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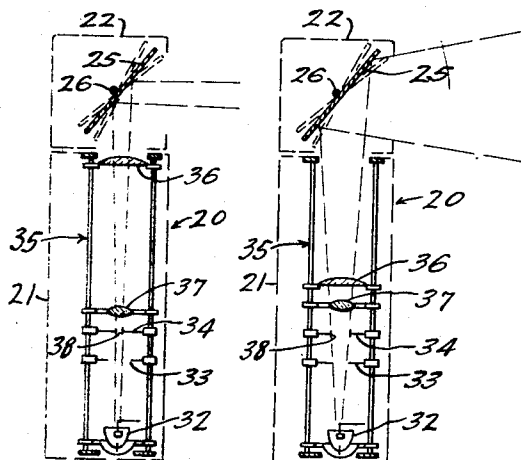
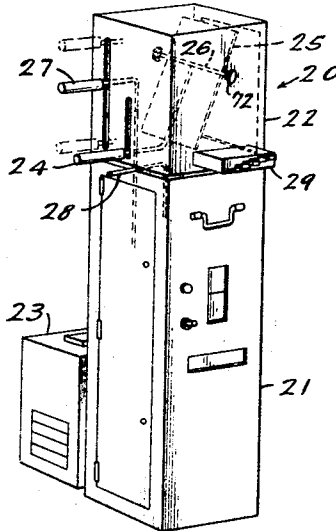
3,069,536 12/1962 Dion et al. 240/3
Primary Examiner—Louis R. Prince
Assistant Examiner—Frederick Shoon
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[54] **LIGHT PROJECTOR**
 7 Claims, 18 Drawing Figs.

[52] U.S. Cl. 240/3
 [51] Int. Cl. F21p 5/00
 [50] Field of Search 240/3

[56] **References Cited**
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ABSTRACT: A theatrical spotlight for directing an adjustable diameter focused beam of light at either fixed or moving objects. A high-intensity beam of light passes upwardly from a xenon lamp through a shutter, an iris diaphragm and an adjustable lens system. A mirror is positioned to reflect the light beam to the target. The beam diameter and focus are adjusted with a single control lever which simultaneously adjusts the lens system and the iris diaphragm. The shutter is adjustable to cut off either a portion of or all of the light beam.



