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Kanatani

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(54) **DIMMABLE LIGHTING APPARATUS USING A DISCHARGE LAMP**

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(52) **U.S. Cl.** **315/316**; 315/292; 315/312; 362/85; 362/233; 362/284; 362/285

(58) **Field of Search** 315/292, 294, 315/298, 312, 313, 316, 317, 318, 324; 362/233, 284, 285, 286, 293

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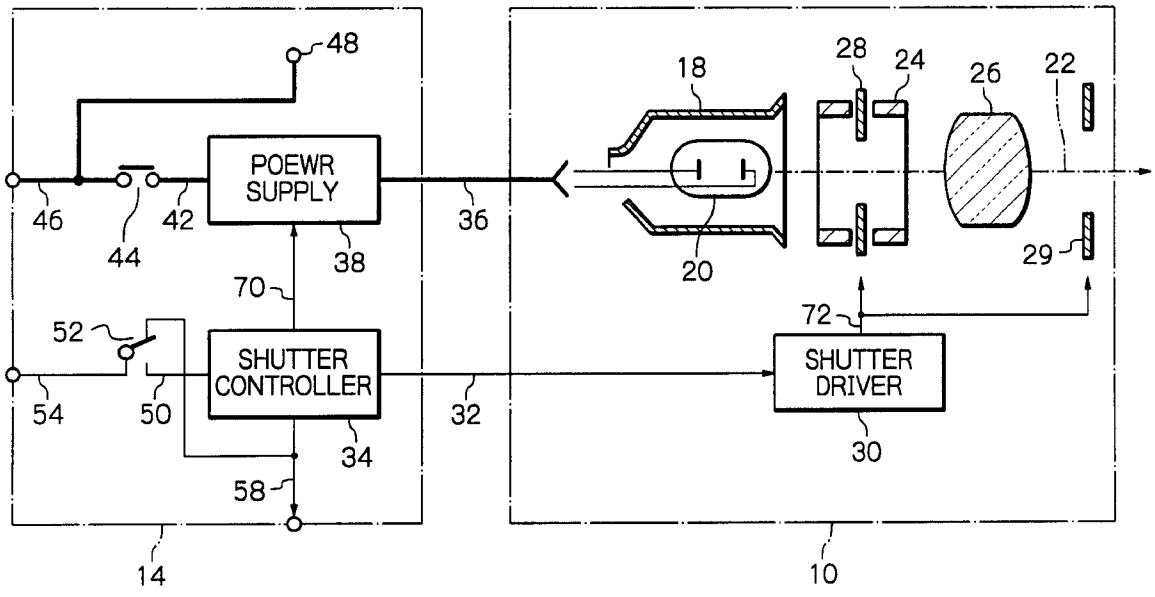
(57) **ABSTRACT**

A lighting apparatus capable of dimming lighting units using a discharge lamp in various ways. Each lighting unit includes a metal halide lamp and two spaced shutters arranged in front of the lamp on the optical path of the lamp. A shutter driver selectively opens or closes the shutters for mechanically dimming light issuing from the lamp. Six lighting units are cascaded in a single group. Ballast boxes each are assigned to a particular lighting unit and include a power supply section for feeding electric power to the lamp and a shutter controller for controlling a shutter driver. These structural elements are collectively controlled from a keyboard via a single control box. A command generating section included in the control box transforms a command input on the keyboard to a command for controlling the individual lighting unit. A selector also included in the control box distributes the command to five groups of lighting units. The apparatus allows the power supply and dimming of the individual lighting unit to be controlled via the keyboard.

