Nov. 17, 1942. O. H. SCHADE 2,302,147

TELEVISION VIEWING SCREEN

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Fig. 1.

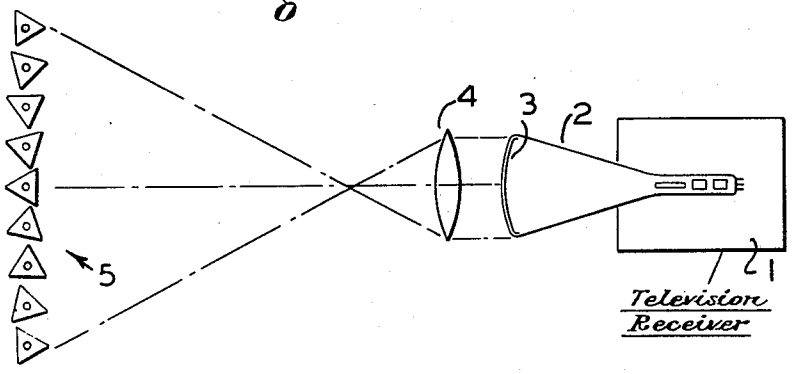


Fig. 2.

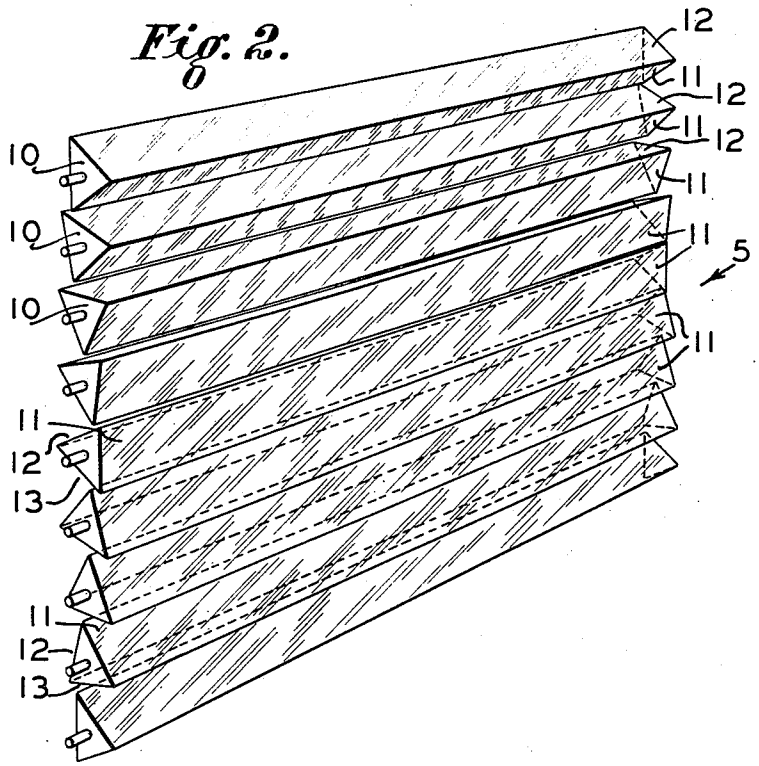
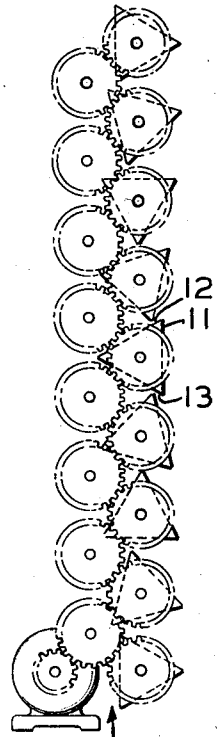


Fig. 3.



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Fig. 4.

