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D. W. EPSTEIN
PROJECTION APPARATUS

2,295,779

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Fig. 1.

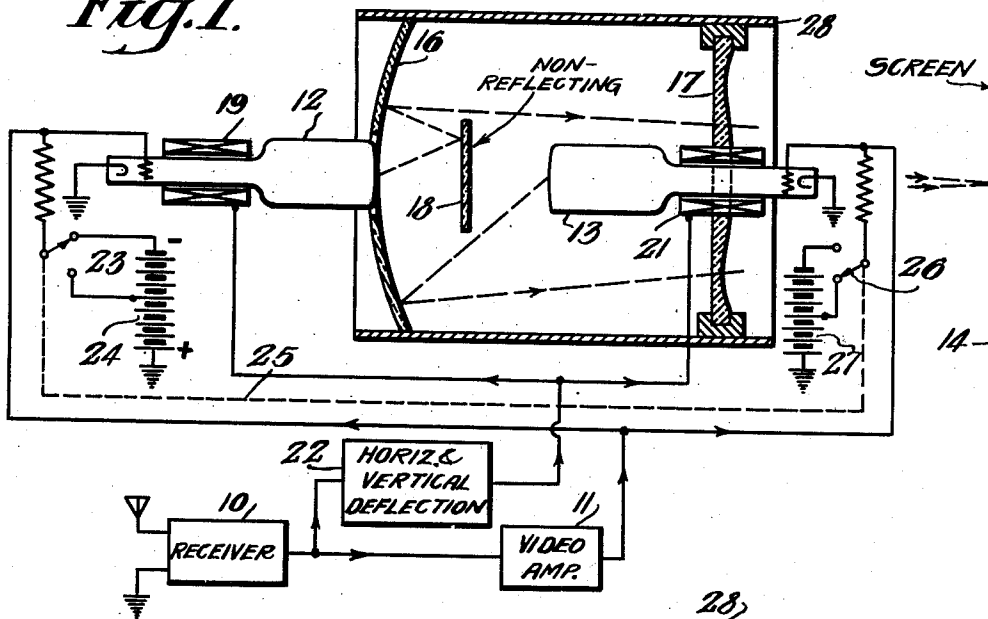


Fig. 2.

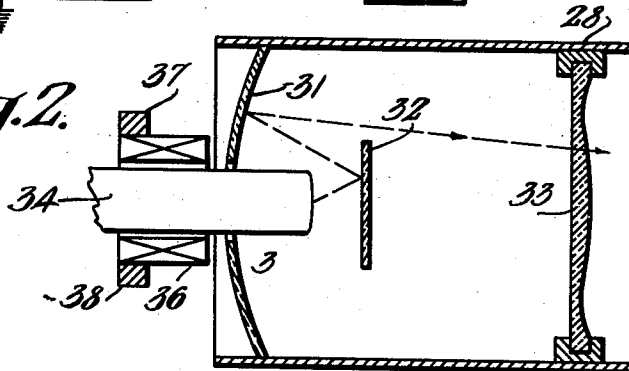
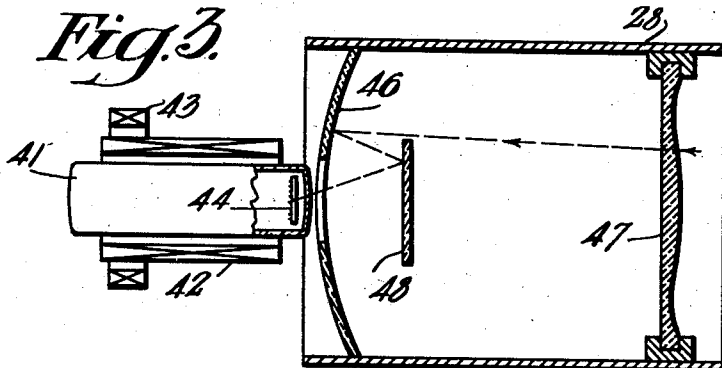


Fig. 3.



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PROJECTION APPARATUS

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Application August 17, 1940, Serial No. 353,003

7 Claims. (Cl. 178—7.5)

My invention relates to fast or wide aperture lens systems of high quality which comprise mirrors and correcting plates or lenses, and also to the combination of such lens systems with television apparatus or the like.

In Patent No. 2,273,801, issued Feb. 17, 1942, in the name of Daniel O. Landis, and assigned to the Radio Corporation of America, there is described a television projector utilizing a lens system of the above-mentioned type. In the television projector disclosed by Landis, the cathode ray receiver tube is located in front of a spherical mirror and at such a point that the spherical mirror in cooperation with a correcting plate projects an enlarged image of the reproduced television picture on a screen. With this arrangement, the cathode ray tube and its associated parts, such as the deflecting coil and the tube supports, are in the path of some of the light rays reflected from the spherical mirror. In some designs, the relative dimensions of the optical system and the cathode ray tube and associated parts are such that the blocking of the light is negligible and has no appreciable effect on the projected picture. In other cases, however, especially where it is desired to employ an optical system of small dimensions, which in turn requires that the diameter of the cathode ray tube be small, it is found that the deflecting yoke and/or the tube supports block so much of the correcting plate and thus the light emanating from the edge portions of the picture that the projected picture appears on the projection screen with insufficient illumination at the edges of the picture. In still other cases, the tube or the tube and its associated parts may completely block the light reflected from the spherical mirror.

