My present invention relates to television. A general object of my present invention is to provide improved apparatus and methods for the transmission by means of electricity, magnetism or electromagnetic waves, of pictures, photographs or images of stationary or moving objects or the like in natural colors. Still other general objects of my invention are to provide an improved system of television in which ultimate reproduction is in the natural colors of the images transmitted to an improved transmitting system for the transmission of television in color and to provide an improved receiving system and apparatus for receiving television in color. Other objects, as well as advantages and features of my present invention, will be apparent as the more detailed description thereof proceeds. The latter will be given with the aid of the accompanying drawings, in which:

Figure 1 is a schematic diagram of one form of my improved color television transmitting system;

Figure 2 is a schematic plan view of one type of a multi-color elementary screen used in connection with the transmitter and receiver of my system; and

Figure 3 is a schematic diagram of one embodiment of my improved television color receiving system.

In order to understand my present invention in greater detail, the steps and apparatus for picking up, transmitting and reproducing a color television picture will now be given.

Referring to the transmitting system of Figure 1, an object to be transmitted in color, diagrammatically illustrated at O, is illuminated by the incandescent lighting system ILS. Light reflected from the object O is collected by a suitable lens system L and focussed on the left side of plate P of the television camera tube T of the two-sided "iconsocope" type. The camera tube T, however, differs from the normal type of two sided "iconsocope" by the provision of a tri-color screen system TCS, the nature and function of which will be explained more fully later.

The plate P is made in such a way that photo emission takes place from one side, namely, that nearest the lens system and the electron beam B scans the other. For a more detailed description of the conventional portion of the two sided iconsocope tube T, its conventional or usual type of collecting ring CR, plate P, electron gun EG and anode AN, reference is made to a book entitled "Television" by V. K. Zworykin and G. A. Morton, published by John Wiley and Sons, Inc., New York (1940), page 302 et seq. In my invention, the collector ring CR is so mounted in geometric or space relationship to the color screen TCS and the photo sensitive surface of the plate P that the emitted photo electrons can be readily withdrawn approximately radially from the space between TCS and P, thus minimizing false picture shading effects.

The scanning may be accomplished by deflecting the electron beam B, projected from the electron gun EG, electromagnetically by means of the horizontal coil HC and vertical coil VC external to the tube T. If desired, of course, the beam B may be deflected electrostatically. The coils HC and VC are excited with currents derived from the horizontal deflecting circuits and apparatus HD, vertical deflecting circuits and apparatus VD and synchronizing generator SG.

The currents applied to coils HC and VC are of frequencies and wave shapes such as to cause the point of impact of the electron beam B upon plate P to move across the two-sided mosaic or plate P in approximately a horizontal line at uniform speed, then fly back (blanked out or extinguished during the return periods) and scan another line and so on until the entire mosaic or plate has been scanned by, for example 441 lines in the desired sequence. The complete scanning is repeated at a rate of preferably thirty times per second, or 13,860 lines per second.

The resulting video voltage pulses set up across the coupling resistor CPR are fed, together with pulses from the synchronizing generator SG, into the amplifying system A. The latter is connected to the radio transmitter RT and serves to modulate with the complete picture signal, including the synchronizing signals, the radio waves transmitted over the transmitting antenna TA.

In order to transmit the video program in color, in accordance with my present invention, a tri-color disc-like screen TCS is mounted within tube T in any suitable way, as, for example, by means of an annular glass bead GB. As shown in plan view Figure 2, the tri-color screen TCS may be mounted upon or otherwise supported by a transparent carrier (for example, of glass) TRC in turn carried by the glass bead GB (or other form of support) of Figure 1. The color transmitting part of the system of Figure 2 consists of parallel, equally high or thick strips of material r, g, b which transmit only the primary colors red, green and blue. The strips or color elements r, g, b are arranged and repeated systematically.
The linear scanning direction SD is preferably perpendicular to the color filter lines, unless multiple interface systems of scanning are used, as described below, in which case SD should be parallel to and centered on the color filter lines. In one embodiment of my invention, single series of the strips r, g, b; namely, a single red, a single green and a single blue strip, are of such size that together they are equal to the height of the normal spot size or height employed in the beam for the transmission of ordinary black and white television and the scanning spot size is correspondingly reduced to one-third of that for corresponding black and white television. This permits transmitting a color picture wherein the fineness of detail for each color is equal to that of the corresponding black and white picture, thus permitting viewing of the received color picture at about the same distance as for black and white pictures. Alternatively, the strips r, g, b may be each of the height of the normal scanning spot for black and white television and the scanning spot size may be the same as for black and white television. In this case the color structure of the received picture will be more conspicuous and therefore it must be viewed for satisfactory at a greater distance to avoid intrusion of the color-elementary structure. The strips r, g, b may be colored glass film plates or plates having parallel and adjacent to each other or they may be different colored gelatin deposits and within a transparent non-gas-porous hermetically sealed coating or housing which may in turn be placed between two glass plates with hermetically sealed edges. Obviously, as illustrated, the color filter strips shown in section in Figures 1 and 3 and in plan in Figure 2, have been greatly exaggerated in size so as to facilitate understanding and description thereof. It is here emphasized that, while a linear structure of the color filter elements has been shown, any other color filter structure may be substituted within the scope of my invention provided the elements are not larger than will give sufficiently fine color detail for viewing of the received picture, and provided they are capable of systematic and identical arrangement on the transmitting and receiving color filters respectively, and are capable of identical synchronized scanning regimes at the transmitter and receiver.

