

Dec. 7, 1948.

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2,455,476

MOUNTING SYSTEM FOR ELEMENTS OF TELEVISION PROJECTORS

Filed July 20, 1945

Fig. 3.

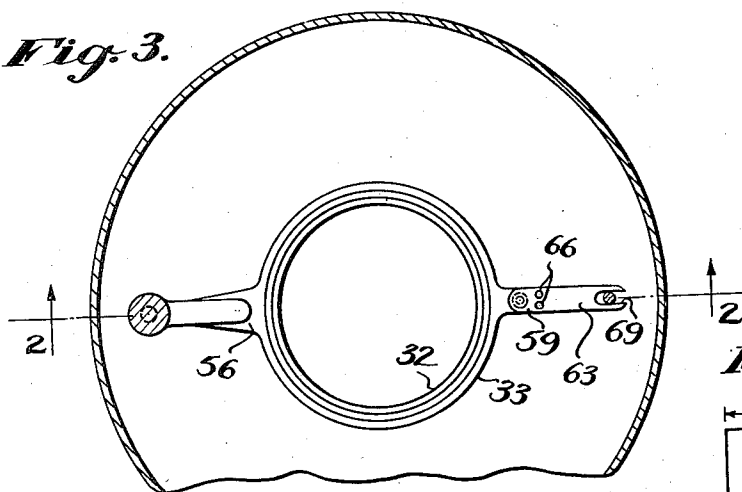


Fig. 1.

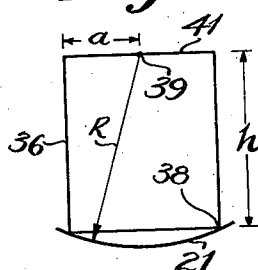
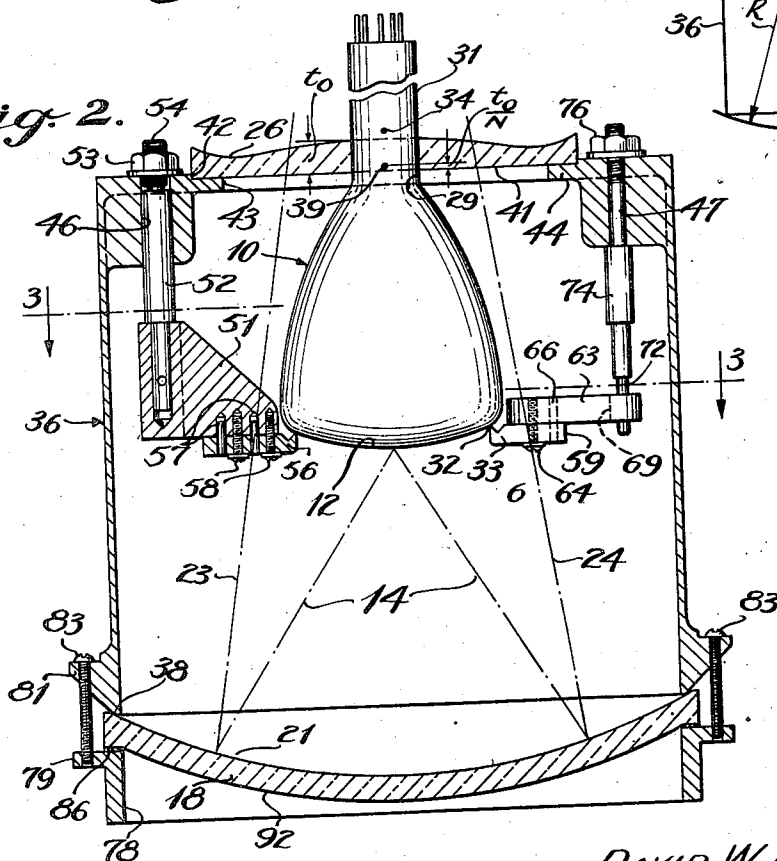


Fig. 2.



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2,455,476

MOUNTING SYSTEM FOR ELEMENTS OF TELEVISION PROJECTORS

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Application July 20, 1945, Serial No. 606,215

11 Claims. (Cl. 178-7.5)

1

The present invention relates to a system for projecting images produced by the image producing device of a television receiver, and more particularly, though not necessarily exclusively, to an organization of elements comprising a spherical mirror, an aspheric zone plate, and the image producing surface of a cathode ray tube associated together in proper alignment whereby to project an image upon a screen which may be readily located in a preferred position with respect to this organization. The invention is also concerned in one of its aspects with a method of locating the several parts of the organization with respect to each other in a novel manner.