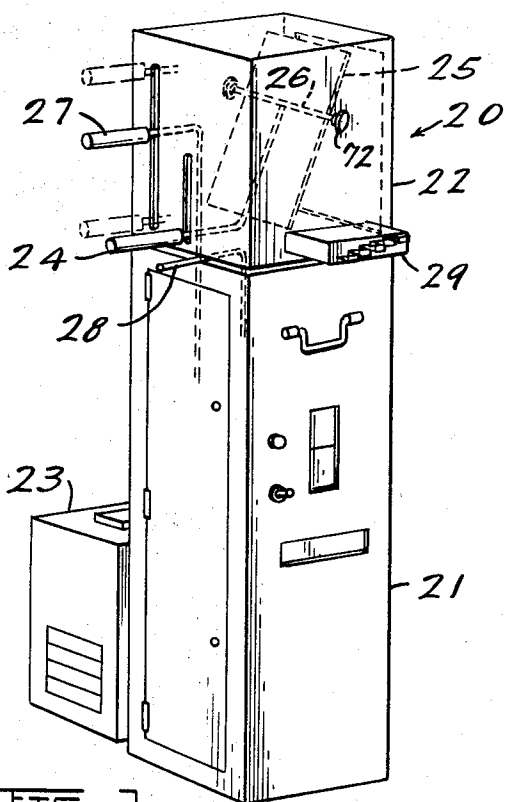


FIG-1-

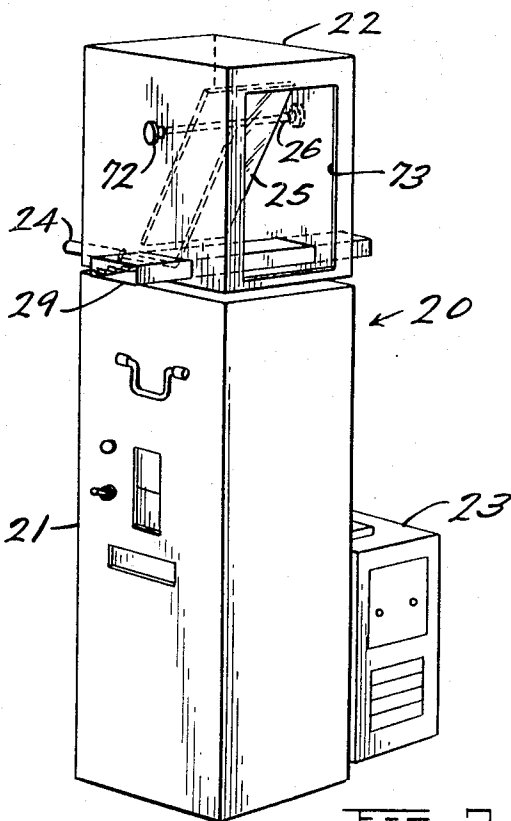


FIG-2-

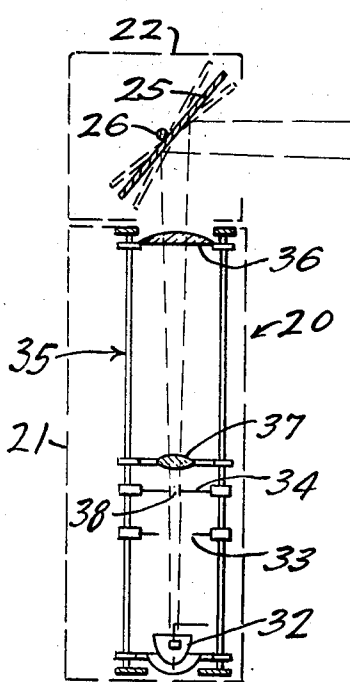


FIG-3-

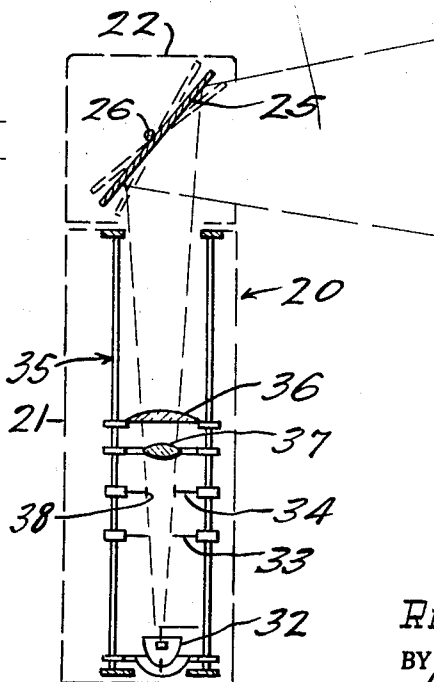


FIG-4-

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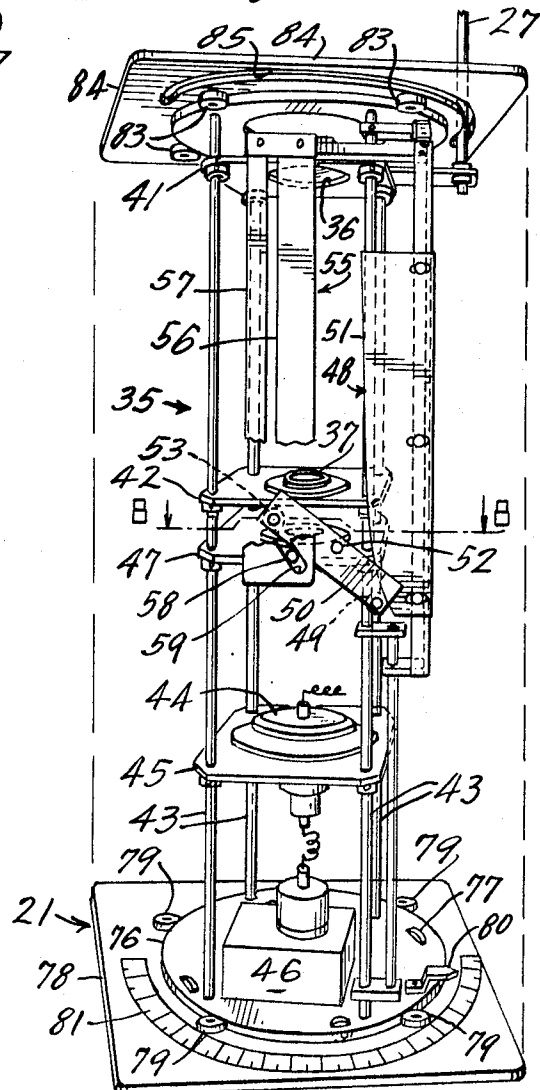
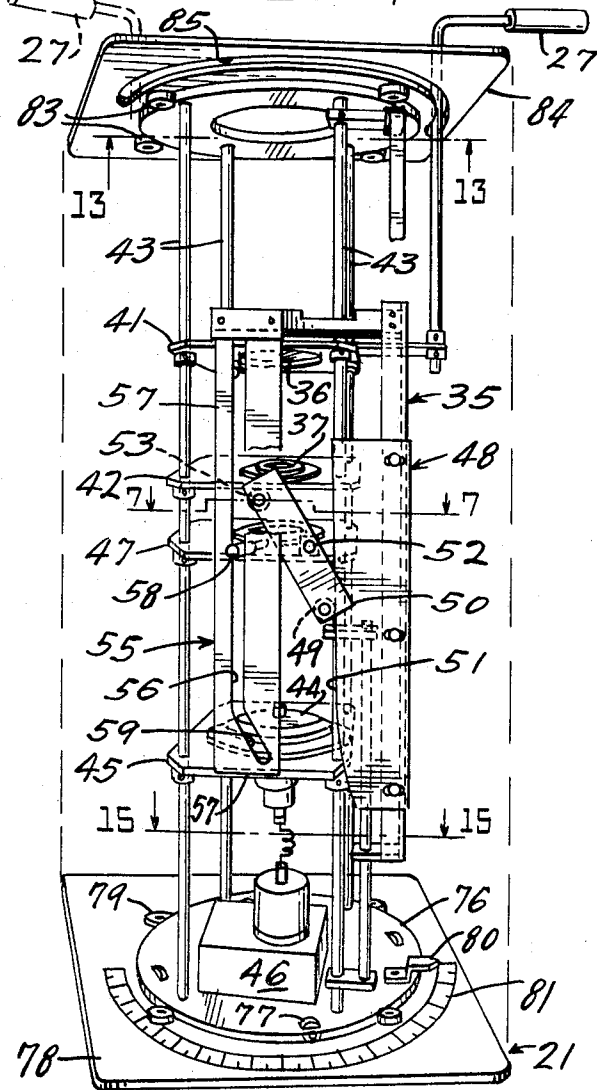
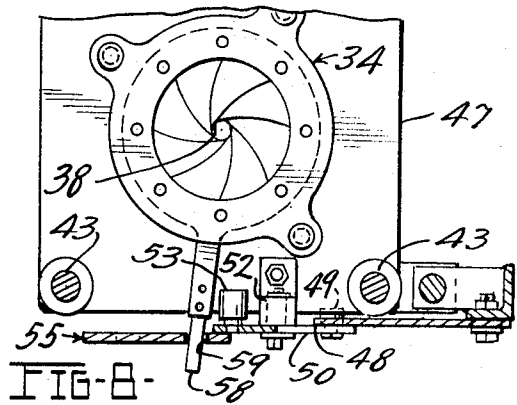
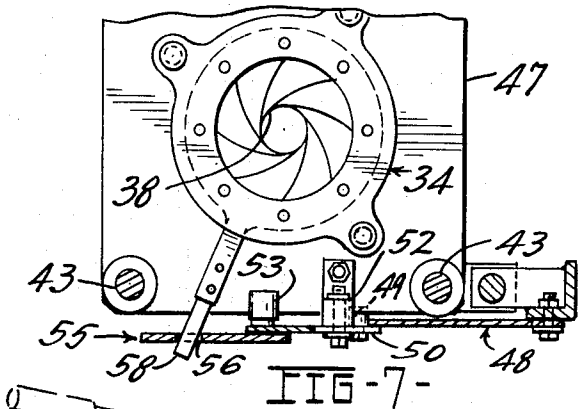