It is to be noted that the tri-color elementary screen TCS is at a finite separation from the photo sensitive surface of the plate P and is mounted within the evacuated chamber of tube T. However, screen TCS should be as close to the photo sensitive surface as is feasible considering the electrical function of collector CR.

It will be observed that by the system outlined above, the illumination of the photo sensitive surface of plate P will vary not only with intensity, but also with color. Thus, as the beam scans a line immediately in the rear of a red element of the tri-color screen TCS, the voltage pulses arising across coupling resistor CPR indicate varying intensities or complete absence of red on the object O. As the next adjacent color line is scanned, the pulses across resistor CPR indicate the intensity of green reflected from the object O, the next line blue and then the process is repeated until the whole plate P is scanned when the process at the transmitter is repeated.

At the receiver, as shown in Figure 2, there is placed, resting upon or at a finite separation from, and immediately in front of the usual white fluorescent screen WFS, a tri-color filter or screen TCS similar and homologous to that employed at the transmitter. The color screen TCS at the receiver may be placed outside of the cathode ray tube CRT and adjacent the fluorescent screen WFS or both may be mounted within the evacuated portion of the cathode ray tube.

The remainder of the receiving system is generally conventional and consists of a receiving antenna RA and a heterodyne type of radio receiver RR. The picture components are amplified in the latter and then separated, as shown, and utilized for operating the vertical and horizontal deflecting apparatus as well as the picture and brightness control system PBC.

The tri-color elementary screen at the receiver is homologous and similar to the tri-color filter TCS, as before stated. The receiving system is provided with precise but conventional means for precise adjustment of picture size and position upon the fluorescent screen in relation to the tri-color elements of the tri-color elementary screen. The receiving system of Figure 2 also is provided with suitable means for adjusting the degree of linearity of the deflection versus time curves for the horizontal and vertical scanning of the receiver to give correspondence of such degree of linearity at the receiver with that at the transmitter. Linearity controls are well known and need not be further here described. (See, for example, the "speaking" or linearity control shown in Figure 17, page 553, Zwyerton and Morton, cited above.)

Moreover, in one preferred operation of my color television system, three-to-one interlacing is provided for at the receiver, it being noted that each interlace scanning corresponds to a single primary color component in the transmitter and also corresponds to the identical primary color component scanning at the receiver.

In this embodiment, the color filters are horizontal lines or narrow strips, parallel to the scanning direction, and of a vertical width effective to a scanning spot which is capable of systemic and identical arrangement per traversal across the picture. Interlaced scanning per se is well known in the art and need not be further described.

Any number of different colors, such as two, four the tri-color etc., may, of course, be used recurrently in the color filter systems, as found desirable, although I prefer to employ the three specified. Also in operating, as explained, I prefer to make the color elements small as compared to the regulation size of picture element. Thus, ordinary 411-line scanning would have a spot size three times that employed herein. However, it is to be understood that the system described herein may use the same size spot; or 411-line scanning, without requiring increased channel space and which would also permit use of my color system in conjunction with proposed television systems and apparatus with a minimum change in apparatus and operation.

If desired, as shown in Figure 1, an additional filter F may be provided following the lens system LS. This filter is arranged to pass only the visible light spectrum, (excluding infra-red and ultra violet light) thereby insuring operation only in response to the color system chosen.

It is to be noted further that at the scanning spot size divided by the color filter line width or other relevant dimension is made the same at the transmitter and receiver. This condition
can be satisfied by proper electron gun design and focusing of the scanning spots at the transmitter and receiver. Secondly, at all times, the scanning spot position in relation to the red, green and blue filter lines or elements must be identical at the transmitter and receiver. This is accomplished by exact adjustment of picture width and height and exact adjustment of the scanned area relative to color elements, and also by fine adjustment of the deflection controls; namely, the deflection voltages for electrostatic deflection or deflection currents for magnetic deflection, which has been illustrated in the drawings. This also entails the utilization of constant direct current voltages for electrostatically controlled tubes or constant direct current sources for the magnetically controlled tubes enabling the provision of fine adjustments for the centering controls at transmitter and receiver.

