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(54) MULTIPLE FOCUS POINT LIGHT

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(60) Provisional application No. 60/783,636, filed on Mar. 17, 2006, provisional application No. 60/864,125, filed on Nov. 2, 2006.

(51) **Int. Cl.**
F21S 8/00 (2006.01)
F21V 5/00 (2006.01)

(52) **U.S. Cl.** **362/268**; 362/331

(58) **Field of Classification Search** 362/268, 362/331, 293, 277, 279, 281, 290, 319; 353/30, 353/62

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2,391,430	A	12/1945	Macek	
4,769,743	A	9/1988	Callahan	
4,800,474	A	1/1989	Bornhorst	
4,891,738	A	1/1990	Richardson et al.	
4,984,143	A	1/1991	Richardson	
5,258,895	A *	11/1993	Bosse	362/281
5,379,083	A *	1/1995	Tomita	353/122
5,590,955	A	1/1997	Bornhorst et al.	
5,691,886	A	11/1997	Stacy	
5,816,690	A	10/1998	Romano	
5,934,794	A	8/1999	Hutton	
6,504,301	B1 *	1/2003	Lowery	313/512
6,607,280	B2	8/2003	Koyama et al.	
7,102,833	B2 *	9/2006	Cole et al.	359/738
7,301,646	B2 *	11/2007	Wegmann et al.	356/515
2003/0072161	A1	4/2003	Hough et al.	
2004/0125602	A1	7/2004	Hunt et al.	

* cited by examiner

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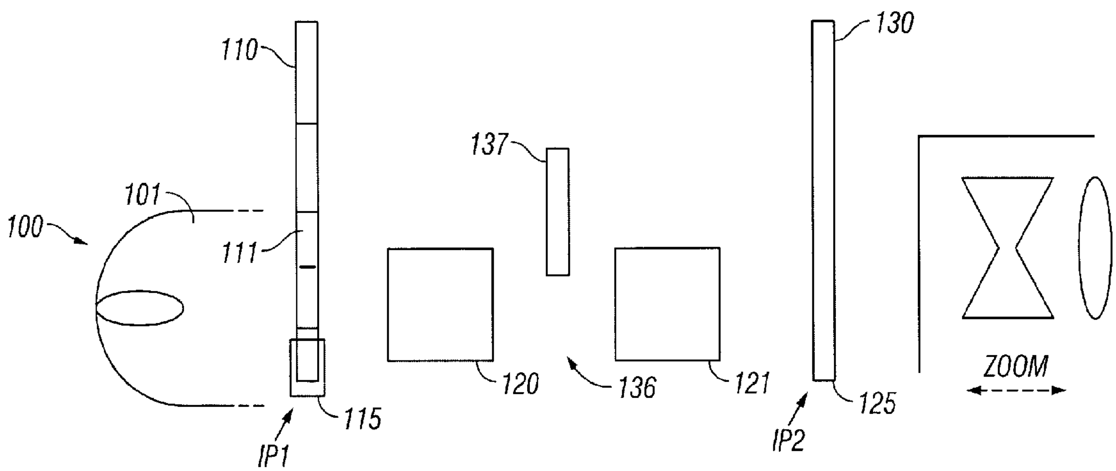
(57) **ABSTRACT**

A lamp unit with a relay lens that allows two different focus points. Two different optical altering elements are hence simultaneously in focus. The elements can be taken in and out of focus to allow different effects.