9 Claims, 4 Drawing Sheets



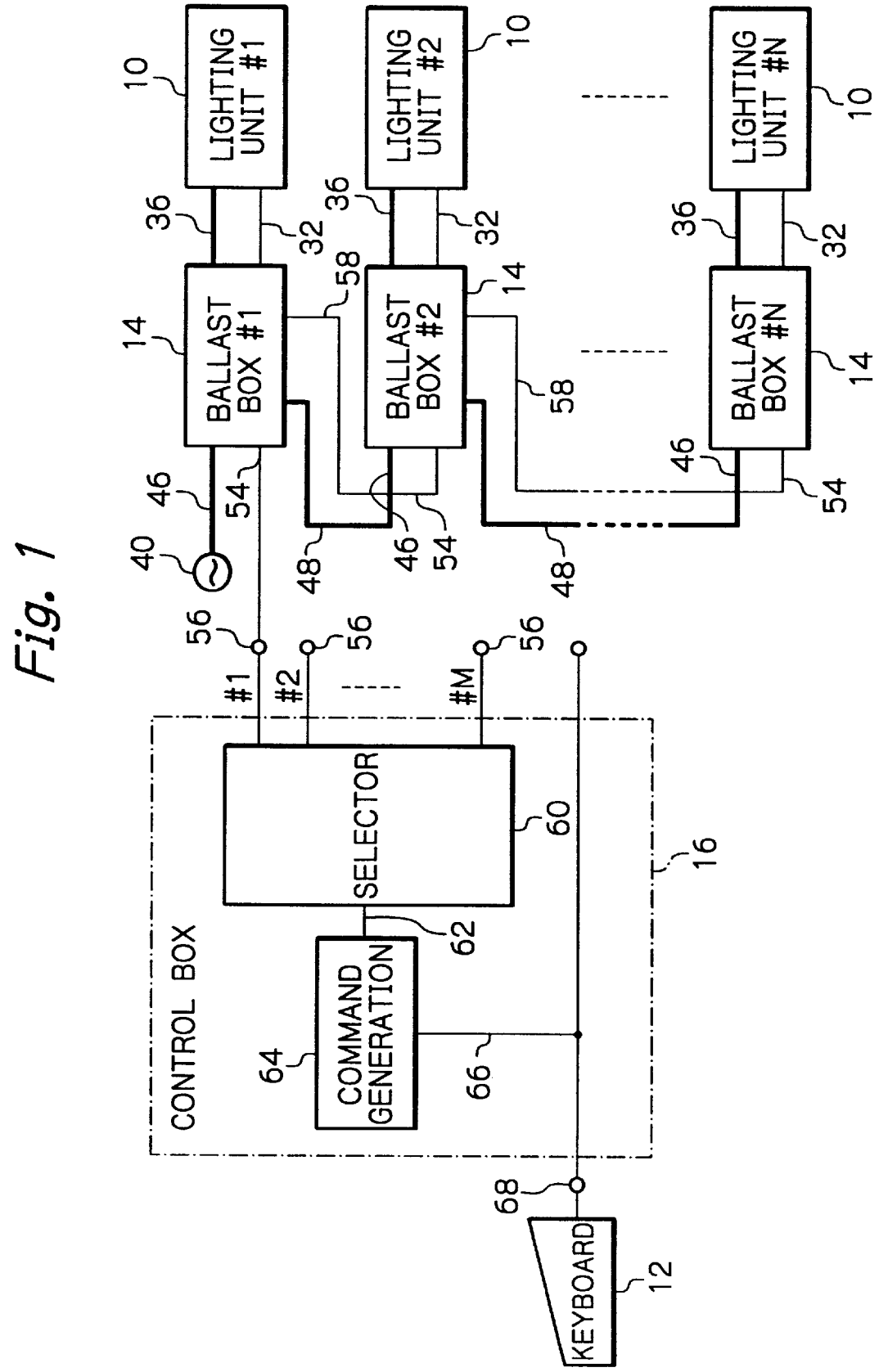

LIGHTING UNIT #1
LIGHTING UNIT #2
LIGHTING UNIT #N
BALLAST BOX #1
BALLAST BOX #2
BALLAST BOX #N
SELECTOR
COMMAND GENERATION
CONTROL BOX
KEYBOARD
#1
#2
#M
10
12
14
16
32
36
40
46
48
54
56
58
60
62
64
66
68