FIG-5-

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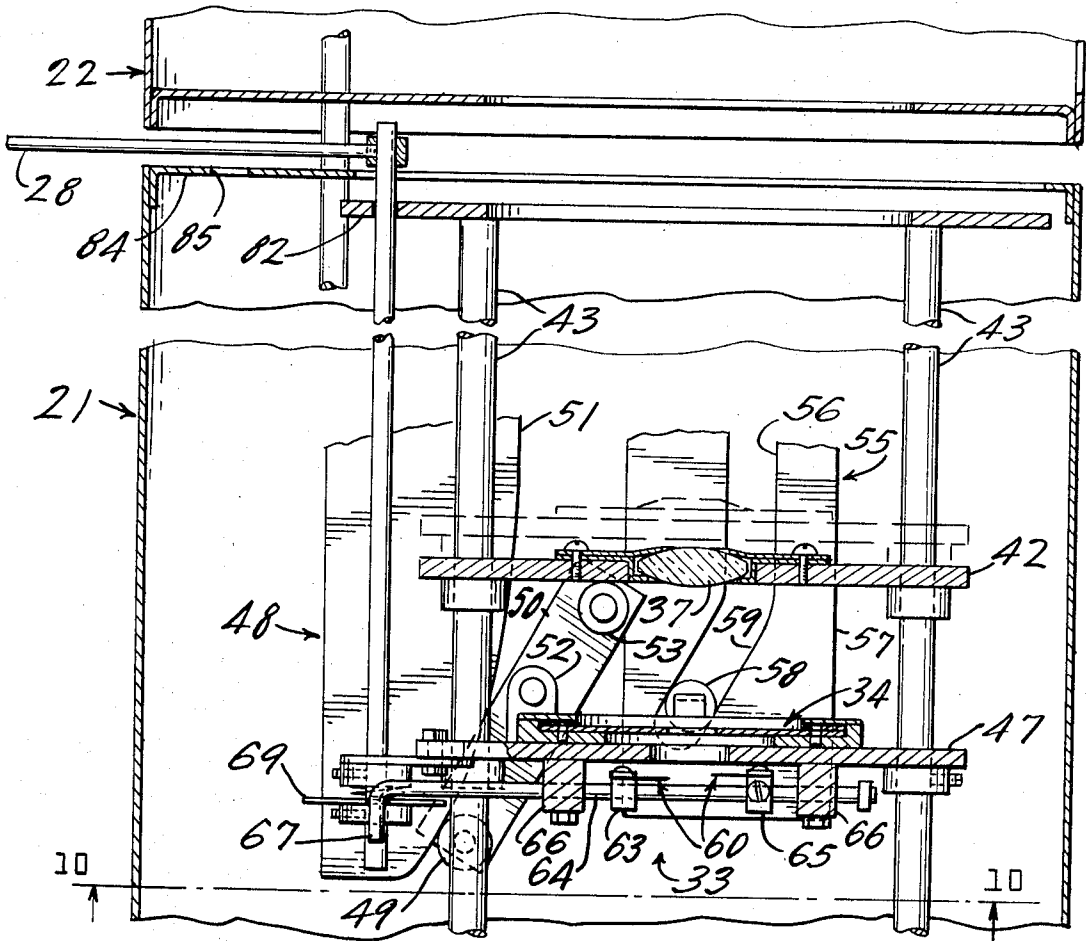