15 Claims, 3 Drawing Sheets



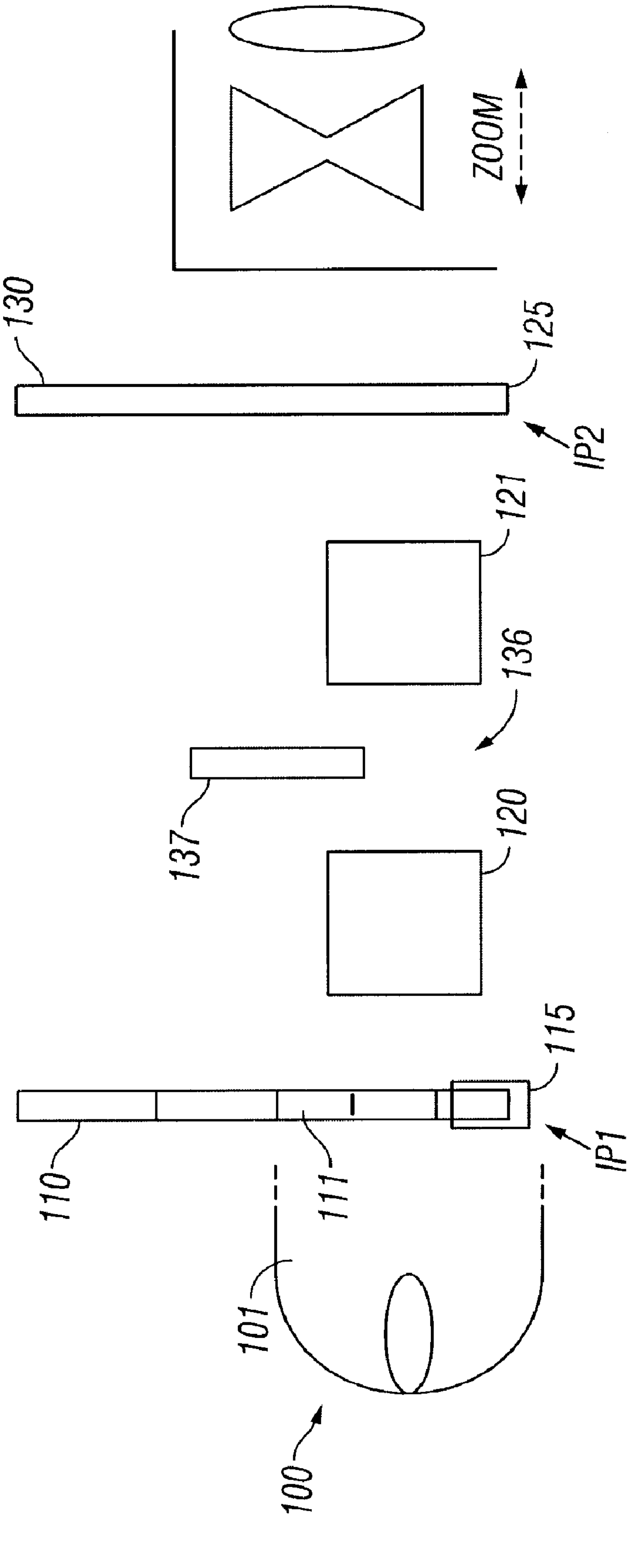
