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Belliveau

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(45) **Date of Patent: May 13, 2003**

(54) **MULTIPLE LIGHT VALVE LIGHTING DEVICE OR APPARATUS WITH WIDE COLOR PALETTE AND IMPROVED CONTRAST RATIO**

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(51) **Int. Cl.**[7] **G03B 21/00**; G03B 21/26; G03B 21/14; H04N 3/12; G02F 1/1335

(52) **U.S. Cl.** **353/31**; 353/34; 353/37; 353/84; 353/88; 353/89; 353/97; 353/121; 348/740; 348/742; 348/743; 348/744; 349/5; 349/7; 349/8; 362/284; 362/257

(58) **Field of Search** 353/30, 31, 81, 353/84, 88, 89, 97, 121; 348/740, 742, 743, 744; 349/5, 6, 7, 8; 362/257, 269, 238, 239, 251, 284, 295

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(57) **ABSTRACT**

An apparatus is disclosed comprising a lamp which produces a first light which may be a white light; a first light valve, a second light valve, and a first aperture device, which may be a first electronically switchable filter. The first aperture device or the first electronically switchable filter function as selectively variable color separators. The first aperture device or the first electronically switchable filter each can be placed in a first state where the first light is separated into a first color light and a first residual light, and a second state where the first light is separated into a second color light and a second residual light. The first light valve receives the first light in the first state and the second light in the second state. The second light valve receives at least a portion of the first residual light in the first state or at least a portion of the second residual light in the second state.

18 Claims, 15 Drawing Sheets

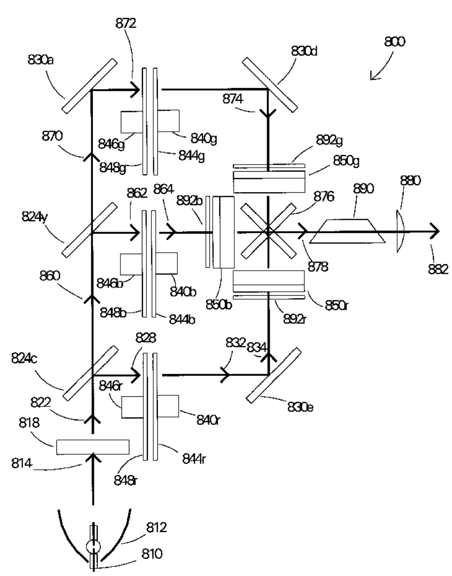


FIG 1
prior art

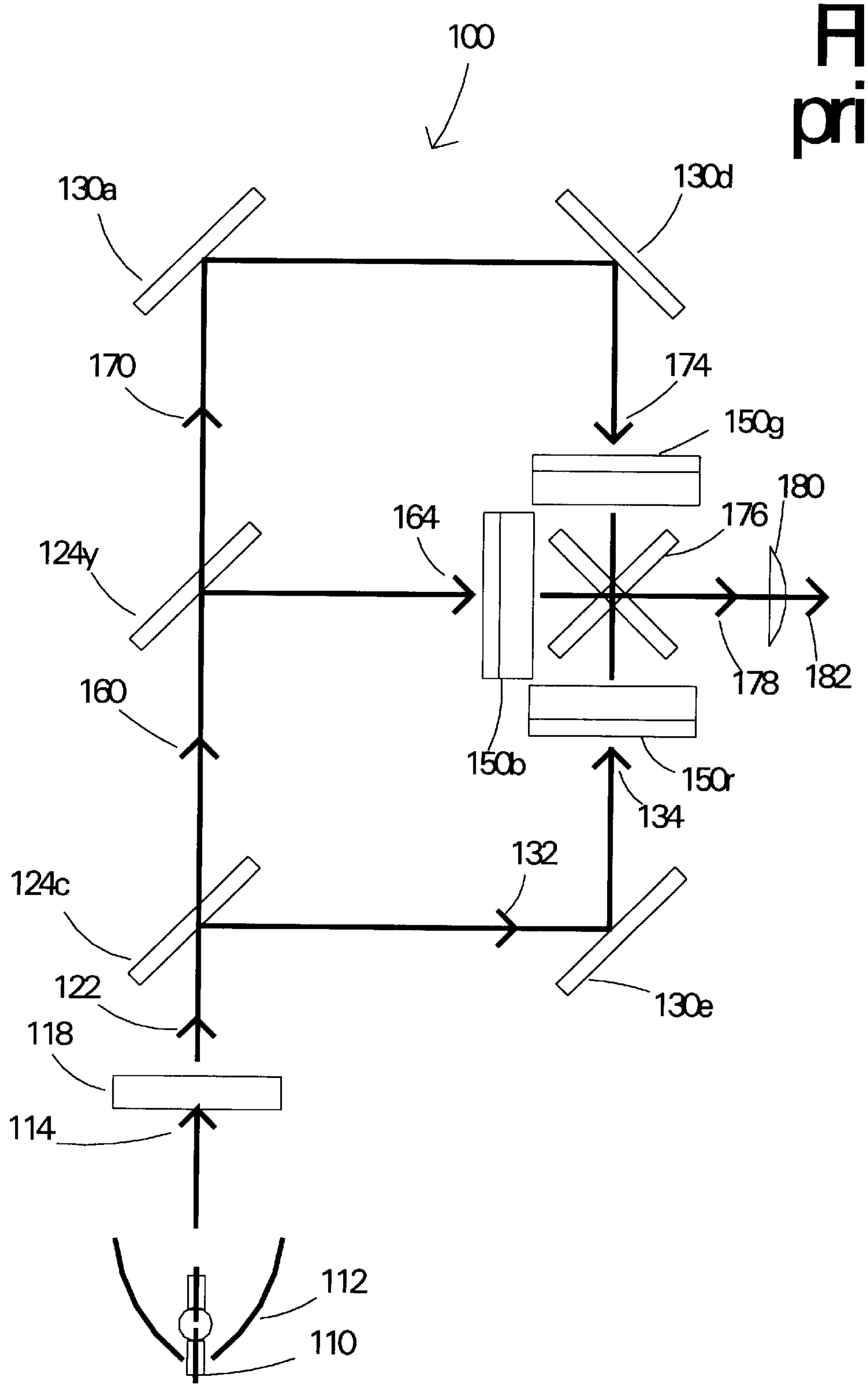


FIG 2
prior art

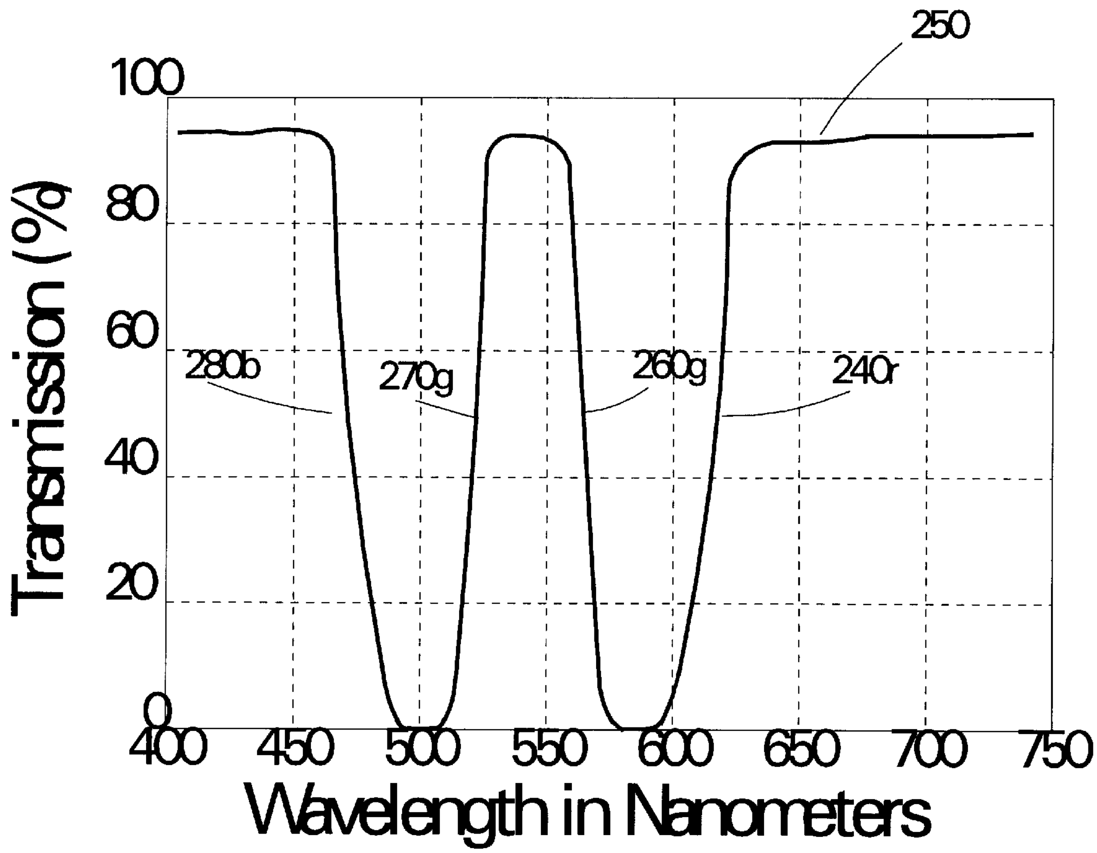
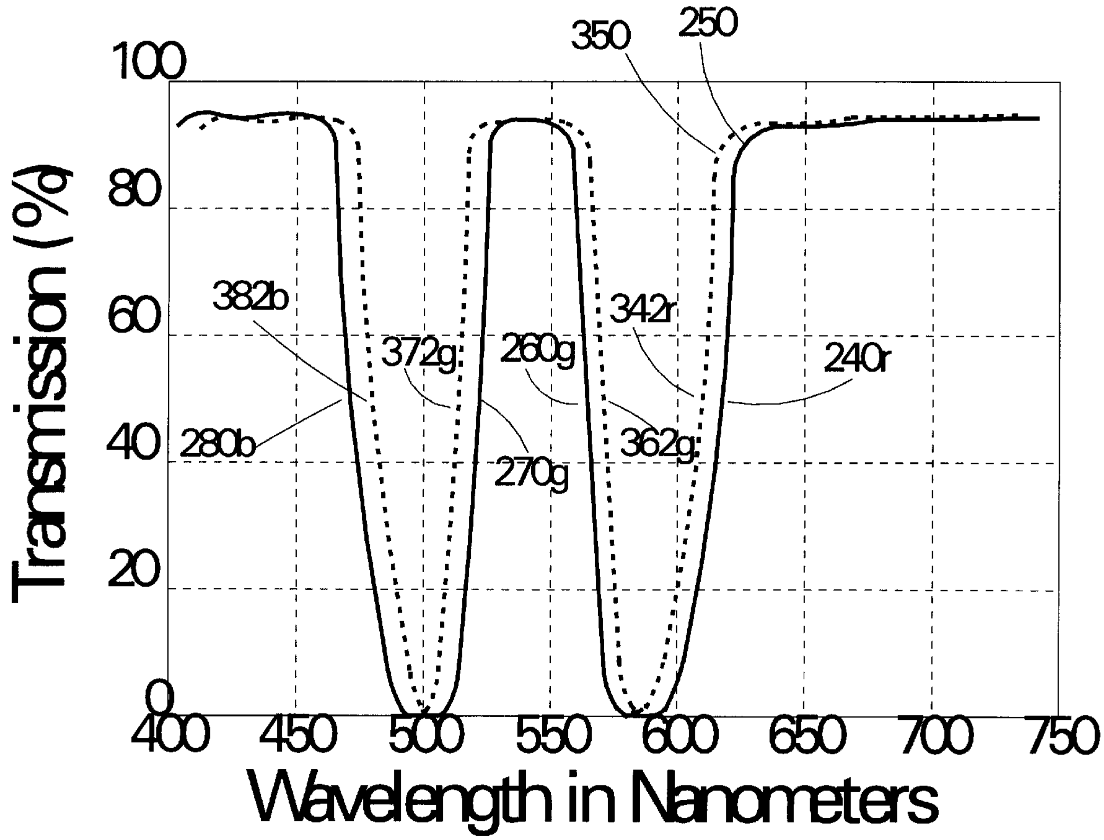


FIG 3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250
100
80
60
40
20
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Transmission (%)
382b
372g
260g
342r
240r
280b
270g
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400
450
500
550
600
650
700
750
Wavelength in Nanometers

FIG 4A

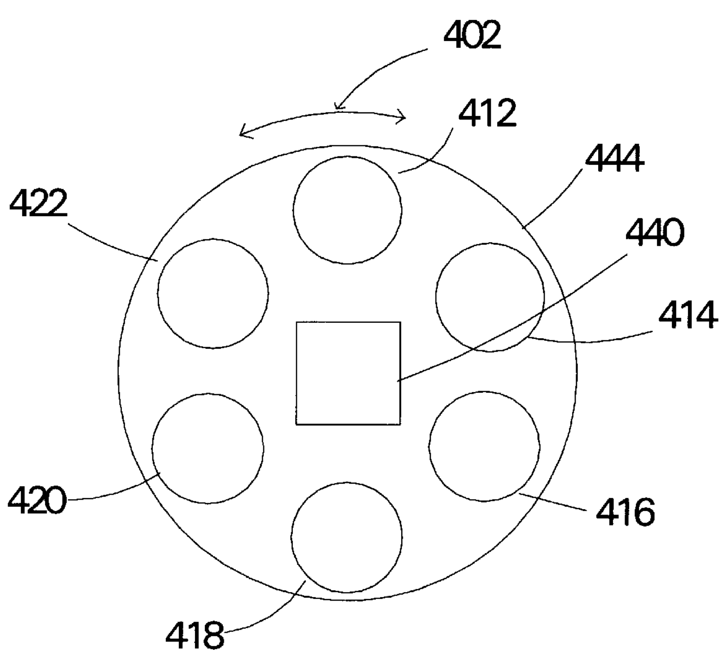


FIG 4B

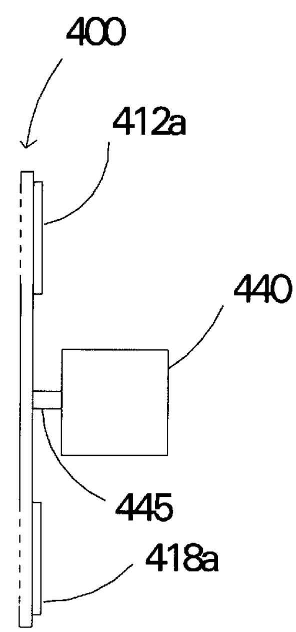


FIG 5

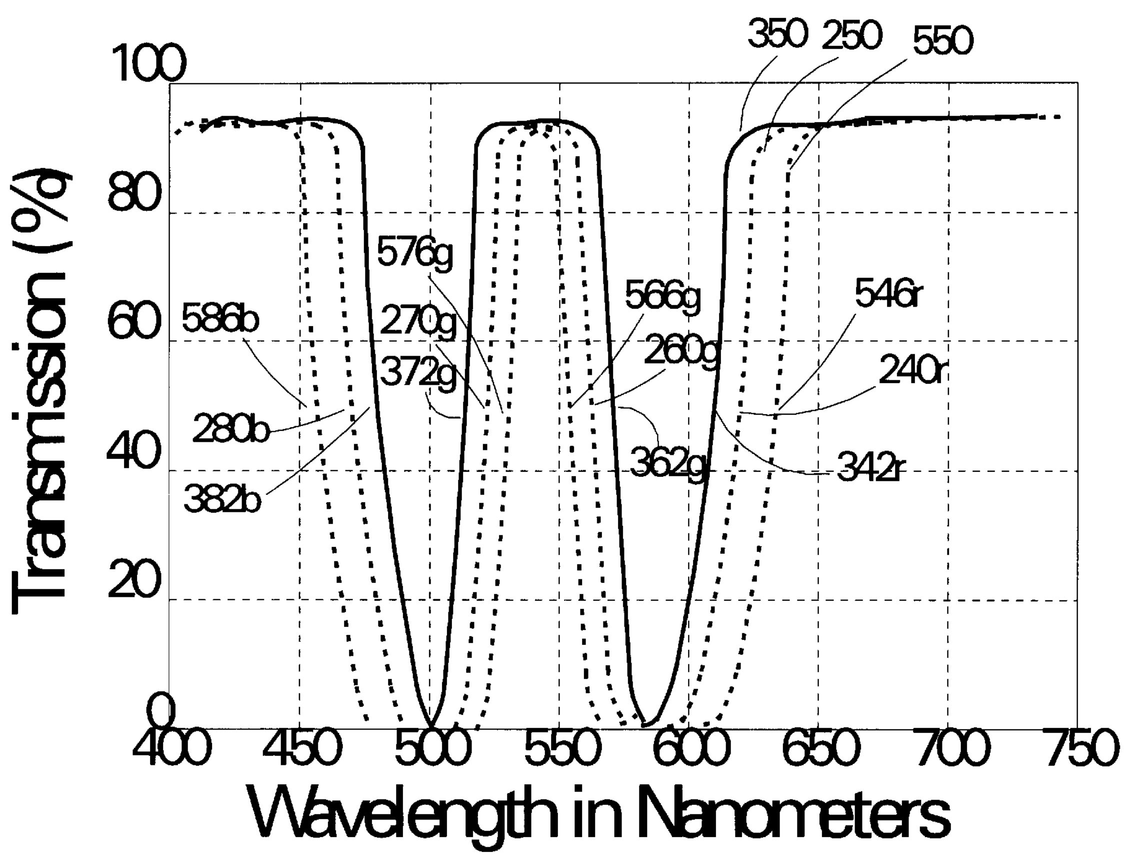

100
80
60
40
20
0
Transmission (%)
400
450
500
550
600
650
700
750
Wavelength in Nanometers
350
250
550
576g
270g
372g
586b
280b
382b
566g
260g
362g
546r
240r
342r

