Feb. 27, 1940. O. VON BRONK 2,191,515

COLOR TELEVISION

Filed Jan. 6, 1938

Fig. 1

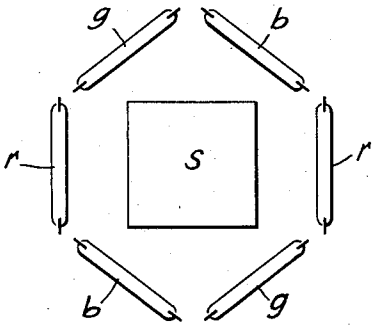


Fig. 2

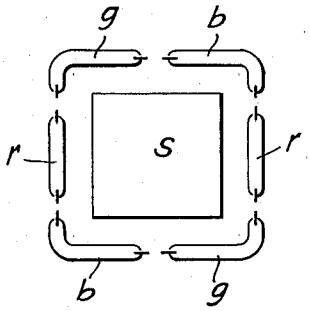


Fig. 3

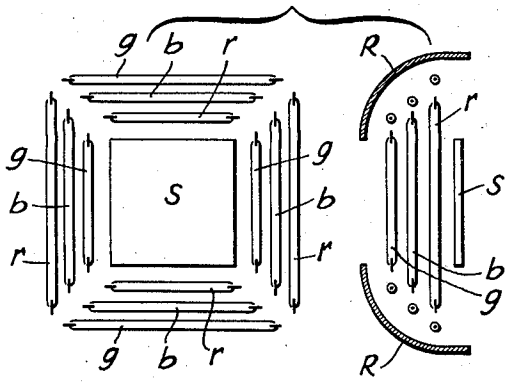
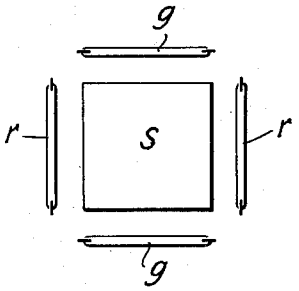


Fig. 4



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COLOR TELEVISION

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3 Claims. (Cl. 178—5.2)

This invention relates to an improvement in the means for and method of transmitting television images which may be received, at will, either in natural colors or else in black-white shading. In this method a black-and-white contrast film is scanned in the transmitter, said film comprising groups of elementary or individual images that have been taken with suitably chosen color filters. At the receiving end, between the light source and the eye of the viewer a filter arrangement is to be interposed which will transmit only that part of the spectrum with which any given partial picture or image had been taken.

The invention is predicated upon the use of the following action: When a black and white contrast image is projected upon a screen and is illuminated with monochromatic light, say, red, it will be noticed that the black portions of the image appear red, while the white portions thereof will assume this coloration to a less marked degree, with the result that the latter appear a faint or pale color or neutral. In other words, the picture which before was positive is turned into a negative presenting a red hue.

Now, this fact is utilized in the present invention in the following manner: If film made for the sending equipment consists of constituent pictures made with varicolored filters, is transmitted over the television system and is projected with white light upon a screen at the receiver (it being understood that, of course, distinct camera filters could be dispensed with, while emulsions exhibiting dissimilar sensitiveness to different colors could be used instead for the constituent pictures), and if this screen is additionally illuminated from a source of light which has the same color as the filter through which the particular frame of the film which happens to be projected had been taken, then the eye of the viewer will have the impression produced by the natural color of the imaged object, provided that the logical assumptions, to wit, sufficiently rapid sequence of the frame or images and suitable composition of the different colors, have been fulfilled. Because of the inversion of luminous values previously mentioned, the projected film frame must be a negative in order that, upon the screen, the impression of a positive picture in natural colors may be created.

Now, the application of these physical facts to television work turns out to be extremely simple. Suppose that at the sending end a negative film is to be scanned whose composite pictures have been taken sequentially, in a cyclic order, by the aid of filters of the three primary colors, for instance, red, blue and green. At the receiving end the image is re-created by light being as white as possible with equipment whose nature is basically immaterial, say, by the aid of a mirror drum and a gaseous-discharge or glow-tube presenting whitish luminescence or a Kerr cell with a glow-lamp or arc-lamp. The image may be projected either upon a screen or else may be viewed by translux action upon a frosted or ground-glass pane. It would also be possible to use a Braum (cathode-ray) tube, with the image being viewed upon the luminescent screen itself or upon a projection surface.

