cathode and grid or control electrode of the tube in the sense such that the picture signals decrease the potential difference between the cathode and grid and even the smallest picture signals cause an emission of electrons to the screen whilst the synchronising signals operate in the opposite sense.

Three advantages of the method will be immediately perceived.

In the first place slow changes in average brightness of the object are transmitted and automatically reproduced at the receiver. Secondly, since the synchronising signals modulate the cathode ray in the blacker than black sense at the receiver they have no effect upon the intensity of the reconstituted picture and, thirdly, in the absence of picture and synchronising signals the intensity of the ray is automatically reduced to zero so that no damage is done to the fluorescent screen if the combined signals fail for any reason.

The maximum duration of a line synchronising signal is determined by the interval between the scanning of successive lines and the minimum duration is determined by the highest frequency it is possible to transmit to the synchronising means at the receiver without appreciable attenuation. For example if this highest frequency is 100 kilocycles per second ample variations in average brightness can be obtained.

I claim:

1. Television transmitting apparatus comprising a scanning device for generating from an object to be transmitted trains of picture signals having intervals between successive trains, an amplifier for amplifying substantially only those components of said signals which have a frequency exceeding a predetermined value, means for utilising the components of said signal having frequencies below said predetermined value to obtain a series of pulses of constant amplitude with respect to a fixed datum line, each of said pulses occurring in one of said intervals and having an energy corresponding to the average energy of a plurality of said trains of picture signals, and means for modulating a carrier with the first named components of said signal and said pulses sequentially so that they be on opposite sides of the datum line fixedly related to black in said object.

2. Television transmitting apparatus comprising a scanning device for generating trains of picture signals from an object to be transmitted, an amplifier incapable of amplifying direct current and low frequency signals for amplifying said picture signals, an electro-optical device for generating auxiliary signals such as synchronising signals of constant amplitude with respect to a fixed datum line, means for generating a control current representative of the brightness, and slow changes in the brightness, of the whole object, means for utilising said control current so as to vary the average energy contained by said auxiliary signals in accordance with changes in average energy contained by said trains of picture signals, an electric mixing circuit for mixing said auxiliary and picture signals in such manner that they lie on opposite sides of the datum line fixedly related to black in said object, means for generating a carrier wave, means for modulating said carrier wave with said mixed signals and means for feeding said modulated carrier wave into a transmission channel.

3. Television transmitting apparatus comprising a scanning device for generating trains of picture signals from an object to be transmitted, an amplifier incapable of amplifying direct current and low frequency signals for amplifying said picture signals, an electro-optical device for generating auxiliary signals such as synchronising signals of constant amplitude with respect to a fixed datum line, means for passing a beam of light derived from the whole object into a photocell to generate a control current representative of the brightness, and slow changes in brightness, of the whole object, means for utilising said control current so as to vary the average energy contained by said auxiliary signals in accordance with changes in average energy contained by said trains of picture signals, an electric mixing circuit for mixing said auxiliary and picture signals in such manner that they lie on opposite sides of the datum line fixedly related to black in said object, means for generating a carrier wave, means for modulating said carrier wave with said mixed signals and means for feeding said modulated carrier wave into a transmission channel.

4. Television transmitting apparatus comprising a scanning device for generating trains of picture signals from an object to be transmitted, an amplifier incapable of amplifying direct current and low frequency signals for amplifying said picture signals, an electro-optical device for generating auxiliary signals such as synchronising signals of constant amplitude with respect to a fixed datum line, means for generating a control current representative of the brightness, and slow changes in the brightness, of the whole object, means for utilising said control current so as to vary the average energy contained by said auxiliary signals in such manner that these changes are substantially equal to the changes in average energy contained by said trains of picture signals, an electric mixing circuit for mixing said auxiliary and picture signals in such manner that they lie on opposite sides of the datum line fixedly related to black in said object, means for generating a carrier wave, means for modulating said carrier wave with said mixed signals and means for feeding said modulated carrier wave into a transmission channel.

5. Television transmitting apparatus comprising a scanning device for generating trains of picture signals from an object to be transmitted, an amplifier incapable of amplifying direct current and low frequency signals for amplifying said picture signals, an electro-optical device for generating auxiliary signals such as synchronising signals of constant amplitude with respect to a fixed datum line, means for generating a control current representative of the brightness, and slow changes in the brightness, of the whole object, means for utilising said control current so as to vary the amplitude of said auxiliary signals in accordance with changes in average energy contained by said trains of picture signals, an electric mixing circuit for mixing said auxil-

iary and picture signals in such manner that they lie on opposite sides of the datum line fixedly related to black in said object, means for generating a carrier wave, means for modulating said carrier wave with said mixed signals and means for feeding said modulated carrier wave into a transmission channel.

6. Television transmitting apparatus comprising a scanning device for generating trains of picture signals, an amplifier incapable of amplifying direct current and low frequency signals for amplifying said picture signals, a rectifier for rectifying a portion of said amplified picture signals, an electro-optical device for generating auxiliary signals such as synchronising signals, means for utilising said rectified picture signals so as to vary the average energy contained by said auxiliary signals in accordance with changes in average energy contained by said trains of picture signals, said auxiliary signals having constant amplitude with respect to a fixed datum line, an electric mixing circuit for mixing said auxiliary and picture signals in such manner that they lie on opposite sides of the datum line fixedly related to black in the object, means for generating a carrier wave, means for modulating said carrier wave with said mixed signals and means for feeding said modulated carrier wave into a transmission channel.