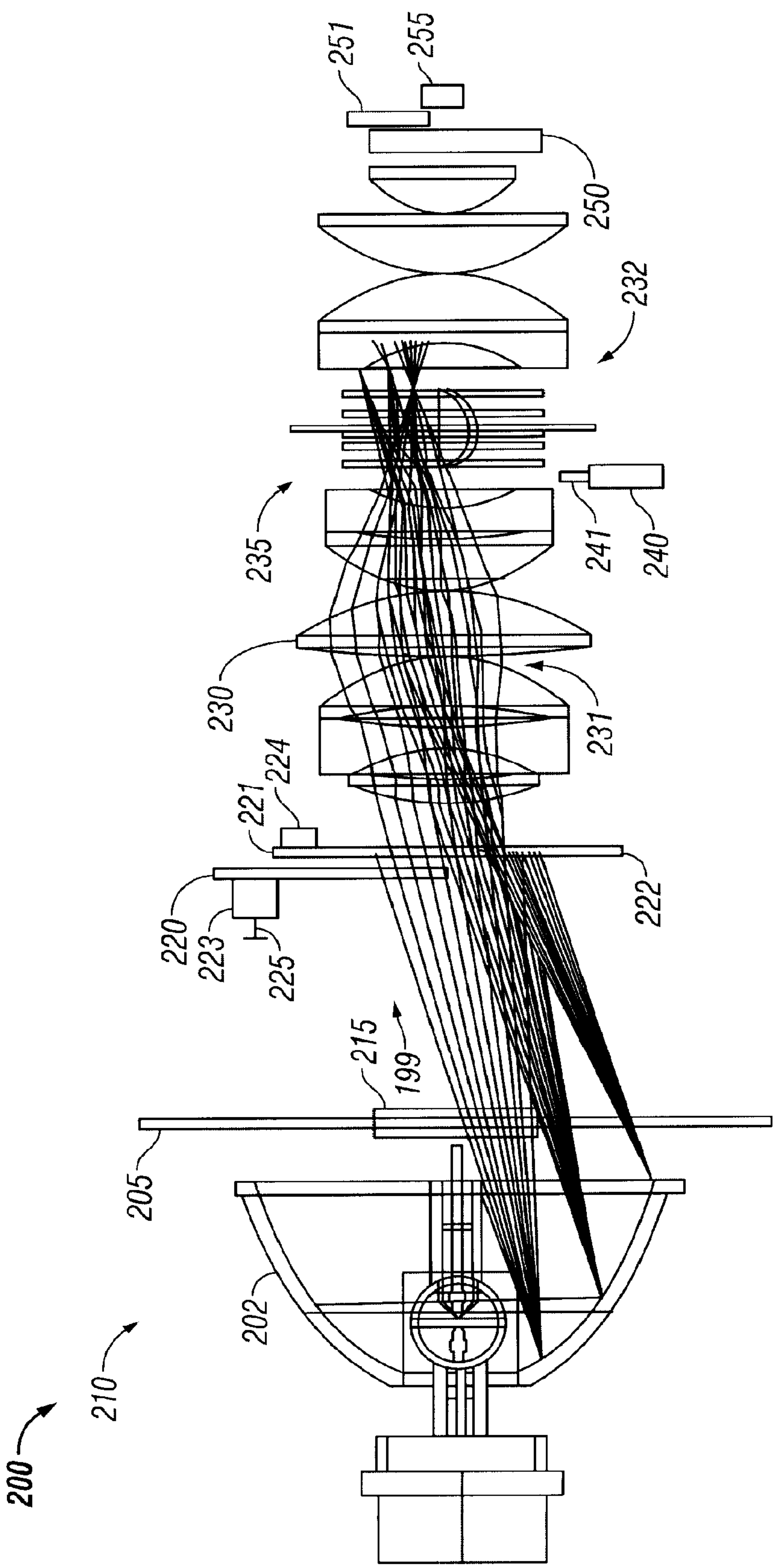