FIG 6A

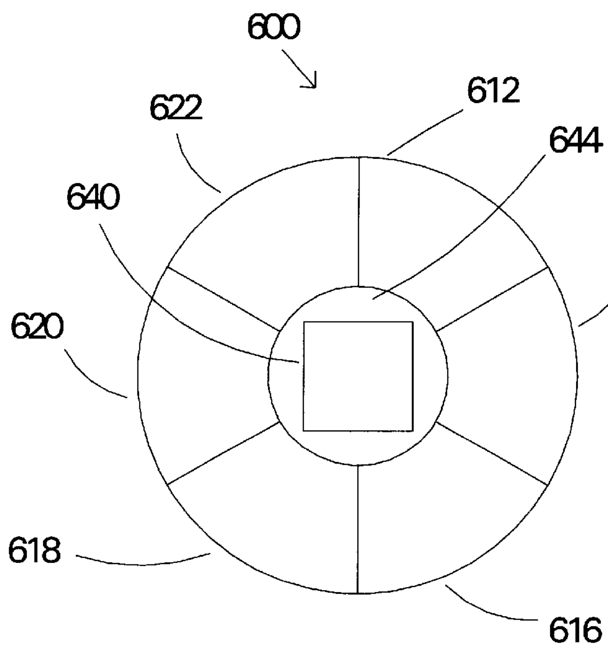


FIG 6B

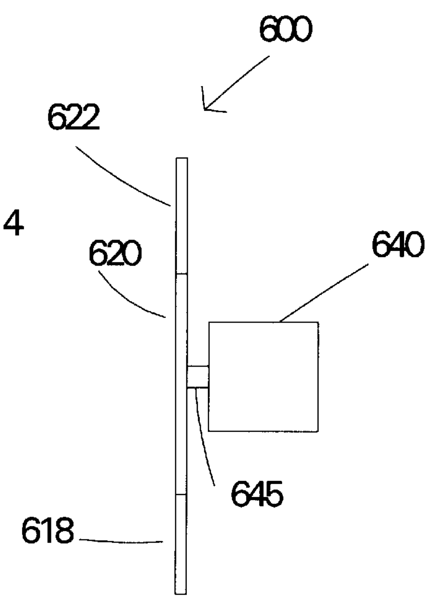
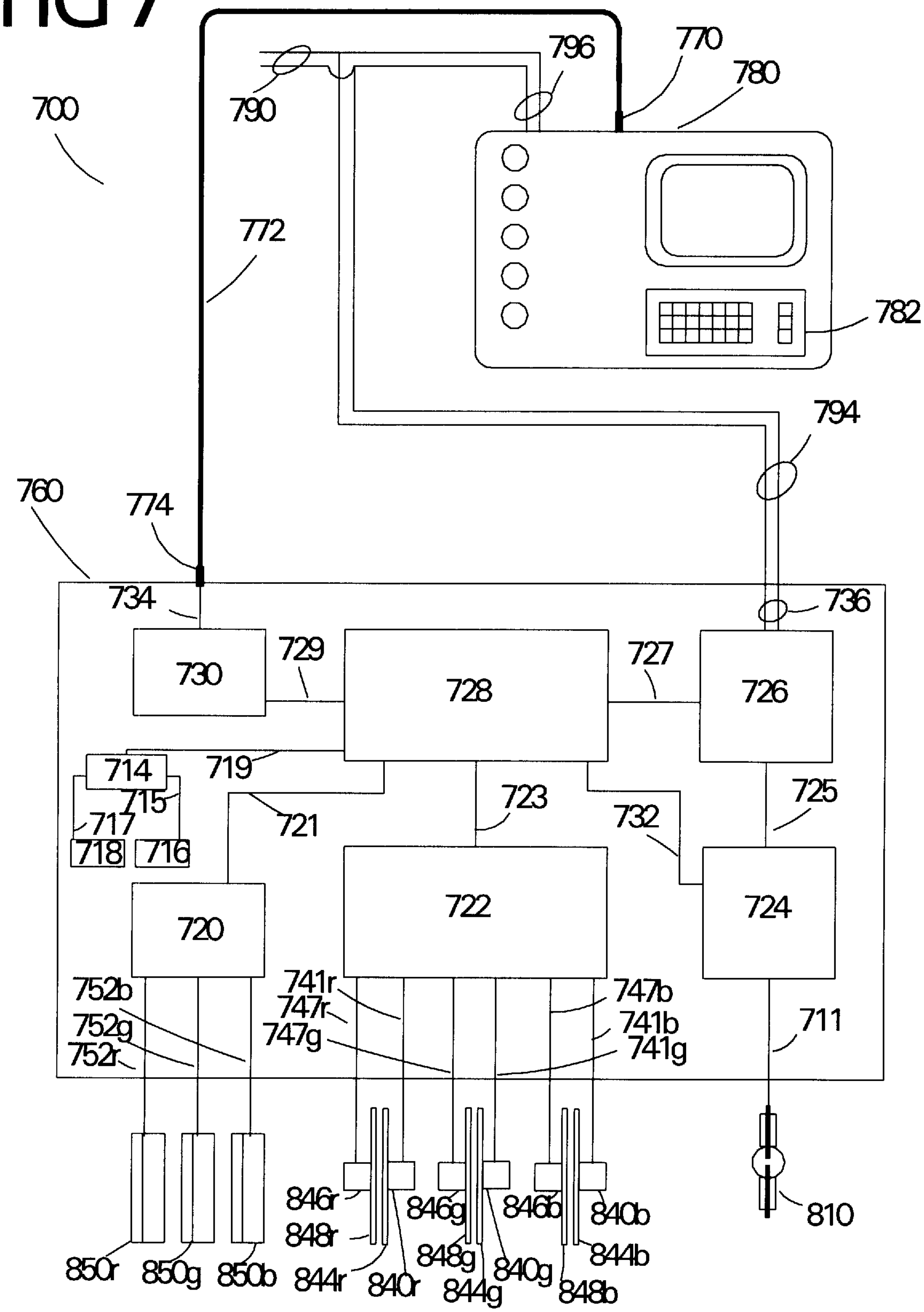


FIG 7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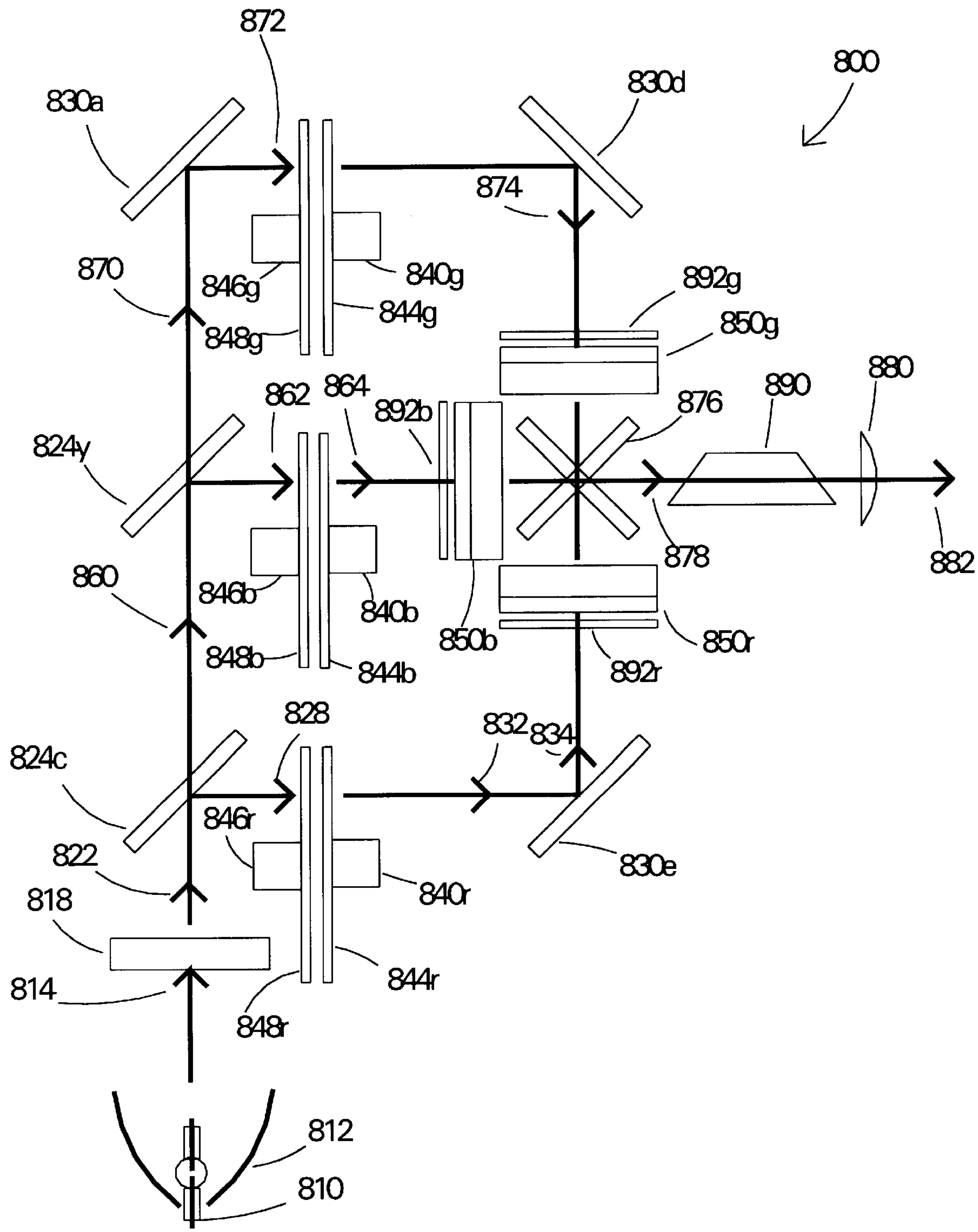
715
717
718
716
721
723
732
725
720
722
724
752b
752g
752r
741r
747r
747g
747b
741b
741g
711
846r
848r
844r
840r
846g
848g
844g
840g
846b
840b
844b
848b
850r
850g
850b
810

FIG 8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862
864
892b
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880
824y
878
882
860
846b
840b
850b
850r
848b
844b
892r
828
832
834
824c
846r
830e
822
840r
818
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812
810