Now, in the neighborhood of the viewing surface are mounted vari-colored lamps disposed so as to irradiate the picture surface, though they should be concealed from the direct view of the observer. These lamps should fulfill the demand that they will be ignited and extinguished at the rate and rhythm of the color change, in the absence of any appreciable inertia. If the image frequency or frame frequency is 60 per second, with three colors, each lamp would be switched on and off 20 times each second, and it would burn about 1/60 of a second. It would thus seem that gaseous-conduction (or glow) tubes are particularly adapted to the present purpose. Recourse could be had either to the inherent or natural color of the glow column of different gases (say, neon gas to produce red and mercury-vapor for blue), or else the desired hue or color could be secured by the insertion of a suitable filter or else coloring of the lamp bulb or tube. Moreover, glow-lamps possessing a low inherent thermal inertia would be suited, and finally also luminescent tubes in which, similarly as in a Braun tube, a luminescent substance is caused to luminesce by electron irradiation or bombardment. In this instance, by suitable admixtures incorporated in the luminescent substance, or suitable choice of the luminescent substance or phosphor the desired color effects could be produced. (For instance, extremely pure zinc sulfide furnishes blue light.)

The cutting in circuit of the different lamps is insured in synchronism with the change of the picture at the sending end. To effect such a change in connections, recourse could be had again to various ways and means. In the simplest case, a revolving switch comprising mechanical contacts could be employed, the switch being driven from a synchronous motor. The drive frequency is transmitted from the television

transmitter, or else it is generated at the receiving end by a generator of stable frequency. If a mirror drum is employed at the receiving end, or a mirror screw or a perforated disk is used to act as the picture re-creator, then the revolving switch could be in direct coupling relationship with the mirror drum. However, even if for the drive of the switch a distinct motor is provided, the latter may be of such reduced dimensions that the synchronizing power may be made readily available. This is an essential advantage over the use of a rotating filter organization since such an arrangement would require considerably more driving power because of its larger dimensions.

However, quite a number of ways and means are conceivable in which such a change in connections is accomplished also without the use of revolving mechanical parts. Among these may be mentioned the cathode-ray switch in which a pencil of cathode-rays is caused to sweep over a bank of target electrodes, with the result that the circuits associated therewith are sequentially closed and opened.

The circuit changing scheme becomes particularly simple, safe and reliable in operation by resorting to relaxation-wave or time-base circuit organizations which may be easily controlled by the agency of impulses transmitted from the sending station in a similar manner as is done for pencil deflection in a Braun or cathode ray tube. If desired, the circuit-changing frequency could be transmitted also from the sound transmitter equipment which sends out the acoustic accompaniment for the television picture.

Time-base or relaxation-wave organization may be regarded as well known from the earlier art. Their operation is predicated upon the periodic charging and discharging of an electric energy accumulator or storing means such as a condenser. It would be feasible to directly feed the colored lamps or tubes with the current or potential impulses supplied from the time-base or ratchet arrangement. It is suitable to provide an auxiliary or igniter electrode of a kind well known in the art inside the glow-tube. The time-base potentials are impressed upon these auxiliary electrodes, and they may be comparatively low, while the burning potential is furnished from a powerful source of supply such as the illumination circuit or power mains. If glow-tubes are used for illumination, these could be included in the actual ratchet or time-base circuit organization, for the purpose of insuring the discharge of a storing condenser, as soon as the latter has been charged up to the firing potential of the associated glow-tube.

As previously pointed out, the black-white contrast image re-created at the receiving end must be a negative if it is to appear as a colored positive picture under vari-colored illumination. However, it is by no means necessary for this purpose that the image itself should be actually a negative when sent out from the transmitter. On the contrary, it is possible to provide and use reversing means at the receiving end predicated for their operation and function upon electrical methods. (Details of the methods which would be adapted to the said end need not be dwelt upon at this time since means for picture reversal in an amplifier stage or in a Kerr cell have been disclosed exhaustively in Handbuch der Bildtelegraphie und das Fernsehen, by Fritz Schroeter, pp. 315–317 to which reference is here made.) At any rate, this offers the notable advantage that images transmitted in the usual manner may again be picked up and re-created by any standard black-white contrast image reproduction and picture receiving means. It will be understood that it is readily possible to utilize at will a black-white picture receiver as such or for colored image reception by the use of the color-filter attachment hereinbefore disclosed. It may be suitable to provide only one operating handle or knob which will insure or render operative and inoperative at the same time the reversal of the image in the amplifier (cutting in or out a reversing stage) and the color-light device.

The means adapted to furnish the additional illumination turns out to be especially simple when working with the two-color method. The two primary colors of the camera or picture-taking filters are in such case green and red, in other words, a pair of complementary colors. Now, it can be shown that it is sufficient to illuminate the screen red when transmitting the partial image taken with the red filter, while for the partial picture that had been taken with the green filter no additional or supplementary illumination is required. It has been ascertained that the eye—and this is a physiologically explainable fact—upon extinction of the red, supplementary illumination spontaneously furnishes the complementary green, that is, that it perceives or senses a green stimulus. Now, this phenomenon could be further boosted by imparting a slightly greenish tinge to the permanent or background light with which image re-creation takes place. If a Braun tube is used for picture reception, then the fluorescent light which mostly is inherently greenish in the usual fluorescent or luminescent screen, will assist and boost the said physiological effect. Of course, the procedure could also be reversed by choosing green as the sole and only supplementary illumination rather than red.