In United States Patent No. 2,273,801, granted February 17, 1942, to D. O. Landis, there is disclosed an arrangement whereby a spherical mirror or reflecting surface is arranged to direct and focus light rays forming the enlarged television image upon a viewing screen with the aid of an aspheric correcting plate or correcting lens. The organization of essential optical parts shown in this Landis patent must, for best results, be aligned and spaced in a certain definite relationship within very close tolerance limits, and the primary aim of the invention is to provide methods of and means for so aligning and spacing the essential optical parts. This important aim of the invention is carried out in an illustrative embodiment thereof which will be described in detail hereinafter in such a way that commercial requirements may be met for quantity production of television receivers of the projection type.

The second important aim or object is to provide a novel method of and means for aligning and positioning the optical parts of the image projection system of a television receiver within predictable tolerance limits.

Still another object is to provide for locating a cathode ray image producing tube in a television receiver with respect to a spherical reflector and its associated aspheric zone plate with a sufficient degree of accuracy.

A still further object is to provide a novel casing or housing for supporting and/or containing the optical elements of an image projection system for a television receiver.

A still further object is to produce an image projector in which alignment of the parts in correct optical relationship is automatic upon assembly of the parts and depends primarily on manufacture of principal supporting parts in accordance with the invention and not upon critical adjustments after assembly.

A still further object is to provide a novel positioning arrangement for the cathode ray tube in a television receiver projection system.

2

Other objects and advantages of the invention will, of course, become apparent and immediately suggest themselves to those skilled in the art to which the invention is directed from a reading of the following specification in connection with the accompanying drawings in which:

Fig. 1 is a geometrical representation of the relationship of the principal parts of a projection optical system correlated in accordance with the invention;

Fig. 2 is a view in sectional elevation of a projection optical system in accordance with the invention showing details of the several parts thereof, the section being taken on line 2-2 of Fig. 3; and

Fig. 3 is a top plan view in section of the apparatus of Fig. 2, the section being taken on line 3-3 of Fig. 2.

Referring to Fig. 2 of the drawings, which shows the general organization of a television projection system embodying the invention in one of its forms, an image producing tube 10, which has a television image produced on its luminescent target 12, projects the television image along an optical path conventionally represented at 14 toward a reflecting element 18 which has a spherical reflecting surface 21. The image which has been projected upon the reflecting surface 21 is then reflected therefrom along the optical path conventionally represented at 23 and 24 toward a suitable viewing screen (not shown). At an intermediate point in the optical path an aspheric zone plate 26 (also termed a "correcting plate" or "correcting lens") is positioned to receive the light reflected from the reflecting surface 21. The aspheric zone plate 26 is arranged externally to the light path from the tube to the reflector and is axially aligned with each. This zone plate is arranged to correct for any spherical aberrations introduced into any of the light rays by the curved reflecting surface 21 of the member 18 so that a sharply focused reproduction of the image developed on the fluorescent or luminescent target area 12 of the tube 10 is produced on the previously mentioned viewing screen. The aspheric zone plate 26 has a central opening 29 for the purpose of accommodating the tube neck 31 and, if desired, the deflecting yoke (not shown) for producing deflection of the cathode ray beam within the tube 10. The curved target face 12 of the tube 10 rests upon a circular edge 32 provided by a ring 33. In place of the ring 33, a series of points, no less than three, may be arranged to furnish location and support of the tube face 12 as will be pointed out hereinafter. The target face 12 of the tube 10 will be approximately spherical, or exactly spherical, and

its center is indicated at 34 on Fig. 2. A discussion of contour of the target face is to be found in the previously mentioned Landis patent, No. 2,273,801. The zone plate 26 as well as the ring 33 is located and supported through the agency of a cylindrical member 36. The more detailed features of the cylindrical member 36 as well as details of the mounting of the ring 33 will be discussed more in detail hereinafter.