FIG. 1



200
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FIG. 2

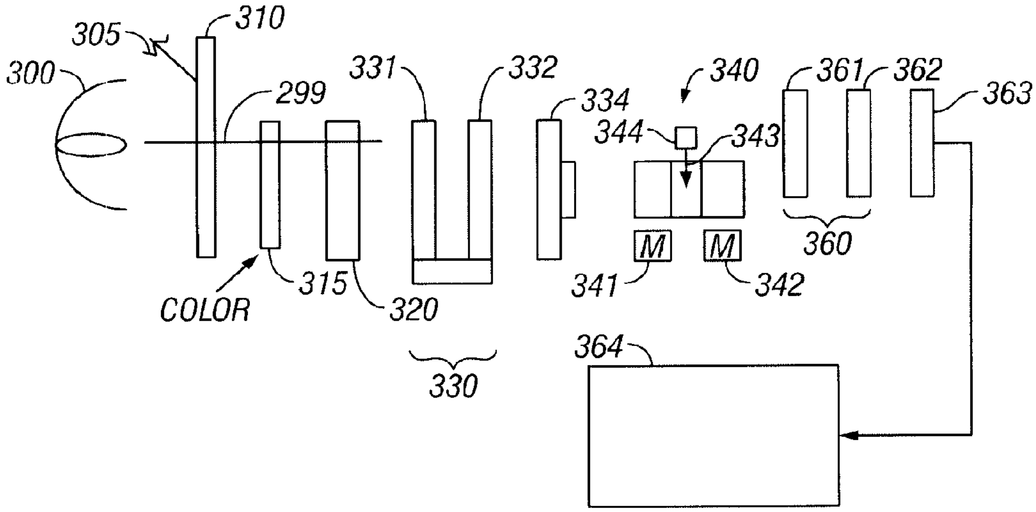

FIG. 3

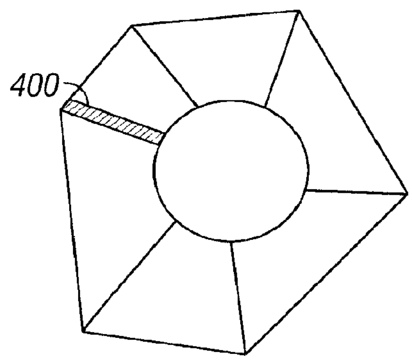

FIG. 4

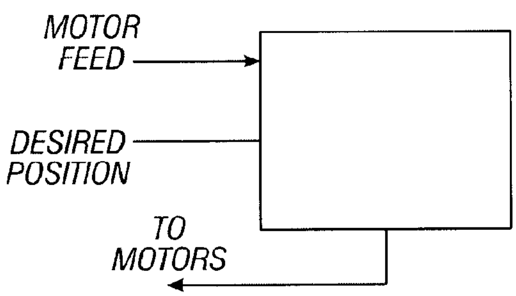

FIG. 5

MULTIPLE FOCUS POINT LIGHT

CROSS-REFERENCE TO RELATED APPLICATIONS

This is a divisional of application Ser. No. 11/687,579, filed Mar. 16, 2007, now U.S. Pat. No. 7,726,843 which claims priority to U.S. Provisional Application 60/783,636, filed Mar. 17, 2006 and 60/864,125, filed Nov. 2, 2006. The disclosure of the prior applications are considered part of (and are incorporated by reference in) the disclosure of this application.

BACKGROUND

Stage lights often allow different kinds of features and effects to be projected onto a stage a typical stage light might be a pan and tilt controllable device, which is remotely controllable over a format such as DMX, and produces a beam with an output intensity of at least 150 W, but more preferably between 400 and 800 W.

Many such devices also allow very sophisticated effects, such as gobos, coloration, blurring, and other similar effects. Many of these effects may depend on whether the item used to adjust the light control is in or out of focus at a specific location.

Most stage lights have only a single focus location.

SUMMARY

The present application describes a stage light with multiple focus points and effects items at these focus points. Embodiments describe various kinds of effects to be carried out.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other aspects will now be described in detail with reference the accompanying drawings, wherein:

FIG. **1** shows an embodiment of the multiple focus point light;

FIG. **2** shows another embodiment which includes multiple structures and includes moving parts for those structures;

FIG. **3** shows another embodiment with additional structures including multiple color wheels and irises and a controller;

FIG. **4** shows a special light altering wheel for such device; and

FIG. **5** shows a motor controlling chip.

DETAILED DESCRIPTION

The general structure and techniques, and more specific embodiments which can be used to effect different ways of carrying out the more general goals, are described herein.

The present application describes a multiple focus point light, which has multiple image planes, and a relay lens to allow relaying an image from image plane **1** into image plane **2**.

FIG. **1** shows an embodiment of the overall light projection system. A lamp **100**, which is preferably 200 W or more, produces an output beam of light shown as **101**. A rotating gobo **110** is placed within the beam of light, such that an effective portion of the gobo, which may be the part **111** of the gobo that shapes the light, is within the optical train formed from the beam of light. The rotating gobo is located at image plane **1** shown as IP**1**, area **115**.