FIG 9A

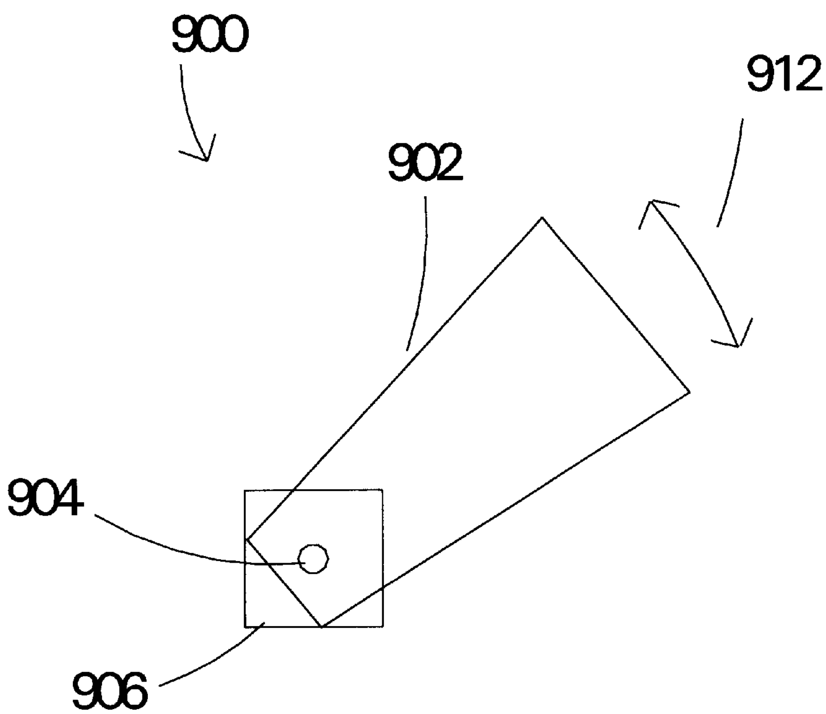


FIG 9B

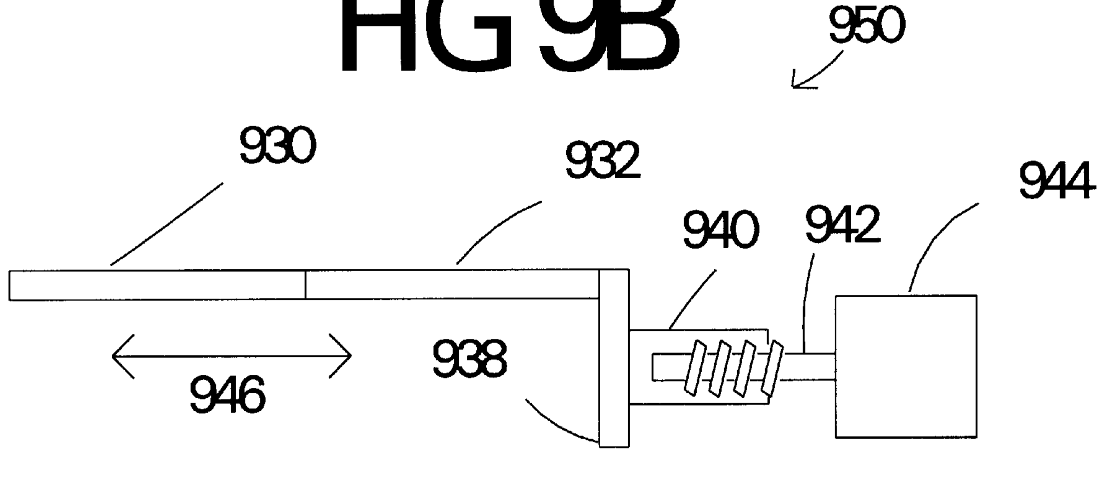
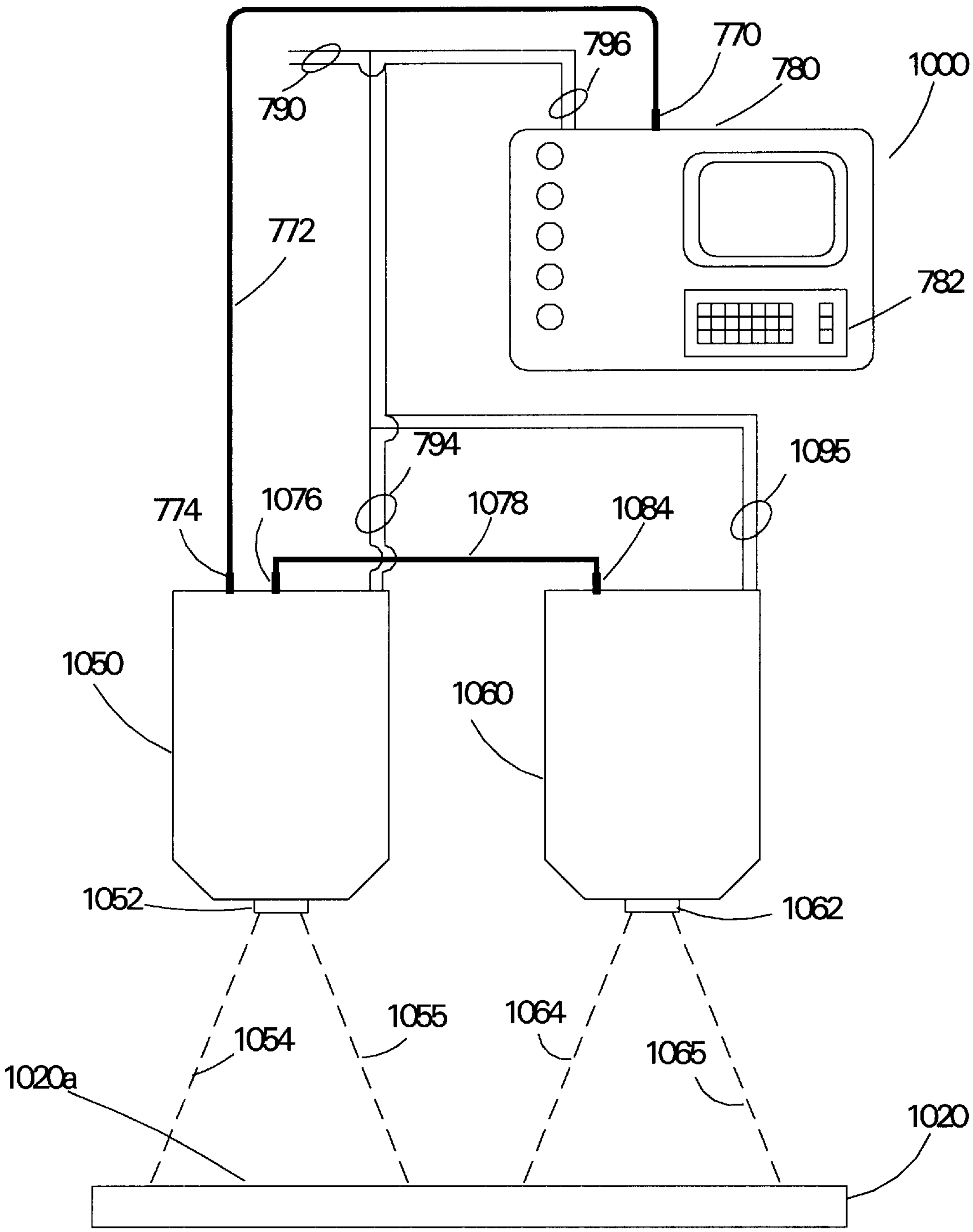


FIG 10



796
770
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1000
790
772
782
794
1095
774
1076
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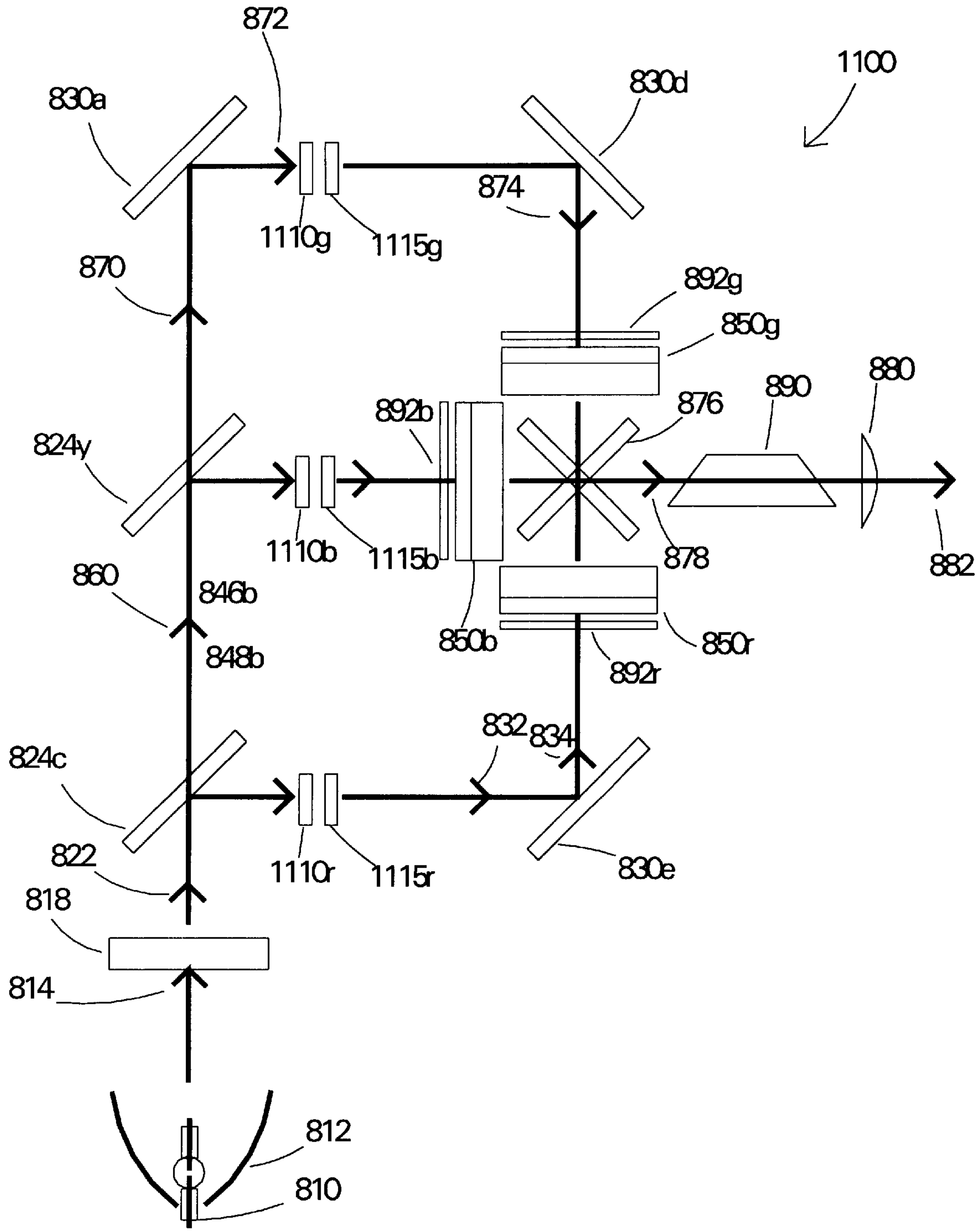
1084
1050
1060
1052
1062
1055
1064
1054
1065
1020a
1020

FIG 11


1100
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850g
880
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876
892b
824y
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878
882
860
846b
850b
850r
848b
892r
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834
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822
1110r
1115r
830e
818
814
812
810

FIG 12A

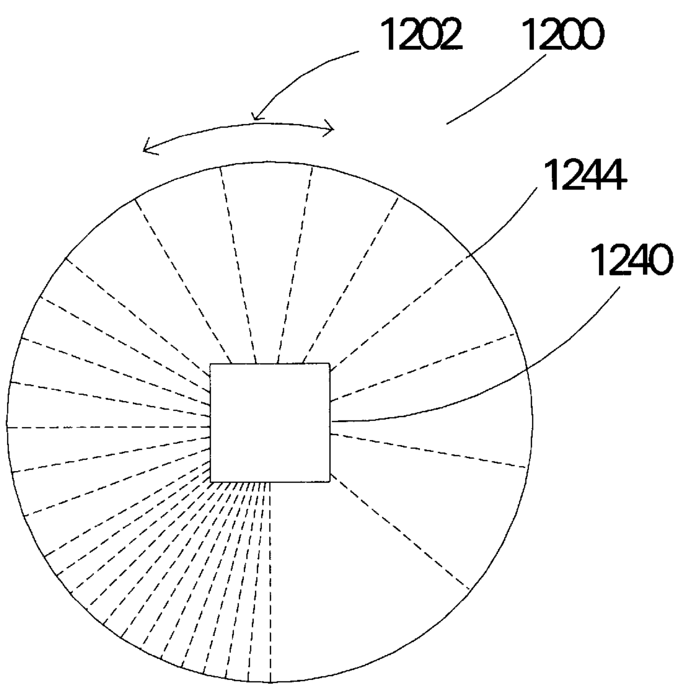


FIG 12B

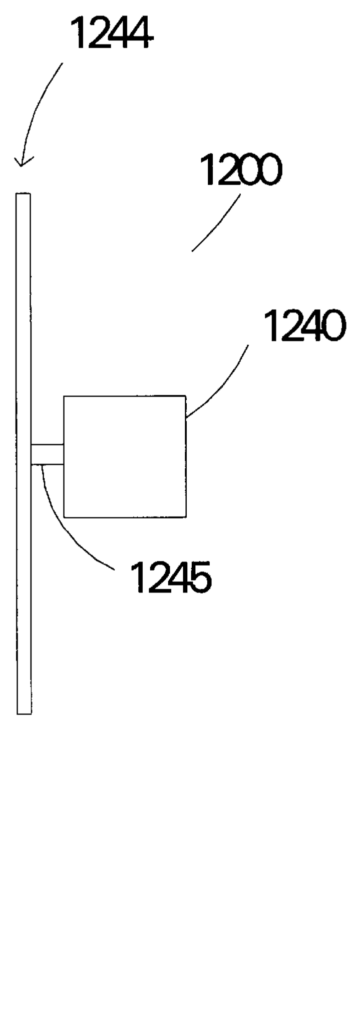


FIG 13A

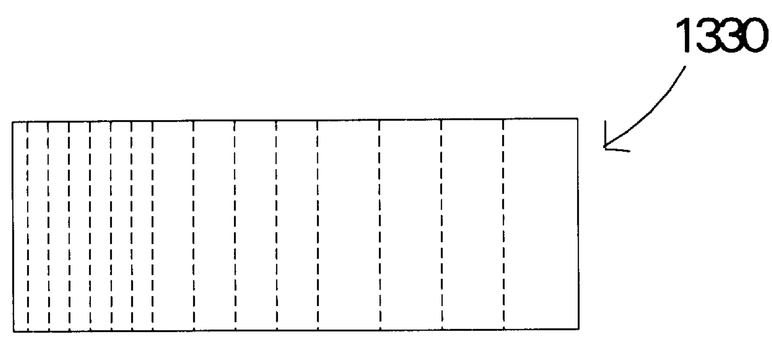


FIG 13B

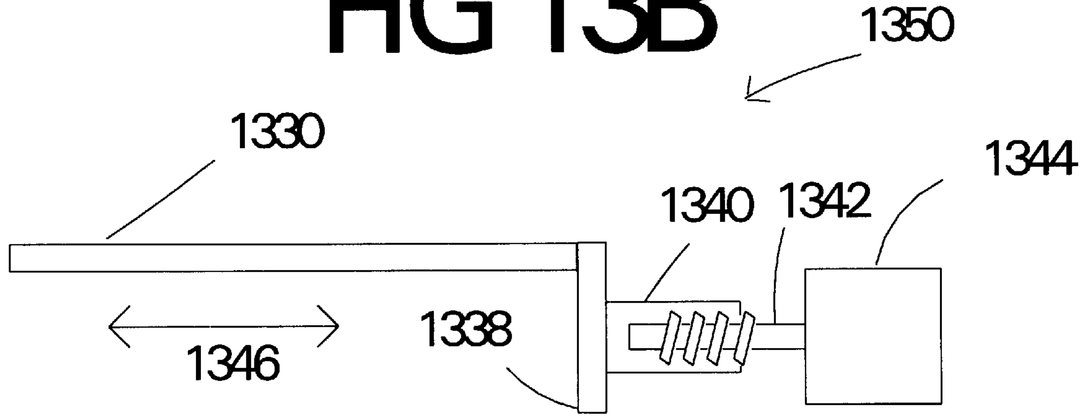
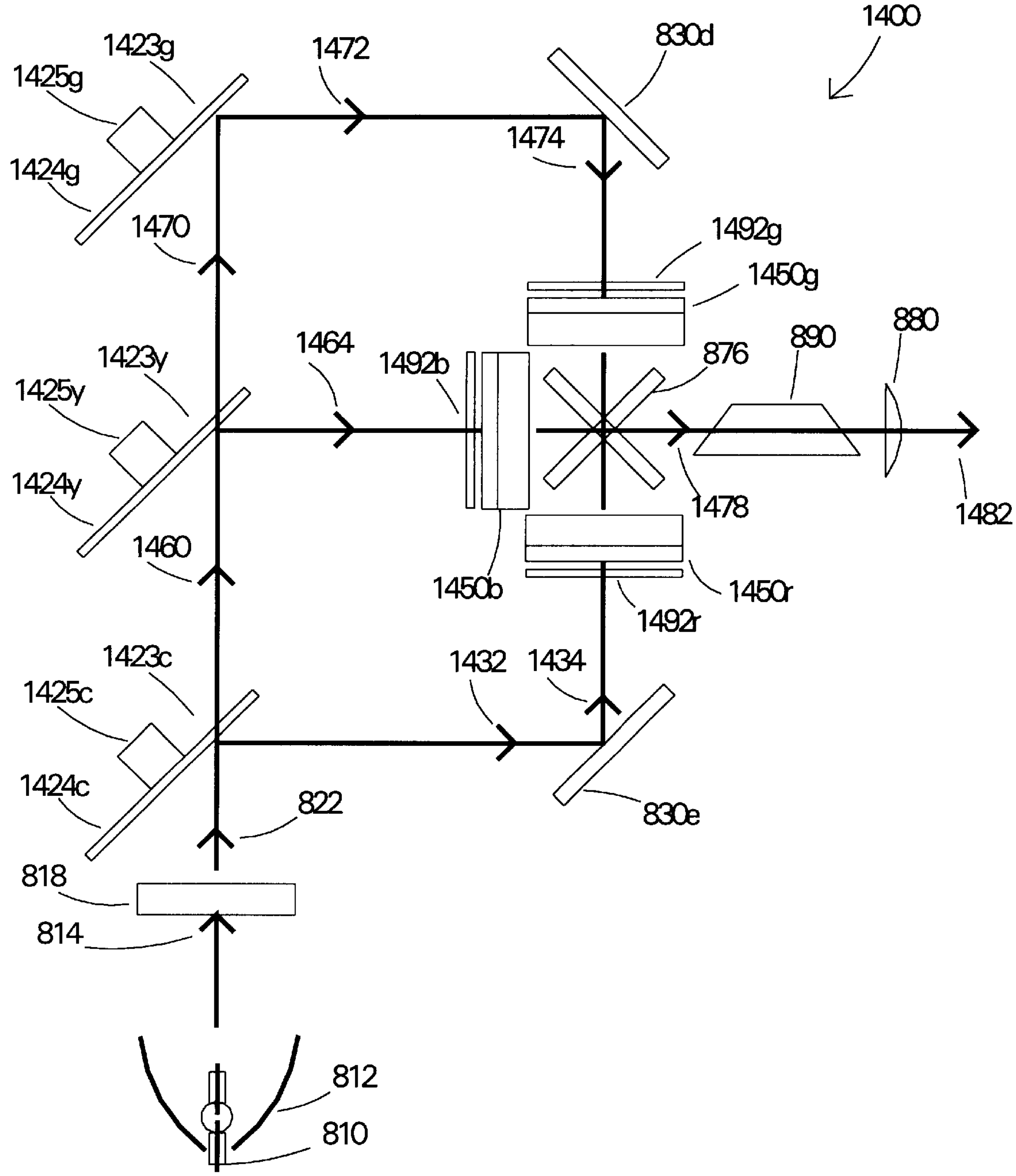


