Feb. 17, 1948. P. C. GOLDMARK 2,435,963

COLOR TELEVISION

Filed Dec. 13, 1940 2 Sheets-Sheet 1

Fig. 1.

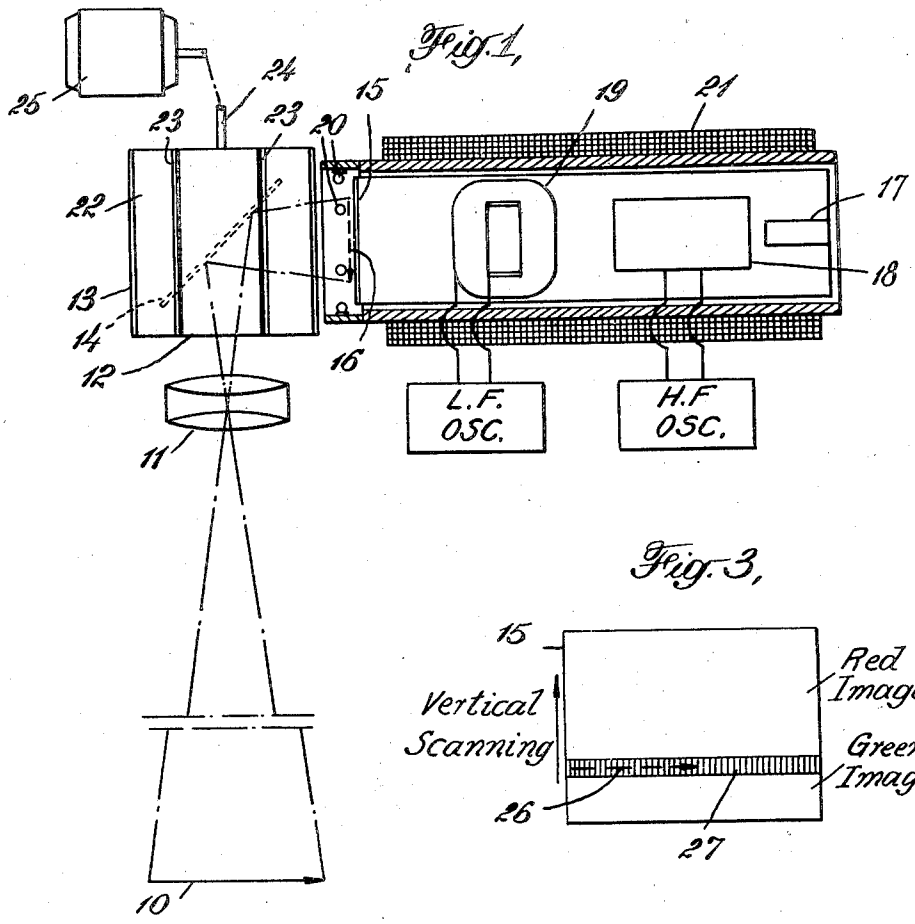

Fig. 3.

Fig. 2.