FIG-9-

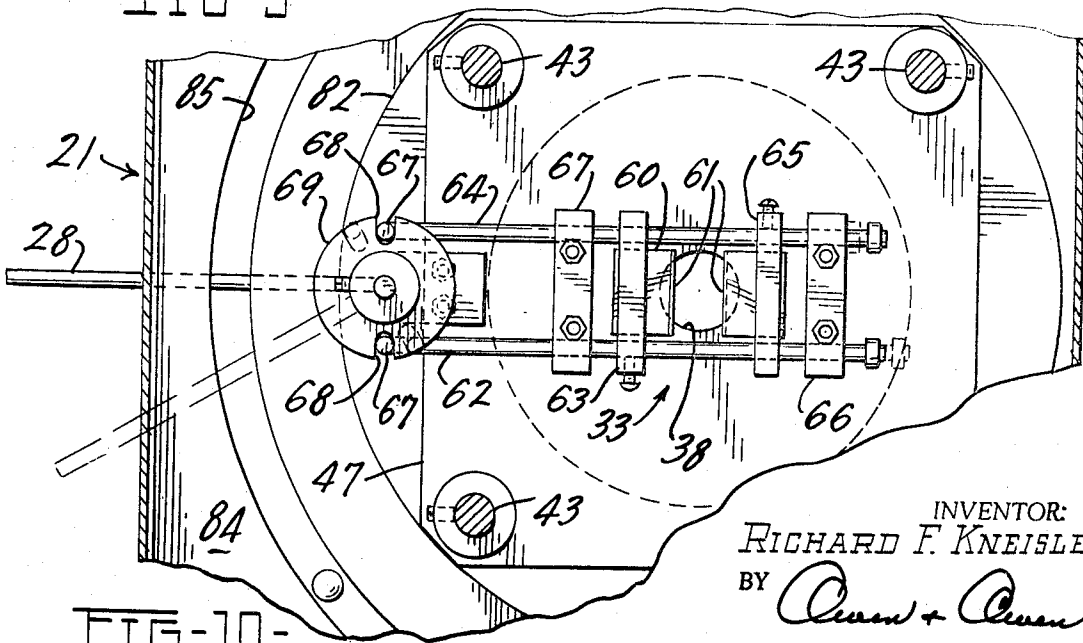


FIG-10-

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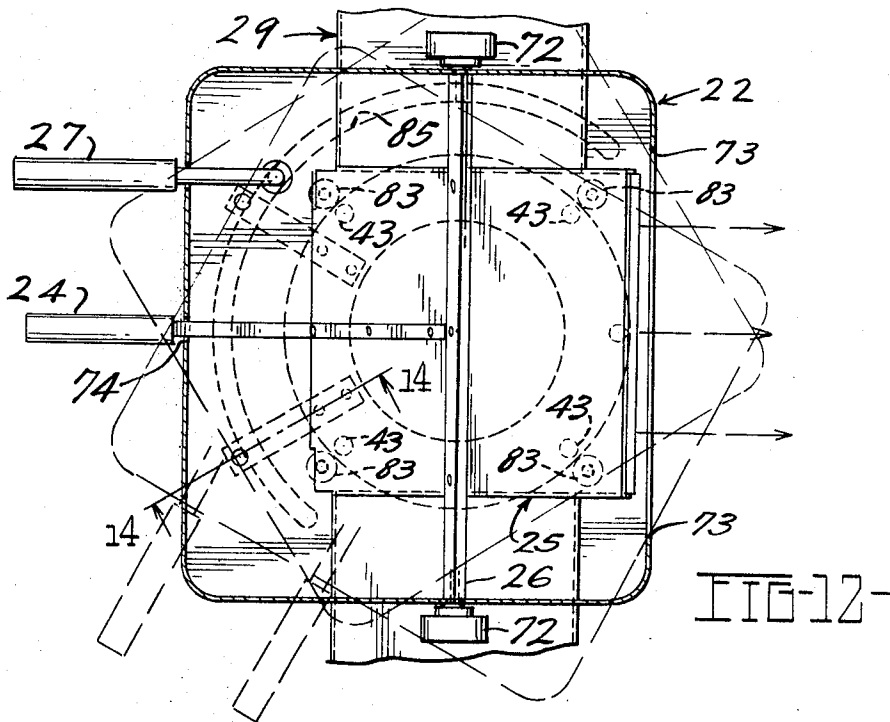