A movable relay lens **120** is adjacent to the image plane **1**, and receives the image from image plane **1**. The relay lens relays the image from image plane **1** to a second image plane shown as image plane **2** **125**. The relay lens parts **120**, **121** however, are movable/adjustable so that different effects are possible.

Another optical element is located in the image plane **2**. FIG. **1** shows color wheel **130** at that location. Therefore, the focus point of image plane **2** receives the color wheel at that exact location. This completely spreads the image over a desired area.

By relaying the image from one image plane to another image plane, different items located at the different image planes can be projected as though they were precisely on top of one another. Two different gobos can be used, for example, at the two different image planes, with both gobos being sharply in focus. A color wheel can be sharply in focus at the same as the gobo. Previous systems which used two gobos required one of the two gobos to be out of focus. This system allows both gobos to be in focus.

More generally, in a two-image plane system such as this one, any two optical elements can be simultaneously in focus. Elements can include coloration device, filters, lenses, blurs, effects, gobos, or any other element that changes any projected aspect of the light.

The area **136** between the two portions of the relay lens **120**, **121** is called the optical stop. Any optical effect, e.g. gobos, color wheel, lens, filters such as blurs or effects, that is in the optical stop pattern becomes substantially perfectly integrated in the projected image. Therefore, different effects can be obtained by putting items such as color filters and the like in the optical stop **136**. FIG. **1** shows a color wheel **137** in the optical stop, but it should be understood that other effects can be placed therein. Multiple effects can be used in the stop.

FIG. **2** illustrates an alternative embodiment. **200** represents an optical beam producing part producing a light beam along a path which can include a bulb and reflector assembly. For example, this may use an 1100 Watt bulb and a spherical or parabolic reflector **202**. In the embodiment, a heat blocking device **205** serves to form a hot chamber in the area **210** behind the blocking part. The heat blocking portion **205** may include a wall of metal such as aluminum, with an opening area **215** formed of a UV/IR filter with areas that allow angles relative to the direction **199** of the optical beam to pass. The UV/IR filter **215** reflects ultraviolet and infrared, and passes a beam of light which is as cooled as possible.

First and second light altering devices **220**, **221** are located at the focused location **222** of the reflector **202**. The relay lens parts such as **230** are associated with a moving part that allows them to be moved along the optical train. The moving parts allow the relay lens parts to be moved in the direction **225**, substantially parallel to the direction of the optical train **199**. The movement is done to allow either of the devices **220**, **221** to be at exactly a focus point of the relay lens, or out of the point of image of the relay lens. In the embodiment, one of the devices is brought into focus, while the other is brought out of focus.

The light changing devices **220**, **221** can be gobos or color changers, for example.

A relay lens **230** is formed of first and second parts **231**, **232**, with an optical stop **235** in between those first and second parts. A solenoid actuator **240** allows an optical part **241** to be selectively placed partially or completely within the stop between the relay lens parts. Anything placed in that stop is automatically integrated into the resultant light beam. Therefore, placing the optical part **241** one quarter into the stop causes a ¼ effect of the part. For example, a coloration device will cause ¼ its overall coloration, and a light blocking device will cause ¼ intensity dimming.

As described above, the relay lens enables a second point of focus, and the second optical altering device **250**, here a gobo wheel, is placed precisely in the second image plane of the relay lens. There may be an additional optical altering device **251**, located so that there are two optical altering devices in each focus location. These may also be movable.

An objective lens **255** may be a zoom lens, which allows focusing on one or both of the optical altering devices at either of the focus locations.

The purpose of the movement capability is to allow one of the two optical altering devices to be placed exactly at the focus location. The other optical altering device may be placed in its open location, that is so that there is simply an open hole, or may be used as an out-of-focus effect.

