United States Patent [19]

Boudouris et al.

[11] **3,827,782**

[45] **Aug. 6, 1974**

[54] **REFLECTOR APPARATUS**

[75] Inventors: **Angelo Boudouris**, Sylvania, Ohio; **Geoffrey T. Gray**, Lambertville, Mich.

[73] Assignee: **Eprod Incorporated**, Toledo, Ohio

[22] Filed: **Dec. 11, 1972**

[21] Appl. No.: **313,848**

[52] **U.S. Cl.**..... **350/295**, 240/44.1, 240/41.37, 350/293

[51] **Int. Cl.** **G02b 5/10**

[58] **Field of Search**..... 350/293, 288, 295; 240/44.1, 41.37, 103 R, 103 A; 353/85, 87, 98, 99

[56] **References Cited**

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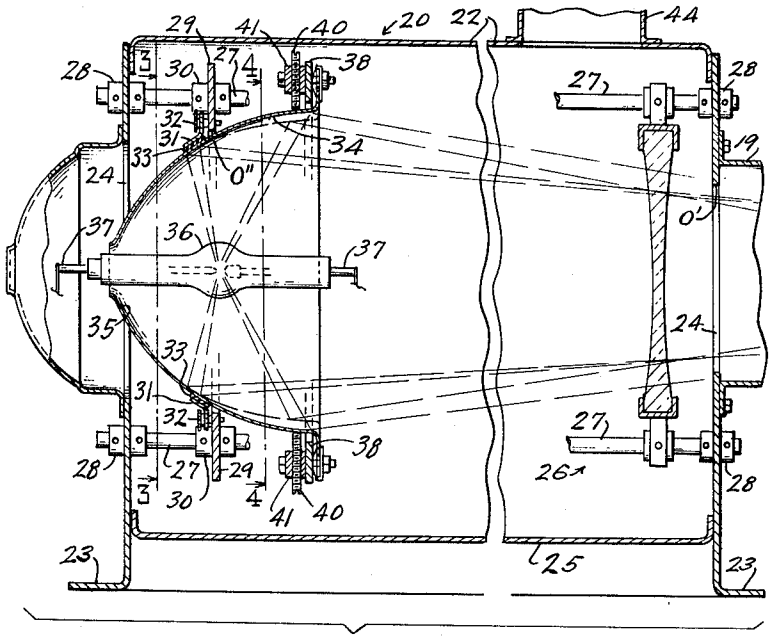
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3,588,493	6/1971	Nordquist	240/41.37
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Primary Examiner—John K. Corbin
Assistant Examiner—Michael J. Tokar
Attorney, Agent, or Firm—Owen & Owen

[57] **ABSTRACT**

A method and apparatus for distorting an open end of a reflector into a predetermined shape is disclosed. The reflector surface generally defines a paraboloid of revolution. The reflector apparatus comprises a housing which contains a suspension system for the reflector. The reflector is connected to the suspension system on a resilient mounting device for movement thereupon within the housing. A compression ring having opposing compression screws is located about the periphery of the reflector adjacent its open end. Adjustment of the opposing compression screws against the reflector causes the open end to distort into a predetermined shape, while the resilient mounting device prevents undesirable distortion at the inner surface of the reflector, thereby providing a desired distribution for reflected light.