Reference will now be had to Fig. 1 for an explanation of the relationship between the parts of Figs. 2 and 3 which provides for accurately determining the respective positions of these parts. In Fig. 1, a segment of a sphere is shown as an arc, for convenience, which corresponds to the reflecting surface 21 of Fig. 2 and is so marked. A cylinder marked 36 is also shown which corresponds to the cylindrical member 36 of Fig. 2. From a consideration of the simple geometrical figures shown in Fig. 1, it will be seen that with the circular edge 38 of the cylinder 36 resting on the spherical curve of the segment 21, the center of the sphere 39 must necessarily lie on the geometrical axis of the cylinder provided that the lower edge 38 of the cylinder is planar and normal to the axis of the cylinder. In a projection system of the type presently under consideration, the most important reference point is the center of the spherical reflecting surface, but it is difficult to locate and difficult to use for the purpose of locating other elements of the system. By the novel construction of the invention illustrated in Fig. 1 of the drawings, it will be seen that the center of curvature 39 of the spherical surface lies at a point on the axis of the cylinder.

It will be understood that in place of the cylindrical member 36 shown by Figs. 2 and 3 and represented in Fig. 1, any surface of revolution with an axis of symmetry such as a frustrum of a cone or system of elements of such a figure such as a tripod will serve the purpose. The center of the aspheric zone plate 26 must be located at the center of curvature of the reflecting surface 21, and for uniform field illumination, the axis of symmetry of the correcting lens preferably coincides with the circular boundary of the portion of the reflecting surface 21 which is used for projection purposes. In Fig. 1 this boundary may be taken as the diameter of the cylindrical figure 36.

The considerations in connection with Fig. 1 so far discussed insure that the aspheric zone plate will be automatically lined up laterally as it is located symmetrically with respect to the axis of the cylinder provided that the resting surface for the aspheric zone plate, which may be represented by the top 41 of the cylinder, is planar, parallel and coaxial with the circle 38. The resting surface diagrammatically shown on Fig. 1 is indicated by reference character 41 in Fig. 2 of the drawings. The shoulder 42 positions the plate 26 concentric with the circle 38. A concentric opening 43 provides a light aperture and admits the tube 10. Axial alignment of the aspheric correcting plate so that it is at the center of curvature 39 of the surface 21 is obtained by using the correct length of the cylinder 36 which is easily calculated from the radius of curvature R of the reflecting surface 21 and radius a of the cylinder. Thus, if h is the height of the cylinder, then, from either right triangle of Fig. 1

$$h = \sqrt{R^2 - a^2}$$

The substantially exact location of the center of curvature 39 of the reflecting surface 21 within

the surface boundaries of the correcting lens 26 and along its axis may be fixed by reference to the formula t_0/N . In this formula, t_0 is indicated on the drawing and N is the index of refraction of the material composing the correcting plate or lens 26. For the special case shown, t_0/N is also indicated. The distance t_0/N is measured from the flat side of the correcting lens when this flat side faces the reflecting surface 21 and the distance determined from the formula is the distance from the apex of the correcting lens when its curved side faces the mirror.

The location of the target face 12 of the tube 10 with respect to other elements in the projection system is important, and locating and positioning the tube 10 generally will be discussed in connection with Fig. 2 of the drawings and the more detailed features of the invention shown therein. However, the plane of the ring 33 must be parallel to and coaxial with the lens holder circle 41 for best results.

Referring again to Fig. 2, one of the very important conditions to be fulfilled, in addition to the one involving the center of curvature 39 of the reflecting surface 21, is the location of the tube target face 12 so that its center of curvature is on the axis of symmetry of the aspheric correcting plate 26. Also, for uniform illumination over the field, the axis of symmetry of the periphery of the tube face and the axis of the symmetry of the correcting plate should preferably coincide. Moreover, the tube target face should be located at the correct axial distance from the reflecting surface 21 or from the aspheric zone plate 26 for focusing.