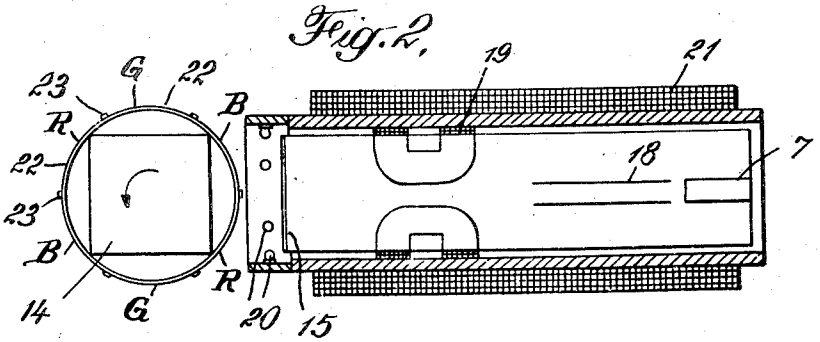

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Fig. 4,

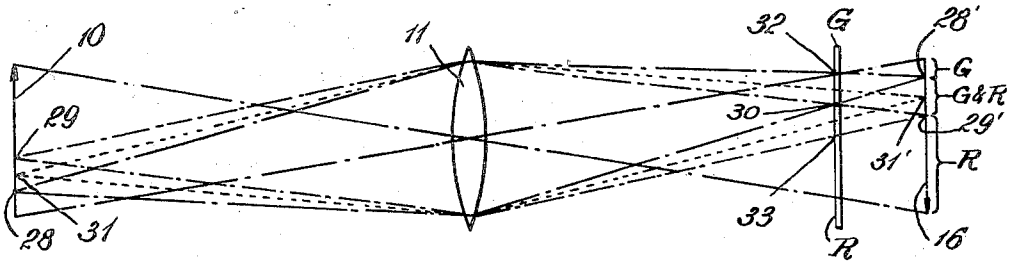
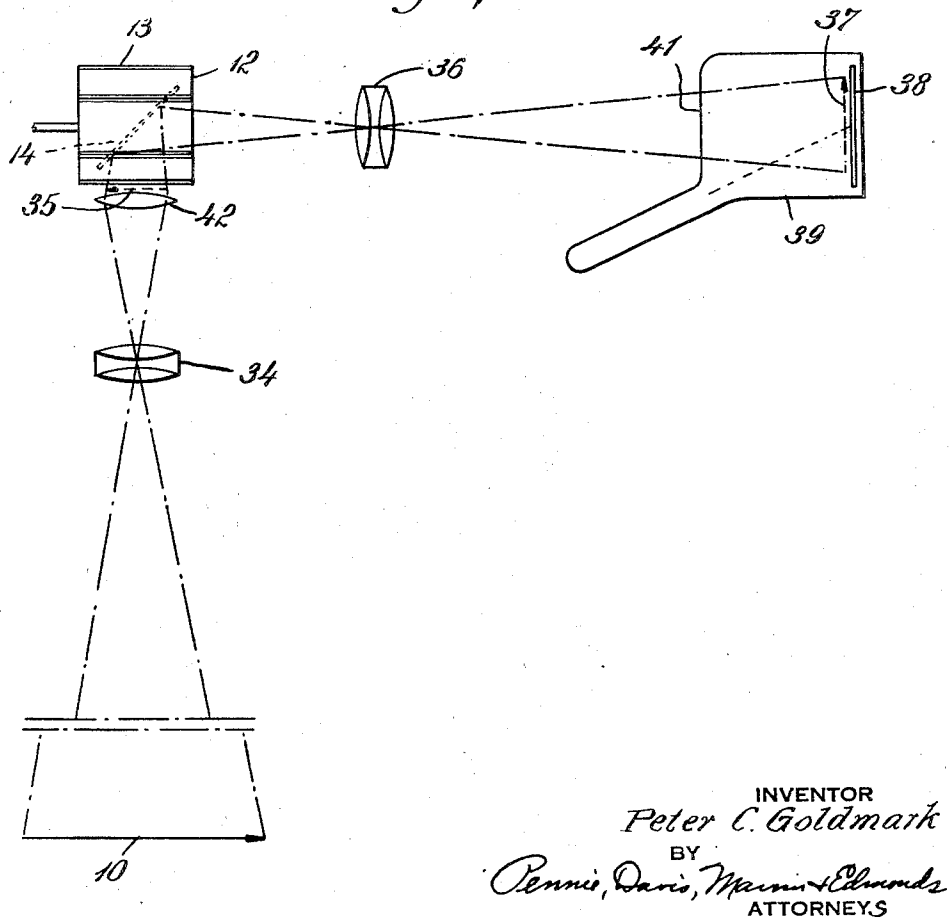


Fig. 5,



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UNITED STATES PATENT OFFICE

2,435,963

COLOR TELEVISION

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Application December 13, 1940, Serial No. 370,008

23 Claims. (Cl. 178—5.4)

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This invention relates to television, especially to television in natural colors. The invention is particularly directed to the provision of direct-pickup apparatus employing a transmitting tube of the storage type. However, many features of the invention are more broadly applicable.

At the present time, scanning devices of the storage type are commonly used for direct pickup, that is, the scanning of natural object fields, either indoors or outdoors, as distinguished from film scanning. Non-storage tubes are suitable for film scanning, where adequate light can be obtained, but are usually much less sensitive than storage type tubes and hence are not as satisfactory for direct pickup.

To televise pictures in color, a number of systems have been suggested. In one type of system an object field is simultaneously scanned by a plurality of scanning devices in a corresponding plurality of colors. The resulting color signals are transmitted over separate channels to a receiver, where they are reproduced. In another type of system an object field is successively scanned in a plurality of primary colors and the corresponding signals sent over a single channel to a receiver. Commonly, a single scanning device is employed and different color aspects of the object field are successively presented to the scanning devices, for example, by a rotating tri-chromatic filter disk. This latter type of system is considered preferable since it avoids the difficulties and complexities of multiple channel transmission and reception.

A difficulty arises in connection with the use of a storage tube and filter disk, namely, color carry-over from one field scansion to the next. In a storage tube the signal is built up throughout all, or a large portion, of a field scanning period, and the signal thus stored up is released at the instant of scanning. For example, in an electronic storage scanning device such as the so-called "Orthicon" or "iconoscope," a light image impinges on the image-receiving area (commonly a mosaic target) and charges are stored up during the interval between successive scansions of a given portion of the area. As the scanning beam passes it discharges the scanned areas, which thereupon begin to recharge in accordance with the image then impinging on them.

For correct color rendition it is desirable that the color impinging on a given line of the mosaic be changed as that line is scanned. In this manner as soon as a line is scanned it begins

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to recharge in accordance with another color aspect of the object field. This change preferably should take place progressively over the entire area of the image in phase with the movement of the scanning beam in the low-frequency direction. Since according to present scanning procedures an area is scanned from top to bottom or vice versa in a plurality of side-by-side lines, the present invention provides means whereby the color may be changed along a straight line substantially coincident with the line being scanned.

In accordance with the present invention, a rotating filter drum having filter segments arranged around its periphery is employed. The drum is preferably arranged in the path of light to the scanning device with the boundaries between segments substantially parallel optically with the lines of the image-receiving area which are scanned. The diameter and speed of rotation of the drum and the number of filter segments are advantageously selected so that the boundaries between segments traverse the image-receiving area at substantially the same field scanning speed and field scanning frequency as the scanning beam. Then, by properly phasing the drum with respect to the scanning beam, the boundaries between filter segments may be made to substantially coincide with the line being scanned throughout the scanning of the image. In this manner, the color of the image impinging on the lines of the scanning device is changed progressively as the lines are scanned, thereby avoiding color carry-over from one field scansion to the next and enabling correct color rendition to be obtained.

The invention will be more fully understood by reference to the specific embodiments illustrated in the drawings and the following description thereof.