9 Claims, 6 Drawing Figures



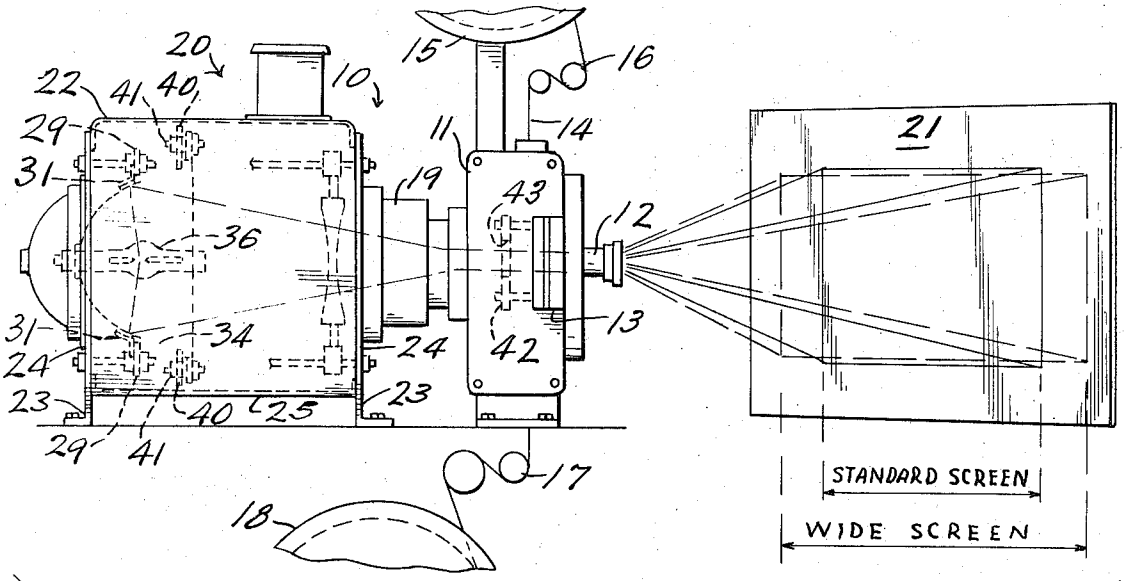

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STANDARD SCREEN
WIDE SCREEN

FIG-1-

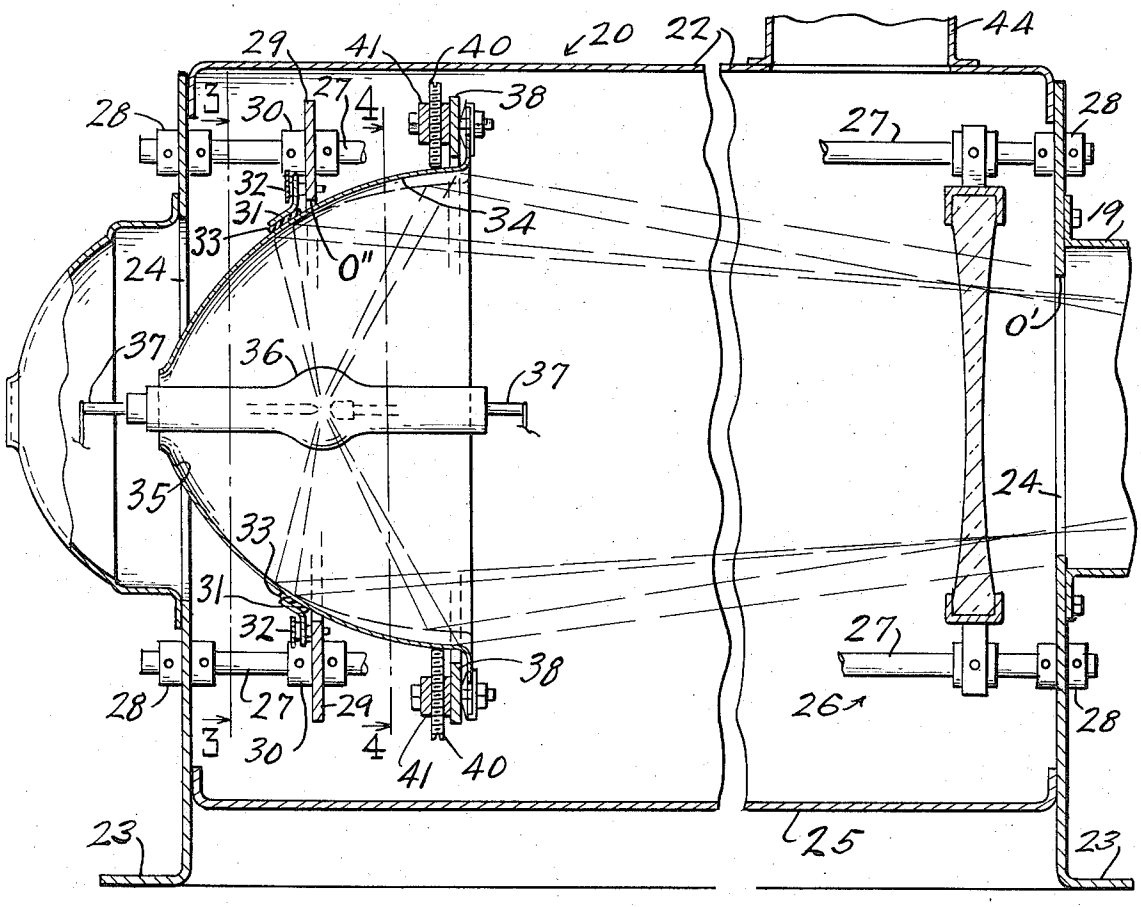

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FIG-2-

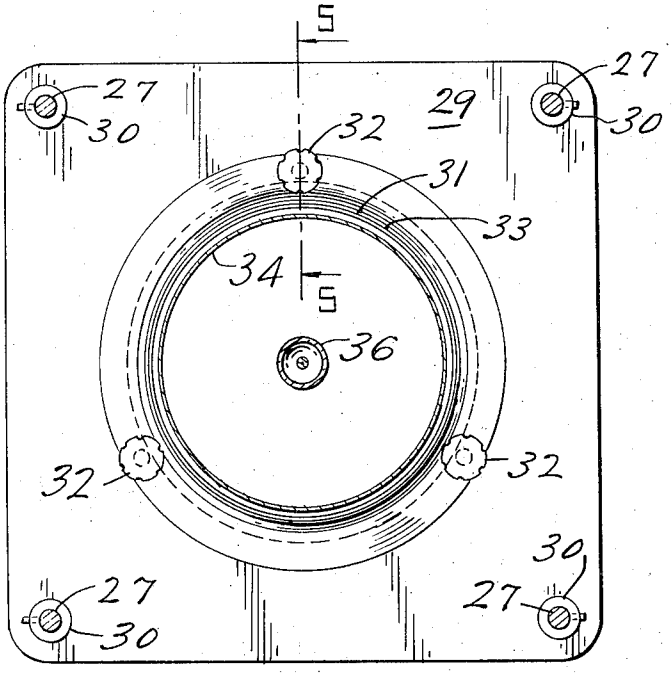


FIG-3-

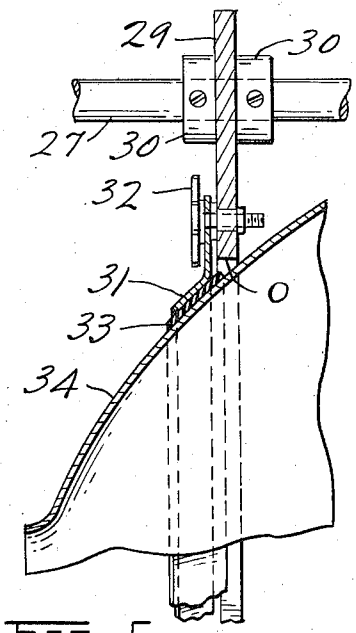


FIG-5-

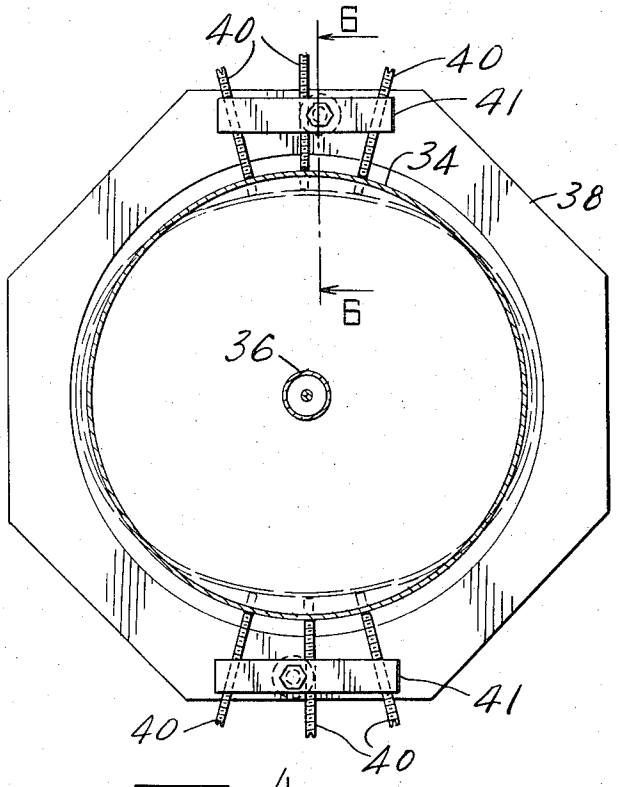


FIG-4-

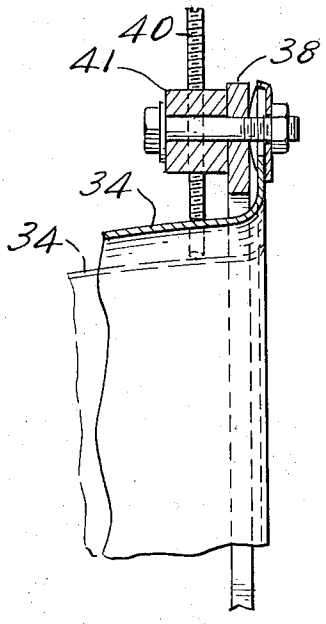


FIG-6-

REFLECTOR APPARATUS

BACKGROUND OF THE INVENTION

Large moving picture projectors and the like utilize high-intensity lamps which are located within polished parabolic reflectors. The lamps often comprise a glass tube filled with pressurized xenon gas. The light emitted from the high-intensity lamp is reflected by the reflector toward a rectangular opening or mask which shapes the emitted light into a pattern matching the desired outline of picture area in the film to be projected on a screen. The image of this film is in turn projected through a lens system onto the screen.