FIG 14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1492g
1450g
1464
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1423y
1425y
1424y
1478
1482
1460
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1424c
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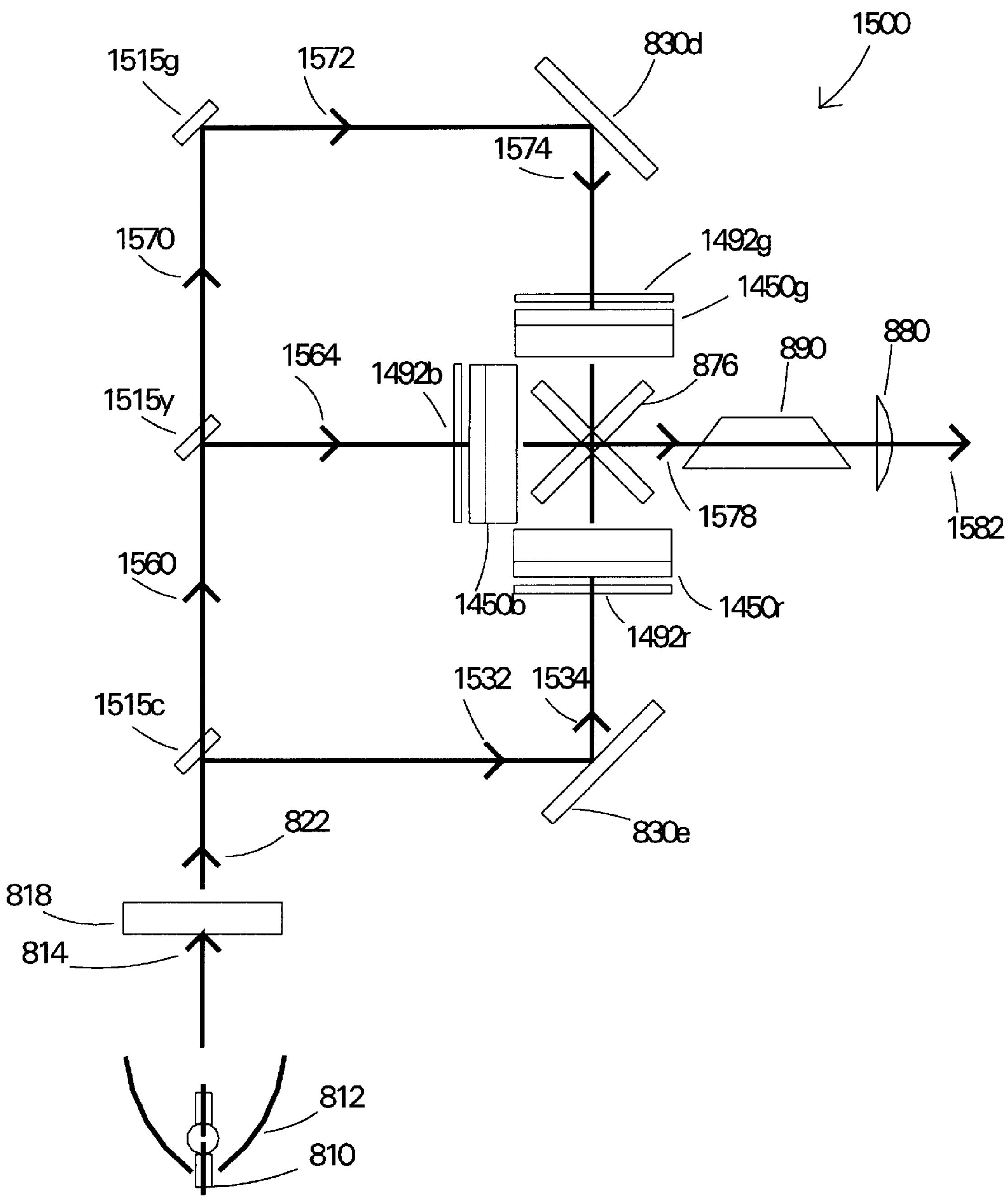
818
814
812
810

FIG 15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1560
1450b
1450r
1492r
1532
1534
1515c
830e
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MULTIPLE LIGHT VALVE LIGHTING DEVICE OR APPARATUS WITH WIDE COLOR PALETTE AND IMPROVED CONTRAST RATIO

CLAIM FOR PRIORITY

This application claims the priority of, and is a continuation in part of, parent application Ser. No. 09/970,845, titled "MULTIPLE LIGHT VALVE LIGHTING DEVICE OR APPARATUS WITH WIDE COLOR PALETTE AND IMPROVED CONTRAST RATIO", which was filed on Oct. 5, 2001.

FIELD OF THE INVENTION

The present invention relates to stage lighting devices incorporating light valves for projecting images on a stage.

BACKGROUND OF THE INVENTION

Stage lighting devices incorporating light valves for the projection of images are known in the art. Stage lighting devices incorporating light valves are used to project patterns on a stage. Before electronic light valves, stage lighting devices used metal stencil patterns that were indexed on a wheel to produce the projected patterns upon the stage.

U.S. patent to U.S. Pat. No. 4,779,176 to Bornhorst titled "Light pattern generator" describes glass substrates with aluminum coatings that are used as projection patterns in a lighting device. U.S. Pat. No. 5,113,332 titled "Selectable mechanical and electronic pattern generating aperture module" to Richardson describes an electronic aperture or light valve used to generate the patterns projected from a lighting device. U.S. Pat. No. 5,758,956 titled "High intensity lighting projectors" to Hutton describes a controllable image quality projection gate providing advanced visual effects. Other types of electronic light valves have also been used with lighting devices. U.S. Pat. No. 5,828,485 titled "Programmable light beam shape altering device using programmable micromirrors" to Hewlett describes a digital micromirror device ("DMD") that is used to alter the shape of light that is projected onto a stage.

The prior art stage lighting devices are designed around a single light valve as the projection gate. The inventors have optimized their inventions to work best as a lighting device. Many inventors prefer the single light valve system as it may have a reduced cost over multiple light valve systems. High End Systems (Trademarked) of Austin, Tex. has found success with a multiple light valve projector in combination with a positioning mirror. The device called a Catalyst (Trademarked) is used like a periscope that mounts to the front of a video projector. It allows static images or moving video to be projected anywhere within a 360° by 180° hemisphere of movement. Images can be manipulated limitlessly in real-time from a dedicated control console. The preferred projector type of the prior art is a three light valve system. More information can be found at: Http://www.highend.com/pdfbin/NewCatalyst.pdf. The device is limited however as it uses a conventional multiple light valve projection system and can only produce a limited color palette.

In the prior art a single light valve is used. An aperture device containing filters or multiple aperture devices containing filters are located between a lamp producing white light and a single light valve to change the color of the light from the lamp sent to the single light valve. The single light valve systems can not do full color images unless they spin an aperture device containing color filters of red, blue and green in front of the single light valve. The aperture device containing the colors of red, blue and green is rotated, in the prior art, at a certain frequency in sync with the single light valve to produce a full color image. Because each color is only on for a third of the time, much of the energy from the lamp is lost. An example of this technique is shown at http://howstuffworks.lycos.com/projection-tv5.htm

With existing regular video projection, three light valves are used with the white light produced from a lamp separated into red, green and blue as more of the light from the lamp is used to produce a full color image.

The problem is that for a video projection device built for video the red, green and blue colors are specially specified.

SUMMARY OF THE INVENTION

The present invention discloses a lighting device using multiple light valves which provide an improved contrast ratio from devices of the prior art. The lighting devices of embodiments of the present invention are capable of projecting a wide range of available colors.

The present invention allows a greater array of colors both saturated and less saturated to be used by first allowing the widest production of red, green and blue by a color separation system or device and then modifying the colors from the color separation system with aperture devices that contain color filters. Aperture devices modify the separated colors.

It is one object of the present invention to construct a multiple light valve lighting device with an improved lighting color palette.

It is yet another object of the present invention to construct a multiple light valve lighting device with an improved contrast ratio.

It is yet another object of the present invention to transmit commands over a communication system to the multiple light valve lighting devices where custom color palettes may be selected remotely.

It is yet another object of the present invention for the multiple light valve device to automatically improve the contrast ratio based upon the program material.

It is yet another object of the present invention for the multiple light valve lighting device to shutter the outputs of the individual light valves upon a command over the communication system.

It is yet another object of the present invention for the multiple light valve lighting device to shutter all of the individual light valves to produce a black out.

It is an object of the present invention to provide an apparatus comprising a lamp which produces a first light which may be a white light, a first light valve, a second light valve, and a first aperture device or a first electronically switchable filter. The first electronically switchable filter and electronically switchable filters generally may be considered to be aperture devices. The first aperture device or the first electronically switchable filter function as selectively variable color separators. The first aperture device or the first electronically switchable filter each can be placed in a first state where the first light is separated into a first color light and a first residual light and a second state where the first light is separated into a second color light and a second residual light. The first color light has a corresponding first frequency and the second color light has a corresponding second frequency. Varying the state of the first aperture device from the first state to the second state, varies a first output of the first aperture device from the first frequency of the first color light to the second frequency of the second color light. Varying the frequency of light produces different color lights. In this application a frequency of light is also referred to as a color light. The color light may have a frequency range or bandwidth as known in the art.

This means that light going to the red light valve may generally be close to the color red but may be selected to be orange, medium red, or dark red for example. Such different shades of red may be considered a first color and a second color. I.e. orange and medium red may be considered different colors or a first color and a second color, respectively. The first light valve receives the first color light in the first state and the second color light in the second state. The second light valve receives at least a portion of the first residual light when the first aperture device is in the first state or the second residual light when the first aperture device is in the second state.

The present invention in one embodiment discloses a lighting device comprised of a first device, a first light valve, a second light valve, a combining device, and a projection lens device. The first device may be comprised of a color separator device and an aperture device. The first device may separate a first light from a light source into a first frequency light and a second frequency light, wherein the first and second frequencies are different. The first and second frequency lights may be applied to first and second light valves, which produce first and second light valve output lights, respectively. Each of the first and second light valve output lights have a frequency. The combining device may combine the first light valve output light and the second light valve output light to produce a combined light at an output of the combining device. The projection lens device may receive the combined light and project light from the projection lens. The frequency of the first light valve output light or the frequency of the second light valve output light can be selectively varied, by, for example, varying the state of the first aperture device from the first state to the second state, which may vary a first output of the first aperture device from a first frequency light to a second frequency light; by an aperture device located in the first device; or by the combining device.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** shows a prior art multiple light valve projector optical system comprised of three light valves;

FIG. **2** is a graph showing the light transmission versus wavelength of the prior art system of FIG. **1**;

FIG. **3** is a graph which compares the prior art FIG. **2** light transmission versus wavelength with the light transmission versus wavelength produced by the embodiment of FIG. **8** in accordance with the present invention;

FIG. **4**A shows an aperture wheel for use with an embodiment of the present invention, such as FIG. **8**, for modifying the bandwidths of red, blue or green light;

FIG. **4**B shows a side view of the aperture wheel of FIG. **4**A;

FIG. **5** is a graph representing three different slope conditions of light transmission versus wavelength. The first set of slopes corresponds to the FIG. **8** embodiment and is also shown in FIG. **3**. The other two sets of slopes can also be obtained by the FIG. **8** embodiment by adjusting the aperture devices;

FIG. **6**A shows an aperture wheel for use in the embodiment of FIG. **8**, with wedge shaped apertures;

FIG. **6**B shows a side view of the aperture wheel of FIG. **6**A;

FIG. **7** shows a remote console and a control system for a multiple light valve lighting device in accordance with an embodiment of the present invention;

FIG. **8** shows an optical apparatus of an embodiment of the present invention using three light valves;

FIG. **9**A shows an apparatus comprised of a shutter device or a single color filter, a light blocking material, a motor shaft, and a motor which can be used in the embodiment of FIG. **8**;

FIG. **9**B shows a linear aperture device that can insert apertures into a light path which can be used in the embodiment of FIG. **8**;

FIG. **10** shows two multiple light valve lighting devices connected over a communication system to a remote console; and

FIG. **11** shows an apparatus which is basically the same as the apparatus of the embodiment of FIG. **8**, except that electronically switchable spectral filters have been substituted for aperture wheels (and their motors);

FIG. **12**A show a front view of an aperture device including a circular variable filter (CVF);

FIG. **12**B shows a side view of the aperture device of FIG. **12**A;

FIG. **13**A shows a front view of a linear variable filter (LVF);

FIG. **13**B shows a side view of a aperture device constructed of an LVF;

FIG. **14** shows an optical apparatus of an embodiment of the present invention using three light valves and aperture devices acting as color separators; and

FIG. **15** shows an optical apparatus similar to the optical apparatus of FIG. **14**, except that electronically switchable spectral filters have been substituted for aperture devices in the apparatus of FIG. **14**, to be used as color separators.

DETAILED DESCRIPTION OF THE DRAWINGS

FIG. **1** shows a prior art multiple light valve projector optical system **100** comprised of light valves **150***g*, **150***r* and **150***b*. The multiple light valve projector optical system **100** is further comprised of a lamp **110**, a reflector **112**, a polarization converter **118**, a color separator **124***c*, a color separator **124***y*, reflector **130***a*, a reflector **130***d*, a reflector **130***e*, a color combining system **176**, and a focusing lens, which can also be referred to as a projection lens **180**.

The lamp or light source **110** produces a white light whose path is illustrated by arrow **114**. The white light or any light of a plurality of frequencies may be considered a first light of a plurality of frequencies within the meaning of various claims of the application. The lamp **110** has its energy focused by the reflector **112**. Only a single lamp is shown as the light source or lamp **110** but it is known in the art that multiple lamps may be coupled together to act as the light source. The lamp **110** produces visible white light with the components of red, blue and green wavelengths. The light focused by the reflector **112** as shown by the arrow **114** is directed to the polarization converter **118**. The light exits the polarization converter **118** and is directed towards color separator **124***c* as shown by an arrow **122**. Color separator **124***c* can be a dichroic color separation filter that reflects red light in the direction of an arrow **132** while transmitting blue and green light in the direction of an arrow **160**. The action by the color separator **124***c* can be described as separating the white light into a first color light and a first residual light. The first residual light may be comprised of one or more frequencies and a "portion" of the first residual light may be defined as including one or more frequencies of the one or more frequencies of the first residual light. Similarly a "portion" of any other particular light as referred to in this application, may be comprised of one or more frequencies of the one or more frequencies of that particular light.

The red light as shown by arrow **132** is directed towards the reflector **130***e*. The reflector **130***e* reflects the red light in the direction of an arrow **134** towards the light valve **150***r*. The blue and green light, or first residual light, transmitted by the color separator **124***c* is directed towards the color separator **124***y* as shown by an arrow **160**. Color separator **124***y* reflects blue light, which is directed towards the light valve **150***b* as shown by an arrow **164**. Color separator **124***y* transmits green light towards reflector **130***a* as shown by an arrow **170**. The action by the color separator **124***y* can be described as separating the first residual light into a second color light and a second residual light. Reflector **130***a* reflects the green light towards the reflector **130***d* and the green light is reflected towards the light valve **150***g* as shown by an arrow **174**.