Fig. 1

Fig. 2

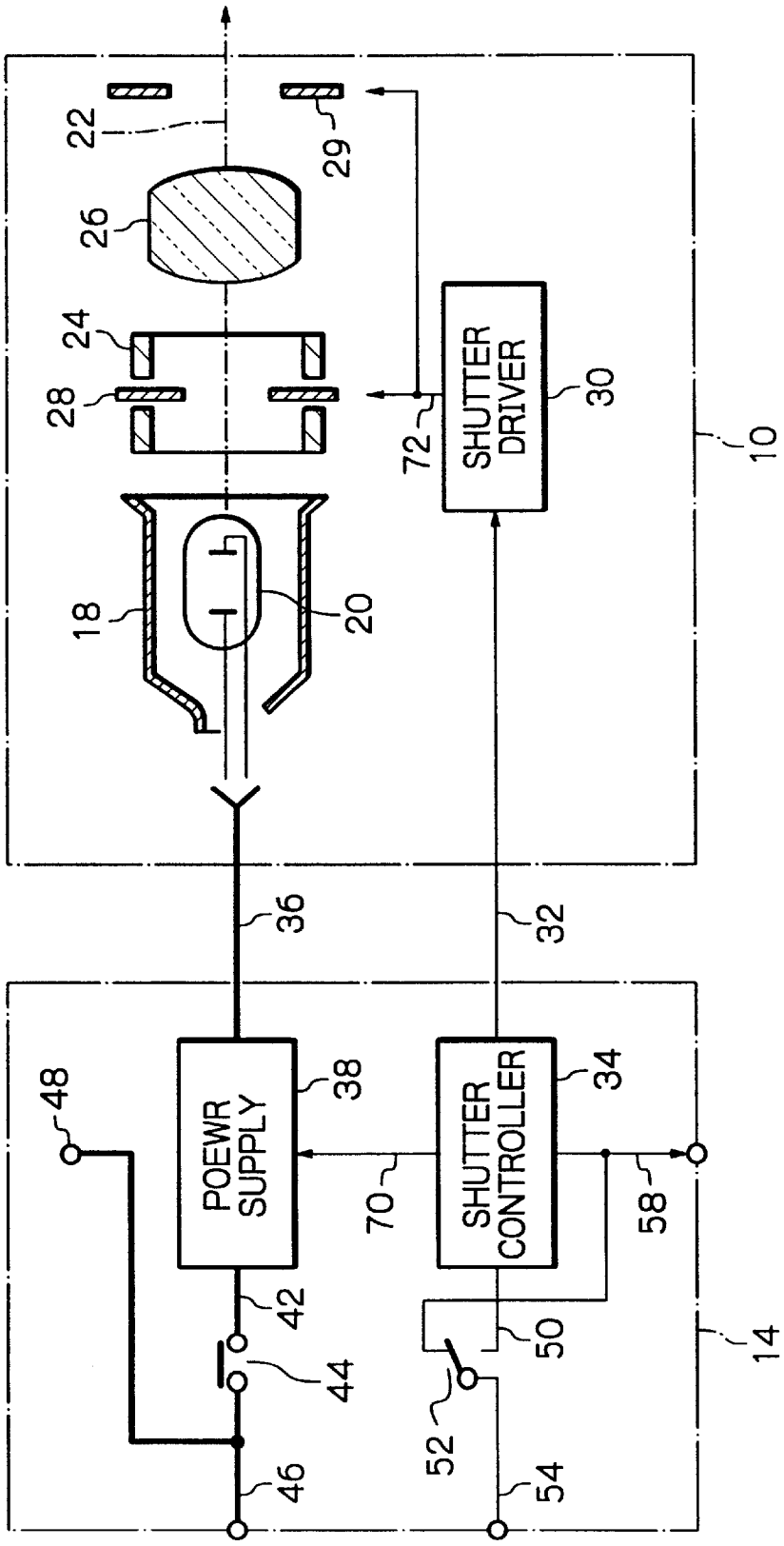