The mask shapes the light by preventing rays emitting from the reflector from passing therethrough at any place other than the open rectangle. All other light from the reflector strikes the face of the mask and is reflected or dissipated in the form of heat through the projector cooling system. A substantial portion of light is often lost at the face of the mask. Conventional projectors have no provision for preventing this light loss but rather have sufficiently intense projection lamps to provide a relatively intense light pattern on the screen despite the light loss at the face of the mask. Other prior art projectors include a condensing lens placed immediately in front of the reflector thereby tending to condense more reflected light through the mask opening, but the pattern of light remains circular.

One apparatus for distorting a reflector having an elliptical cross section is disclosed in U.S. Pat. No. 3,628,852, A. A. Snaper et al. The reflector disclosed in that patent comprises a housing and a planar reflective sheet placed within the housing. The sheet is fixedly mounted on rigid supports near the closed end of the reflector. Set screws adjacent the sheet permit deformation of the sheet in one direction except at the points of contact between the rigid supports and the reflector surface, which prohibit deflection.

It has been found that if a reflector is fixedly suspended on rigid support posts, a change in the frontal shape thereof creates a nonuniform curvature on the reflector interior. Light reflected from the reflector interior tends to create a pattern which has an undesirable configuration. The most objectionable feature is the uneven distribution of light rays, causing unwanted brighter and darker areas in the projected picture.

The present invention provides a means of suspending a reflector comprising a paraboloid of revolution on a resilient mounting ring. The ring has sufficient flexibility to permit a uniform distortion throughout 360° of the reflector interior into a predetermined shape to "squash" the reflected light pattern thereby presenting a pattern which more closely matches the rectangular shape of the mask, thus utilizing much of the light which would otherwise strike the mask outside the rectangular opening.