The points of reference for locating the tube face may be the wall of the cylindrical member 36 or the top member 44 of the cylinder which is recessed to provide the previously mentioned surface 41 for supporting the aspheric zone plate 26. For purposes of illustration, reference points on this top member 44 or zone plate holder have been selected from which to locate the tube face, and this is accomplished in the illustrative example by locating two holes 46 and 47 at diametrically opposite points. A bracket 51 carried at the end of a rod 52 serves as a principal support for the ring 33. The general shape of this bracket is such that it is resistant to bending stress caused by the weight of the tube. For example, it may be generally triangular as shown. The rod 52 is slidable in the hole 46 and is adjustable axially and held in a selected position by a nut 53 upon its reduced threaded end 54. The ring 33 is provided with a lateral extension 56 which is dowelled to the bracket 51 for location purposes by dowel pins 57. Securing means in the form of screws 58, for example, hold the extension 56 to the bracket 51. The ring 33 is provided with a diametrically opposite extension 59 which is secured to a bracket 63 by a screw 64, for example. One or more dowel pins 66 preserve the desired alignment of the bracket 63 with respect to the extension 59. The bracket 63 is slotted as indicated by reference character 69 to accommodate the end of a guide pin 72 which is centered with respect to the hole 47 by being formed upon or carried at the end of a rod 74, secured in the hole 47 by suitable means such as a nut 76.

From the parts thus far described, it will be seen that the reflecting surface 21, the aspheric zone plate 26, and the target face 12 of the tube 10 are all positioned in the desired relationship within necessary and/or desired limits of accuracy. The organization comprising the three

parts just enumerated may be mounted in any desired manner in a television cabinet, or the like (not shown). For example, the reflecting element 18 may have a centrally located aperture to receive a mounting rod, mounting bolt, or the like, inasmuch as a limited area at the center of this element is usually rendered non-reflective. Preferably, however, and in accordance with the invention in a preferred form, the cylindrical member 36 is clamped upon the reflecting surface 21 and the reflecting member 18, in turn, is clamped in a desired position by means of a ring 78 provided with a flange 79. An annular projection 81 provided on the cylindrical member 36 is apertured as by drilling at intervals to accommodate clamping bolts 83. A gasket or washer 86 of yielding material provides for cushioning the member 18 at its clamping edge.

In accordance with the invention, it will be understood that the cylinder 36 may be so positioned within or upon the housing (not shown) for the television apparatus or the like that it may be moved bodily axially for the purpose of bringing an image produced on the target surface 12 of the tube 10 into focus upon a suitable screen or the like (not shown) after projection. Where the cylinder 36 is bodily movable as just stated, the supporting rod 52 may be stationary with respect to the cylinder 36 and the nut 53 will, in that case, be a mere clamping member. Also, it is within the scope of the invention to manufacture the member 18 in such a way that the reflecting surface 21 is concentric with the back 92 of the member, in which case the edge 38 of the cylinder 36 may be provided interiorly of the cylinder and contact the surface 92.

From the foregoing, it will be seen that an optical projection system is provided in which the parts may be held together in proper relationship to fulfill several conditions mentioned above for insuring projection efficiency. To summarize, these conditions are, first, that the center of the aspheric zone plate 26 must be located at the center of curvature of the reflecting surface 21. The luminescent target face 12 of the tube 10 must be located so that its center of curvature is on the axis of symmetry of the aspheric zone plate 26. For uniform illumination over the field, the axis of symmetry of the aspheric zone plate should preferably coincide with the axis of symmetry for the periphery (circle) of the mirror. The luminescent target area 12 of the tube should be the correct axial distance from the reflecting surface 21 or from the aspheric zone plate for focusing. The previously mentioned viewing screen (not shown) should be normal to the axis and at the correct throw either by actual alignment or through the medium of a 45° mirror or other device. This latter requirement may be fulfilled by design of the cabinet or the like in or upon which the ring 78, or its equivalent within the scope of the invention, is mounted.

Having now described the invention, what is claimed and desired to be secured by Letters Patent is the following:

1. The combination with an electron image tube having a surface exposing a target area, of an optical light receiving element having a substantially spherical surface, a member having means defining a circle resting on said spherical surface whereby the center of curvature of said spherical surface lies on the optical axis of both said member and said circle, a correcting plate to receive light reflected from said substantially spherical surface, supporting means for said cor-

recting plate, means associated with said member to maintain said correcting plate coaxial with said circle, and a mount for said tube carried by said member and being coaxial with said circle.

3. The combination with an electron image tube having a surface exposing a target area, of an optical light receiving element having a substantially spherical surface, a member having means defining a circle resting on said spherical surface whereby the center of curvature of said spherical surface lies on the axis of both said member and said circle, a correcting plate to receive light reflected from said substantially spherical surface supporting means for said correcting plate, means associated with said member to maintain said correcting plate coaxial with said circle, and a mount for said tube upon which said target area exposing surface rests to position said surface with respect to said light receiving element, said mount being carried by means located from said supporting means for the correcting plate.