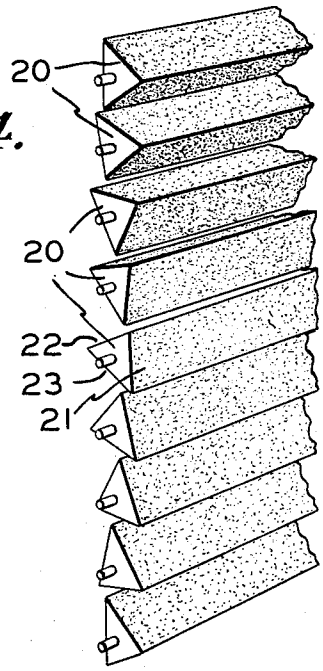
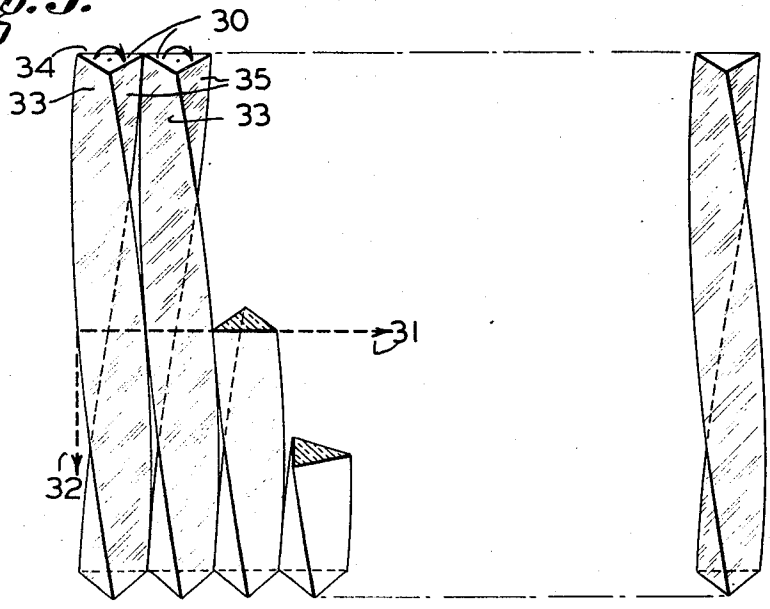


Fig. 5.



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TELEVISION VIEWING SCREEN

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Application October 17, 1940, Serial No. 361,503

5 Claims. (Cl. 178—5.4)

My invention relates to the reception of television images in natural color and particularly to reflection and luminescent-type screens for such reception.

It has been proposed to transmit television images in color by successively exposing a photosensitive target electrode through successively displaced primary color filters to the illuminated object of which an image is to be transmitted. Use is made at the transmitter of a rotating filter containing two or more color filters, and a similar rotating filter at the receiving location is provided, such as in the path of the light between a cathode ray tube or light valve and the observer to recreate the television image in natural colors. The use of such a rotating shutter is objectionable in some cases because of the space required, inasmuch as it must be approximately twice the diameter of the cathode ray tube or light valve screen. A further disadvantage resides in the fact that considerable light is lost by such a filter system so that the light which may be created or controlled by the cathode ray or projection tube is not effectively utilized.

It is an object of my invention to provide a viewing screen for color picture presentation wherein all of the light of the various colors comprising the picture is effectively utilized; and it is a further object to provide a screen and system for recreating colored images which will occupy considerably less space than prior screens and systems; and it is a still further object to provide a screen and image recreating system wherein substantially all of the light incident on the screen is converted to useful light representative of the recreated image. These and other objects, features and advantages of my invention will become apparent when taken in connection with the following description and accompanying drawings wherein:

Fig. 1 shows an image projection system and screen made in accordance with my invention;

Fig. 2 is a perspective view of the type of screen shown in Fig. 1;

Fig. 3 is an end view of the screen shown in Fig. 2 showing the method of rotating the various elements of the screen, and

Figs. 4 and 5 are modifications of the type of screen shown in Fig. 2.

In accordance with one teaching of my invention I provide a reflection-type viewing screen comprising a suitable number of opaque segmented sections preferably of triangular prismatic form, successive faces of which are made selectively reflective to light of various colors, such as red, blue and green, and I rotate these prismatic segments in a sequence determined by the recreation of the television image. Further in accordance with my invention I provide a system wherein the recreated image consists of various intensities of ultra violet light, this light being projected upon a screen having one or more segments which are preferably of triangular prismatic form, the surfaces being responsive to convert the ultra violet light into the primary colors, such as red, blue and green. In each of these preferred modifications of my invention the liberation of light of successive primary colors is controlled by the viewing screen itself and is not dependent upon colored filters interposed between the light source and the viewing screen.