Also, in a system as described in the above-mentioned Landis patent, it is difficult, if not impossible, to replace the cathode ray tube, in event of tube failure, with so little delay that there is substantially no interruption of the program.

One of the objects of my invention is to provide an improved optical system of the above-described type.

A further object of my invention is to provide an improved optical system of the above-mentioned type wherein in certain cases blocking of the light reflected from the mirror is substantially reduced.

A still further object of my invention is to provide an improved projection apparatus of the above-described type which may be operated with substantially no interruption of the program, in

the event of failure of the cathode ray tube or other image source.

In accordance with a preferred embodiment of my invention, the optical system consists of a spherical mirror having an opening in the center thereof, a correcting plate positioned in front of the spherical mirror to correct for spherical aberration, and a plane mirror located between the spherical mirror and the correcting plate with its reflecting surface facing the opening in a spherical mirror whereby the cathode ray tube or other image-producing source may be positioned with its light-obstructing parts at the rear of the spherical mirror.

In the embodiment of my invention in which the projection apparatus is so designed that there will be substantially no program interruption in the event of projection tube failure, the projection system includes a cathode ray tube located at the rear of the spherical mirror, as above described, and a second cathode ray tube located in front of the spherical mirror. In this application of the invention where the two projection tubes are employed, the relative dimensions of the optical system of the cathode ray tubes and their associated parts may be similar to those described in the above-identified Landis patent, whereby there is no appreciable blocking of the light by the cathode ray tube and associated parts located in front of the spherical mirror. With this arrangement, only one projection tube is in use at any one time, while the other projection tube is maintained ready for instant use but with no picture thereon.

The invention will be better understood from the following description taken in connection with the accompanying drawing, in which:

Figure 1 is a view showing an embodiment of my invention wherein a spare tube for the optical system may be switched in instantly in the event of failure of the projection tube being used;

Figure 2 is a view showing my invention applied to a television projector comprising an optical system of small size; and

Figure 3 is a view showing my improved optical system employed as a camera in combination with a cathode ray pickup tube of the type surrounded by a focusing coil.

Referring to Fig. 1, my invention is shown applied to a television receiver of the projector type. In the example illustrated, it is assumed that the picture is received from the radio transmitter, amplified and demodulated in a suitable receiver indicated at 10, and the resulting picture signal

supplied through a video amplifier 11 to a pair of cathode ray tubes 12 and 13.

If the tube 13 is in operation, the reproduced image appearing on the end thereof is projected upon a screen indicated at 14 by means of the optical system described in the above-mentioned Landis patent, this optical system consisting of a spherical mirror 16 and a spherical aberration correcting plate 17.

If the tube 12 is in operation, the reproduced picture appearing on the end thereof is projected upon the screen 14 by means of my improved optical system consisting of a plane mirror 18, the spherical mirror 16, and the correcting plate 17.

During a program, the tubes 12 and 13 are maintained in condition for instant operation. They may be held in this condition by applying all operating voltages thereto and by applying the horizontal and vertical deflecting waves to the deflecting yokes 19 and 21 of the two tubes from the deflection circuits indicated at 22. The spare tube may be rendered ineffective to reproduce a picture by applying to its control grid a negative voltage sufficient to block the scanning beam. This condition is indicated for the tube 12 in Fig. 1, where a switch 23 is positioned to apply a high negative bias to the control grid of tube 12 from a biasing source 24.

The cathode ray tube 13, on the other hand, has a picture appearing thereon, if there is an incoming picture, since its associated switch 26 is positioned to apply normal operating bias to the control grid of the tube 13 from the biasing source 27. As indicated by the dotted line 25, the switches 23 and 26 may be gauged so that one switch is closed when the other one is opened.

In the example illustrated, the optical system is mounted inside a cylindrical casing 28, which is open at both ends. As indicated on the drawing, the back side of the mirror 18 should be non-reflecting.

The improved optical system per se will be described in more detail with respect to Fig. 2. In this figure, the optical system consists of a spherical mirror 31, a plane mirror 32 and a correcting plate 33. This particular system is one of comparatively small dimensions which is designed for use with a cathode ray projection tube of small diameter, such as the tube of 2-inch diameter indicated at 34, the correcting plate 33 being 8 inches in diameter, for example. The deflecting yoke for the cathode ray tube is indicated at 36. It will be apparent that, if the cathode ray tube 34 with its deflecting yoke were positioned in front of the spherical mirror 31, the deflecting yoke 36 would block a substantial part of the light reflected from the spherical mirror. Therefore, so much of the light from the picture edges would be blocked that the projected picture would have sufficient brightness only in the central region of the screen. Also, supporting means must be provided for the projection tube, such means being indicated at 37 and 38, and, in a system having comparatively small dimensions, the tube-supporting means will block a large part of the light if located in front of the spherical mirror.