FIG-12-

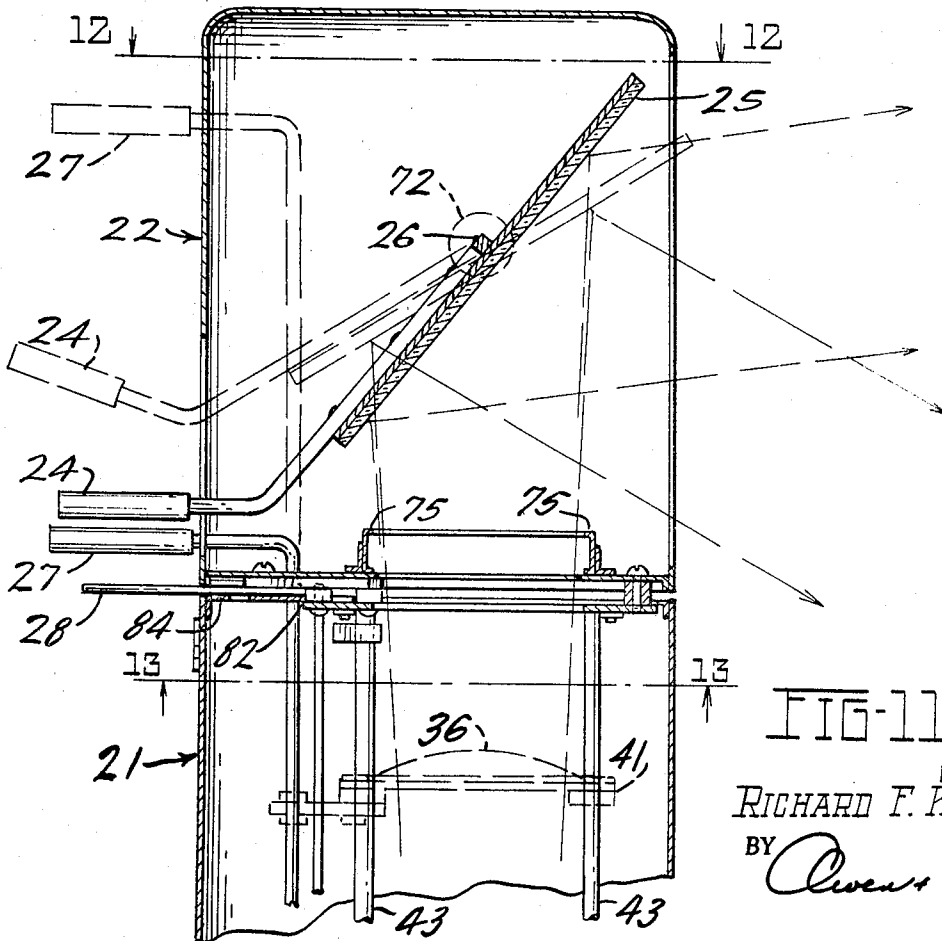


FIG-11-

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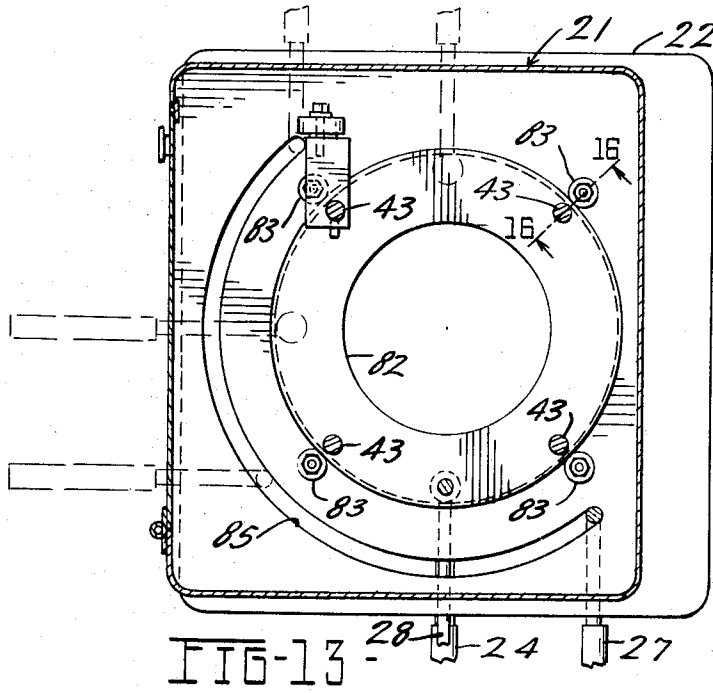


FIG-13

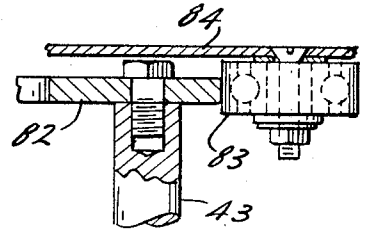


FIG-16

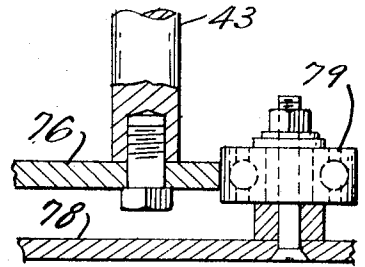


FIG-17

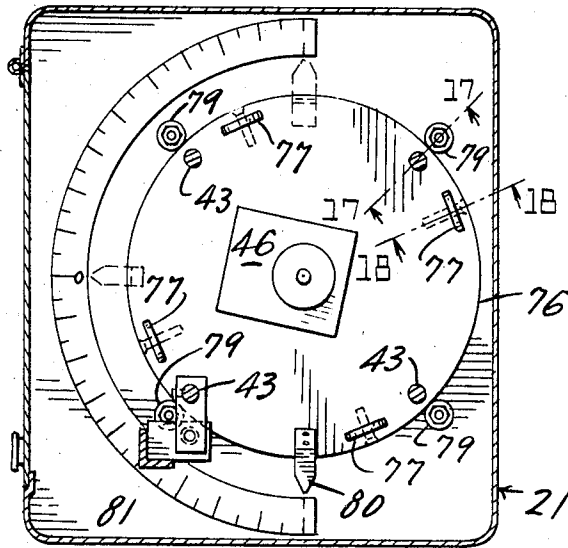


FIG-15

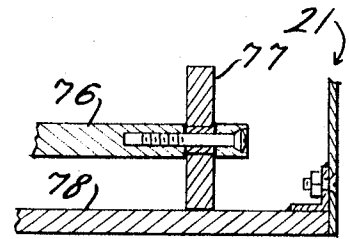


FIG-18

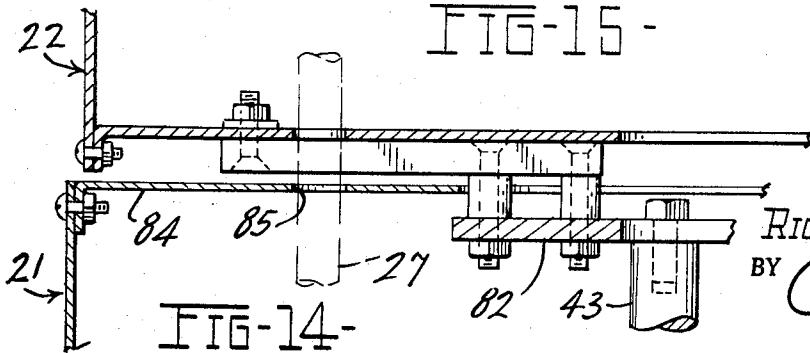


FIG-14

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LIGHT PROJECTOR

BACKGROUND OF THE INVENTION

This invention relates to light projectors and more particularly to light projectors of the theatrical type for projecting an adjustable, high-intensity beam of light at either a fixed object such as a singer or a moving object such as a dancer.

In prior art theatrical spotlight projectors, two methods are commonly used to vary the diameter of a projected beam of light. In one method, an iris diaphragm is positioned adjacent a light source to provide a variable diameter aperture for controlling the diameter of the projected light beam. Although this method is effective, it is wasteful of light when the aperture is stopped down, since only a small percentage of the light from the source passes through the aperture. In a second method, a light source projects a light beam serially through a fixed aperture and two adjustable lenses. The light beam has a small diameter when the first of the lenses is positioned relatively near the fixed aperture and the second of the lenses is positioned away from the fixed aperture. The beam diameter is increased by moving the second lens toward the fixed aperture. The first lens is simultaneously moved away from the fixed aperture to maintain the aperture in sharp focus. This method has the advantage of producing a high-intensity, uniform light beam employing a high percentage of the light generated by the source at all beam diameters. For small beam diameters, however, this method has the disadvantage of requiring an excessive spacing between the second lens and the fixed aperture.

It is recognized in Dion et al. U.S. Pat. No. 3,069,536 that an improved theatrical spotlight may be produced by combining the two above methods on beam control. The Dion et al. patent provides a spotlight having a first control for adjusting the lens system and a second control for adjusting the iris diaphragm. An interlock is provided to prevent the projector operator from adjusting the iris diaphragm except when the lenses are positioned for a minimum beam diameter and from adjusting the lenses except when the iris diaphragm is set for a maximum beam diameter. This spotlight produces an adjustable light beam having a wide range of diameters with a maximum light intensity at all diameters. However, a spotlight of this design is difficult to operate since there are two separate controls and each control is operable only when the other control is set at a predetermined position. Thus, it is difficult to rapidly change the diameter of the projected light beam between the maximum setting and the minimum setting. In attempting to make such a change, the operator may force the two controls, thus breaking the interlock. There is an additional problem in maintaining a sharp focus at small beam diameters since the interlock holds the lenses at a fixed setting while the iris diaphragm is being adjusted. No provision is made for maintaining the aperture in the iris diaphragm in sharp focus as the aperture is changed.