A colored image to be televised is broken up at the transmitting station into a series of image fields of representative colors, thus a single frame of the television image may comprise three fields of red, blue and green successively scanned to generate a succession of image impulses representative of the optical image to be transmitted. The television image may be received by a conventional television receiver 1, shown schematically in Fig. 1, having a cathode ray tube 2 capable of recreating the television image which appears due to persistence of vision as a black and white replica of the original image such as upon a fluorescent screen 3 associated with the tube 2. The luminescent material comprising the screen 3 may be of mixed sulphides, the principal requirement being that each of the primary colors is present in the light generated by the screen. Preferably the luminescent materials used for the screen 3 should have a rapid phosphorescent decay time, a property which is inherent in mixed sulphide screens. In accordance with known systems the image replica, which when viewed directly appears black and white on the screen 3, may be viewed in its natural colors by rotating a filter disc containing successively displaced filters transparent to the primary colors and viewing the screen through this disc which is operated in synchronism with a corresponding filter disc or mechanism at the transmitter. However, in accordance with my invention and as shown by Fig. 1, the light forming the black and white replica appearing on the fluorescent screen 3 is projected and focused such as by a lens system 4, which may be of the transmission or reflection type, upon a viewing screen 5, only the cross-section of which is shown in Fig. 1, and on which the televised image appears in its natural colors.

Referring to Fig. 2 which shows a perspective

view of the screen 5, the screen comprises a plurality of individual reflecting members 10 having an equilateral triangular cross-section and the members are rotated in accordance with the recreation of the black and white television image appearing on the screen 3. More specifically, the members 10 are of triangular prismatic form having three elongated intersecting and reflecting surfaces, each of the three surfaces being made reflective to light of one of the component colors such as red, blue and green. Thus the surfaces 11 may be made to liberate only red light so that all blue or green light incident thereon is absorbed, whereas the surfaces 12 liberate only blue light. Similarly, the surfaces 13 are made to liberate only green light. The members 10 are supported with their longitudinal axes, preferably lying in a common plane, and are arranged to be rotated about their axes at a speed related to the vertical scanning speed of the fluorescent screen 3. Thus, each of the individual reflecting members may be geared together as shown in Fig. 3 and driven by a synchronous motor controlled by synchronizing impulses received from the transmitter such that each of the members revolves through an angle of 120° during the time occupied by one color field of scanning. The members are successively displaced in phase by an angle depending upon the number of members 10 used, and are also so phased that the members follow the scanning of the receiving tube such that the surface of the desired color is in its reflecting position for a corresponding vertical position of the scanning beam in the receiving tube 2. Thus with such an angular displacement, light incident upon the members is reflected in a single direction by only one of said members at a time, this member being the one which is being scanned by the light beam from the tube 2 at that particular time. For a screen comprising 12 members the members would be successively displaced in phase by an angle of 10°. Their relation is synchronized such as by the synchronous motor driving means so as to present a reflecting surface of the same color towards the scanning beam of the cathode ray tube 2 during each field. Thus the maximum change of angle with respect to the light beam or the observer for a continuous drive, such as shown in Fig. 3, and a screen having 12 members is 10° for the time of reflection from an individual member. If a smaller change of angle with respect to the light beam or observer is desired, the number of members 10 may be increased to any desired number. Likewise, the surfaces 11, 12 and 13 may be made specularly reflective to the successive colors or may be made to produce diffused reflection. Thus the surfaces of the members 10 may be beaded with small reflective and light diffusing beads using red beads for the surface 11, blue beads for the surface 12 and green for the surface 13.

I have shown in Fig. 3 means for rotating the members 10 continuously. However, where it is desired, the members 10 may be rotated intermittently such as by a conventional Geneva movement. Such a Geneva movement is particularly advantageous in a screen structure of the type shown in Fig. 4.

Referring to Fig. 4, the members 20, corresponding to the members 10 of Figs. 2 and 3, instead of having three reflective surfaces, reflective to different colors of light, have the three surfaces coated with luminescent materials, each of which has a different spectral response characteristic when subjected to ultra violet radiation. When utilizing a viewing screen of the type shown in Fig. 4, the fluorescent screen of the television receiving tube or the light source for a light valve is constructed to produce ultra violet light. Thus the fluorescent screen 3 may consist of pure zinc silicate having no fluorescent activator which, when scanned by an electron beam in a manner well known in the art, recreates an ultra violet television image wherein the light and shade areas of the original optical image are recreated in various intensities of ultra violet light. In accordance with this teaching of my invention, the ultra violet light from a sequentially scanned cathode ray tube or light valve is projected upon the segmented sections of prismatic form, the faces of which are responsive to the ultra violet light to generate various colors such as red, blue and green. One face of each of the triangular prismatic members 20 shown in Fig. 4 is provided with a coating 21 of material which, when subjected to ultra violet light, produces red light, whereas the coating 22 on one adjacent face produces blue, and the coating 23 on the other adjacent face produces green light under the influence of the ultra violet light from the fluorescent screen 3. For example, a luminescent material comprising 10 to 30% of zinc sulphide mixed with 70 to 90% cadmium sulphide may be used to form the luminescent material coating 21 capable of giving red light. Silver activated zinc sulphide may be used for the luminescent blue responsive coating 22, and 30 to 40% zinc cadmium sulphide with 60 to 70% zinc sulphide may be used for the green responsive coating 23. As indicated above, each of the individual members 20 may be geared together as shown in Fig. 3 and driven by a synchronous motor controlled by the synchronizing impulses received from the transmitter. However, the phosphorescent properties of these materials may be utilized by the use of a driving movement such as of the Geneva type wherein the individual members 20 remain stationary for almost an entire scanning field time and are suddenly rotated through an angle of 120° during the remainder of the field time. In this manner additional light output may be obtained because of the utilization of the phosphorescent decay time of the coatings 21, 22 and 23.