The red, green and blue lights that are received by the light valves **150***r*, **150***g*, and **150***b*, respectively are next directed through their corresponding light valve towards the color combining system or device **176**. The red, green and blue lights are recombined to a common path and are directed towards the focusing lens **180** as shown by an arrow **178**. The lens **180** forms an image from the lights which passes through the valves **150***r*, **150***b* and **150***g* and which are combined by combining system **176** and directs the combined light in the direction of an arrow **182** to a projection surface (not shown) where the image from the light valves **150***r*, **150***b*, and **150***g* is projected.

FIG. **2** is a graph showing slopes **250** of light transmission versus wavelength of the prior art system of FIG. **1**. The slopes **250** show the transmitted frequencies of light to be combined as the overall available light output at arrow **182**. The lamp **110** provides white light, which includes light of a variety of wavelengths. As an example, about ninety percent of a light component in the white light at arrow **114** having a wavelength of 450 nanometers is transmitted through the lens **180** to arrow **182** (minus the normal losses associated with the various optical components), as shown by FIGS. **1** and **2**. As another example, about zero percent of a light component in the white light at arrow **114** having a wavelength of 500 nanometers is transmitted through the lens **180** to arrow **182**.

The prior art slopes **250** in FIG. **2** shows cutoff points **280***b*, **270***g*, **260***g*, and **240***r*. FIG. **2** represents the transmission, and cutoff of the red, blue and green wavelengths created by the color separation filters **124***c* and **124***y* of the prior art system **100** of FIG. **1**. The blue light created by the color separation filters **124***c* and **124***y* has a cutoff point **280***b*. A blue light cutoff **280***b* in FIG. **2** is approximately 472 nanometers (or abbreviated as nm).

Green light cutoffs are determined at two locations on the graph, **270***g* and **260***g*. Green light cutoff **270***g* is located at approximately 518 nm and the green light cutoff **260***g* is located at approximately 560 nm. The red light cutoff **240***r* is located on the graph at approximately 615 nm.

FIG. **3** is a graph which compares the prior art FIG. **2** slopes **250** of light transmission versus wavelength with the slopes **350** of light transmission versus wavelength produced by the embodiment of FIG. **8** in accordance with the present invention. The slopes **350** show the available frequencies of light that can be transmitted from the lamp **810** to be combined and projected from the lens **880** in the direction of **882**.

The present invention in the embodiment of FIG. **8** increases the bandwidth of the colors red, green and blue (shown by the dashed slopes **350** of FIG. **3**) versus the FIG. **2** prior art bandwidth of the colors red, green and blue (shown on the FIG. **3** graph by the solid slopes **250**). The prior art blue cutoff (approximately 472 nm) is shown at point **280***b* on solid line slope **250**. The new blue cutoff is shown at a location on the dashed slope **350** identified by **382***b* (approximately 478 nm).

The prior art green light cutoffs are shown at a location **270***g* (approximately 518 nm) and a location **260***g* (approximately 560 nm) on the solid sloped line **250** in FIG. **3**. The wider bandwidth of the embodiment of FIG. **8** is shown by locations **372***g* (approximately 512 nm) and **362***g* (approximately 566 nm) on the dashed sloped line **350** in FIG. **3**.

The prior art red light cutoffs are shown at a location **240***r* (approximately 615 nm) on the solid sloped line **250** in FIG. **3**. The wider bandwidth of the present invention is shown by a location **342***r* (approximately 609 nm) on the dashed sloped line **350** in FIG. **3**.

Generally speaking the greater bandwidth of the FIG. **8** embodiment versus the FIG. **1** prior art embodiment means that if the same amount of light is supplied by lamp **110** and lamp **810**, the system **800** of FIG. **8** will produce more light at its output than the prior art system of FIG. **1**.

FIG. **4**A shows an aperture wheel **400** for use with the embodiment of FIG. **8** of the present invention for modifying the bandwidths of the red, blue or green light. The aperture wheel **400** is comprised of apertures **410**, **412**, **414**, **416**, **418**, **420**, and **422**, and motor **440**.

The arrows **402** show that the wheel **400** can be rotated to bring the apertures **412**, **414**, **416**, **418**, **420**, and **422** in a desired position. The apertures **412**, **414**, **416**, **418**, **420**, and **422** may be comprised of bandwidth modifying filters and if desired at least one of the apertures **412**–**422** may be left without a filter to pass light unobstructed. Any of the apertures **410**–**422** may also be aluminum or a suitable light blocking material to act as a shutter. The motor **440** is used to rotate the aperture wheel **400**. The aperture wheel **400** can be called an aperture device and can be used in the embodiment of FIG. **8** for any of the aperture devices in FIG. **8**, such as aperture device **848***r*.

FIG. **4**B shows a side view of the aperture wheel **400** of FIG. **4**A. Filters **412***a* and **418***a* are shown fixed over apertures **412** and **418**, respectively, in any suitable way. The motor **440** is shown connected to a motor shaft **445**. The motor shaft **445** is fixed to the aperture wheel **400** in any suitable way.

FIG. **5** is a graph which includes three different available slopes of light transmission versus wavelength for the colors of red, green and blue light frequencies. Referring to FIG. **5**, the three different cutoffs of **280***b*, **382***b* and **586***b* are all blue cutoffs. The point **382***b* is obtained by using color separators **824***c* and **824***y* specially selected to combine to produce that slope cutoff point. In this case if we refer to FIG. **8**, aperture devices **848***r* and **844***r* are most likely in a through hole position so that no additional modification of the blue light from the color separators **824***c* and **824***y* takes place. If next we energize a motor to move a color modifying filter into place we can alter the color of the blue light so that the frequency changes as shown by the slope **280***b* of FIG. **5**. In this example, we are just altering the blue light color and not the red or green. If we energize the motor on aperture device **848***r* or **844***r* to bring yet another different modifying filter into place, we further alter the frequency of light being sent to the blue light valve **850***b* of FIG. **8** so that the slope on the graph changes to 50% point **586***b* of FIG. **5**. At no time did the rest of the slopes for Green and Red change as we were only changing the Blue aperture devices.

The 50% cutoff points for the blue, green, green, and red light on the solid slopes **350** of FIG. **3** are at points **382***b,* **372***g,* **362***g,* and **342***r,* respectively. The blue cutoff **382***b* (approximately 478 nm) can be modified by an aperture wheel like aperture wheel **400** of FIG. **4**A or aperture wheel **600** of FIG. **6**A in order to provide for selectable cutoffs. I.e. the aperture wheel **400** may be the aperture device **848***b* and/or the aperture device **844***b* in the FIG. **8** embodiment. The motor of the aperture device **440** of FIG. **4***a* may rotate the apertures on the aperture device to place a color modifying filter in the light path of the blue light reflected by the color separator **824***y* of FIG. **8**.

The green light cutoffs **372***g* and **362***g* can be modified by an aperture wheel like aperture wheel **400** of FIG. **4**A or aperture wheel **600** of FIG. **6**A. The aperture wheel **400** or **600** may be the aperture device **848***g* or **844***g*. The aperture wheel **848***g* or **844***g* may be controlled to modify the cutoff of **372***g* and **362***g* to new selectable cutoffs of **270***g* (approximately 512 nm) and **260***g* (approximately 560 nm) on the slopes shown as dashed lines **250** or cutoffs of **576***g* (approximately 525 nm) and **566***g* (approximately 552 nm) on the dashed slopes **550**.

The red cutoff **342***r* can be modified by an aperture wheel like aperture wheel **400** of FIG. **4**A or aperture wheel **600** of FIG. **6**A as to now provide for selectable cutoffs. The aperture wheel **400** or **600** may be the aperture device **848***r* or **844***r* in FIG. **8**. The aperture wheel **848***r* or **844***r* may be controlled to modify the red light cutoff of **342***r* (approximately 609 nm) to **240***r* (approximately 615 nm) on the dashed slope **250** and **546***r* (approximately 628 nm) on the dashed slopes **550** in FIG. **5**.

FIG. **6**A shows another type of aperture wheel **600**. The aperture wheel **600** has trapezoidal apertures **612, 614, 616, 618, 620**, and **622**. The apertures **612–622** may be color filter sections such as dichroic filters or other color filters known in the art. The apertures **612–622** may also be aluminum or a light blocking material to act as a shutter. The apertures **612–622** are fixed to the central section **644** of the aperture wheel **600** by any suitable means. A motor **640** rotates the apertures **612–622** to a position in the path of a light. Shutters and color filters may be positioned in any aperture location (of apertures **612–622**) on the aperture wheel **600**. The aperture wheel **600** may only use one or two apertures as desired and not all of the apertures **612–622** need to have filters or light blocking material and some can be left open if desired. Blocking in the present application may mean blocking by shutter a particular color light without changing the frequency.

FIG. **6**B shows a side view of the aperture wheel **600**. A side view of the apertures **618, 620**, and **622** are also shown. Each of the apertures **618, 620**, and **622** may include a color filter or shutter. The motor **640** has a motor shaft **645** that is fixed in any suitable manner to the aperture wheel **600** to rotate the aperture wheel **600**. The aperture wheel **600** can rotate with respect to the motor **640**.

FIG. **7** shows a remote console **780**, a power source **790**, and a control system **760**. The control system **760** would be part of and used in a lighting device such as lighting device **1050** of FIG. **10**. The power source **790** provides power to the lighting device, such as **1050** and the remote console **780** can control the lighting device **1050**.

The control system **760** in FIG. **7** includes thermal monitoring device **714**, sensor **716**, sensor **718**, a light valve driving device **720**, a motor drive device **722**, a lamp power supply **724**, a power supply **726**, microprocessor **728**, and communications node **730**.

The remote console **780** for generation of command signals receives power from the power source **790** (which may be a power line) and the power source **790** is coupled to the remote console **780** through conductors **796** in a known manner. A communications cable **772** is connected between the remote console **780** at connection point **770** and the control system **760** at connection point **774**. The communications used over the communication cable **772** may be serial data that contain unique addresses for discrete communication with potentially a plurality of multiple light valve lighting devices, such as for example, lighting device **1060** or **1050** shown in FIG. **10**. The communications used over the communication cable **772** may be bidirectional or more than one communications system may be used for example that disclosed in my copending application titled "METHOD AND APPARATUS FOR DIGITAL COMMUNICATIONS WITH LIGHTING DEVICES" Ser. No. 09/394,300 filed Sep. 10, 1999, incorporated by reference herein.

Control system **760** of FIG. **7** may be enclosed within a housing of a lighting device like that shown as **1050** of FIG. **10**. The communications node **730** of FIG. **7** receives command signals from the remote console **780** over the communications cable **772** through the connection point **774** and the conductors **734**. The connection point **774** may be a suitable connector as known in the art and is connected by conductors **734** to the node **730**. The communications node **730** transfers data and commands from the remote console **780** to microprocessor **728** through conductors **729**.

The microprocessor **728** may also include the memory necessary for the operating system and the processing of commands. The microprocessor **728** may be comprised of several microprocessors or it may be constructed of several discrete logic circuits. Power supply **726** is connected through conductors **736** and power connection point **794** to the power source **790**. The power source **790** provides the necessary power to the power supply **726** through connection point **794** and through internal conductors **736** and to the lamp power supply **724** through conductors **725**. The power supply **726** is connected to the microprocessor **728** through conductors **727** and to the lamp power supply **724** through conductors **725**. The lamp power supply **724** is connected to the lamp **710** through conductors **711**. The lamp power supply **724** may also receive control signals through the conductor **732** from the microprocessor **728**.

The microprocessor **728** receives thermal information from the thermal monitoring device **714** via conductors **719**. The thermal monitoring device **714** may receive information from multiple thermal sensors such as the sensors **718** and **716** through conductors **717** and **715**, respectively. The sensors **718** and **716** can be any thermal sensor as known in the art.

The microprocessor **728** connects to the motor drive device **722** through conductors **723** and may provide power and control signals to the motors **846***r,* **840***r,* **846***g,* **840***g,* **846***b,* and **840***b*. The motor drive device **722** connects to the motors **846***r,* **840***r,* **846***g,* **840***g,* **846***b* and **840***b* through conductors **747***r,* **741***r,* **747***g,* **741***g,* **747***b* and **741***b,* respectively. The motors **846***r,* **840***r,* **846***g,* **840***g,* **846***b* and **840***b* rotate aperture wheels **848***r,* **844***r,* **848***g,* **844***g,* **848***b* and **844***b,* respectively. The microprocessor **728** is connected to the light valve driving device **720** through conductors **721**. The light valve driving device **720** controls the light valves **850***r,* **850***g* and **850***b* over conductors **752***r,* **752***g,* and **752***b.* The conductors **736**, **734**, **729**, **727**,**723**,**725**,**711**,**721**,**752***r,* **752***g,* **752***b,* **747***r,* **741***r,* **747***g,* **741***g,* **747***b,* **741***b,* **732**, **717**, **715**, and **719** are shown simplified. The conductors may be multiple conductors and may be wired or copper conductors such as for example a circuit board as known in the art.

FIG. **8** shows an optical apparatus **800** of an embodiment of the present invention of the invention using three light valves **850***g,* **850***b,* and **850***r.* The apparatus **800** also includes a lamp **810**, polarization converter **818**, reflectors **812**, **830***a,* **830***d,* **830***e,* color separators **824***c* and **824***y,* motors **840***r* and **846***r* and aperture wheels **844***r* and **848***r,* motors **840***b* and **846***b* and aperture wheels **844***b* and **848***b,* motors **840***g* and **846***g,* and aperture wheels **844***g* and **848***g,* a color combining device **876**, and a focusing lens **880**.

The lamp **810** has its energy focused by the reflector **812**. The lamp produces visible white light with light components having red, blue and green wavelengths. The white light focused by the reflector **812** as shown by an arrow **814** is directed to the polarization converter **818**. The white light exits the polarization converter **818**. The purpose of a polarization converter is known in the art. It converts the unpolarized white light from the lamp **810** and reflector **812** into polarized light. The light valves **850***g,* **850***b,* and **850***r* operate with polarized light. In one controlled condition the light valves **850***g,* **850***b,* and **850***r* let polarized light pass through and in the other controlled condition light is blocked from passing. Color separator **824***c* can be a dichroic color separation filter that reflects or separates out red light in the direction of an arrow **828** while transmitting or separating out a residual light comprised of blue and green light in the direction of an arrow **860**. The color red light which is reflected at the first color separator **824***c* can be called the first color light in a process in accordance with an embodiment of the present invention.

The red light as shown by arrow **828** is directed towards the two aperture wheels **848***r* (driven by the motor **846***r*) and **844***r* (driven by the motor **840***r*). The aperture wheels **848***r* and **844***r* may be similar to aperture wheels shown in FIGS. **4**A–B and **6**A–B and may be considered aperture devices by themselves or in combination or in combination with the motors **840***r* and **848***r.* The red light may pass through to the selected filters or shutters positioned by the aperture wheels **848***r* and **844***r* in the path of the red light at the location shown by arrow **828** and may next travel in the direction of an arrow **832** to the reflector **830***e.* The red color light next travels in the direction of an arrow **834** towards a variable aperture **892***r.* The variable aperture **892***r* may be an iris. The term iris, generally speaking, is known in the art. The variable aperture **892***r* may be motorized. The variable aperture **892***r* may act as a mask to change a rectangular image created by a rectangular light valve, which is the type of light valve that light valve **850***r* may be, to a round image that is adjustable. The red light passes through the variable aperture **892***r,* then through the light valve **850***r* where the red light is controlled through the light valve **850***b* in a manner known in the art. The red light may pass though the light valve **850***b* to the color combining device **876**.