In the drawings:

Fig. 1 is a diagrammatic plan view illustrating a specific embodiment of direct-pickup apparatus employing a filter drum in accordance with the invention;

Fig. 2 is a front view of the apparatus of Fig. 1;

Fig. 3 is a diagram illustrating the coincidence between the boundary between filter segments and the line being scanned;

Fig. 4 is a diagram illustrating the use of an opaque strip between adjacent filters to avoid color overlapping; and

Fig. 5 is an embodiment employing an intermediate image.

Referring to Fig. 1, light rays from an object

field 10 are collected by lens 11 and enter the open end 12 of the filter drum 13. Positioned inside the filter drum is a mirror 14 which diverts the light rays through the filters 22 located on the peripheral surface of the drum, and thence to the image receiving area 15 of a storage scanning device. Lens 11 focusses the rays to form an image 16 of the object field at the image-receiving area 15.

Any suitable type of storage scanning device may be employed, as desired. The tube specifically illustrated is of the Orthicon type, having an electron gun 17, horizontal deflecting plates 18, vertical deflecting coils 19 and axial field coil 21. The horizontal deflecting plates and vertical deflecting coils are energized by suitable high-frequency and low-frequency sawtooth wave generators, as indicated. In the Orthicon, the image area 15 is a translucent mosaic charge-storing target.

In the drum specifically illustrated, there are six filter segments 22 arranged around and forming the peripheral surface thereof, and comprise two sets of red, green and blue filters, denoted R, G and B (Fig. 2). Narrow strips 23 are provided between adjacent filter segments. These strips may be of any suitable material, such as brass, to which the filter segments may be secured. Instead of strips 23, other suitable means may be employed for securing the filter material to the surface of the drum. The boundaries between the filter segments, here formed by strips 23, extend laterally of the drum, and are advantageously parallel to the axis 24 of the drum, as shown. The drum is driven by motor 25 through suitable mechanical coupling means.

The speed of rotation of the drum is selected with respect to the number of filter segments so that the segments traverse the image receiving area at field scanning frequency. Proper synchronization may be obtained in ways known in the art. The diameter of the drum is advantageously selected in view of the number of segments so that the boundaries between segments traverse the image-receiving area 15 in the low-frequency direction (commonly the vertical direction) at substantially the same speed as that of the scanning beam in that direction. Then, by properly phasing the drum with respect to the scanning beam, the boundaries between segments can be made to coincide with the lines being scanned as the scanning proceeds. The length of the segments in the axial direction will usually be sufficient to include light rays of substantially the full length of the scanning lines.

In the embodiment of Fig. 1 the circumferential length of a given segment is approximately equal to the height of the image on area 15 plus an amount to allow for the blanking period, slightly modified by the optical magnification between the surface of the drum and the scanning area 15. The calculation of the actual dimensions will be clear to those in the art. With a uniform speed of rotation of the drum, the projection of the boundary onto the area 15 will not move down the area at a precisely uniform speed. However, with a six-filter drum and a radius approximately equal to the image height, the departure from exact linearity does not exceed about 1%. This variation will usually be quite permissible, but could be diminished by using a larger drum if desired.

Fig. 3 illustrates the coincidence of scanning and color changing. The scanning area 15 is scanned in horizontal side-by-side lines, it being

assumed that scanning begins at the bottom and progresses toward the top. The position of the scanning beam at the instant under consideration is indicated by the dotted arrow 26. The dark band 27 represents the boundary between two adjacent filter segments, say, the red and green segments, as projected to the plane of the image. Prior to the passing of the scanning beam 26, the lines of the image correspond to the red aspect of the object field, as indicated. Immediately after the passing of the scanning beam 26, the lines are exposed to the green aspect of the image, as indicated. Since the boundary between segments coincides substantially with the scanning beam, there is no color carryover from one field scansion to the next.

It will be understood that the boundary between adjacent segments will usually be wider at the scanning area than a scanned line, so that the boundary and line will not be coextensive. "Coincidence" as used herein hence refers to a condition where the boundary includes the line.

Although it is considered advantageous to have the boundary between adjacent segments coincide with the line being scanned as the scanning progresses, in some cases a small amount of color carry-over may be permissible. In such case, the drum need not be accurately phased with respect to the scanning beam, but may lead or lag somewhat. Usually the lead or lag of the beam with respect to the boundary is advantageously small, so that substantial coincidence ensues.

Any suitable scanning system for scanning the area 15 may be employed as desired for example, either interlaced or non-interlaced. In the case of electronic scanning devices employing a charge-storing mosaic, such as the Orthicon or iconoscope as at present constructed, it is found that a single scanning of the lines of the mosaic does not completely remove the charge on the lines. Thus, if the mosaic is exposed to an image and the image cut off, the lines may be scanned several times and corresponding signals of progressively decreasing magnitude developed during each scansion. The employment of bias light extending uniformly over the surface of the image-receiving area has been found advantageous in many cases to produce a more pronounced decay between first and second scansions. Hence, the residual signal of one color aspect of the image will not seriously affect the signal corresponding to the next color aspect. The desired bias light may be obtained by the ring of small lights 28 positioned in front of the image-receiving area of the scanning tube. Bias light may of course be omitted if desired.

In the case of interlaced scanning of the area 15, when successive field scansions correspond to different colors, color carry-over may result due to the fact that both sets of lines are exposed to one color, say red, but only one set of lines is scanned to obtain the red image signals. Both sets of lines are then exposed to the next color, say green, and the other set of lines scanned. However, since the latter set of lines will have been exposed to both the red and green aspects of the image, correct color rendition may be seriously impaired. In such case it has been found advantageous to enlarge the diameter of the scanning spot somewhat so that the scanning of one line will discharge the adjacent lines, at least to some extent. This procedure will normally result in the loss of some detail, but the psychological effect of the addition of color to the image offsets the decrease in detail.

