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MULTICHANNEL TELEVISION SYSTEM

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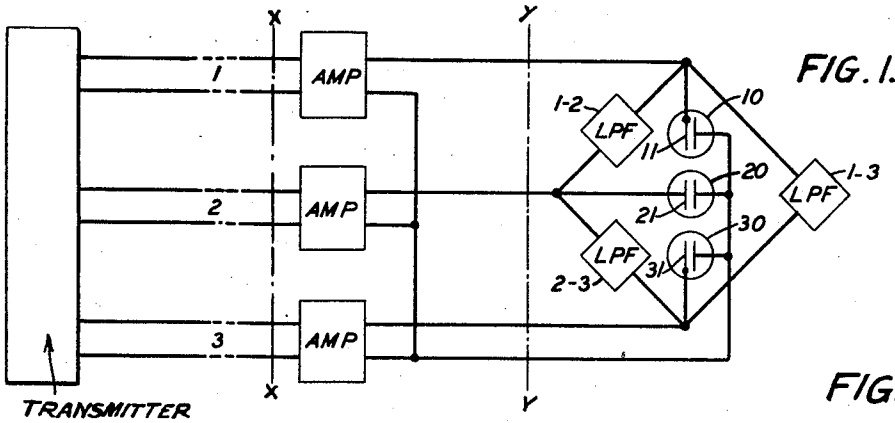


FIG. 2

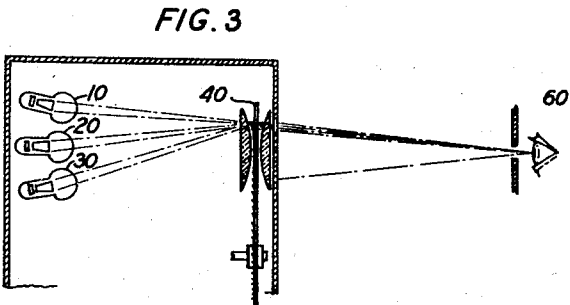
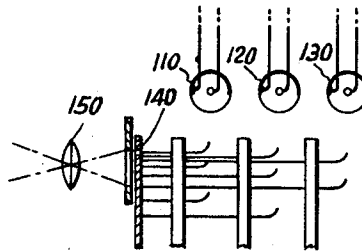
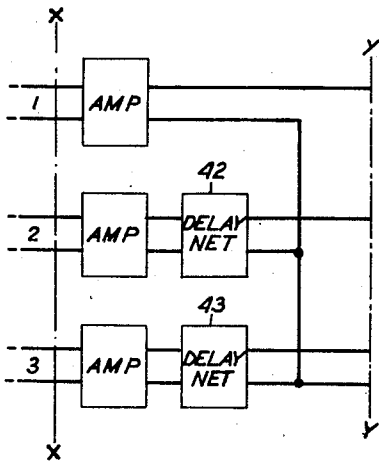
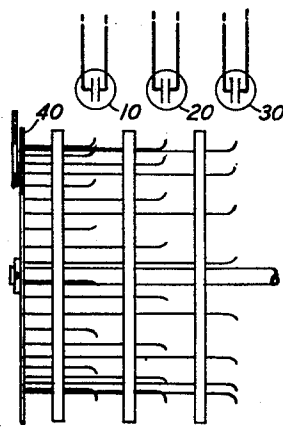


FIG. 4



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MULTICHANNEL TELEVISION
SYSTEM

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This invention relates to multiple channel signaling operation and more particularly to a method of and apparatus for reducing the lined appearance of images produced by television or other electro-optical methods when the image currents are transmitted simultaneously over a plurality of channels, which lined appearance is due to physical differences in the several channels.

In usual methods of television scanning the field of view is scanned in parallel elemental strips, the whole field being scanned within the period of the persistence of vision. The speed at which the scanning is carried out is very great and the resultant signaling current contains frequency components extending over a very wide range compared with that encountered in any ordinary signaling system. Most transmission circuits are so designed that this wide band of frequencies cannot be transmitted over them without undue signal distortion. To overcome this difficulty it has been repeatedly proposed to utilize a plurality of channels and to assign to each channel a definite portion of the field of view. This amounts to a reduction in the size of the field to be scanned for transmission over a single channel and permits a corresponding reduction in the speed of scanning, thus materially reducing the width of the signal frequency band of the signal for each channel. At the receiving station the image is built up in portions corresponding to those assigned to the different channels at the transmitting station.