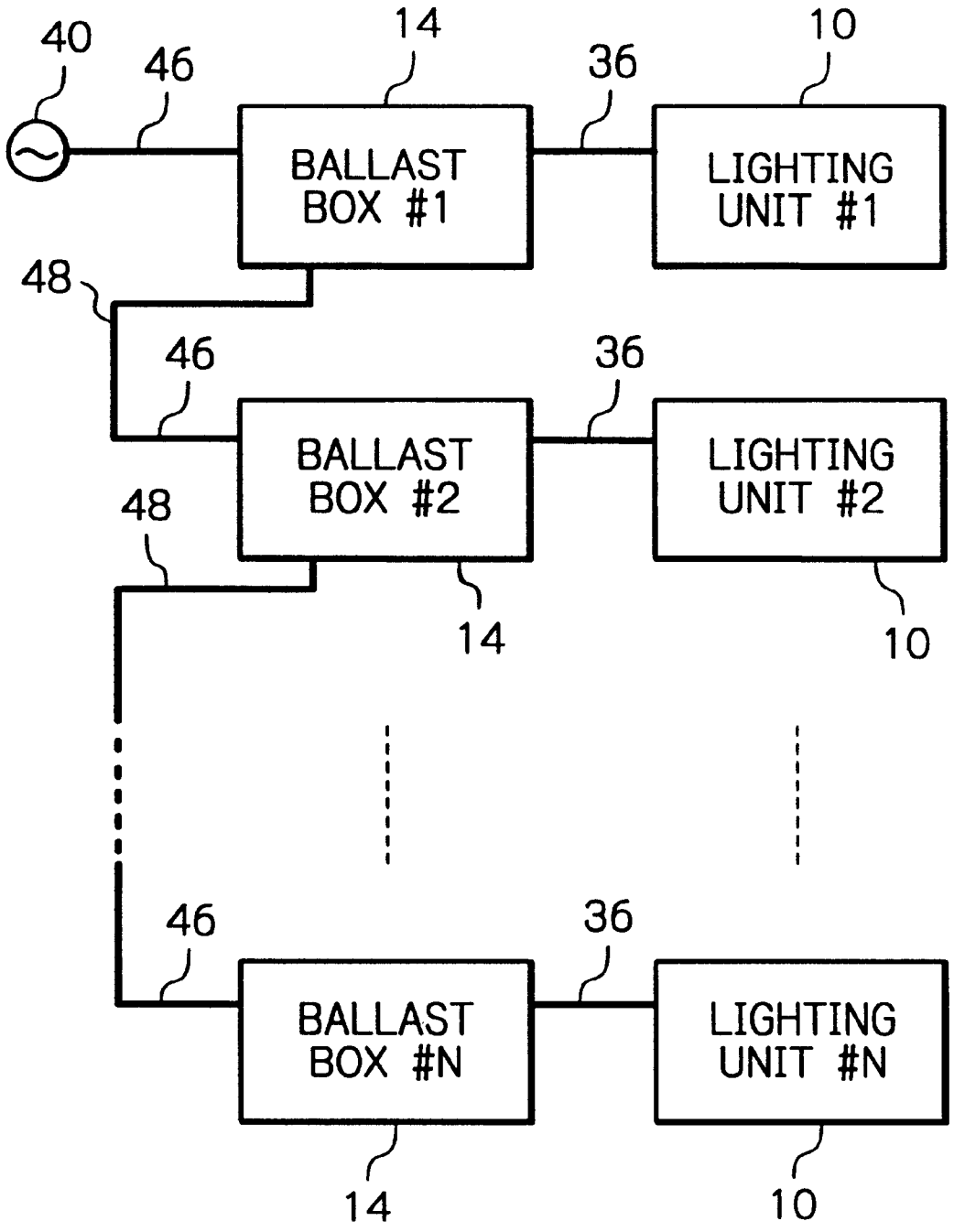