The residual blue and green light transmitted or separated out by color separator **824***c* is directed towards the color separator **824***y* as shown by arrow **860**. Color separator **824***y* reflects blue light, which is directed towards the two aperture wheels **848***b* (driven by the motor **846***b*) and the aperture wheel **844***b* (driven by the motor **840***b*). The aperture wheels **848***b* and **844***b* may be similar to those shown in FIGS. **4**A–B or **6**A–B and may be thought of separately or in combination or in combination with the motors **840***b* and **846***b* as aperture devices. The blue light may pass through a selected filter or shutters (similar to that shown in FIGS. **4**A–B or **6**A–B) positioned by the aperture wheels **848***b* and **844***b* in the path of the blue light at the location of arrow **862** and may next travel in the direction of arrow **864** towards a variable aperture **892***b.* The variable aperture **892***b* may be an iris. The variable aperture **892***b* may be motorized. The variable aperture **892***b* may act as a mask to change a rectangular image created by a rectangular light valve, which is the type of light valve that light valve **850***b* may be, to a round image that is adjustable. The blue light passes through the variable aperture **892***b,* then through the light valve **850***b* where the blue light is controlled through the light valve **850***b* in a manner known in the art. The blue light may pass though the light valve **850***b* to the color combining device **876**.

Color separator **124***y* transmits or separates out green light towards reflector **830***a* as shown by an arrow **870**. Reflector **830***a* reflects the green light towards the two aperture wheels **848***g* (driven by the motor **846***g*) and the aperture wheel **844***g* (driven by the motor **840***g*). Aperture wheels **848***g* and **844***g* may be similar to those shown in FIGS. **4**A–B or FIGS. **6**A–B and may be considered to be separately or in combination, or in combination with motors **846***g* and **840***g* to be aperture devices. The blue light may pass through a selected filter or shutter positioned by the aperture wheels **848***g* or **844***g* in the light path and may next travel in the direction towards the reflector **830***d.*

The green light is reflected off of reflector **830***d* in the direction of the arrow **874** towards a variable aperture **892***g.* The variable aperture **892***g* may each be an iris. The variable aperture **892***g* may be motorized. The variable aperture **892***g* may act as a mask to change a rectangular image created by a rectangular light valve, which is the type of light valve that light valve **850***g* may be, to a round image that is adjustable. The green light passes through the variable aperture **892***g,* then through the light valve **850***g* where the green light is controlled through the light valve **850***g* in a manner known in the art. The green light may pass though the light valve **850***g* to the color combining device **876**.

The color combining device **876** combines the red, green and blue light controlled by the light valves **850***g,* **850***b,* and **850***r* and the combined light is sent in the direction of the arrow **878** towards a prism **890** which may be a Dove prism as known in the art for rotation of images created by the light valves **850***g,* **850***b,* and **850***r.* The prism **890** may be rotated with a motor as known in the art. The green light may pass through the prism **890** and then to the focusing lens **880**. The lens **880** may be considered to be a projection lens. An image is focused in the direction of arrow **882** onto a projection surface not shown.

FIG. **9**A shows an apparatus **900** comprised of a shutter device, single color filter, or light blocking material **902**, a motor shaft **904**, and a motor **906**. The single color filter **902** can be rotated into a light path by the motor **906**. The filter **902** rotates with respect to the motor **906** on the shaft **904**. The shaft **904** is rotatably connected to the motor **906**, and the shaft **904** is fixed to the filter or light blocking material (shutter) **902** in any suitable way. Arrows **912** show the direction of the filter or light blocking material **902** when the motor **906** is energized and the shaft **904** is rotated. Apparatus **900** can be considered an aperture device in accordance with the present invention and can be placed in the FIG. **8** embodiment in the same locations as any of the aperture devices for example **844***r* or **846***r* of FIG. **8**. Or **846***r* could be an aperture device that is an aperture wheel while **844***r* could be apparatus **900** of FIG. **9** and might act as a shutter only as **902** is fitted with light blocking material.

FIG. **9**B shows a linear aperture device **950** that can insert apertures into a light path. The linear aperture device **950** is comprised of apertures **930** and **932**, a mounting plate **938**, a power nut **940**, a worm gear shaft **942**, and a motor **944**. The apertures **930** and **932** may contain color filters or light blocking materials. The apertures **930** and **932** are fixed to the mounting plate **938** that is in turn fixed to the power nut **940**. The power nut **940** is driven by a worm gear shaft **942** by the motor **944**. The worm gear shaft **942** is rotatably connected to the motor **944**. Arrows **946** show the direction of movement of the apertures **930** and **932** when the motor worm gear shaft **942** is rotated. The device **950** of FIG. **9**B can be used in any location where an aperture device is used. For example it could be place in the location of **844***r* of FIG. **8**. It could place a color filter or a light blocking material into the path of the red light before the light passes through to the reflector **830***e*.

Video projection systems used for projecting conventional video in the prior art have a preferred color range for video. For example in the prior art devices, such as FIG. **1**, the color separators **124***c* and **124***y* work together as known in the art to separate white light emitted from a lamp into separate red, green and blue components. Specifications of the color separators **124***c* and **124***y* are designed so that the bandwidths of red, green and blue light are controlled to produce the best video image. This is important to video because if the colors of red, blue and green light have too wide a bandwidth, the video images can appear washed out and unnatural looking to the viewer. If the bandwidths of red, green, and blue light are too narrow the color will look very saturated but the projector can suffer from poor overall output. An example of the prior art bandwidths and cutoff frequencies for video is shown in FIG. **2**.

The present invention in various embodiments specifies a color separation system with wide bandwidths and a selectable bandwidth system for modifying the color palette of a multiple light valve lighting device for lighting applications. FIG. **3** shows the prior art cutoffs for red, green and blue light on the solid slope line **250** on the transmission graph. The dashed line **350** shows an increased bandwidth of the present invention over the prior art for red, green and blue light. It is preferred to have the greatest bandwidth possible for each of the red, green and blue colored lights. Once the wide bandwidth color separation system of the present invention is used, selectable aperture wheels or aperture devices with variable cutoff frequencies can be placed in the locations of for example aperture wheels **848***g*, **844***g*, **848***b*, **844***b*, **848***r* and **844***r* of FIG. **8** to provide adjustable bandwidths for the red, green and blue wavelengths.

FIG. **5** illustrates a wide bandwidth color separation system of the present invention of red, green and blue light as shown by the solid slopes **350**. Selectable aperture wheels, such as apertures wheels **400** and **600** of FIGS. **4**A–B and FIGS. **6**A–B, respectively, can be used as such as one or more of aperture wheels **848***r* and **844***r* (to modify the red light) as one or more of aperture wheels **848***b* and **844***b* (to modify the blue light) and as one or more of aperture wheels **848***g* and **844***g* (to modify the green light). As in FIG. **8**, the aperture wheels **848***r* and **844***r*, **848***b* and **844***b*, **848***g* and **844***g* can be used before the light valves (such as **850***r*, **850***b*, and **850***g* in FIG. **8**, respectively) and after the one or more color separators (such as **824***c* and **824***y*). The selectable aperture wheels or aperture devices are shown located before the light valves (such as aperture wheels **848***r* and **844***r* before light valve **850***r*) but it is possible to locate the selectable aperture wheels after the light valves.

The solid slopes **350** in FIG. **5** shows the FIG. **8** embodiment with the aperture devices **848***r*, **848***g*, **848***b*, and **844***r*, **844***g*, and **844***b* in an unmodified case, i.e. all of the aperture devices act as through holes with no filter. In FIG. **5** the unmodified color separation cutoff point of the blue light is shown as **382***b* on the solid slopes **350** and has a cutoff of approximately 478 nm. In the “unmodified case” the aperture wheel **444** like that shown in FIG. **4**A or aperture wheel **600** of FIG. **6**A has an aperture (such as one of apertures **410**–**422** or apertures **612**–**622**) selected into the blue light path that is a through hole with no filter. In this way the blue light reflected from color separator **824***y* of FIG. **8** passes freely through the selected apertures of the aperture wheels **848***b* and **844***b* without modifying the cutoff of the blue light. The green light and the red light are treated similarly to the blue light in the unmodified case.

The dashed slopes **250** shows a case where one of the aperture wheels for each colored light path has been rotated so that an aperture with the appropriate cutoff filter has been placed into the appropriate light path. For example, **280***b* shows a modified cutoff over **382***b*. The **280***b* cutoff is approximately 472 nm and it is now apparent that the bandwidth has been reduced. The **280***b* cutoff was produced when one of the aperture wheels **848***b* or **844***b* of FIG. **8** was rotated so that an aperture with the appropriate cutoff filter was placed into the blue light path.

The term cutoff filter, as used in this application, is a filter designed to cutoff unwanted frequencies and to produce a desired frequency range. An aperture device or component of an aperture device comprised of a group of cutoff filters would allow for the selection of different cutoff frequencies. The selection of different frequencies would appear visually as modifications of the original colors of light. When a frequency is modified from an original frequency different cutoff filters representing different cutoff frequencies are selected to be placed in the path of light after a color separator.

The dashed slopes **550** shows a case where one of the aperture wheels for each colored light path has been rotated so that an aperture with a different cutoff filter has been placed into the appropriate light path. For example, by rotating one of the aperture wheels **848***b* or **844***b* to a new aperture, a different cutoff filter can be placed into the blue light path producing a result like that of **586***b* of FIG. **5**. When the aperture wheel, such as wheel **848***b* is rotated to place a cutoff filter that produces the results of **586***b* of FIG. **5** into place, it is clear that the bandwidth of the blue light has been substantially narrowed over that of the unmodified bandwidth having a cutoff point at **382***b*. The cutoff point of **586***b* is approximately 460 nm.

It could be possible to just simply electronically switch off (preventing the light to pass through the light valve) all of the areas around a round transmitted image created by the light valves **850***g*, **850***b*, and **850***r* in FIG. **8**, by the light valves themselves. However it can be possible to see a ghost image of the areas surrounding the round image created by the light valves **850***g*, **850***b*, and **850***r* because each of the light valves may not be capable of switching off one hundred percent (100%) of the light surrounding the round image. With a variable aperture, (such as variable apertures **892***r*, **892***g*, and **892***b*) the areas around the desired round image can be masked.

The irises or variable apertures **892***r*, **892***g*, and **892***b* for the corresponding individual light valves **850***r*, **850***g*, and **850***b*, respectively, may be driven by motors as known in the art and may respond individually or all together. The size of the aperture created by each of the variable apertures **892***r*, **892***g*, and **892***b* can be controlled by commands sent from the remote console **780** in FIG. **7** if desired.

It is also possible to have aperture wheels that contain different types of apertures located in the variable aperture position of **892***r*, **892***b* and **892***b*. Aperture wheels that contain different types of apertures are known in the art as gobo wheels. They are also driven by motors. The gobo wheels containing two or more apertures each, may respond individually to modify the aperture size prior to the corresponding appropriate light valve, such as **850***r*, **850***g*, or **850***b* or gobo wheels may respond all together to modify the aperture prior to all the light valves **850***r*, **850***g*, or **850***b*.

Variable apertures, such as variable apertures **892***g*, **892***b*, and **892***r* can be used as in FIG. **8** before corresponding light valves **850***g*, **850***b*, and **850***r*, respectively. In either case the light valves **850***g*, **850***b*, and **850***r* can be a reflective or a transmissive type [depending on how the optical system is designed.] Variable apertures, such as variable apertures **892***g*, **892***b*, and **892***r* can also be used after corresponding light valves **850***g*, **850***b*, and **850***r*, respectively, but before the color combining device **876**. In either case the variable apertures **892***g*, **892***b*, and **892***r* should also be used after white light has been separated into the component colors of light, which in this case is green, blue, and red light.

While only two bandwidth modification examples are shown in FIG. **5** for the modification from the unmodified slope **350** of FIG. **5**, it is clear that many more incremental modifications can take place for each of the blue, green and red lights. An aperture wheel, such as aperture wheel **848***b*, **848***g*, **848***r*, **844***b*, **844***g*, or **844***r* or aperture device may contain many more filters for further modifying the bandwidth.

In FIG. **5**, the green light spectrum from the color separation system of an embodiment of the present invention is shown on the solid sloped line **350** which includes the green cutoff points **372***g* and **362***g*. The solid sloped line **350** is again the unmodified case for FIG. **8**, i.e. a through hole for all of the aperture devices or aperture wheels. The aperture wheels **848***g* and **844***g* for green light are positioned in front of the green light valve **850***g* in FIG. **8** similar to the way the aperture wheels **848***b* and **844***b* are positioned for the blue light valve **850***b* discussed above. The green light transmitted through color separator **824***y* of FIG. **8** reflects off of reflector **830***a* and passes through the aperture wheels **848***g* and **844***g*. The aperture wheels **848***g* and **844***g* may be similar to aperture wheel **400** of FIG. **4**A or aperture wheel **600** of FIG. **6**A.

If one of the aperture wheels of **848***g* and **844***g* is rotated to position a cutoff filter into the green light path at the location of arrow **872** in FIG. **8**, a modification to the green light color cutoff can take place. For example, cutoff points **270***g* and **260***g* are shown on dashed slopes **250** of FIG. **5** and together show a narrower band of green light than cutoff points **372***g* and **362***g* for the unmodified case. The result of narrowing the green bandwidth to the bandwidth between the cutoff points of **270***g* and **260***g* was accomplished by rotating a cutoff filter into the green light path at location of arrow **872** in FIG. **8** by one of the aperture wheels **848***g* or **844***g* of FIG. **8**. If yet a different cutoff filter were to be placed into the green light path by one of the aperture wheels **848***g* or **844***g* of FIG. **8** then we can see the results on the dashed slopes **550** on which the cutoff points **576***g* and **566***g* are located in FIG. **5**. The cutoff points of **576***g* and **566***g* of FIG. **5** have produced a substantially narrower bandwidth and in turn a more saturated green color than the original unmodified bandwidths on the solid slope **350** corresponding to the cutoff points of **372***g* and **362***g*.

It is important to note that it is possible to use combinations of cutoff filters to modify the color of light produced by the color separation system of the present invention. For example, in FIG. **5** we could select a cutoff filter to be placed on the aperture wheels (such as one of aperture wheels **848***g* or **844***g*) that only modifies one side of the green bandpass. In this example we might only modify the original cutoff point **372***g* to a cutoff point of that shown by **576***g* yet there will be no modification to the cutoff point of **362***g* of the green light. Combinations of high pass cutoff and low pass cutoff filters can allow for many variations in the green color bandwidth.

Cutoff point **342***r* of FIG. **5** shows an unmodified color separation cutoff for the red light on the unmodified solid slopes **350**. In the unmodified state the aperture wheels **848***r* and **844***r* of FIG. **8** have been rotated to an unfiltered aperture for the cutoff point of **342***r*. A modification to the cutoff point of **240***r* of dashed line slopes **250**, is produced when an aperture containing a cutoff filter is rotated into position by one of the aperture wheels **848***r* or **844***r* of FIG. **8**. For example, the cutoff point of **240***r* on the dashed slopes **250** produces a narrower bandwidth red than the cutoff point of **342***r*. Additional cutoff filters can be rotated into place by the aperture wheels **848***r* or **844***r* of FIG. **8** to produce a cutoff point like **546***r* of FIG. **5** on the dashed slopes **550**.