SUMMARY OF THE INVENTION

The invention is a reflector apparatus and a method of distorting an open end of the reflector to a predetermined shape. The reflector apparatus comprises a housing with a resilient suspension system connected to tracks within the housing. A reflector comprising a curved figure of revolution is connected to the suspension system through a resilient mounting means for movement along the tracks within the housing. A high-intensity lamp is located on the axial centerline of the reflector. A light-restricting mask is located adjacent the rear surface of the film in the projector head. A compression ring having opposing compression screws is mounted on the reflector adjacent an open end thereof. The compression screws are mounted on the compression ring for movement toward the center of the ring against the reflector. Inward movement of the opposing compression screws for a sufficient distance distorts the circular, open end into a predetermined shape to focus reflected light from the lamp more intensely through the restricting mask. The resilient mounting means permits the reflector to distort uniformly to present a more uniformly distributed light pattern over the area of the mask.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic view of the reflector apparatus of the present invention in a projection system with the screen rotated 90°;

FIG. **2** is an elevation view of the reflector apparatus of the present invention with parts broken away;

FIG. **3** is a sectional view of the reflector apparatus of the present invention taken along the line **3—3** of FIG. **2**;

FIG. **4** is a sectional view of the reflector apparatus of the present invention taken along the line **4—4** of FIG. **2**;

FIG. **5** is a fragmentary sectional view of the reflector apparatus of the present invention taken along the line **5—5** of FIG. **3**; and

FIG. **6** is a fragmentary sectional view of the reflector apparatus of the present invention taken along the line **6—6** of FIG. **4**.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. **1**, a movie projection system **10** includes a projector mechanism housing **11** having a lens assembly **12** and a film guide assembly **13** adjacent a rear portion of the lens assembly **12**. Movie film **14** is delivered from a feed reel **15** around a feed sprocket **16** through the film guide **13**, around a take-up sprocket **17** and onto a take-up reel **18**, at a predetermined rate of speed.

A light tunnel **19** is connected to an opening in the projector mechanism housing **11** in alignment with the lens system **12** for transmission of light from a reflector apparatus **20**, according to the present invention, through the film guide **13** and the lens system **12** to a movie screen **21**.

The reflector apparatus **20** includes a housing **22** resting on support feet **23** and having front and rear walls **24** connected to the support feet **23**. Top and bottom walls **25** are connected to the front and rear walls **24**; side walls **26** are connected to the top and bottom walls **25** to form a light-tight enclosure. An opening **0'** in the front wall **24** (see FIG. **2**) is in axial alignment with the light tunnel **19** which is connected to the front wall **24**.

Referring to FIGS. **2, 3** and **5**, a reflector suspension system **26** within the housing **22** is shown. The reflector suspension system includes four parallel, threaded guide members **27** which are received by castings **28** mounted in the front and rear walls **24**. A bulkhead support plate assembly **29** having threaded set screw collars **30** in complementary engagement with the

threaded guide members **27** is mounted for movement toward and away from the front wall **24.** A circular mounting member **31** is connected to the support plate assembly **29** by thumbwheels **32** and extends about the periphery of an opening **0''** defined by the support plate **29.** The mounting member **31** is mounted at approximately the plane of the center of a light source, to be described below, and is normal to the optical centerline of the source. A resilient gasket material **33** is adhered to the circular mounting member **31.** The circular mounting member **31,** carrying the resilient gasket material **33,** is shaped for receiving the rear portion of a generally parabolic reflector **34.** The resilient gasket material **33** grippingly engages the reflector **34.**

The reflector **34** comprises a highly finished nickel reflector having a mirrored interior surface. The reflector interior surface generally defines a paraboloid of revolution. An opening **35** in the axial rear end of the reflector **34** receives a high-intensity xenon bulb **36.** Electrical leads from a power source (not shown) are connected to cathode and anode electrodes **37** on the xenon bulb **36** and supply power to the bulb **36.** The xenon bulb **36** is precisely aligned to be in the axial center of the reflector **34** with the center of the light source substantially in the plane of the support plate **29.**