It has been found very difficult in practice to exactly match the impedance characteristics of the various channels and slight differences in physical characteristics result in differences in current levels sufficient to introduce a lined appearance in the produced image. For example, it is very difficult to obtain amplifier tubes whose characteristics are exactly the same. This effect may be considerably reduced by assigning adjacent elemental strips to different channels. Such a method is disclosed in the patent of H. E. Ives, No. 1,989,618, dated Jan. 29, 1935. It is found that even when this precaution is taken the problem of matching up the several circuits with sufficient accuracy to reduce the lined appearance to an unobjectionably small value becomes serious. It is found that when several channels are matched for some particular character of scene so that the lined appearance of the image is no longer noticeable, lines in the image again appear when the general character of the scene changes, showing that the

circuits while in balance for a particular part of the tone range are unbalanced for another part.

An object of this invention is to provide a simple and improved method of and means for automatically controlling the channel levels in a manner to reduce line structure in the image.

This invention is based upon the discovery that for many types of field of view the energy level of the lower frequency components can be equalized for the several channels without materially affecting the quality of the image, such equalization substantially eliminating the line structure resulting from variations in transmission characteristics of the several channels, that variations in the energy levels for the higher frequency components of the different channels are of minor importance so far as concerns the introduction of line structure when the transmission characteristics of the different channels vary and that by confining the equalization of energy to the lower frequency components the higher frequency components may be left free to vary in level as the scanning proceeds and therefore to be effective in producing the details in the image.

In accordance with the invention in its preferred form, means are provided which act selectively upon the signaling currents to separate the lower frequency components from the higher and to effect a continual equalization of the energy levels for the lower frequency components of the signaling currents.

In order to carry out the invention in a simple manner it is only necessary for example to modify an ordinary multichannel television system in which the object field is scanned by an apertured scanning disc in say horizontal elemental strips, the total number of strips being equally divided between the channels for transmission and the effective apertures for the several channels respectively at each instant lying on the same radius of the scanning disc, by inserting between the several channels low-pass filters which will selectively transmit the lower frequency components, the filters transmitting for example the lower third of the frequency range of the signaling currents. These filters may be located anywhere in the system but are obviously most effective when placed at the receiving end of the channels. One such illustrative arrangement is shown in the accompanying drawing (Fig. 1 taken with Fig. 4) in which a plurality of lamps, one for each channel, is provided, these lamps being associated with a scanning disc carrying curved light conducting rods. By looking at a window placed in front of the disc to define the field of view, an observer

sees an image formed by the light conducted from the various lamps by the rods as they pass the field of view. Such a scanning arrangement is disclosed in Fig. 4 of the patent of O. B. Black-

well and J. Herman, No. 2,101,976, dated Dec. 14, 1937. In that patent the simultaneously effective apertures are not shown as being on the same radius of the scanning disc, but for the purpose of this invention it is desirable to have them on the same radius so that there will be no phase difference between the currents in the channels, or delay networks can be introduced into all but one of the channels to accomplish the same purpose as the radial alignment of the scanning apertures.

It is characteristic of the invention that when, for example, the elemental strip scanned for one channel is of decidedly different tone value than that for a different channel being simultaneously scanned, the resulting low frequency components in the various channels being averaged, an incorrect tone value is produced for each of the strips of the image simultaneously produced. This will happen only occasionally, especially if adjacent strips are assigned to different channels throughout the scanning. It is therefore preferable to utilize the invention in connection with scanning arrangements which assign adjacent lines to different channels. Such a system is disclosed, for example, in the patent to H. E. Ives, No. 1,796,931, issued March 17, 1931.

In the application of the present invention each channel is associated with each of the other channels through a low-pass filter which freely transmits the lower frequency components, say the lower one-third of the frequency range handled by any one of the channels and which offers high impedance to the remaining portions of the transmission range. By this means the levels of the signals received on the several channels, for frequencies lying within the range transmitted by the filters are made substantially identical, whereas the appropriate differences of the higher frequencies of the three channels are maintained. If the direct current components are to be transmitted, the filters are designed to freely transmit direct current. The direct current components and all of the lower frequency components are identical for all three lamp electrodes simultaneously associated with the three channels, while these electrodes each receive different higher frequency signal components. The higher frequency components still show the differences in level which are now characteristic of the whole image. However, the smaller the detail the less noticeable will variations of this sort become.