22
29
26
24
28
18
20
72
SHUTTER DRIVER
30
10
36
32
48
POEWR SUPPLY
38
SHUTTER CONTROLLER
34
70
58
42
44
46
50
52
54
14

Fig. 3


40
46
14
36
10
BALLAST BOX #1
LIGHTING UNIT #1
48
46
36
BALLAST BOX #2
LIGHTING UNIT #2
48
14
10
46
36
BALLAST BOX #N
LIGHTING UNIT #N
14
10

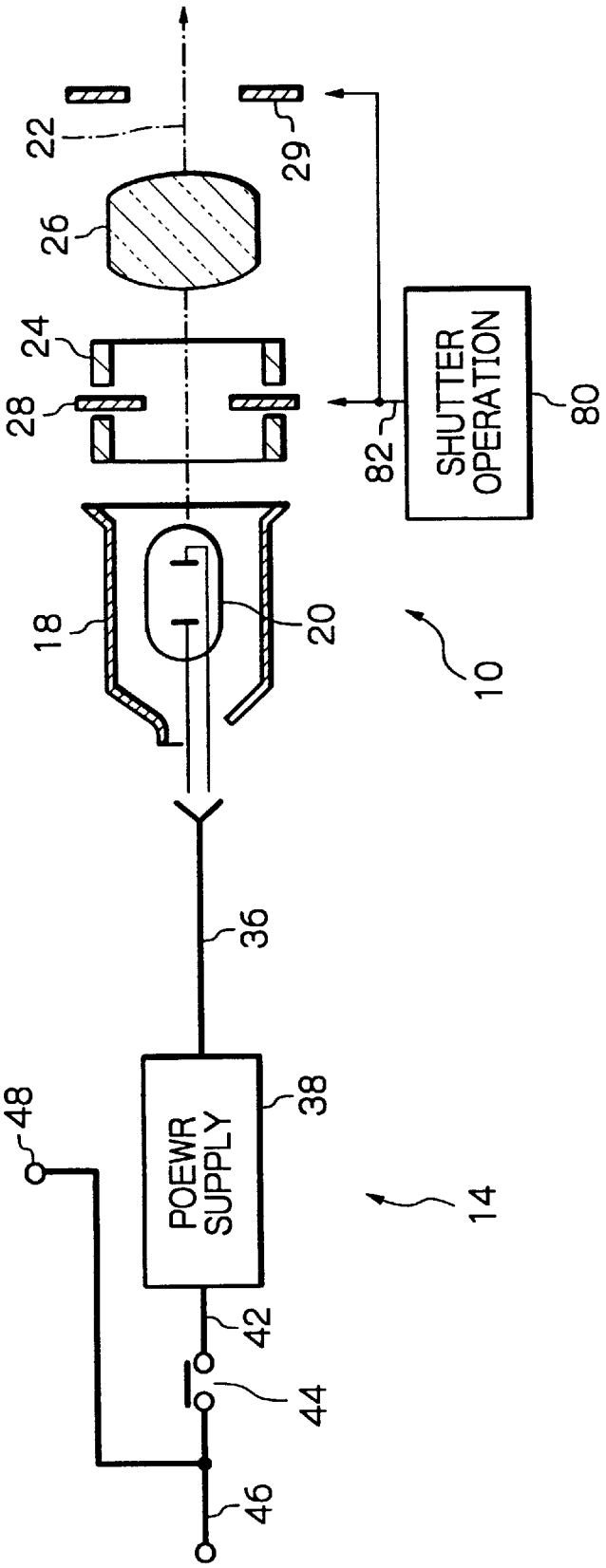

22
29
26
24
28
82
SHUTTER OPERATION
80
18
20
10
36
48
POEWR SUPPLY
38
14
42
44
46

Fig. 4

DIMMABLE LIGHTING APPARATUS USING A DISCHARGE LAMP

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a lighting apparatus and more particularly to a profile spotlight or similar lighting apparatus capable of controllably dimming a lighting unit using a discharge lamp.