Another alternative is to scan only a single interlaced set of lines of the mosaic and shift the image optically between successive scansions as disclosed in the copending joint application of Peter C. Goldmark and John N. Dyer, Serial No. 366,400, filed November 20, 1940. The filter drum of the present invention may be employed in connection with the image shifting disk disclosed in the aforesaid copending application.

Still further, only a single set of interlaced lines of the mosaic may be scanned during successive field scansions using a somewhat enlarged spot diameter, and the sets of lines reproduced at a receiver with normal interlacing and normal spot size. Some loss of detail will result, but will be offset by the color.

In Fig. 1 the drum is positioned as close to the face of the scanning tube as possible, so that the boundaries between segments will be fairly sharply focussed on the image receiving area 15. Thus, rays passing through adjacent filters of different color do not overlap on the image receiving area. In some cases this may not be feasible and it may be necessary to place the drum at such a distance from the image receiving area that the boundaries between filters are substantially out of focus at the image area, so that rays passing through adjacent filters of different color may overlap at the image receiving area and cause undesirable color inter-mixture. In such case, the opaque bars 23 may be made sufficiently wide to prevent such inter-mixture of colors.

Fig. 4 illustrates this effect. In this figure an object field 10 is focussed by lens 11 to form an image 16. Image 16 may be formed on the image receiving area 15 of the scanning tube as illustrated in Fig. 1. In the path of the rays to the image area are shown two contiguous filter segments R and G, leaving a boundary line 30 therebetween. These filters may be taken to represent the surface of the drum 13 of Fig. 1 at some selected instant, with the filter segments contiguous rather than separated by the bars 23. As indicated in the figure, all light rays from point 28 in the object field pass through the green filter and impinge on the corresponding point 28' in the image field. Similarly, all light rays from point 29 in the object field pass through the red filter and impinge on the corresponding point 29' in the image field. Rays from all points between 28 and 29 in the object field will pass partly through the red filter and partly through the green filter before impinging on the image area, as illustrated by the rays drawn from point 31 to the corresponding point 31'.

There will thus be a band of mixed green and red in the image area, denoted "G & R" in Fig. 4. This mixed band may be eliminated by rendering opaque the portion of the filter between points 32 and 33. Such an opaque band will cut off all rays from all parts of lens 11 which pass through different filters before converging to a given point of the image field.

The proportions of Fig. 4 are exaggerated in order to illustrate more effectively the use of the opaque band between filter segments. In a specific case, the width of the opaque band may be readily determined so as to cut off the undesired rays without cutting off more rays than are necessary. A small amount of intermixture may be permissible, in which case the opaque band may be made somewhat narrower than is required for the complete prevention of color intermixture. If the filters are close enough to the image area, the opaque band may be eliminated entirely, or made just wide enough to provide the required structural strength.

It will be observed that portions of the image area immediately adjacent the area denoted G & R receive rays from only a fraction of the lens 11 when the portion of the filter plane between 32 and 33 is made substantially opaque. However, since the filters will be moving, all parts of the image area will receive substantially the same total illumination.

In some cases it may be necessary to place the drum so remote from the image receiving area that the use of an opaque band as shown in Fig. 4 will seriously restrict the total mount of light reaching the image receiving area during a field scanning period. In such case an intermediate image may be formed of the object field, the color drum placed at or near the intermediate image, and the resultant image of progressively changing color aspects projected to the scanning device.

Referring to Fig. 5, an object field 10 is focussed by a first projection lens 34 to form an intermediate image 35 at a selected plane. The color filter drum 13 is positioned with the effective portion of its periphery at or near the plane of the intermediate image. After passing through the periphery of the drum the rays impinge on the mirror 14 which diverts the rays through the open end 12 of the drum to a second projection lens 36. Lens 36 forms an image 37 of the intermediate image 35 at the image receiving area 38 of the scanning device, thereby rendering the intermediate plane and image area 38 conjugate to each other. Since the drum is at or near the intermediate plane, the boundaries will be substantially in focus at the image receiving area.

The scanning device is here shown as an electronic scanning tube 39 of the so-called "iconoscope" type. In the conventional iconoscope the image receiving area 38 is a charge-storing mosaic which is positioned several inches away from the window 41 of the tube. With such a tube the drum must necessarily be placed a considerable distance away from the image receiving area 38 and hence the use of an intermediate image with the filter drum placed at or near the plane of the intermediate image is advantageous. Of course, an iconoscope could be used in the single projection lens system in Fig. 1, if desired, particularly where a long focal length lens is employed. A field lens 42 may be employed with advantage to direct the rays forming the intermediate image to the second projection lens 36.

Since the size of the intermediate image may be larger or smaller than that of the scanning device, the drum in Fig. 5 may be correspondingly larger or smaller than that of Fig. 1. As the boundaries traverse the image 35 at the intermediate plane, the projection lens 36 causes a corresponding effective traversal of the image 37 at the scanning device by the boundaries, enlarged or reduced as the case may be.

It will be noted that the axis of the filter drum in Fig. 5 is at right angles to the face of the scanning tube 39, rather than being parallel thereto as in Fig. 1. Nevertheless, the boundaries of the filter segments, although physically not parallel to the scanning lines of the scanning device, are optically parallel thereto because of the diverting of the light rays by mirror 14. It will be understood that when the term "parallel optically" is employed in the specification

and claims it refers to a system such that the projection of the boundaries between filter segments on the image receiving area are effectively parallel to the scanning lines of the area. The boundaries may or may not be physically parallel to the scanning lines.