SUMMARY OF THE INVENTION

According to the present invention, an improved theatrical spotlight is provided for directing a controlled beam of light at either fixed or moving objects. Light from a high-intensity xenon lamp is directed upwardly through a shutter, an iris diaphragm and an adjustable lens system onto a mirror. The mirror is vertically and horizontally rotated to aim the reflected light beam at the object to be illuminated. When a beam of colored light is desired, a color filter may be positioned between the lens system and the mirror.

Its lens system includes either a double convex aperture lens or an achromatic lens or other suitable lens mounted above the iris diaphragm beam a movable carriage and a planoconvex lens mounted above the aperture lens on a second movable carriage. A handle is connected to the second carriage for moving the second carriage vertically towards and away from the iris diaphragm, thereby changing the diameter

of the projected light beam. A first cam is attached to move with the second carriage. A follower engages the surface of the first cam and is attached to move the first carriage simultaneously with the second carriage. The cam and follower move the first carriage towards and away from the iris diaphragm in a direction opposite to movement of the second carriage. The aperture lens is moved to keep the aperture of the iris diaphragm in focus as the diameter of the light beam is varied by moving the planoconvex lens or by adjusting the iris diaphragm. A second cam is also mounted to move with the second carriage. A follower, attached to the iris diaphragm for controlling the diaphragm aperture, engages the second cam. The follower and second cam normally hold the iris diaphragm at a maximum opening. However, as the lenses approach the minimum beam diameter setting, the iris diaphragm is simultaneously stopped down to further reduce the beam diameter. The aperture in the iris diaphragm is maintained in sharp focus by the lens system as the iris diaphragm is stopped down.

The shutter is positioned below the iris diaphragm for selectively cutting off either a portion of or all of the light beam. The shutter generally comprises a pair of parallel blades which are moved between a closed position where no light is admitted by the spotlight and an open position where light passage is not hindered. At intermediate positions, the parallel blades cut off equal portions of the top and the bottom of the light beam, thereby producing an adjustable horizontal strip of light. The adjustable lens system, the iris diaphragm and the shutter are mounted to rotate with the mirror about a vertical axis to maintain the strip of projected light in a horizontal position as the mirror is rotated.

Accordingly, it is a primary object of the invention to provide an improved theatrical spotlight having an adjustable diameter light beam.

Another object of the invention is to provide improved apparatus for adjusting the light beam diameter of a theatrical spotlight wherein a single control simultaneously adjusts both a lens system and an iris diaphragm.

Other objects and advantages of the invention will become apparent from the following detailed description, reference being made to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a theatrical light projector constructed in accordance with the instant invention;

FIG. 2 is a second perspective view of a theatrical light projector according to the instant invention;

FIG. 3 is a diagrammatic view of a light projector according to the instant invention and showing the basic optics of the projector with the projector set for a minimum beam diameter;

FIG. 4 is a diagrammatic view of a light projector according to the instant invention and showing the basic optics of the projector with the projector set for a maximum diameter light beam;

FIG. 5 is a partially cutaway view in perspective of the base portion of a light projector according to the instant invention, with the cover removed, and showing the lenses positioned for an intermediate diameter light beam;

FIG. 6 is a partially cutaway view in perspective of the base portion of a light projector according to the instant invention, with the cover removed, and showing the lenses positioned for a minimum diameter light beam;

FIG. 7 is a cross-sectional view taken along line 7-7 of FIG. 5 and showing the iris diaphragm open;

FIG. 8 is a cross-sectional view taken along line 8-8 of FIG. 6 and showing the iris diaphragm closed;

FIG. 9 is a partially sectioned view showing the aperture lens control and the shutter mechanism in detail;

FIG. 10 is a cross-sectional view taken along line 10-10 of FIG. 9 and showing the shutter mechanism in detail;

FIG. 11 is a sectioned view of the control head portion of a light projector according to the instant invention and showing in detail the mirror assembly for aiming the adjustable light beam at an object;

FIG. 12 is a cross-sectional view taken along line 12-12 of FIG. 11;

FIG. 13 is a cross-sectional view taken along line 13-13 of FIG. 11;

FIG. 14 is a cross-sectional view taken along line 14-14 of FIG. 12;

FIG. 15 is a cross-sectional view taken along line 15-15 of FIG. 5, but with the lamp starter omitted;

FIG. 16 is a cross-sectional view taken along line 16-16 of FIG. 13;

FIG. 17 is a cross-sectional view taken along line 17-17 of FIG. 15; and

FIG. 18 is a cross-sectional view taken along line 18-18 of FIG. 15.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to FIGS. 1 and 2, an improved theatrical spotlight 20 is shown according to the instant invention. The theatrical spotlight 20 generally comprises a base 21 for housing a high-intensity light source and the optical system for controlling a light beam emitted by the source, a control head 22, and a suitable power supply 23 for energizing the light source. The control head 22 is mounted on the base 21 to rotate about a vertical axis for moving the projected light beam in a horizontal direction. A control 24 pivots a mirror 25 about a horizontal axis 26 for moving the projected light beam in a vertical direction. The control head 22 also contains an optical system control lever 27 for adjusting the diameter of the projected light beam and a shutter control 28 for opening and closing a shutter. A conventional color boomerang 29 is positioned below the mirror 25 for selectively inserting various colored filter elements in the path of the light beam passing from the base 21 to the mirror 25. The theatrical spotlight 20 is designed such that the power supply 23 and the control head 22 can be readily removed from the base 21, permitting the spotlight 20 to be easily transported as three lightweight units.