Referring to FIGS. **4** and **6,** a compression plate **38** complementary with the largest circumference of the reflector **34** surrounds the reflector **34.** Opposing compression screws **40** are threadably engaged with opposed adjustment blocks **41** connected to the compression plate **38** for movement toward and away from the axial centerline of the reflector **34.** While two blocks **41** are shown in the present embodiment, any number of blocks **41** may be positioned around the reflector **34.** Ends of opposing compression screws **40** are in contact with the circular outer surface of the reflector **34.** The opening defined by the compression plate **38** is sufficiently large to permit changes in shape of the reflector **34** through adjustment of the compression screws **40** as will be described.

A light-restricting mask **42** is positioned adjacent the rear surface of the film at the film guide **13.** The restricting mask **42** comprises a flat plate defining a rectangular opening **43** whose plane is perpendicular to the longitudinal axis of the xenon bulb **36.**

The xenon bulb **36** is energized to produce a highintensity light source within the reflector **34.** Light emits from the xenon bulb **36** and strikes the mirrored interior surface of the reflector **34** and is reflected from the mirrored surface toward the restricting mask **42.** The light emitting from the reflector partially passes through an opening **0'** in the apparatus **20,** through the light tunnel **19,** the rectangular opening **43** in the mask **42,** the lens system **12** and onto the screen **21** as is diagrammatically shown by the lined pattern in FIG. **1.** Light rays which do not pass through the opening **0'** are dissipated in the form of heat energy through a cooling stack **44** (see FIG. **2**) in the top wall **25.** The projected light pattern is shaped by the rectangular opening **43** and is made substantially complementary to the shape of the opening **43** by adjustments which will be described.

To properly adjust the light distribution pattern striking the mask **42,** the xenon bulb **36** is energized and the reflector **34** carried by the suspension system **26** is moved toward or away from the restricting mask **42.** Adjustment of the threaded guide rails **27** causes the support plate **29** threadably engaged therewith through the set screw collars **30** to move toward or away from the restricting mask **42** to permit the use of the apparatus **20** with different light sources. The reflector **34** is thus axially adjusted until a relatively uniform light distribution is visible on the movie screen **21.** The guide tracks thereby provide means whereby various bulbs from various manufacturers and having various power ratings and various axial dimensions can be used.

Once the parabolic reflector **34** is axially adjusted along the threaded guide rails **27,** the compression screws **40** are tightened against the reflector **34** until sufficient force is exerted to compress the circular open end thereof into a "squashed" condition. The distortion of the reflector **34** by the compression screws **40** places a uniform and opposing distortion in the geometry of the reflector including that portion of the reflector adjacent the resilient gasket material **33.** As the reflector distorts, the gasket material **33** correspondingly distorts to permit all points of the reflector **34** in contact therewith to distort uniformly the compression screws **40** are moved inwardly.

As the open end of the reflector **34** is thus "squashed," the light pattern emitted from the parabolic reflector is correspondingly focused from a generally circular configuration to a configuration more complementary with the rectangular opening **43** of the restricting mask **42.** As a result, more light rays are reflected from the interior surface of the reflector **34** through the restricting mask **42,** thereby projecting an intensified and more uniform light pattern through the film **14,** the lens system **12,** and ultimately to the movie screen **21.**

Because the reflector apparatus **20** of the preferred embodiment is adjustable both axially and in a plane perpendicular to the optical axis, as described, the projection system can be adapted to the particular lighting requirements of a wide range of indoor and outdoor theaters. It is understood that changes may be made in the numerous details of construction described in the preferred embodiment of the present invention which would not limit the scope or spirit of the invention defined in the following claims. In addition, means may be added for either automatically or manually changing the light distribution from the reflector apparatus **20** to facilitate the use of different masks **42.** In a fully automatic projector having an automatic mask changer to facilitate different film formats, for example, solenoids may be provided for automatically changing the degree of squash of the reflector **34** when masks are automatically changed. Or, a cam mechanism may be provided for manually changing the degree of squash between preset positions to adapt for use with different size aperture plates. With such an arrangement, the aperture plate could be quickly changed from one having a square opening to one having a rectangular opening without an appreciable darkening of the corners of the light passing through the rectangular opening.