7. Television transmitting apparatus comprising a scanning device for generating trains of picture signals, an amplifier incapable of amplifying direct current and low frequency signals for amplifying said picture signals, a rectifier for rectifying a portion of said amplified picture signals, an electro-optical device for generating auxiliary signals such as synchronising signals, means for utilising said rectified picture signals so as to vary the average energy contained by said auxiliary signals in such manner that these changes are substantially equal to the changes in average energy contained by said trains of picture signals, said auxiliary signals having constant amplitude with respect to a fixed datum line, an electric mixing circuit for mixing said auxiliary and picture signals in such manner that they lie on opposite sides of the datum line fixedly related to black in the object, means for generating a carrier wave, means for modulating said carrier wave with said mixed signals and means for feeding said modulated carrier wave into a transmission channel.

8. Television transmitting apparatus comprising a scanning device for generating trains of picture signals, an amplifier incapable of amplifying direct current and low frequency signals for amplifying said picture signals, a rectifier for rectifying a portion of said amplified picture signals, an electro-optical device for generating auxiliary signals sich as synchronising signals of constant amplitude with respect to a fixed datum line, means for utilising said rectified picture signals so as to vary the time duration of said auxiliary signals in accordance with changes in average energy contained by said trains of picture signals, an electric mixing circuit for mixing said auxiliary and picture signals in such manner that they lie on opposite sides of the datum line fixedly related to black in the object, means for generating a carrier wave, means for modulating said carrier wave with said mixed signals and means for feeding said modulated carrier wave into a transmission channel.

9. Television transmitting apparatus comprising a scanning device for generating trains of picture signals, an amplifier incapable of amplifying direct current and low frequency signals for amplifying said picture signals, a rectifier for rectifying a portion of said amplified picture signals, an electro-optical device for generating auxiliary signals such as synchronising signals of constant amplitude with respect to a fixed datum line, means for utilising said rectified picture signals so as to vary the average duration of said auxiliary signals in accordance with changes in average energy contained by said trains of picture signals, an electric mixing circuit for mixing said auxiliary and picture signals in such manner that they lie on opposite sides of the datum line fixedly related to black in the object, means for generating a carrier wave, means for modulating said carrier wave with said mixed signals and means for feeding said modulated carrier wave into a transmission channel.

10. Television transmitting apparatus comprising a scanning device for generating trains of picture signals, an amplifier incapable of amplifying direct current and low frequency signals for amplifying said picture signals, a rectifier for rectifying a portion of said amplified picture signals, an illuminated aperture, a photo-cell, means for periodically sweeping an optical image of said illuminated aperture over said photo-cell so as to generate auxiliary signals, an electromagnetic device for varying the size of said illuminated aperture, means for applying said rectified picture signals to said electromagnetic device so as to vary the size of said aperture, and thus the average duration of said auxiliary signals, in accordance with changes in average amplitude of said picture signals, an electric mixing circuit for mixing said auxiliary and picture signals in such manner that they lie on opposite sides of a datum line fixedly related to black in the object, means for generating a carrier wave, means for modulating said carrier wave with said mixed signals and means for feeding said modulated carrier wave into a transmission channel.

11. Television transmitting apparatus comprising a scanning device for generating trains of picture signals, an amplifier incapable of amplifying direct current and low frequency signals for amplifying said picture signals, a rectifier for rectifying a portion of said amplified picture signals, a source of light, a photo-cell, means for periodically sweeping an image of said source over said photo-cell so as to generate auxiliary signals of constant amplitude with respect to a fixed datum line, means for varying the energy supplied to said source in accordance with the wave form of said rectified picture signals, an electric mixing circuit for mixing said auxiliary and picture signals in such manner that they lie on opposite sides of the datum line fixedly related to black in the object, means for generating a carrier wave, means for modulating said carrier wave with said mixed signals and means for feeding said modulated carrier wave into a transmission channel.

12. Television transmitting apparatus comprising a scanning device for generating trains of picture signals, an amplifier incapable of amplifying direct current and low frequency signals for amplifying said picture signals, a rectifier for rectifying a portion of said amplified picture signals, an electro-optical device for generating auxiliary signals in the form of a series of pulses of substantially constant amplitude and duration with respect to a fixed datum line, a thermionic

valve having a cathode, an anode and two grids, means for applying said series of pulses between the cathode and a first grid of said thermionic valve, means for applying said rectified picture signals between the cathode and a second grid of said thermionic valve, an electric mixing circuit for mixing the pulses generated in the anode circuit of said thermionic valve with said amplified picture signals in such manner that they lie on opposite sides of the datum line fixedly related to black in the object, means for generating a carrier wave, means for modulating said carrier wave with said mixed signals and means for feeding said modulated carrier wave into a transmission channel.

CECIL OSWALD BROWNE.