2. Description of the Background Art

A theater, hall, window display or similar cite is, in many cases, lighted by lighting units using halogen lamps. Metal halide lamps have a higher emission efficiency than halogen lamps and can emit a great quantity of light with small power while radiating a minimum of heat. However, metal halide lamps, which are discharge lamps, are difficult to electrically dim and are not suitable for profile spotlights required to dim a plurality of lighting units in various ways at the same time.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide a lighting apparatus capable of dimming a plurality of lighting units using discharge lamps in various ways.

In accordance with the present invention, a lighting apparatus includes a housing accommodating a removable discharge lamp. A shutter mechanism is positioned on the optical path of the discharge lamp in front of the lamp for p physically or mechanically opening or closing the optical path to thereby dim light issuing from the lamp. A lens converges the light passed through the shutter mechanism. A casing accommodates the housing, shutter mechanism and lens. A power supply section feeds electric power to the discharge lamp. A controller is operative in response to a control signal to control the power supply section for setting up or interrupting electric power feed from the power supply section to the discharge lamp, and control the shutter mechanism for dimming the light.

Also, in accordance with the present invention, a lighting apparatus includes a housing accommodating a removable discharge lamp. A first shutter mechanism is positioned on the optical path of the discharge lamp in front of the lamp for physically or mechanically opening or closing the optical path to thereby dim light issuing from the lamp. A lens converges the light passed through the first shutter mechanism. A second shutter mechanism is positioned on the optical path for physically or mechanically opening or closing an optical path on which the light converged by the lens is propagated to thereby dim the light. A casing accommodates the housing, first shutter mechanism, second shutter mechanism and lens. A power supply section feeds electric power to the discharge lamp. A controller is operative in response to a control signal to control the power supply section for setting up or interrupting electric power feed from the power supply section to the discharge lamp, and control at least one the first and second shutter mechanisms to thereby dim the light.

BRIEF DESCRIPTION OF THE DRAWINGS

The objects and features of the present invention will become more apparent from the consideration of the following detailed description taken in conjunction with the accompanying drawings in which:

FIG. **1** is a schematic block diagram showing a lighting apparatus embodying the present invention;

FIG. **2** is a schematic block diagram showing a specific configuration of a lighting unit and a ballast box included in the illustrative embodiment;

FIG. **3** is a schematic block diagram showing an alternative embodiment of the present invention; and

FIG. **4** is a schematic block diagram showing a specific configuration of a lighting unit and a ballast box included in the alternative embodiment.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. **1** of the drawings, a lighting apparatus embodying the present invention is implemented as a profile spotlight system by way of example. As shown, the lighting apparatus includes N lighting units **10** (#1 through #N) and a keyboard **12**. It is to be noted that N is a natural number and may be "6" by way of example. The operator of the lighting apparatus is capable of controllably dimming the lighting units **10** via the keyboard **12**. The lighting units **10** can therefore play the role of high illumination, ellipsoidal spotlights.

Specifically, N ballast boxes **14** (#1 through #N) are respectively connected to the N lighting units **10**. A single control box **16** is connected to the N ballast boxes **14** for controlling them collectively.

As shown in FIG. **2**, each lighting unit **10** includes a reflector housing **18** and discharge lamp **20** removably accommodated in the housing **18**. The discharge lamp **20** should preferably be implemented by a high illumination, metal halide lamp. A rotatable barrel **24** and a lens tube **26** are arranged on the optical axis **22** of the discharge lamp **20**, as illustrated. The lens tube **26**, preferably including a convex lens and a plano-convex lens, is capable of converging light issuing from the discharge lamp **20** to a desired object to be lighted. The lighting unit **10** with such a configuration can be implemented if, e.g., a commercially available device Source-Four (trade name) is modified for use with a halogen lamp.