4. The combination with an electron image tube having a surface exposing a target area, of an optical light receiving element having a substantially spherical surface, a member having means defining a circle resting on said spherical surface whereby the center of curvature of said spherical surface lies on the axis of both said member and said circle, a correcting plate to receive light reflected from said substantially spherical surface, said member having an end opposite to said circle defining means, said end being provided with a recess coaxial with the circle defining means, and a mount for said tube coaxial with said member.

5. The combination with an electron image tube having a surface exposing a target area, of an optical light receiving element having a substantially spherical surface, a member having means defining a circle resting on said spherical surface whereby the center of curvature of said spherical surface lies on the axis of both said member and said circle, a correcting plate, supporting means for said correcting plate fixed to be coaxial with said member, means for supporting said tube by contacting its target exposing surface, said member having an end opposite to said circle defining means, a pair of diametrically positioned rods depending from said end, said tube supporting means being substantially rigidly carried by one of said rods, and the other of said rods serving as a guide to position said tube supporting means coaxial with the axis of said member.

6. The combination with an electron image tube having a surface exposing a target area, of an optical light receiving element having a substantially spherical surface, a member having means defining a circle resting on said spherical surface whereby the center of curvature of said spherical surface lies on the axis of both said member and said circle, a correcting plate, supporting means for said correcting plate fixed to be coaxial with said member, means for supporting said tube by contacting its target exposing surface, said member having an end opposite to said circle defining means, said end being provided with a circular recess coaxial with the circle defined by said circle defining means, a pair of diametrically positioned rods depending from said end, said tube supporting means being substantially rigidly carried by one of said rods, and the other of said rods serving as a guide to posi-

tion said tube supporting means coaxial with the axis of said member.

7. In an image projection system including a mirror having a spherical reflecting surface, an aspheric correcting plate and a cathode ray tube having a target exposing surface, a correcting plate supporting means comprising a member having means to support the correcting plate substantially at the center of curvature of the spherical mirror, a tube supporting member having a circular edge to contact the curved tube face to provide support for the tube, a rod connected to said correcting plate supporting means and being axially adjustable thereon, a second rod rigidly connected to said correcting plate supporting means, and a slot in said tube supporting member to receive said rigidly connected rod.

8. A cathode ray tube image projection device comprising an optical system including a spherical mirror and a correcting plate located substantially at the center of curvature thereof to correct for spherical aberration, a housing having means defining a circle resting on the spherical light reflecting surface of said mirror, said correcting plate being also centered on the axis of said housing to provide alignment of said correcting plate with respect to said mirror, an electron image tube having a surface comprising a light transmitting window so located relative to the housing and optical system that light may be directed in each direction between the tube and the spherical mirror, a support for said tube surface so that the center thereof lies on the axis of said mirror which in turn coincides with the axis of said correcting plate means associated with said housing to provide axial adjustment of said tube, and guide means for cooperating with said adjustable means for maintaining the tube window in aligned relationship with the spherical mirror and the correcting plate.

9. A projection device for use with a cathode ray tube comprising a reflecting member, a housing having a circular edge for contacting a spherical surface of said reflecting member, a ring member for contacting said reflecting member on a surface opposed to that on which said circular edge rests, said ring member having a flange, a flange on said housing disposed opposite

the flange on said ring member, and fastening means for clamping said flanges.

10. The combination of an optical light receiving element having a substantially spherical surface, a member having means defining a circle resting on said spherical surface whereby the center of curvature of said spherical surface lies on the optical axis of both said member and said circle, a correcting plate, and supporting means for said correcting plate coaxial with said circle to receive light reflected from said substantially spherical surface.

11. In an image projection system including a mirror having a spherical reflecting surface, an aspheric correcting plate and a cathode ray tube having a spherical target exposing surface, a correcting plate supporting means comprising a member having means to support the correcting plate substantially at the center of curvature of the spherical mirror, a tube supporting member having means for engaging the spherical tube face to provide support for and position the tube face with respect to the spherical reflecting surface of the mirror, means to align said tube supporting member whereby a tube placed thereon will be correctly aligned comprising a rod connected to said correcting plate supporting means and being axially adjustable thereon, a second rod rigidly connected to said correcting plate supporting means, and a slot in said tube supporting member to receive said rigidly connected rod.

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