The drum in Fig. 5 may of course be oriented with its axis parallel to the face of tube 39, as in Fig. 1. In such case the intermediate image may be formed as the light rays leave the drum.

In Figs. 1 and 5 the mirror 14 is at an angle of 45° with respect to the axis of the drum, and the axis of the rays entering the drum are at right angles with respect to the axis of the rays leaving the drum. This angular relationship is advantageous in avoiding optical distortion. Nevertheless, if desired for any reason, the angular relationship may be otherwise. In such case, the optical relationships may be such that the boundary between a pair of filter segments is somewhat keystoned at the image receiving area. For example, in Fig. 5 if the mirror is at an angle of 60° with respect to the axis and the axial ray enters the drum perpendicular to the axis as shown, the axial exit ray will be at an angle with respect to the axis and consequently one end of the boundary between a given pair of segments may be magnified more than the other end with resultant keystoning at the image receiving area. In some cases such keystoning may not seriously adversely affect the operation of the apparatus. It will be understood that the term "parallel optically" applies also to such a case.

In general it is desirable that the boundary of a filter segment at the image receiving plane be a straight edge moving down the image receiving area at the same speed and in coincidence with the line being scanned. However, departures from this relationship may be permissible in specific instances.

In Figs. 1, 2 and 5 the filter drum is circular in cross section. If desired, however, the filter segments may be flat rather than curved in which case the cross section would be hexagonal in shape for a drum having six segments. The number of segments may of course differ from that specifically illustrated.

The present invention has been developed for color television and is especially adapted thereto. However, many aspects of the invention are of broader application. The use of the drum in conjunction with a scanning device may be advantageous not only with color filter segments but also with segments of different optical characteristics generally, especially where it is desired to change a characteristic of the image progressively with the scanning thereof. The use of the opaque band and intermediate image may also be advantageous with such apparatus.

The features of an opaque band between segments of different optical characteristics, and an intermediate image with a rotatable element having segments of different optical characteristics at or near the plane thereof, may also be useful in connection with rotatable elements or devices other than drums, for example, disks. Both the opaque band and intermediate image may be employed in a single apparatus, if desired.

Although the invention is particularly directed to direct pick-up apparatus employing a storage tube, the invention can also be employed in other apparatus, for example, in connection with non-storage scanning devices, in film-scanning

apparatus, and in receivers. The use of the drum in a receiver may be particularly advantageous with a receiver tube of the storage type or one having considerable after-glow, since the change from one filter to the next may be made to follow the scanning beam closely and all parts of the image area may be exposed through a given segment for equal intervals.

Many modifications of the apparatus of the invention may be made by those skilled in the art without departing from the spirit and scope of the invention.

I claim:

1. In color television apparatus, the combination which comprises an electronic scanning device, means for scanning an image area with said scanning device in two dimensions in a plurality of side-by-side lines, a rotatable color-filter drum having a plurality of color-filter segments of different optical characteristics arranged around the peripheral surface thereof, said drum being positioned and arranged in the path of the image light of said image area with the boundaries between segments substantially parallel optically with said lines of the image area, and said light passing through said segments as the drum rotates with progressive change of color at substantially the same speed at which the lines are scanned.

2. In color television apparatus, the combination which comprises an electronic scanning device, means for scanning an image area with said scanning device in two dimensions in a plurality of side-by-side lines, a rotatable color-filter drum having a plurality of color-filter segments of different optical characteristics arranged around the peripheral surface thereof with the boundaries between segments substantially parallel to the axis of the drum, said drum being positioned and arranged in the path of the image light of said image area with the boundaries between segments substantially parallel optically with said lines of the image area and said light passing through said segments as the drum rotates with progressive change of color at substantially the same speed at which the lines are scanned, the length of the segments in the axial direction being sufficient to include light rays of substantially the full length of said lines.

3. In color television apparatus, the combination which comprises an electronic scanning device, means for scanning an image area with said scanni g device in two dimensions in a plurality of side-by-side lines, a rotatable color-filter drum having a plurality of color filter segments arranged around the peripheral surface thereof with laterally extending boundaries therebetween, said drum being positioned and arranged in the path of the image light of said image area with the boundaries between segments substantially parallel optically with said lines of the image area and said light passing through said segments as the drum rotates with progressive change of color at substantially the same speed at which the lines are scanned, the length of the segments in the axial direction being sufficient to include light rays of substantially the full length of said lines.

4. In color television apparatus, the combination which comprises an electronic scanning device of the storage type having an image area associated therewith, means for scanning said image area in two dimensions in a plurality of side-by-side lines, a rotatable color-filter drum having a plurality of color-filter segments of

different optical characteristics arranged around the peripheral surface thereof with boundaries substantially parallel to the axis of the drum, said drum being positioned and arranged in the path of the image light of said image area with said boundaries substantially parallel optically with said lines of the image area, the length of the segments in the axial direction being sufficient to include light rays of substantially the full length of said lines, and means for rotating said drum in substantial synchronism with the low frequency scanning of said image area to cause said boundaries to traverse the image area in substantial synchronism with the scanning of said lines, said drum being arranged so that said light passes through the segments successively as the drum rotates and the circumferential extent of a segment being sufficient to include light of a substantial proportion of said lines when said segment is in operating position.