The shape and relative size of the plane mirror 32 will depend upon the design of the particular projector. It may be noted, however, that it may be either circular or rectangular in shape and may have a diameter or transverse dimension about twice the diameter of the end of the cathode ray tube upon which the picture appears.

These relative dimensions, however, are not critical and may be varied within wide limits. Likewise, the location of the plane mirror 32 is not critical since it may be placed anywhere between the spherical mirror and its focus (at about one-half the center of curvature) so long as the cathode ray tube position is changed correspondingly. As a practical matter, the plane mirror should not be too close either to the spherical mirror or to its conjugate focus if maximum optical efficiency is desired.

In Fig. 3, my invention is shown applied to a television camera or pick-up unit which includes a cathode ray pick-up tube 41 of the low velocity beam type surrounded by a focusing coil 42 and a deflecting coil 43. The tube 41 includes a semi-transparent mosaic 44 upon which is formed an image of the scene to be transmitted.

My invention permits the use of a very fast and highly corrected optical system with the above-described type of low-velocity beam tube in spite of the comparatively large diameters of the coils 42 and 43. This optical system comprises a spherical mirror 46, a correcting plate 47, and a plane mirror 48, the design of the system being the same as previously described.

The optical system in combination with two cathode ray tubes, that is, the combination illustrated in Fig. 1, may be utilized for the reproduction of color pictures, if desired. It will be understood that when the system is utilized for this purpose, the two cathode ray tubes are in operation simultaneously to project two superimposed images, one image being of one color and the other image being of a different color. As is well known in the art, the different colors for the two projection tubes may be obtained either by the use of color screens positioned in the front of cathode ray tubes or by means of fluorescent material selected to give light of the desired color.

From the foregoing description, it will be apparent that various other modifications may be made in my invention without departing from the spirit and scope thereof.

I claim as my invention:

1. For use in a television system, an optical system comprising a spherical mirror having an opening or window in the center thereof, a plane mirror having its reflecting surface facing said spherical mirror and located between said spherical mirror and its nearest conjugate focus, and a correcting plate located in the region of the center of curvature of said spherical mirror and shaped or figured to correct for spherical aberration.

2. In combination in a television system, an optical system comprising a spherical mirror having an opening or window in the center thereof, a plane mirror having its reflecting surface facing said spherical mirror and located between said spherical mirror and its nearest conjugate focus, a correcting plate located in the region of the center of curvature of said spherical mirror and shaped or figured to correct for spherical aberration, and an image source positioned opposite the reflecting surface of said plane mirror and so located that effectively it is substantially at the said nearest conjugate focus of the spherical mirror.

3. For use in a television system, a projection system comprising a spherical mirror having an opening or window in the center thereof, a plane mirror having its reflecting surface facing said spherical mirror and located between said spherical mirror and its nearest conjugate focus, a correcting plate located in the region of the cen-

ter of curvature of said spherical mirror and shaped or figured to correct for spherical aberration, means for providing an image located opposite the reflecting surface of said plane mirror and so positioned as to project said image upon a surface at the other conjugate focus of the optical system, and means for providing an image located substantially at the said nearest conjugate focus whereby said last image will be projected upon said last surface.

4. A cathode ray tube projection system comprising a spherical mirror having an opening or window in the center thereof, a plane mirror having its reflecting surface facing said spherical mirror and located between said spherical mirror and its nearest conjugate focus, a correcting plate located in the region of the center of curvature of said spherical mirror and shaped or figured to correct for spherical aberration, a cathode ray tube having a screen structure upon which a picture may be reproduced, said screen structure being located opposite the reflecting surface of said plane mirror and so positioned as to project an image upon a surface at the other conjugate focus of the optical system, and a second cathode ray tube having a screen structure upon which a picture may be reproduced, said last screen structure being located substantially at the said nearest conjugate focus whereby an image appearing thereon will be projected to form an image upon said last surface.

5. The invention according to claim 4 where-

in means is provided for making only one of said cathode ray tubes effective to project a picture at a given time.

6. The invention according to claim 4 wherein means is provided for maintaining said two cathode ray tubes in operative condition for projecting a picture, and means for blocking the cathode ray of one of said tubes during the time the other of said tubes is projecting a picture.

7. An optical system for the projection and enlarging of an image on a cathode ray tube, said system comprising a cathode ray tube adapted to emit light for producing a bi-dimensional optical image of finite area substantially centered on the optical axis of the system, a plane mirror positioned to reflect light from said cathode ray tube image, a light reflecting surface of revolution having its concave reflecting surface positioned facing said plane mirror to receive reflected light therefrom, an aspherical zone plate positioned to receive the light reflected from said concave surface, said zone plate being arranged external to the light path from the cathode ray tube image to the concave reflecting surface and axially aligned with each and adapted to correct the spherical aberrations introduced into the reflected light rays by the concave reflecting surface whereby a sharply focused enlargement of the original finite dimension cathode ray tube image is developed at a plane located at a finite distance from the aspherical zone plate.

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