The coloration may include additional devices and out-of-focus locations after the cold mirror **205**. Four separate color wheels can be used in the system, a three color wheel additive system formed of a cyan color wheel, a magenta color wheel and a yellow color wheel, and also a custom color wheel, are shown in detail in FIG. **4**. The custom color wheel may allow replacement of color lenses, for example, so that each of a plurality of different colors become possible. The color wheel also includes a ⅛-¼ inch black line **400** between two adjacent colors. This allows the projection of split color on the screen. For example, since this may be used at an out-of-focus location, the black line will not be visible in the final image; but rather only a split color effect will be seen.

The gobo wheels may be etched gobo wheels, or may be images that are printed using a halftone technique. In operation, with a system, a number of effects become possible. Two different forms of coloration are possible, one in a relatively in-focus position, formed of custom colors, and the other, formed of an additive or subtractive three color wheel system in out-of-focus locations which are effectively integrated by the optical system. In addition, the two gobos may be halftone gobos, formed at a dot pitch, for example, of 300 dots per inch. Both gobos can be precisely in focus at the same time. It was found that when two gobos are in focus that the same time, something which has never been possible in any previous light, that interference or "moire" effects start to occur. The interference effects may produce a rainbow light effect from the imaging. Additional aliasing effects may also be possible. The aliasing changes may be enhanced when the gobos are rotated relative to one another.

It was found that when the two gobos are both precisely in focus, then the moire effect occurs based on the halftone patterns of the gobos causing aliasing between the two patterns of the gobos. The moire effect is caused when both gobos are exactly in focus at the same time, and both have the same printing characteristic. Circles and patterns can be used to emphasize the effect, as well as a third gobo wheel.

Another effect is caused by defocusing one of the two gobo images. Then, zoom lens **255** may be moved back and forth to focus and defocus the images which are in the image plane.

Any time that an additional optical element is brought into the system, the different parts may need to be moved slightly to maintain focus. Therefore, when one of the pieces is in its transparent or open position, a different focus position of the different parts is necessary then when it is in the other position. A refocusing to maintain the focus becomes necessary.

The actuator **240** may move, for example, a piece of frosted glass, or other kind of blurry integrator into the stop, to add that effect to the system. Again, by moving the effect material halfway into the stop, the effect is only seen halved. The position of the effect material is never seen, only its effect.

Another embodiment, shown in FIG. **3**, shows an entire optical train with a relay lens system. A lamp **300** is initially producing light along an optical axis **299**, through a UV/IR filter **310** that reflects infrared **305**. A rotatable color wheel **315** and a dimmer wheel **320** are placed in series with the optical beam **299**. These devices are at an out-of-focus location. A first in-focus location at **330** includes a first gobo wheel **331**, and a first color wheel **332**. As in the FIG. **2** embodiment, the relay lens parts can move to change the focus position to allow one or the other of the devices to be placed in focus.

A beam size iris **334** may be used to crop down the gobo to a reduced size. The beam size iris **334** is maintained in an out-of-focus location. The relay lens **340** is also located on a motorized part, with the first lens part **341** located on a motorized part **341** and the second lens part located on a second motorized part **342**. At the second optical stop **360**, a second gobo wheel **361** is located, along with other color wheels **362**, **363**.

The final image is directed through a zoom lens **364** which allows zooming the final image.

The positions of the lenses may be controlled using brushless DC servo motors, and using a chipset which controls based on the motor feedback and the desired position, the operation of the servo motors. FIG. **5** illustrates a chipset that can be used to drive the brushless DC servo motors, where the chip receives motor feedback through one input, and an indication of the desired position through another input and produces an output that controls the position of the motor.

As in the FIG. **2** embodiment, the stop **343** within the relay lens **340** can include an articulated arm **344** to push an external device in and out of the stop. Anything within the stop automatically gets integrated into the light beam. Therefore, the item can be a piece of frosted glass, or a blocking part that blocks light, or a coloration part. The part is pushed in and out of the light beam by an articulated arm **344**. This changes the look of the projected image and since it is in the stop, it automatically integrates the entire stop within the image.