5. In color television apparatus, the combination which comprises an electronic scanning device of the storage type having an image area associated therewith, means for scanning said image area in two dimensions in a plurality of side-by-side lines, a rotatable color-filter drum having a plurality of color filter segments arranged around the peripheral surface thereof with laterally extending boundaries, said drum being positioned and arranged in the path of the image light of said image area with the boundaries between segments substantially parallel optically with said lines of the image area so that as the drum rotates the filter segments are successively interposed in the path of said image light, the length of the segments in the axial direction being sufficient to include light rays of substantially the full length of said lines, and means for rotating said drum in substantial synchronism with the low frequency scanning of said image area to cause said boundaries to traverse the image area in substantial synchronism with the scanning of said lines, said drum being arranged so that said light passes through the segments successively as the drum rotates and the circumferential extent of a segment being sufficient to include light of a substantial proportion of said lines when said segment is in operating position.

6. In color television transmitting apparatus, the combination which comprises an electronic storage scanning device having an image-receiving area associated therewith, means for focusing a two-dimensional light image of an object field on said image-receiving area, means for scanning an image on said image-receiving area in two dimensions in a plurality of side-by-side lines, a rotatable color-filter drum having a plurality of color-filter segments of different optical characteristics arranged around the peripheral surface thereof with laterally extending boundaries, said drum being positioned and arranged in the path of light rays forming said image with the boundaries between segments as projected to said image-receiving area substantially parallel with said lines as the projections of the boundaries traverse said area, the length of the segments in the axial direction being sufficient to include light rays of substantially the full length of said lines, and means for rotating said drum in substantial synchronism with the low frequency scanning of said image area to cause said boundaries to traverse the image area in substantial synchronism with the scanning of said lines, said drum being arranged so that said light passes through the segments successively as the drum rotates with progressive change of color at substantially the same speed at which the lines are scanned, and the circumferential extent of a segment being sufficient to include light of a substantial proportion of said lines when said segment is in operating position.

7. In color television transmitting apparatus, the combination which comprises an electronic scanning device of the storage type having an image-receiving area associated therewith, means for focusing a two-dimensional light image of an object field on said image-receiving area, means for scanning an image on said image-receiving area in two dimensions in a plurality of side-by-side lines, means for progressively changing the color aspect of said light image including a rotatable color-filter drum having a plurality of color filters arranged around the peripheral surface thereof with laterally extending boundaries therebetween, said drum being positioned and arranged in the path of light rays forming said image with the boundaries between said filters substantially parallel optically with said lines, and means for rotating said drum in substantial synchronism with the low frequency scanning of said image area to cause said boundaries to substantially coincide with the line being scanned as the boundaries successively traverse the image-receiving area, said drum being arranged so that said light passes through the filters successively as the drum rotates with progressive change of color at substantially the same speed at which the lines are scanned, and the circumferential extent of a filter being sufficient to include light of a substantial proportion of said lines when said filter is in operating position.

8. In color television transmitting apparatus, the combination which comprises an electronic scanning device of the storage type having an image-receiving area associated therewith, means for focusing a two dimensional light image of an object field on said image-receiving area, means associated with said scanning device for scanning an image on said image-receiving area in two dimensions in a plurality of side-by-side lines at a selected field-scanning frequency, a rotatable color-filter drum having a plurality of color filters arranged around the peripheral surface thereof with laterally extending boundaries therebetween, said drum being positioned and arranged in the path of light rays forming said image with the boundaries between said filters substantially parallel optically with said lines so that as the drum rotates the color impinging on said lines is progressively changed over the image-receiving area, light of the colors of adjacent filters impinging on adjacent areas of the image-receiving area as the boundary therebetween traverses the image-receiving area, and means for rotating said drum so that said boundaries traverse the image-receiving area at field scanning frequency and at substantially field-scanning speed with said boundaries substantially coinciding with the line being scanned as the boundaries successively traverse the image-receiving area, said drum being arranged so that said light passes through the filters successively as the drum rotates and the circumferential extent of a filter being sufficient to include light of a substantial proportion of said lines when said filter is in operating position.

9. In color television transmitting apparatus, the combination which comprises an electronic scanning device of the storage type having an

image-receiving area associated therewith, means for focusing a two-dimensional light image of an object field on said image-receiving area, means associated with said scanning device for scanning an image on said image-receiving area in two dimensions in a plurality of side-by-side lines at a selected field-scanning frequency, a rotatable drum having a plurality of transparent color filter segments arranged around the peripheral surface thereof with the boundaries between filters substantially parallel with the drum axis, a mirror within said drum, said drum and mirror being positioned and arranged in the path of light rays forming said image to cause said light rays to pass through part of the periphery and one end of the drum, the boundaries between said filters being substantially parallel optically with said lines so that as the drum rotates the color impinging on said lines is progressively changed over the image-receiving area, light of the colors of adjacent filters impinging on adjacent areas of the image-receiving area as the boundary therebetween traverses the image-receiving area, and means for rotating said drum so that said boundaries traverse the scanning area at field-scanning frequency and at substantially field-scanning speed with said boundaries substantially coinciding with the line being scanned as the boundaries successively traverse the image-receiving area, the circumferential extent of each segment being sufficient to include light rays of a substantial proportion of said lines when the segment is in operating position.