Lighting devices are often used on a stage where total darkness is possible. It is desirable to have high contrast ratios on the projection surface (such as surface on which the combined light is projected towards in the direction shown by arrow **882** in FIG. **8**) between the image to be projected and the part of the projection surface that is supposed to be absent of any light. For instance, a multiple light valve lighting device might normally produce a rectangular image. This is because many of the available light valves have a rectangular aperture as known in the art. It could be a requirement for the lighting device to project a round image. While projecting the round image it is most desirable to effectively black out the outside corners of the rectangular image surrounding the round image. Unfortunately, light valves are not 100% effective in blocking out all the light when in the light blocking state. This means that an audience might still see a ghost of the original rectangular image when the lighting device is projecting the round image. In order to improve this situation under certain conditions, the invention uses apertures with light blocking material (or shutters) on the aperture wheels to block the light before it passes through the light valve. For example, if a round image were comprised entirely of blue and red light and as there is no need for the green light, a shutter would be placed into the path of the green light before the green light passes through the green light valve. In the embodiment of the present invention of FIG. **8**, aperture wheel **848***g* or **844***g* may contain at least one shutter aperture for blocking the path of light. In the prior art when projecting images were comprised of red and blue light only, some small amount of green light would leak through the green light valve and further reduce the contrast ratio. With the embodiment of the present invention of FIG. **8**, when an image is projected and is comprised entirely of red and blue light, an aperture containing a shutter would be placed, (such as on aperture wheel **848***g* or **844***g*) to block the green light from passing through the aperture wheel (such as aperture wheel **848***g* or **844***g*) to the green light valve (such as valve **850***g*).

Similarly, when an image is projected entirely of green and blue light an aperture containing a shutter would be placed (such as on aperture wheel **848***r* or **844***r*) to block the red light from passing thought the aperture wheel to the red light valve (such as **850***r*). Also similarly when an image is projected entirely of green and red light an aperture containing a shutter would be placed (such as on aperture wheel **848***b* and **844***b*) to block the blue light from passing through the aperture wheel to the blue light valve (such as valve **850***b*). Depending on what the image is comprised of, more than one aperture devices may block the light to more than one light valves. For instance, if the image is comprised of only blue light then it is possible to block the light to the red and green light valves.

When the lighting device, such as lighting device **1050** of FIG. **10** of the present invention, is not being used to project an image, such as via light shown by dashed lines **1055** and **1054**, the aperture wheels (**848***r* and **844***r*, **848***g* and **844***g*, **848***b* and **844***b*) for the red, green and blue light can rotate to place shutters to block the red, green and blue light from passing through to their prospective light valves (such as **850***r*, **850***g*, and **850***b*). In this way the invention prevents any light leakage from passing through the red, green and blue light valves insuring a good black out in very dark conditions. It would also be possible to position an aperture device with a shutter or a mask after a light valve if desired.

FIG. **4**A shows an aperture wheel **400** with round apertures **410**–**422**. The apertures **410**–**422** would be sized to allow the desired amount of light to pass through each aperture and then to the appropriate light valve. The apertures **410**–**422** on the aperture wheel **400** of FIG. **4**A could also be of different shapes including rectangular or square. Any of the apertures **410**–**422** may have cutoff filters or color modifying filters, contain no filter and be a through hole, or may contain a shutter.

FIG. **6**A shows an aperture wheel **600** with wedge shaped apertures **612**–**622**. The apertures **612**–**622** would be sized to allow the light passing through the appropriate aperture on it's way to the appropriate light valve so that all the desired light would pass through the light valve. Any of the apertures **612**–**622** may have cutoff filters or color modifying filters, contain no filter and be a through hole, or may contain a shutter.

It is possible that the aperture wheels **848***r*, **848***b* and **848***g* may only be used as shutters and contain no cutoff filters. In this case only a single shutter aperture may be needed. This could improve the speed of the shutter allowing faster transitions between passing and blocking the light to the appropriate light valve (such as one of light valves **850***g*, **850***b*, and **850***r*). FIG. **9**A shows single aperture device **900** that could either contain a filter or a shutter.

Various aperture devices can be used to place apertures into and out of a light path instead of an aperture wheel. FIG. **9**B shows an aperture slide device **950** where apertures **930** and **932** are moved linearly into and out of the light path. Either aperture **930** or aperture **932** can contain filters of light blocking material. The aperture slide device **950** can be used instead of or combined with one or more of the aperture wheels **848***r*, **848***g*, **848***b*, **844***r*, **844***g*, or **844***b*, and at any of the locations of those aperture wheels in the FIG. **8** embodiment.

Instead of a mechanical aperture device that places filters into a light path, an aperture device like an electronically switchable spectral filter like that produced by ColorLink of Boulder Colo. (www.colorlink.com) could be used for modification of the color produced by the color separation system. By chromatically manipulating polarization, the switchable spectral filter can be designed to provide several different cutoff frequencies used to modify the color spectrum sent by a color separator to a light valve (such as light valves **850***g*, **850***r*, and **850***b* of FIG. **8**).

FIG. **11** shows the apparatus **1100** which is basically the same as the apparatus **800** of the embodiment of FIG. **8**, except that electronically switchable spectral filters have been substituted for aperture wheels (and their motors). Electronically switchable filters **1110***r* and **1115***r* have been substituted for aperture wheels **848***r* and **844***r* (and their motors), electronically switchable filters **1110***b* and **1115***b* have been substituted for aperture wheels **848***b* and **844***b* (and their motors), and electronically switchable filters **1110***g* and **1115***g* have been substituted for aperture wheels **848***g* and **844***g* (and their motors).

FIGS. **12**A and **12**B show front and side views of an aperture device **1200**. Aperture device **1200** is comprised of a variable filter **1244**, a motor shaft **1245** and a motor **1244**. The variable filter **1244** may be attached or fixed to the motor shaft **1245** in any suitable manner. The motor shaft **1245** is rotatably connected to the motor **1240** and the motor shaft **1245** can be rotated by the motor **1240**, to cause the variable filter **1244** to rotate, in the clockwise or counterclockwise directions shown by the arrows **1202**. The variable filter **1244** may be an aperture wheel.

The variable filter **1244** may be a circular variable filter ("CVF"). A CVF can be designed as known in the art to vary its cutoff frequency as it is rotated. Variable filters are manufactured by several optical filter manufacturers including Optical Coating Laboratory, Inc of Santa Rosa Calif. More information on variable filters is found at their web site at: http://www.ocli.com/pdf_files/products/variable_filters.pdf

A CVF can vary the cutoff frequency as the circular wheel, such as variable filter **1244**, is rotated, in either the counterclockwise or clockwise directions shown by arrows **1202** in FIG. **12**A. This allows smooth transitions that are not obtrusive to the audience viewing the particular multiple light valve lighting device of which the variable filter **1244** may be a part, such as a multiple light valve lighting device similar to **1050** of FIG. **10**. This is because instead of the separate multiple filters inserted into the light path to change the cutoff frequency as shown, for example, in FIGS. **4**A, **6**A, and **9**B, the variable filter **1244** of FIG. **12**A can gradually change its cutoff frequencies as it is rotated in a path of light by motor **1240** of FIG. **12**B. Of course it is important to note that it is known in the art that dichroic filters separate light by transmitting one frequency or set of frequencies and reflecting another frequency or set of frequencies. Variable filters like a CVF, that are variable dichroic filters, also separate light by transmitting one frequency or set of frequencies and reflecting another frequency or set of frequencies but are adjustable as known in the art.

FIG. **13**A shows a front view of another type of variable filter, variable filter **1330**, which can also be called a linear variable filter or LVF. The variable filter **1330** is typically continuously variable and the dashed lines are shown only as a symbols of the filter **1330**'s variability. As known in the art an LVF, such as variable filter **1330**, can vary its cutoff frequency as it is moved linearly in the path of the light. More information can be found on linear variable filters from Optical Coating Laboratory, Inc of Santa Rosa Calif.

More information of variable filters is found at their web site at: http://www.ocli.com/pdf_files/products/variable_filters.pdf

FIG. **13**B shows a side view of an aperture device **1350** comprised of variable filter **1330**, a mounting plate **1338**, a power nut **1340**, a worm gear shaft **1342**, and a motor **1344**. The variable filter **1330** is fixed to the mounting plate **1338** that is in turn fixed to the power nut **1340**. The power nut **1340** is driven by a worm gear shaft **1342** by the motor **1344**. The worm gear shaft **1342** is rotatably connected to the motor **1344**. Arrows **1346** show the direction of movement of the variable filter when the motor worm gear shaft **1342** is rotated. The aperture device **1350** of FIG. **13**B, generally can be used in any location where any other aperture device disclosed in the present application has been used.

FIG. **14** shows an optical apparatus **1400** of an embodiment of the present invention. The optical apparatus **1400** is similar to optical apparatus **1100** of FIG. **11** with some exceptions. Optical apparatus **1400** is comprised of three light values, **1450***r,* **1450***b,* and **1450***c* which are similar to light valves **850***g,* **850***b,* and **850***r* in FIG. **11**. Light valves **1450***r,* **1450***b,* and **1450** receive green, blue, and red light respectively, and the frequencies of each of the lights received are adjustable. In FIG. **14**, the color separators **1425***c,* **1425***y,* and **1425***g* adjust the frequencies. Optical apparatus **1400** includes components **810**, **812**, **818**, **830***d,* **830***e,* **876**, **890**, and **880** like apparatus **1100** of FIG. **11**. Reflecting mirror **830***a,* and color separators **824***y* and **824***c* in apparatus **1100** have been replaced by aperture devices **1423***g,* **1423***y,* and **1423***c.* In addition, FIG. **11** includes components **1110***g,* **1110***b,* **1110***r,* **1115***g,* **1115***b,* and **1115***r* which are not included in FIG. **14**. Optical apparatus **1400** also includes variable apertures **1492***a,* **1492***b,* and **1492***c* which are similar to variable apertures **892***g,* **892***b,* and **892***r,* respectively, shown in FIG. **11**.

The aperture devices **1423***g,* **1423***y,* and **1423***c* shown in FIG. **14** are comprised of aperture wheels **1424***g,* **1424***y,* and **1424***c,* respectively, and motors **1425***g,* **1425***y,* and **1425***c,* respectively. In the embodiment of FIG. **14**, the aperture devices **1423***g,* **1423***y,* and **1423***c* act as selectively variable color separators and replace the color separators **824***c,* **824***y,* and reflecting mirror **830***a* of FIG. **8**. By rotating an aperture wheel in a color separator position such as aperture wheel **1424***c* in FIG. **14**, the cutoff frequency of the reflected light in the direction of arrow **1432** can be varied. This eliminates the need for aperture devices, such as the aperture device comprised of wheel **848***b* and **844***b* in FIG. **8**, to be positioned after the wide band non-variable color separators, such as separator **824***y,* as shown in the embodiment of FIG. **8**. Any one of the aperture devices **1423***g,* **1423***y,* and **1423***c* can be placed in one of a plurality of states to select a particular color separation. For example, aperture device **1423***c* can be placed in a first state to separate the light it receives from direction arrow **822** into a first color light output in direction **1432** and a first residual light output in direction **1460**. Aperture device **1423***c* can also be placed in a second state to separate the light it receives from direction arrow **822** into a second color light output in direction **1432** and a second residual light output in direction **1460**. Variable filters, such as the circular variable filter (CVF) in the color separator position as shown in FIG. **12**A is preferred in this application.

The aperture wheel **1424***c* used as a color separator, may separate out the red light in the direction of an arrow **1432** by reflection, while transmitting or separating out a residual light comprised of blue and green light in the direction of an arrow **1460**. The colored red light which is reflected at the first aperture wheel **1424***c* acting as a color separator can be called the first color light in a process in accordance with an embodiment of the present invention.

The separated residual light from aperture wheel **1424***c* heads in the direction of arrow **1460** towards the aperture device **1423***y* comprised of aperture wheel **1424***y* and motor **1425***y.* The aperture wheel **1424***y* acting as a variable color separator, may separate out the blue light from the blue and green residual light that is transmitted from aperture wheel **1424***c.* The reflected separated blue light heads in the direction of arrow **1464** towards variable aperture **1492***b* and blue light valve **1450***b.* The residual green light transmitted from aperture wheel **1424***y* is sent in the direction of arrow **1470** towards the aperture device **1423***g* comprised of aperture wheel **1424***g* and motor **1425***g.* At aperture wheel **1424***g* the green light is reflected in the direction of arrow **1472** towards reflecting mirror **830***d.* The green light is reflected off of the reflecting mirror **830***d* as shown in the direction of arrow **1474** towards variable aperture **1492***g* and the blue light valve **1450***g.*

The aperture wheels **1424***c,* **1424***y* and **1424***g* can be rotated in the light path by their motors **1425***c,* **1425***y,* and **1425***g,* respectively. When any one of the aperture wheels **1424***c,* **1424***y,* and **1424***g* are rotated, different filters on the particular aperture wheel are placed into the light path to vary the reflective light. Each of aperture devices **1423***g,* **1423***y,* and **1423***c* can be, or can be replaced by one of the aperture devices shown for example in FIGS. **4**A, **6**A, and **9**B. At least two different cutoff filters would be used for each aperture device. The cutoff filters would be dichroic filters and their reflective and transmissive properties would be used. Each of aperture devices **1423***g,* **1423***y,* and **1423***c* can be replaced by a type of aperture device that linearly places different cutoff filters into the light path, as shown for example, by FIG. **9**B. The aperture devices **1423***g,* **1423***y,* and **1423***c* in FIG. **14** could also use, or be replaced by aperture devices that use, variable filters such as those shown in FIGS. **12**B and **13**B instead of multiple discrete filters.

Aperture wheel **1424***c* acts as a variable color separator using a variable filter, and aperture wheel **1424***c* reflects red light. When varying the aperture wheel **1424***c* the reflected light frequencies can be varied from a dark red light, to a medium red color, to an orange red color to an orange color. As the aperture wheel **1424***c* or variable filter **1424***c* is rotated the reflected cutoff frequencies are varied. This is because the variable filter or aperture wheel **1424***c* is specified to reflect red light from orange to dark red as it is rotated. Specifying a variable filter to do such is known in the art.

FIG. **15** shows the apparatus **1500**. Apparatus **1500** contains the same components as apparatus **1400** in FIG. **14**, except that apparatus **1500** includes electronically switchable spectral filters **1515***g,* **1515***y,* and **1515***c* in place of aperture devices **1423***g,* **1423***y,* and **1423***c* of apparatus **1400**. The spectral filters **1515***g,* **1515***y,* and **1515***c* would provide the same function as their counterparts **1423***g,* **1423***y,* and **1423***c* in FIG. **14**. Also the direction arrows **1432**, **1434**, **1460**, **1464**, **1470**, **1472**, **1474**, **1478**, and **1482**, have been replaced by direction arrows **1532**, **1534**, **1560**, **1564**, **1570**, **1572**, **1574**, **1578**, and **1582**, however, these similarly numbered direction arrows may symbolize the same light or light path focussed in the same direction.

In operation, the apparatus **1500** functions somewhat similar to the apparatus **1400** of FIG. **14**. In the embodiment of FIG. **15**, the electronic spectral filters **1515***g,* **1515***y,* and

1515*c* act as selectively variable color separators. Any one of the filters **1515***g*, **1515***y*, and **1515***c* can be placed in one of a plurality of states to select a particular color separation. For example, aperture device **1515***c* can be placed in a first state to separate the light it receives from direction arrow **822** into a first color light output in direction **1532** and a first residual light output in direction **1560**. Aperture device **1515***c* can also be placed in a second state to separate the light it receives from direction arrow **822** into a second color light output in direction **1532** and a second residual light output in direction **1560**.

FIG. **7** shows a control system **760** for controlling aperture wheels **848***r*, **844***r*, **848***g*, **844***g*, **848***b*, and **844***b* and lighting valves **850***r*, **850***g*, and **850***b* of the FIG. **8** embodiment. The control system **760** and the remote control **780** is used for the operation of a multiple light valve lighting device such as device **1050** of FIG. **10**.

In operation, signals are sent over a communications system from the remote console **780** to the control system **760** through the wiring conductors **772**. The communication system may be used to send program material to the control system **760** from the remote console **780**. The program material may provide information as to how the light valves **850***r*, **850***g*, and **850***b* are controlled to produce an image. Some examples of program material are computer graphic and video signals. It is also possible that a second communication system between the remote console **780** and the control system **760** may be used to send live video or graphical information to be stored into memory of the microprocessor **728** of FIG. **7**.