Referring now to FIGS. 3 and 4, the optical system for the spotlight 20 is shown diagrammatically. A high-intensity lamp 32, preferably a xenon lamp having a high light output and a low heat output, is mounted at the lower end of the base 21 to emit an upwardly directed light beam. The light beam passes from the lamp 32 sequentially through a shutter 33, an iris diaphragm 34, and a lens system 35. The controlled light beam emitted by the lens system 35 strikes the mirror 25 and is directed to an object to be illuminated. The lens system 35 generally comprises a planoconvex lens 36 having a relatively long focal length and either a double convex lens 37 or an achromatic lens having a relatively short focal length. The planoconvex lens 36 is moved towards the iris diaphragm 34 for increasing the diameter of the projected beam and away from the iris diaphragm 34 for decreasing the diameter of the projected light beam. Control linkages, which are described in detail below, move the double convex lens 37 away from the iris diaphragm 34 as the planoconvex lens 36 is moved towards the iris diaphragm 34 and, conversely, move the double convex lens 37 towards the iris diaphragm 34 as the planoconvex lens 36 is moved away from the iris diaphragm 34. The double convex lens 37 is moved to maintain the aperture 38 in the iris diaphragm 34 in sharp focus as the planoconvex lens 36 is moved to change the spot diameter. The optical system is shown positioned for a minimum spot diameter in FIG. 3 and for a maximum spot diameter in FIG. 4. Thus, in FIG. 3, the planoconvex lens 36 is positioned at a maximum distance from the iris diaphragm 34, the aperture 38 in the iris diaphragm 34 is at a minimum setting, and the double convex lens 37 is relatively close to the iris diaphragm 34 for focusing the aperture 38. In FIG. 4, a maximum spot is obtained by opening the aperture 38 in the iris diaphragm 34, moving the

planoconvex lens 36 to a minimum distance above the iris diaphragm 34 and moving the double convex lens 37 away from the iris diaphragm 34 to maintain the aperture 38 in sharp focus. The shutter 33 may be closed to block either a part of or all of the light beam when the lens system 35 and the iris diaphragm 34 are set either for a minimum diameter beam as in FIG. 3, for a maximum diameter beam as in FIG. 4, or for an intermediate diameter beam.

Referring now to FIGS. 5, 6, and 9, the lens system 35 is shown in detail. The planoconvex lens 36 is mounted on a carriage 41 and the double convex lens 37 is mounted on a carriage 42. The carriages 41 and 42 are confined for vertical movement by a plurality of guide rods 43. A high-intensity light source 44 is mounted on a platform 45 which is in turn attached to the guide rods 43. If the light source 44 is a xenon lamp or other type requiring a high frequency starter, a conventional starter such as a Tesla coil 46 is positioned below the platform 45. The light source 44 is mounted on the platform 45 such that it has an upwardly directed light beam. A platform 47 for mounting the shutter 33 and the iris diaphragm 34 is attached to the guide rods 43 above the platform 45.

The optical system control lever 27 is attached directly to the carriage 41 for the planoconvex lens 36. The carriage 41 is moved up and down on the guide rods 43 by merely raising or lowering the control lever 27. A plate cam 48 is mounted below the carriage 41 for vertical movement with the carriage 41. A roller 49 is mounted on a lever 50 for engaging and following a camming surface 51 on the plate cam 48. As the roller 49 follows the surface 51, the lever 50 pivots about an axle 52 which is attached to the fixed platform 47. The carriage 42 for the double convex lens 37 rests on a roller 53 attached to the lever 50. Thus, the platform 42 is raised and lowered as the lever 50 is rotated about the axle 52 by the plate cam 48. The camming surface 51 of the plate cam 48 is shaped such that the double convex lens 37 is positioned to focus the aperture 38 in the iris diaphragm 34 for all settings of the planoconvex lens 36.

A second cam 55, consisting of a groove 56 in a flat plate 57, is also attached to and moved by the carriage 41 for the planoconvex lens 36. A follower 58 engages the groove 56 for rotating the iris diaphragm 34 to control the diameter of the aperture 38. As shown in FIGS. 5 and 7, the groove 56 extends vertically along the plate 57 for holding the iris diaphragm 34 open for all but extreme upper settings of the control lever 27, where the light beam has a minimum diameter. As the carriage 41 is moved towards the extreme upper position by the control lever 27, the follower 58 enters an angled portion 59 of the groove 56, thereby moving the follower 58 to stop down the aperture 38 in the iris diaphragm 34, as shown in FIGS. 6 and 8. Thus, when the control lever 27 is set for any relatively large diameter light beam, the aperture 38 is held at a maximum open position. As the control lever 27 is moved upward to produce a minimum-diameter beam, the aperture 38 in the iris diaphragm 34 is simultaneously stopped down to further decrease the beam diameter.

Referring now to FIGS. 9 and 10, the shutter 33 is shown in detail. The shutter 33 is mounted below the fixed platform 47 which supports the iris diaphragm 34. The shutter 33 basically comprises a pair of plates 60 having parallel knife edges 61. One of the plates 60 is attached to a rod 62 by means of a bracket 63 while the other plate is attached to a rod 64 by means of a bracket 65. The rods 62 and 64 are mounted parallel to each other and for axial movement by means of two guide blocks 66. The rods 62 and 64 each have a bent end 67 which engages notches 68 on opposite sides of a disc 69. The disc 69 is rotated by means of the shutter control 28, thereby moving the rods 62 and 64 axially in opposite directions. Movement of the rods 62 and 64 in opposite directions moves the knife edges 61 of the plates 60 towards and away from each other to cut off equal portions of opposite sides of the light beam. At one extreme setting of the shutter control 28, the light beam is entirely cut off. At the other extreme setting, the light beam passes unhindered to the aperture 38 in the iris

diaphragm 34. At intermediate settings of the shutter 33, the light beam takes on the form of an elongated horizontal strip of light having an adjustable width and height.