The entire unit can be remotely controllable via a remote console, over four example DMX, arcnet, or any other remotely controllable protocol.

Although only a few embodiments have been disclosed in detail above, other embodiments are possible and the inventors intend these to be encompassed within this specification. The specification describes specific examples to accomplish a more general goal that may be accomplished in another way. This disclosure is intended to be exemplary, and the claims are intended to cover any modification or alternative which might be predictable to a person having ordinary skill in the art. For example, other effects beyond gobo wheels and colors can be used. For example, while the above shows all of the optical elements arranged along a straight line, it should be understood that mirrors can be used to shorten the overall length of the optical element by adjusting the direction of the light movement. Other optical elements besides those specifically mentioned herein can be used. In addition, more complex relay lenses can be used to allow multiple different focus points. Also, the optical altering elements themselves, such as the zoom lens can be moved, instead of moving the relay lens, to bring the parts into focus.

The computers described herein may be any kind of computer, either general purpose, or some specific purpose computer such as a workstation. The computer may be a Pentium class computer, running Windows XP or Linux, or may be a Macintosh computer. The programs may be written in C, or Java, or any other programming language. The programs may be resident on a storage medium, e.g., magnetic or optical, e.g. the computer hard drive, a removable disk or other removable medium. The programs may also be run over a network, for example, with a server or other machine sending signals to the local machine, which allows the local machine to carry out the operations described herein.

Also, the inventors intend that only those claims which use the words "means for" are intended to be interpreted under 35 USC 112, sixth paragraph. Moreover, no limitations from the specification are intended to be read into any claims, unless those limitations are expressly included in the claims.

What is claimed is:

1. A method, comprising: shining a beam of light along an optical train; modifying said beam of light from two simultaneously in focus locations along said optical train using halftone gobos at each of said two in focus locations; forming a moiré effect based on said beam of light passing though both of the two halftone gobos by adjusting at least one of said halftone gobos; and projecting said beam of light which has been modified from said two simultaneously in focus locations with said moiré effect.

2. A method as in claim **1**, wherein said modifying further including coloring.

3. A method as in claim **1**, wherein said modifying including shaping an outer perimeter of the beam of light.

4. A method as in claim **1**, further comprising second modifying said beam of light at a location that is out of focus.

5. A method as in claim **4**, wherein said second modifying comprises modifying the beam of light in a way that integrates over an entire field of the beam of light.

6. A method as in claim **1**, wherein said modifying comprises changing between different effects at the in focus locations.

7. A method as in claim **1**, wherein said

two in focus locations are at opposite sides of a relay lens group.

8. A lighting device, comprising:

an optical element, shining a beam of light along an optical train;

an optical system that creates first and second simultaneously in focus locations along said optical train;

a first halftone gobo, at said first in focus location along said optical train to create a first in focus image based on said beam of light;

a second halftone gobo, at said second in focus location along said optical train, to create a second simultaneously in focus image based on said beam of light where both said first and second in focus images are simultaneously in focus; and

an adjustment part, which adjusts at least one of said first halftone gobo or said second halftone gobo to form a moire effect between said first and second in-focus images passing through both of the first and second halftone gobos; and

said optical system producing a projected output that is based on said first and second simultaneously in focus images, and said moire effect.

9. A lighting device as in claim **8**, further comprising a coloring device for said light, along said optical train.

10. A lighting device as in claim **8**, further comprising a shaping device for said light, along said optical train.

11. A lighting device as in claim **8**, further comprising another light modifying device at a location that is out of focus.

12. A lighting device as in claim **11**, wherein said another light modifying device integrates over an entire field of the beam of light.

13. A lighting device as in claim **11**, wherein said optical system includes a relay lens group between said in focus locations.

14. A lighting device as in claim **13**, wherein said another light modifying device is located at an area between two parts of said relay lens group.

15. A lighting device as in claim **8**, wherein said adjustment part changes between different effects at the in focus locations.

* * * * *