The barrel **24** is rotatable about the optical axis **22** while supporting a replaceable negative for a slide. In the illustrative embodiment, the barrel **24** should preferably support, e.g., a movable iris shutter **28** for following operation in its iris slot. Intervening between the lamp or light source **20** and the lens tube or converging lens **26**, the iris shutter **28** allows the light **22** to form a spot having a desired diameter and a sharp edge on a desired object. A douser shutter **29** for dimming, for example, is positioned on the optical axis **22** of the lens tube **26** in front of the lens tube **26** in addition to or in place of the iris shutter **28**. The douser shutter **29** should preferably be of the type having a pair of bladed plates, not shown, each being formed with sixteen slits in the form of saw-teeth. The bladed plates face each other on opposite sides of the optical path **22**. A drive motor, not shown, causes the bladed plates to move toward or away from each other for adjusting the size of the optical path **22**, i.e., the brightness of the light **22**. If desired, the two bladed plates may be replaced with four to sixteen bladed or slit plates, not shown, and arranged around the optical path to be movable toward and away from each other.

A shutter driver **30** controls the above movement of the shutters **28** and **29**. The shutter driver **30** includes a motor or a solenoid, not shown, for driving the shutters **28** and **29**, as schematically represented by arrows **72**. The ballast box **14** assigned to the lighting unit **10** includes a shutter controller **34** connected to the shutter driver **30** by a drive line **32**. The ballast box **14** additionally includes a power supply **38**

connected to the discharge lamp **20** by a power supply line **36**. In the illustrative embodiment, the lighting unit **10** and associated ballast box **14** each are accommodated in a respective casing, as represented by a dotted line in FIG. **2**. The drive line **32** and power supply line **36** are removably connected to the lighting unit **10** and ballast box **14** via connectors not shown. Alternatively, the lighting unit **10** and ballast box **14** may be accommodated together in a single casing.

The power supply **38** included in the ballast box **14** includes a ballast and a no-fuse breaker, not shown, and plays the role of a power supply circuit for receiving electric power from, e.g., a commercially available 100 V power supply **40**, see FIG. **1**. For this purpose, the power supply **38** has its input side **42** connected to a feed line **46** via a power supply switch **44**. The feed line **46** is connected to the commercial electricity power supply **40**. The feed line **46** is connected to the other or output feed line **48** also. This feed line **48** is removably cascaded to the corresponding input feed line **46** of another ballast box **14**, as shown in FIG. **1**.

In the ballast box **14**, the shutter controller **34** has its input **50** connected to a control line **54** via a mode switch **52**. The control line **54** is connected to a control output **56** included in the control box **16**, see FIG. **1**. The mode switch **52** is a selector for allowing the operator to select either a local operation mode for operating the ballast box **14** within the operator's reach or a remote operation mode for operating it by remote control, as desired. The mode switch **52** sets up the local operation mode in the position shown in FIG. **2** or sets up the remote operation mode in the position opposite thereto. The input **50** of the shutter controller **34** should preferably have the USITT (United States Institute for Theatre Technology, Inc.) Standard, DMX-512 protocol and can be connected to, e.g., a general-purpose personal computer via an interface RS-412.

The shutter controller **34** has another control output **70** connected to the power supply **38**. The shutter controller **34** decodes a command, which will be described later, applied to its input **50** and decodes it. In accordance with the decoded command, the shutter controller **34** controls the electric power feed from the power supply **38** to the lamp **20** via the control line **70** in order to turn on, turn off or blink the lamp **20**, as desired. At the same time, the shutter controller **34** controls the motor and/or the solenoid of the shutter driver **30** for causing the shutters **28** and **29** to open or close. The shutter controller **34** additionally has an output control line **58** removably cascaded to the corresponding input control line **54** of another ballast box **14**, as shown in FIG. **1**.

Referring again to FIG. **1**, the control box **16** has M output control lines **56**, M being a natural number. Therefore, in the illustrative embodiment, the control box **16** is capable of accommodating M groups of N pairs of lighting units **10** and ballast boxes **14**. It follows that the lighting apparatus allows N×M lighting units **10** at maximum to be arranged in, e.g., a theater, hall, window display or similar cite and collectively controlled via the keyboard **12** as to blinking and lightness/darkness. In the illustrative embodiment, there are provided a first group including control channels #**1** through #**6**, a second group including control channels #**7** through #**12**, and so forth; a fifth group includes channels #**25** through #**30**.