In order to secure uniformly satisfactory image re-creation, it will be advisable to pay particular attention to the geometrical disposition of the sources supplying supplementary illumination, and to the proper balancing of the brightness or intensity of the various colored lamps or tubes. It will be found recommendable to provide for each one of the various colored lamps or tubes, or for all but one colored lamp (that is, excepting the one used to act as the fixed or determinant quantity) a distinct regulating resistance or rheostat, or else to tap the potential to be impressed upon each one of the various lamps or tubes from an adjustable voltage divider. It is thus possible to balance and trim the brightness or luminous intensity of each of the different lamps or tubes so that when blended and mixed there will result pure white. It would thus also be possible to shade or blend a given image so as to suit personal tastes.

A number of exemplified embodiments to illustrate the geometrical mounting of the colored lamps or tubes are shown in the appended drawing, wherein Figures 1, 2, 3 and 4 illustrate different embodiments of the present invention.

Referring to the drawing, the screen upon which the image is projected for direct viewing or by transmission (trans-lux) and which may be the luminescent screen of a cathode-ray or Braun tube or projection surface is indicated at S. The lamps or tubes producing red, blue and green colors are denoted by *r*, *b*, and *g*, respectively. A reflector or masking surface is indicated at R.

Figure 1 shows a rectangular picture screen

around which are grouped pairs of red, green and blue lamps or light sources. These lamps are of tubular shape. They are either glow-tubes or gaseous- or vapor-conduction tubes and colored bulbs or attached filters or glow-lamps (incandescent lamps) furnished with elongated filaments involving low thermal inertia. Inasmuch as different filling gases of a glow-tube produce different luminous intensities, the length of the various lamps will have to be appropriately chosen because of this fact. That is to say, a lamp filled with a gas luminescing at greater brightness will have to be chosen of correspondingly reduced length. At any rate, it is convenient to so dispose the lamps that they will produce as thorough and as uniform as possible an illumination of the picture area or image field. In fact, it is for this reason that more than one lamp or tube should be chosen for each color.

By choosing a suitable shape for the lamps, it is possible as illustrated in Fig. 2 to make conditions so that the lamps will snugly and uniformly fit and surround the contour of the picture area. It goes without saying that it is advisable to screen the lamps from the observer's view and eyes in order to prevent dazzle, and the means provided for the screening could serve at the same time as a reflector designed so as to direct the light-rays towards the picture field. Under certain circumstances, it will be found expedient to diffuse and scatter the colored light in order that it may become uniformly distributed over the picture field. For this purpose, there is interposed a ground or frosted glass or opal pane or else the bulb of the lamps could be matted or delustered.

Figure 3 shows another mode of mounting the lamps. Four of each color are here provided, and they are staggered towards the viewer. The result is that the image field is thoroughly and uniformly illuminated by each of the colors. A reflector R, as previously indicated, serves for screening the lamps from the viewer's eyes and for condensing or focusing the light-rays.

One way of distributing the lamps in the case of a two-color system is illustrated in Figure 4. Only red and green lamps are provided. If the physiological action previously referred to, that is, for spontaneous addition of the complementary color, is to be used, then all of the four lamps may be red or else the lamps designated by *g* could be dispensed with. Of course, also the red color could be spontaneously complemented and only green be used for actual illumination.

One way of simplifying the scheme and present organization would be to cause a single glow-tube or gaseous-conduction lamp to alternately glow in two colors. For instance, the tube or lamp could be filled with two different gases or with one gas and one metal vapor which present dissimilar striking (starting) and ionizing potentials. Thus, by changing the connections of the tube so that only one of two glow-discharges will be initiated, thereby resulting in the particular color or hue characteristic therefor. Inasmuch as glow-tubes of this kind are known from the earlier art of advertising sign illumination, there is no need to enter into details in the present disclosure.

It should be mentioned in conclusion that one particular advantage of the new receiver system may be seen to reside in the fact that the incoming image is not only not weakened by the filters, but that it is even intensified somewhat by the provision of the additional light sources.

I claim:

1. The method of producing substantially natural color television images which comprises the steps of cyclically transmitting signals each individually representing a different color value of the subject, producing a series of negative black and white images on the viewing screen, and simultaneously and successively illuminating the screen by differently colored light sources in synchronism with and corresponding to the images produced by the transmitted signals.

2. A television system for producing substantially natural color images comprising means for successively and cyclically producing negative black and white images on a viewing screen, each individual image of the cycle being representative of a different color value of the subject being transmitted, a plurality of sources of differently colored light, and means whereby the screen may be simultaneously illuminated by said sources individually and in succession and synchronism with the individual images representing the different color values.

3. A television system for producing substantially natural color images comprising means for successively and cyclically producing negative black and white images on a viewing screen, each individual image of the cycle being representative of a different fundamental color value of the subject being transmitted, a plurality of differently colored light sources, and means whereby the screen may be simultaneously flooded by light from said sources individually and in succession and synchronism with the individual images produced on the viewing screen.

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