It is highly desirable, of course, as mentioned above, to maintain the signal currents in the various channels in phase with each other when the regulating means herein described are employed. It may be done either by causing the scanning of the various channels at the transmitter to be maintained in phase with each other or by the introduction of appropriate delay networks in one or more of the channels to compensate for the delay introduced when the various scanings are not maintained in phase. The patent of H. E. Ives No. 1,796,931, supra, discloses a multiple grid light source at the receiver and an optical scanning arrangement at the transmitter which maintains the signal currents in the several channels in phase with each other. An arrangement adaptable to this invention by the use of delay networks to bring the signals of each channel into phase with the others is shown in the patent of H. E. Ives, No. 1,989,618, supra. Figs.

2 and 3 of the drawing accompanying this specification taken with Fig. 1, illustrate the invention applied to a system employing a signal generating arrangement similar to that shown in this Ives patent No. 1,989,618.

It is within the scope of the invention to equalize the levels of only a few, or even a single one, of the frequencies which have the greatest effect in producing the appearance of lines in the image. For example, tuned circuits could be provided to freely transmit only the line scanning frequency or the field scanning frequency, or separate circuits could be provided for freely transmitting both of these components. In systems in which the direct current component is transmitted to the receiving station, the channel connecting means should in general be designed to transmit direct current.

While this invention is particularly applicable to television systems, it is obvious that it is not limited in use to such systems, but may be applied, wherever, in multichannel signaling operation objectionable differences in level result from the differences in transmission characteristics of the several channels and where the resulting distortion is caused principally by a change of level in a certain portion only of the transmission frequency range.

A more detailed description of the embodiment of the invention illustrated in the accompanying drawing follows:

Fig. 1 of the drawing is a diagrammatic showing of a circuit arrangement utilizing this invention;

Fig. 2 is a diagrammatic showing of a portion of Fig. 1 modified to include delay networks in all but one of the incoming channels;

Fig. 3 is a side elevation, in part diagrammatic, of receiving apparatus adaptable to this invention;

Fig. 4 is a side elevation of an alternative type of receiving apparatus; and

Fig. 5 is a side elevation, in part diagrammatic, of transmitting apparatus adaptable to this invention.

Referring to Fig. 1 the incoming electro-optical signals generated by suitable scanning means at the transmitter 100 are received over the several transmission channels 1, 2 and 3 and upon being suitably amplified are impressed upon the cathodes 11, 21 and 31 of light sources 10, 20 and 30, respectively. The anode connections are made to a common lead which is connected to one side of each of the circuits of the incoming channels as shown. The cathodes of the light sources are separately connected to the other side of each of the incoming circuits. The three cathodes are interconnected through low-pass filters, cathodes 11 and 21 through low-pass filter 1-2; cathodes 11 and 31 through low-pass filter 1-3; and cathodes 21 and 31 through low-pass filter 2-3. Each cathode circuit receives a composite signal of the direct current components and all of the lower frequency components of the several channels, thus making such components identical for all of the light sources. The higher frequency components, which are not passed by these interconnecting low-pass filters, maintain the characteristic of the photoelectric signal current generated for the respective channels. The receiving light translating device may obviously be a triple electrode glow discharge lamp having three separate cathodes and a common anode, or three separate lamps properly connected and positioned may be used.

Fig. 2 diagrammatically shows the incoming channels 1, 2 and 3 and delay networks 42 and 43 connected in channels 2 and 3, respectively, which may be substituted for the portion of Fig. 1 between lines X—X and Y—Y when the scanning operation for each simultaneously active aperture of each channel occurs in succession. As already pointed out this invention for relative level control is applicable when the several channels are in phase with each other and this optically obtains if the active scanning apertures which simultaneously cross the field of view are positioned in a line normal to the scanning paths, but as an alternative arrangement the apertures may pass in succession provided delay networks are used to bring the several simultaneously generated signals into phase with each other. Delay networks are well known to the art and details thereof are consequently not shown here.

Fig. 3 shows the essential elements of an electro-optical receiver arranged to use three lamps connected as shown in Figs. 1 and 2, these preferably being crater lamps. The scanning arrangement here shown is similar to that shown by H. E. Ives in Patent No. 1,989,618, supra. The three crater light sources 10, 20 and 30, one for each channel, direct their light towards the scanning disc 40 in three distinct paths or channels. The apertures of the scanning disc are equipped with prisms so arranged that one-third of the apertures operate in a given channel. The produced image may be directly viewed from a position 60 as indicated.

Fig. 4 is another electro-optical receiving arrangement in which the light from the apertures in the scanning disc 40 is channelized by means of quartz rods or the equivalent. By means of these light conductors one-third of the scanning apertures are associated with each channel and the active or effective apertures passing the field of view at each instant may readily be positioned as desired, for example, along the same radial line. The linear light sources 10, 20 and 30 associated with the respective channels are scanned by the light conducting rods passing them while rapidly moving across the field of view in proper sequence. This arrangement is somewhat similar to that shown in the patent of O. B. Blackwell and J. Herman, No. 2,101,976, supra.