10. In color television transmitting apparatus, the combination which comprises an electronic scanning device having an image-receiving area associated therewith, means for focusing a two-dimensional image of an object field at a selected intermediate plane, means for focusing an image at said intermediate plane on said image-receiving area of the scanning device, means for scanning an image on said image-receiving area in two dimensions in a plurality of side-by-side lines, and a rotatable color-filter drum having a plurality of color-filter segments of different optical characteristics, said rotatable color-filter drum being positioned near said intermediate plane so that said plurality of segments are successively interposed in the path of the image light rays with the boundaries between segments traversing the image area in a direction transverse to said lines with progressive change of color at substantially the same speed at which the lines are scanned. whereby an optical characteristic of an image impinging on said image-receiving area may be progressively changed at a position remote from said area with the boundaries between segments substantially in focus at said area.

11. In color television transmitting apparatus, the combination which comprises an electronic scanning device of the storage type having an image-receiving area associated therewith, means for focusing a two-dimensional light image of an object field at a selected intermediate plane, means for focusing an image at said intermediate plane on said image-receiving area of the scanning device, means associated with said scanning device for scanning an image on said image-receiving area in two dimensions in a plurality of side-by-side lines at a selected field-scanning frequency, a rotatable drum having a plurality of transparent color filters arranged around the peripheral surface thereof with laterally extending boundaries therebetween, said drum being positioned and arranged in the path of the light rays near said intermediate plane so that the boundaries are substantially in focus at said image-receiving area as the boundaries traverse the area, the boundaries being substantially parallel optically with said lines of the image-receiving area so that as the drum rotates the color impinging on the lines is progressively changed over the image-receiving area, light of the colors of adjacent filters impinging on adjacent areas of the image-receiving area as the boundary therebetween traverses the image-receiving area, and means for rotating said drum so that said boundaries traverse the image-receiving area at field-scanning frequency and at substantially field-scanning speed with said boundaries substantially coinciding with the line being scanned as the boundaries successively traverse the image-receiving area, the circumferential extent of each segment being sufficient to include light rays of a substantial proportion of said lines when the segment is in operating position.

12. A color television signal-translating system comprising, a cathode-ray tube including a target, means for successively scanning said target with an electron beam in a series of parallel lines, color-filter-carrying means interposed in the optical path between said target and the television image to be translated, means for moving said filter-carrying means so that the lines of color demarcation thereof remain substantially parallel to said lines of said series for changing the color of light associated with each line a predetermined interval after such line is scanned and for maintaining said color associated with said line until said line is next scanned by said beam, and means for blocking the image of each line during the interval said line is being scanned.

13. In a television system adapted to generate and transmit signals representative of images in natural colors a tube having a charge storage electrode and means to develop an electron beam, a movable filter comprising a plurality of filter segments adapted to move sequentially and transmit to said electrode light representative of individual colors from an object of which colored image representations are to be transmitted, means to move said filter at a predetermined rate to expose successive areas of said electrode to colored image components of said object, means to scan the electron beam of said tube over a portion of said electrode in the direction and at the predetermined rate of exposure of said colored image components while other portions of said electrode are illuminated by a differently colored light image component of said object, and means to maintain the said portion of said electrode being scanned by said beam unilluminated by light from said object whereby the signal derived as a result of said electron beam scanning is representative at any one time of only one color of light projected on said electrode.

14. In color television apparatus, the combination which comprises an electronic scanning device, means for scanning an image area with said scanning device in two dimensions in a plurality of side-by-side lines, a rotatable color-filter assembly having a plurality of color-filter segments of different optical characteristics, said assembly being positioned and arranged in the path of the image light of said image area with the boundaries between segments substantially parallel optically with said lines of the image area and said light passing through said segments as the assembly rotates with progressive change of color

at substantially the same speed at which the lines are scanned.

15. A color television transmitting system including a transmitting tube having a light responsive electrode, means in said tube for generating a focused beam of electrons, means for deflecting the beam in horizontal and vertical directions at different rates in order to cyclically scan the light responsive electrode, a lens system for projecting an optical image on the light responsive electrode, a color filter assembly having a plurality of filters of different colors, means for moving the color filter so that a differently colored filter is interposed in the optical axis for each vertical deflection cycle of the cathode ray beam to produce a succession of differently colored images on said electrode, and means to synchronize the movement of said color filter with the vertical deflection cycle of said beam to cause said beam to scan a progressively moving area of said electrode adjacent the junction of two differently colored images on said electrode.

16. In a television transmitting system for transmitting signals representative of a colored optical image including a cathode ray tube having a light responsive target electrode adapted to receive an image of an object of which a picture is to be transmitted and electron beam generating means, a light filter assembly including a plurality of filters, adjacent filters being capable of transmitting light of different colors, means to project light from an object through the filters of said filter assembly and upon said target electrode, means to move said filter assembly to produce a succession of colored images of the object on said electrode and means to scan said target electrode by the generated electron beam synchronously with the movement of said filter assembly and over an area of said electrode adjacent two differently colored images projected on said electrode through adjacent filters of said filter assembly.

17. In a television transmitting system for transmitting signals representative of color image fields, a signal generating tube including a light sensitive electrode adapted to receive an optical image over the extended surface thereof, and electron beam generating means, a filter assembly including a plurality of differently colored light filters adapted to intercept a portion of light from an object of which an image is to be transmitted, said filters being separated by portions opaque to white light, means to move said filter assembly to subject said electrode to light from said object in successively different colors separated by one of said opaque portions, and means synchronized and phased with said last-mentioned means to scan the generated electron beam over said electrode over a progressively moving area in the shadow cast on said electrode by said opaque portion to develop signals representative in intensity to the illumination of a single color of light.