Another condition to be satisfied, as stated above, is identical linearity (or curvature) of the deflection waves at transmitter and receiver during the scanning interval. This control is well known to the art and generally is accomplished by adjusting the circuit constants of the saw-tooth oscillators employed and the associated amplifiers in the deflection systems.

Reference has already been made to color intensity. In this event, the scanning spot should be no wider than a single color line and, furthermore, the scanning spot should move strictly along color lines. Assuming it is desired to have a three-to-one interface, the scanning sequence would be arranged as follows:

Red (scanning No. 1) lines 1, 4, 7, 10, 13, 16, 19, 22, 25, 28, 31, etc.
Green (scanning No. 2) lines 2, 5, 8, 11, 14, 17, 20, 23, 26, 29, 32, etc.
Blue (scanning No. 3) lines 3, 6, 9, 12, 15, 18, 21, 24, 27, 30, 33, etc.
Red (scanning No. 4) lines 4, 7, 10, 13, 16, 19, 22, 25, 28, 31, etc.

The foregoing system obviously includes many advantages, among which is the possibility of receiving on the system described herein cyclic type of color television transmission, based on color separation resulting from interposition of a tri-color filter disc in an appropriate position to intercept the image-forming beam in the pick-up television camera and thus to produce successively and cyclically the color component image transmission.

While I have shown the color filter surface or screen TCS in Figure 1 as in vacuum inside the iconoscope T, I do not wish to be restricted to this positioning thereof. Thus, if iconoscope T is of the so-called "image iconoscope" type (see Zworykin and Morton, pages 315 et seq.), the color screen TCS may be placed between the semi-transparent photo cathode of the iconoscope on which cathode the image is framed and the lens forming the image, and preferably in air as close as possible to the glass surface carrying the photo cathode. Alternatively, instead of being at or near the outer boundary of this surface and in air, the color screen may be on or near the inner boundary of this surface and in vacuum, the photo cathode being then deposited or positioned on or near the said color screen.

Numerous similar modifications in the position of the color screen relative to the transmitter or reproducing or picture tubes at the receiver will readily be apparent and fall within the scope of my invention.

Having thus described my invention, what I claim is:

1. In a color television system, the combination of a lens system and a cathode ray scanning oscillograph comprising an evacuated envelope, a photosensitive plate mounted within the envelope substantially in the focal plane of the lens system, and a multicolor elementary light filter mounted within the envelope and spaced minutely from the plate on the side of the lens system, the filter elements being substantially coplanar.

2. In a color television system, the combination of a lens system and a cathode ray scanning oscillograph comprising an evacuated envelope, a photosensitive plate mounted within the envelope substantially in the focal plane of the lens system, and a multicolor elementary light filter mounted within the envelope and spaced minutely from the plate on the side of the lens system, the filter being plate-like with a single element across any thickness thereof.

3. In a color television system, the combination of a lens system and a cathode ray scanning oscillograph comprising an evacuated envelope, a photosensitive plate mounted within the envelope substantially in the focal plane of the lens system, and a multicolor elementary light filter mounted within the envelope and spaced minutely from the plate on the side of the lens system, and disposed substantially in the focal plane of the lens system.

4. The combination set forth in claim 1 and further comprising an anodic ring electrode between the plate and filter.

5. The combination set forth in claim 1 and further comprising an anodic ring electrode between the plate and filter, and means for transmitting the voltage pulses set up in said plate.

6. The combination set forth in claim 1, the filter elements being dimensioned to permit a scanning spot to fall within each element.

7. The combination set forth in claim 1, in which the light filter comprises groups of color strips, the strips of each group being of different colors and having a small dimension substantially equal to a scanning spot.

8. The combination set forth in claim 1, in which the light filter comprises groups of color strips, the strips of each group being of different colors and having a small dimension substantially equal to a scanning spot and means for scanning said plate transversely of said strips.

9. In a color television system, a cathode ray scanning oscillograph, comprising an evacuated envelope, a photosensitive plate mounted within the envelope, and a multicolor elementary light filter associated with the plate and minutely spaced from the face of the plate relative to the cathode ray gun, the filter comprising groups of color strips having one dimension co-extensive with the plate and having a small dimension substantially equal to a scanning spot.

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