Referring to FIGS. 11 and 12, the control head 22 is shown in detail. The axle 26 on which the mirror 25 is mounted is pivotally attached to the control head 22 by means of two bearings 72. The mirror 25 is positioned to reflect the light beam through an opening 73 in the control head 22. The opening 73 is sufficiently large that the reflected light beam may be directed through a wide vertical range, for example, from 30° above the horizon to 45° below the horizon. The control 24 for rotating the mirror 25 passes through a vertical slot 74 in the back of the control head 22. A scale (not shown) may be positioned adjacent to the vertical slot 74 for blind cueing the vertical position of the beam. A pair of guides 75 are positioned adjacent the bottom of the control head 22 for slidably receiving a plurality of stacked boomerang slide trays (not shown). Each boomerang slide tray includes a colored filter element which may be positioned in the path of the light beam.

The control head 22 is attached to the base to rotate the light beam horizontally through a 180° swing. To maintain the elongated strip of light produced by partially closing the shutter 33 in a horizontal position, it is necessary to rotate the shutter 33 with the control head 22. This is accomplished by mounting the entire optical system on rollers to rotate about a vertical axis, as shown in FIGS. 11 and 13-18. The guide rods 43 are anchored to a bottom disc 76 adjacent the lower end of the base 21. A number of support rollers 77 are spaced circumferentially around and attached to the bottom disc 76 (see FIGS. 15 and 18). The support rollers 77 rest on a base plate 78 which encloses the bottom of the base 21. A number of guide rolls 79 are attached to the base plate 78 for restraining the bottom disc 76 to rotate about a vertical axis on the support rollers 77 (see FIGS. 15 and 17). A pointer 80 is attached to rotate with the bottom disc 76. The pointer 80 is used in cooperation with a protractor scale 81 on the base plate 78 for blind cueing the horizontal position of the projected light beam. The upper ends of the guide rods 43 are attached to a top ring 82 located adjacent the upper end of the base 21. The top ring 82 is restrained to rotate about a vertical axis by a plurality of guide rolls 83 (see FIGS. 13 and 16). The control head 22 is attached to and rotates with the top ring 82. An arcuate slot 85 is provided in the top plate 84 to pass the optical system control 27 as the control head 22 is rotated. Thus, it can be seen that the controlled diameter vertical light beam emitting from the planoconvex lens 36 is directed to an object to be illuminated by reflecting off the mirror 25. The mirror 25 is aimed by rotating about the horizontal axis 26 and by rotating the control head 22 about a vertical axis.

What I claim is:

1. Apparatus for projecting a beam of light having an adjustable beam diameter comprising, in combination, a light source, an iris diaphragm having an adjustable aperture, first and second lenses for controlling the light beam diameter and focus, said first lens being positioned between said second lens and said light source, and iris diaphragm being positioned between said first lens and said light source, cam means for simultaneously moving said first and second lenses between first, second, and third positions, said first lens moving progressively closer to said iris diaphragm as said cam means is moved progressively between said first, second, and third positions, and means connecting said iris diaphragm to said cam means for holding said iris diaphragm fully open when said lenses are positioned between said first and second positions and for progressively closing said iris diaphragm as said lenses are moved progressively from said second position to said third position.

2. Apparatus for projecting a beam of light having an adjustable beam diameter, as defined in claim 1, and including an adjustable shutter means positioned between said iris

diaphragm and said light source for controlling light between said light source and the aperture in said iris diaphragm, said shutter means being adjustable between an open position and a closed position.

3. Apparatus for projecting a beam of light having an adjustable beam diameter, as defined in claim 1, wherein said light source is a xenon lamp.

4. Apparatus for projecting a beam of light having an adjustable beam diameter comprising, in combination, a light source, an iris diaphragm, first and second lenses for controlling the light beam diameter and focus, said first lens being positioned between said second lens and said light source, said iris diaphragm being positioned between said first lens and said light source, a first carriage for mounting said first lens, a second carriage for mounting said second lens, means for moving said second carriage between first, second, and third positions progressively away from said iris diaphragm, a cam track movable with said second carriage, follower means for engaging said cam track, said cam track and said follower means moving said first carriage progressively towards said iris diaphragm as said second carriage is moved progressively from said first position to said third position, a second cam track movable with said second carriage, a second follower means engaging said second cam track for adjusting the aperture in said iris diaphragm, said second cam track and said second follower means holding said iris diaphragm in a fully open position while said second carriage is positioned between said first and second positions, and said second cam track and said second follower means progressively closing said iris diaphragm as said second carriage is moved progressively from said second position to said third position.

5. Apparatus for projecting a beam of light having an adjustable beam diameter, as defined in claim 4, and including an adjustable shutter means positioned between said iris diaphragm and said light source for controlling light between said light source and the aperture in said iris diaphragm, said shutter means being adjustable between an open position and a closed position.

6. Apparatus for projecting a beam of light having an adjustable beam diameter comprising, in combination, an upwardly directed light source, an iris diaphragm, means mounting said iris diaphragm above said light source to pass a controlled-diameter beam of light, first and second lenses for controlling the diameter and focus of the light beam passing through said iris diaphragm, a first carriage mounting said first lens above said iris diaphragm, a second carriage mounting said second lens above said first lens, means for moving said second carriage between first, second, and third positions progressively away from said iris diaphragm, a cam track movable with said second carriage, follower means for engaging said cam track, said cam track and said follower means moving said first carriage progressively towards said iris diaphragm as said second carriage is moved progressively from said first position to said third position, a second cam track movable with said second carriage, a second follower means engaging said second cam track for adjusting the aperture in said iris diaphragm, said second cam track and said second follower means holding said iris diaphragm fully open while said second carriage is positioned between said first and second positions, said second cam track and said second follower means progressively closing said iris diaphragm as said second carriage is moved progressively from said second position to said third position, and means for aiming the upwardly directed beam of light emitted from said second lens at an object to be illuminated.

7. Apparatus for projecting a beam of light having an adjustable beam diameter, as defined in claim 6, and including an adjustable shutter means positioned between said iris diaphragm and said light source for controlling light between said light source and the aperture in said iris diaphragm, said shutter means being adjustable between an open position and a closed position.