The control system **760** has a communications node **730** for receiving communication signals from the remote console **780**. The communications node **730** passes the signals to the microprocessor **728** through the conductors **729**. The microprocessor **728** receives the data as received by the communication node **730** and first determines if the unique address data contained from the received data is the correct address as known in the art. If the microprocessor **728** determines that it has received a correct address contained within the received data, the microprocessor **728** may next act upon a command signal contained within the received data that is sent from the remote console **780** over the communications system. If a command signal is sent from the remote console **780** that contains a command for modification of the green color, the microprocessor **728** sends control signals via conductors **723** to the motor drive device **722** that in turn sends the appropriate control signals to the motors **840***g* or **846***g*.

The microprocessor **728** may also receive commands from the remote console **780** to control the light valves **850***r*, **850***g*, and **850***b*. The microprocessor **728** sends control signals via the conductors **721** to the light valve controlling device **720**. The light valve controlling device **720** determines which one of the light valves of light valves **850***r*, **850***g*, and **850***b*, the microprocessor **728** desires to control, and sends the appropriate control signals to the light valves **850***r*, **850***g* or **850***b* though conductors **752***r*, **752***g*, or **752***b*, respectively.

The microprocessor **728** receives its necessary operating power from the power supply **726** through conductors **727** and also routes power through conductors **729**, **721**, **719** and **723** to the communications node **730**, the light valve controlling device **720**, thermal monitoring device **714**, and the motor drive device **722**. The power supply **726** also supplies power to the lamp power supply **724** via conductors **725**. The lamp power supply **724** may receive control signals from the microprocessor **728** through conductors **732**. The lamp power supply **724** supplies the necessary power to operate the lamp **710**. The lamp power supply **724** may be variable so as to supply variable power to the lamp **710**.

The lamp power supply **724** may be capable of supplying power to the lamp **710** in excess of the manufacturer's continuous rated power level, for example if the lamp **710** is rated by the manufacturer at 200 watts the power supply **724** may deliver upon signals 300 (three hundred) watts or greater to the lamp **710**. It is possible to control the amount of power to the lamp **710** in accordance with the amount of light energy to pass through a particular light valve (such as one of light valves **850***r*, **850***g*, or **850***b*). For example more saturated colors have less energy to pass through a light valve while less saturated colors pass more energy through the light valves. If one or more of the light valves, such as light valves **850***r*, **850***g*, and **850***b* has a limit as to how much energy can be transmitted through the light valve the power to the lamp **810** may need to be regulated to reduce the energy. If one or more of the light valves **850***r*, **850***g*, or **850***b* has a limit as to how much energy can be blocked by that light valve, the power to the lamp **810** may have to be regulated to reduce the energy. It can be possible using duty cycle control to increase the power to the lamp **810** for brief durations so that light energy passing through the light valves **850***r*, **850***g*, and **850***b* is of higher energy than normally would be allowed as a continuous duty. By varying the power to the lamp **810** under different conditions, the lighting device **1050** of FIG. **10** can be optimized for maximum light output under a variety of conditions. In FIG. **7**, the control system **760** may automatically adjust the power to the lamp **810** by determining the color spectrum in use, the placement of an aperture device, such as an aperture on one of aperture wheels **848***r*, **844***r*, **848***g*, **844***g*, **848***b*, or **844***b* into the light path, the control condition of a light valve (such as one of light valves **850***r*, **850***g*, or **850***b*), or even the physical placement of the lighting device **1050** of FIG. **10**.

It is also possible for the lighting device **1050** of FIG. **10**, to automatically close and open light blocking apertures (shutters), such as on aperture wheel **848***r*, based upon the state of the light valves (such as light valve **850***r*) as controlled by the light valve controlling device **720** as determined by the microprocessor **728** of FIG. **7**. For example, when the green light valve **850***g* of FIG. **7** of an embodiment of the present invention is controlled to the light blocking state for any given amount of time the green aperture device **844***g* can block the light path of the green light from reaching the green light valve **850***g*. The microprocessor **728** of FIG. **7** monitors the state of the red, green and blue light valves **850***r*, **850***g*, and **850***b*, respectively, as controlled by the light valve controlling system **720** and if any of the light valves are determined to be in the light blocking state for any given period of time, the microprocessor **720** will next send control signals to the motor drive device **722** of FIG. **7** to operate one of the motors **846***r*, **840***r*, **846***g*, **840***g*, **846***b* or **840***b* of the respective light valves to rotate the motor and change the aperture of the aperture device such as one of aperture wheels **848***r*, **844***r*, **848***g*, **840***g*, **848***b* or **844***b*. The light blocking state is defined as when a light valve of light valves **850***r*, **850***g*, and **850***b* are controlled by the light valve controlling device **720** to substantially block the light from passing through the light valve onward to the projection lens.

If the microprocessor **728** determines that all three light valves **850***r*, **850***g*, and **850***b* are in the light blocking state, all of the aperture devices, such as aperture devices **848***r*, **844***r*, **848***g*, **844***g*, **848***b*, and **844***b* may block the light going to their respective light valves. This may be done automatically by monitoring the status of the light valve control signals. Also a black out command may be sent to the lighting device (like that shown as **1050** of FIG. **10**) from the remote console **780** that is received by the communications node **730** and in turn is sent through conductors **729** to the microprocessor **728**. The command is interpreted by the microprocessor **728** and control signals are sent to the motor drive device **722** to in turn operate the motors **846***r,* **840***r,* **846***g,* **840***g,* **846***b,* and **840***b*. The motors **846***r,* **840***r,* **846***g,* **840***g,* **846***b,* and **840***b* are operated to place a light blocking aperture from the aperture wheels **848***r,* **844***r,* **848***g,* **844***g,* **848***b,* **844***b* in front of light before their respective light valves. When the light blocking apertures of the aperture devices are placed to block the light with a light blocking material in the light path from the color separators, the aperture devices are considered to be in the light blocking state. Aperture wheels **848***r* and **844***r* (with or without their motors **846***r* and **840***r*) can be considered to be first and second components of a single aperture device. Similarly aperture wheels **848***g* and **844***g* can be considered to be first and second components of a single aperture device. Similarly aperture wheels **848***b* and **844***b* can be considered to be first and second components of a single aperture device.

It is also possible to reduce power to the lamp when the microprocessor **728** of FIG. **7** determines that all three light valves **850***r,* **850***g,* and **850***b* are in the light blocking state. After the microprocessor **728** determines that all three light valves are in the light blocking state, the microprocessor may next sends control signals over the conductors **732** to control the lamp power supply **724** to reduce the power to the lamp **810**. By reducing power to the lamp **810** the light output is reduced. When the light output is reduced by reducing power to the lamp **810** any light that is passing through the light valves **850***g,* **850***b,* and **850***r* in the light blocking state is reduced and thus improves the contrast ratio. If any of the three light valves **850***g,* **850***b,* or **850***r* is determined by the processor **728** not to be in the light blocking state a control signal is sent over the conductors **732** to control the lamp **810** power supply **724** to raise the power to the lamp **810** for normal operation.

FIG. **10** shows two similar multiple light valve lighting devices **1050** and **1060** connected over a communication system to a remote console **780**. The focusing projection lens **880** of the FIG. **8** embodiment is shown for projecting an image onto a stage **1020**. The stage could consist of various projection materials including screens, drapes, walls and flooring as well as props and other materials known in the art of stage lighting. The components of the FIG. **8** embodiment are located in the lighting device **1050**. The control system **760** of FIG. **7** is also located in the lighting device **1050**.

The combined light path from the lens **880** to a stage or projection surface **1020***a* is shown as dashed lines **1054** and **1055**. Device **1060** is similar and may be identical to device **1050** and contains projection lens **1062**. The lens **1062** may be considered to be a projection lens. A focusing lens and a projection lens are considered to be the same as described in this application.

A combined light path from the lens **1062** to the stage or projection surface **1020***a* is shown by dashed lines **1064** and **1065**.

A remote console **780** sends commands over a communication system as known in the art over the communication cables **772** and **778**. Connectors **774, 1076** and **1084** connect the communication cables into internal communication nodes (not shown) like **730** of FIG. **7**. Connector **770** connects the communication cable **772** to the remote console **780**. A power source **790** such as that provided by the power line is connected to power the console **780** at **796** and device **1050** at **794** and device **1060** at **1095**.

The lighting device like that shown as **1050** of FIG. **10** should have a unique address so that it can respond to the command signals from the remote console **780** separately from other lighting devices such as **1060** of FIG. **10** on the same communications system as known in the prior art. In FIG. **10**, two lighting devices are shown however many more may be connected to the same communications system. Some examples of command signals sent over the communication system from the remote console **780** to the multiple light valve lighting device **1050** like that shown in FIG. **10** are: lamp on, lamp off, black out, color modify red, color modify green, color modify blue, shutter open red, shutter close red, shutter open green, shutter close green and shutter open blue, shutter close blue, all shutters open, and all shutters closed.

The operator of the remote console **780** may command the lighting devices **1050** or **1060** by using command signals over the communication system to vary the color palette. This may be done at any time that the lighting devices **1050** or **1060** are in operation and can be used to create special effects and vary the visual look of the projected colors for aesthetic reasons. The operator inputs to the remote console **780** the desired change to the color palette of a particular multiple light valve lighting device via a keypad or a switch entry system as known in the art. The remote console **780** processes the commands received by a keypad **782** and transmits command signals over the communication system over cable conductors **772** and **1078**. The command signals may also contain the unique address of the lighting device **1050** or **1060** that the operator wishes to command. A multiple light valve lighting device such a device **1050** of FIG. **10** receives the commands signals over the communications system and next determines if the lighting device **1050** or **1060** has the correct unique address to respond to the command signals. If the unique address received matches the unique address of the lighting device **1050** of FIG. **10**, the lighting device **1050** next responds to the command signal by changing the color palette of the red, green or blue in accordance with the command issued by the operator through the remote console.

There are several different types of light valves known in the art. There are digital mirror devices (DMD) made by Texas instruments and the Liquid Crystal Displays (LCD) made by various manufacturers. The DMD is a reflective type light valve. LCD light valves may be of the reflective or transmissive type. FIG. **8** shows the transmissive type of light valves. Systems built similarly to prior art FIG. **1** are also built with reflective light valves. Regardless of the use of a reflective or transmissive light valves, the aperture devices can be placed before or after the light valves and after the color separator system to modify the color before or after the light valves.

Although the invention has been described by reference to particular illustrative embodiments thereof, many changes and modifications of the invention may become apparent to those skilled in the art without departing from the spirit and scope of the invention. It is therefore intended to include within this patent all such changes and modifications as may reasonably and properly be included within the scope of the present invention's contribution to the art.

I claim:

1. An apparatus comprising

a first light valve;

a second light valve;

a first aperture device;

wherein the first aperture device receives a first light comprised of a plurality of frequencies,

wherein the first aperture device can be placed in at least a first state and a second state;

wherein in the first state of the first aperture device, the first aperture device separates the first light into a first color light and a first residual light and in the second state of the first aperture device, the first aperture device separates the first light into a second color light and a second residual light, the first color light and the second color light being different;

wherein in the first state of the first aperture device, the first light valve receives the first color light, and in the second state of the first aperture device, the first light valve receives the second color light; and

wherein in the first state of the first aperture device, the second light valve receives at least a portion of the first residual light, and in the second state of the first aperture device, the second light valve receives at least a portion of second residual light.

2. The apparatus of claim **1** wherein

the first aperture device is comprised of a circular variable filter.

3. The apparatus of claim **1** wherein

the first aperture device is comprised of a linear variable filter.

4. The apparatus of claim **1** wherein

the first aperture device is comprised of a first aperture wheel.

5. The apparatus of claim **1** further comprising

a second aperture device;

wherein the second aperture device receives the first residual light from the first aperture device while the first aperture device is in the first state and the second residual light from the first aperture device while the first aperture device is in the second state;

wherein the second aperture device can be placed in at least a first state and a second state;

wherein in the first state of the second aperture device, the second aperture device separates either the first residual light or the second residual light, whichever the second aperture device has received, into a third color light and a third residual light and in the second state of the second aperture device, the second aperture device separates either the first residual light or the second residual light into a fourth color light and a fourth residual light, the third color light and the fourth color light being different; and

wherein in the first state of the second aperture device, the second light valve receives the third color light, and in the second state of the second aperture device, the second light valve receives the fourth color light.

6. The apparatus of claim **5** wherein

the first aperture device is a first electronically switchable filter; and

the second aperture device is a second electronically switchable filter.

7. The apparatus of claim **1** wherein

the first aperture device is a first electronically switchable filter.

8. A lighting device comprised of

a first device which separates a first light from a light source into a first frequency light and a second frequency light, wherein the first and second frequencies are different;

a first light valve having an input to which the first frequency light is applied, and an output, at which a first light valve output light is produced, the first light valve output light having a frequency;

a second light valve having an input to which the second frequency light is applied, and an output, at which a second light valve output light is produced, the second light valve output light having a frequency;

a combining device having an output, and an input to which the first light valve output light and the second light valve output light are applied, wherein the combining device combines the first light valve output light and the second light valve output light to produce a combined light at the output of the combining device; and

a projection lens having an output, and an input to which the combined light is applied, wherein the projection lens projects a combined light at its output,

wherein the frequency of the first light valve output light can be selectively varied.

9. The lighting device of claim **8**

wherein the frequency of the first light valve output light to the projection lens can be selectively varied.

10. The lighting device of claim **8** wherein

the first device is comprised of a color separator and an aperture device;

wherein the first device separates the first light into the first frequency light and the second frequency light by reflection, such that the first frequency light is a reflected light;

and wherein the frequency of the first light valve output light to the projection lens can be selectively varied by the aperture device selectively varying the reflected light.

11. The lighting device of claim **8** wherein

the first device is comprised of a color separator and an aperture device;

and wherein the frequency of the first light valve output light to the output lens can be selectively varied by the aperture device selectively varying the frequency of the first frequency light.

12. The lighting device of claim **8** wherein

the first device is comprised of a color separator and an aperture device;

and wherein the frequency of the first light valve output light can be selectively varied by the color separator.

13. A lighting device comprised of

a first device which separates a first light from a light source into a first frequency light and a second frequency light, wherein the first and second frequencies are different;

a first light valve having an input to which the first frequency light is applied, and an output, at which a first light valve output light is produced, the first light valve output light having a frequency;

a second light valve having an input to which the second frequency light is applied, and an output, at which a second light valve output light is produced, the second light valve output light having a frequency;

a combining device having an output, and an input to which the first light valve output light and the second light valve output light are applied, wherein the combining device combines the first light valve output light and the second light valve output light to produce a combined light at the output of the combining device; and

a projection lens having an output, and an input to which the combined light is applied, wherein the projection lens projects a combined light at its output,

wherein the frequency of the second light valve output light can be selectively varied.

14. A method comprising the steps of

separating a first light from a light source into a first frequency light and a second frequency light, wherein the first and second frequencies are different;

applying the first frequency light and the second frequency light to first and second light valves, to produce first and second light valve output lights, respectively;

combining the first and second light valve output lights to produce a combined light;

projecting the combined light;

and selectively varying the frequency of the first light valve output light.

15. A method comprising the steps of

separating a first light from a light source into a first frequency light and a second frequency light, wherein the first and second frequencies are different;

applying the first frequency light and the second frequency light to first and second light valves, to produce first and second light valve output lights, respectively;

combining the first and second light valve output lights to produce a combined light;

projecting the combined light;

and selectively varying the frequency of the second light valve output light.

16. The method of claim **15** wherein

the frequency of the first light valve output light is selectively varied during the step of separating the first light into a first frequency light and a second frequency light.

17. A light valve lighting device comprising

a first light valve;

a second light valve;

a light source; and

a processor;

wherein the light source is supplied with power and wherein the power supplied to the light source is varied by the processor based upon a controlled condition of at least one of the light valves.

18. A light valve lighting device comprising

a first light valve;

a second light valve;

a light source;

a processor;

an aperture device; and

wherein the aperture device is varied based upon a controlled condition of at least one of the light valves.

* * * * *