While I have described a viewing screen made in accordance with my invention wherein the equilateral triangular prismatic members are rotated about axes substantially parallel to the direction of horizontal scanning the screen, my invention is also applicable to screens wherein the rotation is about an axis or axes normal to the horizontal direction of scanning.

Referring to Fig. 5, the members 30, which correspond to the members 10 and 20 described above, are of prismatic form and are mounted with their axes normal to the horizontal direction of scanning represented by the dashed line 31 and are thus parallel with the vertical direction or frame scanning as indicated by the dashed line 32. In accordance with this teaching of my invention, the prismatic members 30 are helically twisted by an angle of approximately 120° from one end of the members 30 to the opposite end. The cross-section of each of the members 30 in a plane normal to the axis of the members is preferably triangular and the helically twisted surfaces may be said to be generated by moving the lines bounding the cross-section along the axis while revolving the bounding lines about the

axis. The surfaces will have a progressively uniform surface, provided the movement of the generating lines about the axis is proportional to the displacement along the axis, although this displacement may be made non-linear, provided the vertical deflection of the scanning spot of light is non-linear with time to a corresponding degree.

The members **30** are supported with their axes parallel and coplanar to one another and free to rotate, such as in a clock-wise direction as shown. As the members **30** rotate in accordance with the frame rate of scanning, a section of line width will move progressively from the top of the members to the bottom, which is the direction of vertical scanning. The members are shown in Fig. 5 in an instantaneous position at which an elemental line may be drawn along one of the surfaces of the members, the said line being continuous over the entire width of the screen comprising the members **30**. The screen members are so synchronized with the frame rate of scanning that the light beam is incident on the members along this line as it progresses from the top to the bottom of the members during rotation thereof. Thus as shown in Fig. 5, the screen may be scanned along the line **31** which is progressively and during successive scannings displaced in the direction of vertical scanning corresponding to the direction of the line **32**. In accordance with my invention, each of the faces of the prismatic members **30** such as the faces **33**, **34** and **35** are made to liberate light of one of the primary colors such as red, blue or green. Thus the faces may be made reflective to individual primary colors or these faces may be provided with coatings of different luminescent materials which successively luminesce with the three primary colors under excitation such as ultra violet light. Thus whether the faces are reflective to visible light or subjected to ultra violet light, light corresponding to the three primary colors is liberated. Since the members **30** are helically twisted by an angle of 120° from one end thereof to the other and are rotated in synchronism with the frame rate of scanning, the light beam impinges on the members at a time when a surface of elemental line width is in the proper position for reflecting light to the observer. Since the curvature from top to bottom of the members is continuous, a scanning beam of light having very small cross-section is preferable.

As the scanning beam approaches the lower ends of the members **30** and, following scansion, is returned to the top of the members, the angular displacement of the surface along the length of the members places a surface capable of liberating a different color in position for scanning. Since the light beam return time or "fly back" time is finite, somewhat less than the full-length of the members is scanned in the vertical direction. However, a helical displacement of somewhat less than 120° may be provided, depending upon the time required for the return or fly back time, whereupon the full-length of the members may be scanned.

I have described the members **30** as being of triangular cross-section so that they may be aligned with a minimum of spacing between adjacent members. However, a single multi-face member may be used as the viewing screen and, in this case, the member may have more than three surfaces. Thus a member having an equilateral polygonal cross-section with more than three faces but preferably an integral multiple of three faces may be used, each face liberating a different primary color in regular sequence of red, blue and green. Obviously, such a single screen member may have surfaces liberating a number of colors greater than three, such as for a four or five color system of television transmission. The dimensions of each face of a single member screen correspond to full image size and the member is rotated at constant speed.