18. In color television transmitting apparatus, the combination which comprises an electronic scanning device of the storage type having an image-receiving area associated therewith, optical means positioned to focus a two-dimensional light image of an object field onto said image-receiving area, scanning means associated with said scanning device for scanning said image in two dimensions in a plurality of side-by-side lines, a rigid rotatable color-filter assembly having a plurality of color-filter segments of different optical characteristics, said assembly being positioned and arranged in the path of light from said optical means to said image-receiving area with said color-filter segments traversing the image light near said area, the boundaries between color-filter segments being substantially parallel optically with said scanning lines as the boundaries traverse the image-receiving area and said light passing through said segments as the assembly rotates with progressive change of color at substantially the same speed at which the lines are scanned.

19. In color television transmitting apparatus, the combination which comprises an electronic scanning device of the storage type having an image-receiving area associated therewith, optical means positioned to focus a two-dimensional light image of an object field onto said image-receiving area, scanning means associated with said scanning device for scanning said image in two dimensions in a plurality of side-by-side lines, a rigid rotatable color-filter assembly having a plurality of color-filter segments of different optical characteristics spaced therearound with substantially opaque boundaries therebetween, said assembly being positioned and arranged in the path of light from said optical means to said image-receiving area with said color-filter segments traversing the image light near said area, the boundaries between color-filter segments being substantially parallel optically with said scanning lines as the boundaries traverse the image-receiving area and said light passing through said segments successively as the assembly rotates, and driving means for rotating said assembly in substantial synchronism with the low-frequency scanning of said image with said boundaries substantially coinciding with the lines being scanned as the boundaries successively traverse the image-receiving area.

20. In color television transmitting apparatus, the combination which comprises an electronic scanning device of the storage type having an image-receiving area substantially at the front end thereof, a single lens positioned to focus a two-dimensional light image of an object field directly onto said image-receiving area, scanning means associated with said scanning device for scanning said image in two dimensions in a plurality of side-by-side lines, a rigid rotatable color-filter assembly having a plurality of color-filter segments of different optical characteristics spaced therearound with substantially opaque boundaries therebetween, said assembly being positioned and arranged with said color-filter segments traversing the image light closely adjacent to said image-receiving area, the boundaries between color-filter segments being substantially parallel optically with said scanning lines as the boundaries traverse the image-receiving area and said light passing through said segments successively as the assembly rotates, and driving means for rotating said assembly in substantial synchronism with the low-frequency scanning of said image with said boundaries substantially coinciding with the lines being scanned as the boundaries successively traverse the image-receiving area.

21. In color television transmitting apparatus, the combination which comprises an electronic scanning device of the storage type having an image-receiving area associated therewith, optical means positioned to focus a two-dimensional light image of an object field onto said image-receiving area, scanning means associated with said scanning device for scanning said image in

two dimensions in a plurality of side-by-side lines, a rigid rotatable color-filter assembly having a plurality of color-filter segments of different optical characteristics spaced therearound with substantially opaque boundaries therebetween, said assembly being positioned and arranged in the path of light from said optical means to said image-receiving area with said opaque boundaries out of focus at said area, the boundaries between color-filter segments being substantially parallel optically with said scanning lines as the boundaries traverse the image-receiving area and said light passing through said segments as the assembly rotates with progressive change of color at substantially the same speed at which the lines are scanned, said boundaries being sufficiently wide to substantially prevent image light to any point of the image-receiving area from simultaneously passing through adjacent filter segments of different optical characteristics.

22. In color television transmitting apparatus, the combination which comprises an electronic scanning device of the storage type having an image-receiving area associated therewith, a single lens positioned to focus a two-dimensional light image of an object field directly onto said image-receiving area, scanning means associated with said scanning device for scanning said image in two dimensions in a plurality of side-by-side lines, a rigid rotatable color-filter assembly having a plurality of color-filter segments of different optical characteristics spaced therearound with substantially opaque boundaries therebetween, said assembly being positioned and arranged in the path of light from said optical means to said image-receiving area with said opaque boundaries out of focus at said area, the boundaries between color-filter segments being substantially parallel optically with said scanning lines as the boundaries traverse the image-receiving area and said light passing through said segments successively as the assembly rotates, and driving means for rotating said assembly in substantial synchronism with the low-frequency scanning of said image with said boundaries substantially coinciding with the lines being scanned as the boundaries successively traverse the image-receiving area, said boundaries being sufficiently wide to substantially prevent image light to any point of the image-receiving area from simultaneously passing through adjacent filter segments of different optical characteristics.

23. In color television transmitting apparatus, the combination which comprises an electronic scanning device of the storage type having an image-receiving area associated therewith, means for focussing a two-dimensional light image of

an object field on said image-receiving area, means for scanning an image on said image-receiving area in two dimensions in a plurality of side-by-side lines, means for progressively changing the color aspect of said light image including a rotatable color-filter drum having a plurality of color filter segments arranged around the peripheral surface thereof with laterally extending substantially opaque boundaries therebetween, said drum being positioned and arranged in the path of light rays forming said images with the boundaries between said filters substantially parallel optically with said lines and substantially out of focus at said image-receiving area, and means for rotating said drum in substantial synchronism with the low frequency scanning of said image to cause said boundaries to substantially coincide with the line being scanned as the boundaries successively traverse the image-receiving area, said drum being arranged so that said light passes through the filter segments successively as the drum rotates with progressive change of color at substantially the same speed at which the lines are scanned, the circumferential extent of a filter segment being sufficient to include light of a substantial proportion of said lines when said segment is in operating position and said boundaries being sufficiently wide to substantially prevent image light to any point of the image-receiving area from simultaneously passing through adjacent filter segments of different color.

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