What we claim is:

1. A method of distorting the interior surface of a thin-walled reflector having an interior surface defining a curvature of revolution and an open end comprising the steps of: suspending the reflector within a resilient distortable mounting means; engaging the reflector at spaced locations about the reflector adjacent said open end; and urging the open end of the reflector inwardly to distort the interior surface of the reflector to a pre-

determined shape throughout including the area adjacent the mounting means.

2. A reflector apparatus comprising a housing, resilient distortable suspension means within said housing, a reflector normally having the shape of a curvature of revolution carried by said resilient suspension means, and means for compressing an open end of said reflector into a predetermined shape to impart a controlled distribution to light rays emerging from said reflector.

3. A reflector apparatus according to claim 2 wherein said resilient suspension means includes guide means mounted within said housing for guiding said reflector along a longitudinal optical centerline, a support plate mounted for movement along said guide means, said support plate defining an annular opening for receiving a portion of said reflector, and resilient distortable gasket means mounted between said support plate and said reflector for cushioning and suspending said reflector in the opening.

4. A reflector apparatus according to claim 2 wherein said compressing means includes a ring mounted adjacent the open end of said reflector and having an opening for receiving the reflector end, the opening of said ring being larger than the adjacent dimension of said reflector, compression screws threadably connected to said ring for movement into contact with said reflector, whereby movement of said compression screws against said reflector compresses said open end of said reflector into a predetermined shape.

5. A reflector apparatus comprising a longitudinally extending frame, resilient distortable suspension means mounted on said frame, a reflector mounted within said suspension means, the interior surface of said reflector normally having the shape of a curvature of revolution, a light source mounted within said reflector, means for shaping light reflected from said reflector into a predetermined pattern, and adjustable compression means connected adjacent an open light-emitting end of said reflector for distorting said reflector to increase the amount of reflected light passing through said shaping means to produce a high intensity light pattern.

6. A reflector apparatus according to claim 5 wherein said shaping means includes a plate defining a desired opening therethrough, and means mounting said plate in a plane perpendicular to the optical axis of said reflector.

7. A reflector apparatus according to claim 5 wherein said suspension means includes upper and lower guide tracks mounted within said frame parallel to the optical axis of said reflector, a support plate connected for movement along said parallel tracks, said plate having an annular opening for receiving a portion of said reflector therein, and resilient means carried by said plate and within said opening for cushioning and suspending said reflector in the annular opening.

8. A reflector apparatus according to claim 7 and including means mounting said compression means for movement along said tracks.

9. A reflector apparatus according to claim 5 wherein said compressing means includes an annular ring connected adjacent said open end of said reflector, the circumference of said annular ring being larger than the adjacent circumference of said reflector, a plurality of compression screw means mounted adjacent said annular ring for movement toward the center of said ring, the innermost portion of said screw means engaging said reflector, whereby movement of said compression screw means toward the center of said ring distorts said open end of said reflector into a desired shape.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,827,782 Dated August 6, 1974

Inventor(s) Angelo Boudouris and Geoffrey T. Gray

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

The assignee information should be corrected to read: "Assignee: Eprad Incorporated, Toledo, Ohio".

Column 4, line 21, after "uniformly", the word "as" should be inserted.

Signed and sealed this 5th day of November 1974.

(SEAL)
Attest:

McCOY M. GIBSON JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

FORM PO-1050 (10-69)

USCOMM-DC 60376-P69
* U.S. GOVERNMENT PRINTING OFFICE : 1969 O—366-334.