In operation the television image is received and converted into a light and shade replica wherein each of three successive fields of scanning are representative of a different primary color of the original optical image. Depending on the transmission standards chosen, the image may be transmitted at twenty frames per second, each frame consisting of three color fields successively red, blue and green or a vertical scanning field frequency of 60 cycles per second. The horizontal line definition is independent of the field frequency and may be chosen in accordance with the available frequency band width for transmission. With a vertical field frequency of 20 per second the members **10** and **20** or the members **30** having three faces should be rotated at a rate of 1200 revolutions per minute, whereas for 40 frames and 120 fields per second the rate should be 2400 revolutions per minute.

While I have indicated the preferred embodiments of my invention of which I am now aware and have also indicated only one specific application for which my invention may be employed, it will be apparent that my invention is by no means limited to the exact forms illustrated or the use indicated, but that many variations may be made in the particular structure used and the purpose for which it is employed without departing from the scope of my invention as set forth in the appended claims.

I claim:

1. In combination with means for developing a beam of ilght scanned over an image area in two mutually perpendicular directions at different rates, a viewing screen positioned to intercept said beam of light comprising an opaque elongated member having an equilateral polygonal cross-section and a plurality of faces surrounding a longitudinal axis, said member being arranged substantially parallel to one of the directions of scanning said beam of light, and positioned with respect to said first-claimed means such that during rotation thereof only a minor elongated area of said member with respect to said image area extending in the direction of the higher rate of scanning is substantially normal to the path of light from said first-mentioned means during the time of scanning said minor elongated area, the material comprising each face of said elongated member liberating diffused light, when scanned by said beam of light, of a color different from the light liberated from adjacent faces, and means to rotate said member about its longitudinal axis through an angular displacement equal to $360/n$ degrees during the time said light beam is scanned over the said image area at the lower rate of scanning where n is equal to the number of faces surrounding the axis of said member.

2. In combination with means for developing a beam of light scanned over an image area in two mutually perpendicular directions at different rates, a viewing screen positioned to inter-

cept said beam of light comprising an elongated opaque member having three faces, the longitudinal axis of said member being arranged substantially parallel to the direction of the faster rate of scanning said beam of light and positioned with respect to said first-claimed means such that during rotation thereof only a minor elongated area of said member with respect to said image area extending in the direction of the higher rate of scanning is substantially normal to the path of light from said first-mentioned means during the time of scanning said minor elongated area, the material comprising each face of said prismatic member liberating diffused light, when scanned by said beam of light, of a color different from the light liberated from adjacent faces, and means to rotate said member about its longitudinal axis through an angle of one hundred twenty degrees during the time said light beam is scanned over the said image area at the lower rate of scanning.

3. In combination with means for developing a beam of light displaced in two mutually perpendicular directions at different rates over an image area for television reception, a viewing screen to intercept said beam of light and form an optical image observable by persistence of vision, said screen comprising a plurality of rotatable prismatic members, each of said members having three faces of materials capable of liberating diffused light of a different primary color from adjacent faces, means to maintain said members parallel one to another and to the faster rate of movement of said beam of light and with their longitudinal axes substantially in a single plane, each of said members being angularly displaced with respect to one another such that only one member at any instant of time presents one of its faces substantially normal to said beam of light, and means to rotate each of said members about its respective longitudinal axis at a rate equal to the slower of said different rates of displacement of said beam of light.

4. In combination with means for developing an ultra-violet light beam scanned over an image area in successive series of mutually displaced parallel paths, a viewing screen including an elongated member having a polygonal cross section and a plurality of faces, said member being positioned parallel with said parallel paths and intercepting said ultra-violet light beam, the surface of each of said faces being coated with luminescent material of a composition differing from that of the coating on adjacent faces said luminescent material being chosen to liberate visible light of a different color from adjacent faces when scanned by said ultra-violet light beam, and means to rotate said member about its longitudinal axis through an angular displacement equal to $360/n$ degrees during the time said light beam is displaced over said image area through each successive series of parallel paths, where n is equal to the number of faces of said member.

5. In combination with means for developing an ultra-violet light beam scanned over an image area in mutually displaced parallel paths, a viewing screen including an elongated member having three faces said member being positioned parallel with said parallel paths and intercepting said ultra-violet light beam, the cross section of said member normal to its length forming an equilateral triangle, the surface of each of said faces being coated with luminescent materials of a composition differing from that of the coating on adjacent faces said luminescent materials being chosen to liberate visible light of a different color from each face when scanned by said ultra-violet light beam, and means to rotate said member about its longitudinal axis through an angle of one hundred twenty degrees during each scanning of said beam over said image area.

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