The terminal scanning arrangements here shown in Figs. 3 and 4 are obviously reversible and may be used at the transmitting station 100 by substituting light sensitive cells for the light sources and forming an image of the object on the scanning field of the scanning disc.

Fig. 5 shows the essential elements of a multiple channel scanning apparatus arranged for generating a plurality of signal currents. It is a modification of the receiver of Fig. 4, adapted to operate as a transmitter. The rotating scanning disc element 140, a fragmentary portion only being shown, employs quartz rods or the equivalent for channelizing the scanning the same as in Fig. 4. An image of the object being scanned is formed on the scanning field of the scanning disc by lens 150. Three light sensitive cells 110, 120 and 130, one for each channel, at each instant receive light from different elemental areas of the image and generate respective photoelectric signal currents corresponding to the light tone value of the image being scanned. By means of the light conducting rods, one-third of the scanning apertures are associated with each channel and the active or effective apertures passing the field of view at each instant may be readily positioned to correspond with the scanning arrangement employed at the

receiver. While three channels have been shown in the drawing for illustrating this invention, obviously a different number of channels may be employed at both the transmitter and the receiver.

What is claimed is:

1. In an electro-optical image producing system employing a plurality of transmission channels and means for scanning distinctive portions of a field of view for setting up corresponding image currents for transmission over said channels, respectively, means at a receiving point associated with each of said channels for producing corresponding distinctive portions of the image, and means for rendering the lower frequency signaling components substantially identical at each instant in all of said channels at said receiving point.

2. In a television system comprising a plurality of transmission channels, a plurality of translating devices, one for each channel for interconverting electric energy and light energy, and low-pass filters interconnecting said channels, said filters transmitting only the direct and lower frequency components of the signaling currents and equalizing them in the different channels without affecting the higher frequency components which remain unequal and distinctive of the portions of the field of view assigned to said channels respectively.

3. In a multichannel television system, a plurality of circuits transmitting image currents corresponding to a plurality of scanings, image producing means having a plurality of input circuits, and means including frequency selective means connecting and interconnecting said plurality of transmitting circuits to said plurality of input circuits for impressing a lower frequency component band of each electro-optical scanning current upon all circuits of said image producing means and for impressing each remaining frequency component band of said image currents upon a distinctive circuit only of said image producing means.

4. In a multichannel television system a plurality of translating devices, one for each channel for interconverting electric energy and light energy, and frequency selective means for transferring energy between each of the channels, said means selecting the lower frequency components which are not representative of the finer details in the televised object.

5. In a television system comprising a plurality of transmission channels, a plurality of translating devices, one for each channel for interconverting electric energy and light energy, and low-pass filters interconnecting said channels, said filters transmitting only the direct current and a frequency band of approximately the lower third of the frequency components of the signaling currents and equalizing them in the different channels without affecting the higher frequency components which remain unequal and distinctive of the portions of the field of view assigned to said channels respectively.

6. In a television system comprising a plurality of transmission channels, a plurality of translating devices, one for each channel for interconverting electric energy and light energy, and tuned circuits interconnecting said channels, said circuits transmitting relatively narrow bands of frequencies selected within the lower third of the band of frequency components of the signaling currents and equalizing them in the different channels without affecting the higher frequency components which remain unequal and distinctive

of the portions of the field of view assigned to said channels respectively.

7. In a television system comprising a plurality of transmission channels, a plurality of translating devices, one for each channel for interconnecting electric energy and light energy, and tuned circuits interconnecting said channels, said circuits transmitting freely only the direct current and the line scanning and the field scanning frequencies of the signaling currents and equalizing them in the different channels without affecting the higher frequency components which remain unequal and distinctive of the portions of the field of view assigned to said channels respectively.

8. In a television system comprising a plurality of transmission channels, a plurality of translating devices, one for each channel for interconverting electric energy and light energy, and

means selective of a limited range of frequencies within the range of frequencies of the signaling current interconnecting said channels and equalizing said limited range of frequencies in the different channels without affecting the higher frequency components which remain unequal and distinctive of the portions of the field of view assigned to said channels respectively.

9. In a multichannel television system, a plurality of circuits transmitting image currents corresponding to a plurality of scannings, image producing means having a plurality of input circuits, means connecting each of said transmitting circuits to a corresponding input circuit, and means including low frequency selective means connecting each input circuit to every other input circuit.

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