The control box **16** includes a selector **60** having M outputs #**1** through #M each being connected to particular one of the output control lines **56**. The selector **60** transfers a signal applied to its input **62** to one of the M output control lines **56** in accordance with the signal. The input **62** is connected to a command generation **64** having an input **66** thereof connected to the output **68** of the keyboard **12**. In response to a signal output from the keyboard **12**, the command generation **64** generates a command based on the DMX-512 protocol for controlling the individual lighting unit **10**. The control box **16** may advantageously be implemented by a microcomputer or similar processing system. In the illustrative embodiment, the control box **16** is accommodated in a casing independent of the keyboard **12** and ballast boxes **14**.

The keyboard **12** includes keys, not shown, to be operated by the operator of the lighting apparatus. When the operator operates any one of the keys, the keyboard **12** sends a corresponding signal to the control box **16** via the output **68**. The keys include selector switches for designating any one of the lighting units **10** and dim switches for turning on or dimming the designated lighting unit **10** and adjusting the blinking interval of the lighting unit **10**. The keyboard **12** may additionally include a display for displaying the conditions of the control box **16**.

In operation, the operator first turns on the power supply switches **44** of the ballast boxes **14** assigned to the lighting units **10** to be collectively controlled. In addition, the operator conditions the mode switch **52** for the remote operation mode. Subsequently, the operator inputs on the keyboard **12** a number, or channel, assigned to any one of the lighting units **10** to turn on, turn off, blink or control illumination. At the same time, the operator inputs whether to turn on the designated lighting unit **10** or to turn it off, a blinking interval, and illumination. Signals representative of such designated conditions are sent from the keyboard **12** to the command generation **64** via the line **68** and a line **66**. The command generation **64** transforms the input signals to a signal representative of the lighting unit **10** to be controlled and a command representative of the control conditions. The command is fed from the command generation **64** to the selector **60** via the output **62**. The selector **60** transfers the input command to the output **56** assigned to the group including the subject lighting unit **10** in accordance with the DMX-512 protocol.

The command output from the command generation **64** is sequentially transferred to the N cascaded ballast boxes **14**. In each ballast box **14**, the shutter controller **34** determines whether or not the above command includes a command meant for the lighting unit **10** associated with the ballast box **14**. If such a command is present, then the shutter controller **34** takes it in and decodes it. The shutter controller **34** controls, based on the decoded command, power feed from the power supply **38** to the lamp **20** via the control line **70** for thereby turning on or off the lamp **20**, or blinking it at desired intervals. In addition, the shutter controller **34** controls the motor and/or the solenoid of the shutter driver **30** in order to open or close each of the shutters **28** and **29** to a desired degree, thereby providing the light **22** with desired illumination. In this manner, the operator is capable of dimming each of the M groups of N lighting units **10** independently of the others via the keyboard **12**.

Referring now to FIGS. **3** and **4**, an alternative embodiment of the lighting apparatus in accordance with the present invention is identical with the previous embodiments except for the following. As shown, the illustrative embodiment does not include the keyboard **12** or the control box **16**. Each ballast box **14** does not include the shutter controller **34**. Each lighting unit **10** includes a shutter operation **80** in place of the shutter driver **30**. With this configuration, the illustrative embodiment allows the operator to manually turn on

or off, or blink the individual lighting unit **10** via the associated ballast box **14**. In FIGS. **3** and **4**, structural elements like the structural elements of FIGS. **1** and **2** are designated by identical reference numerals and will not be described specifically in order to avoid redundancy.

As shown in FIG. **4**, the operator is capable of turning on or turning off the power supply **38** of each ballast box **14** by operating the power supply switch **44** by hand. The shutters **28** and **29** of each lighting unit **10** may each be configured in the same manner as in FIG. **2**. In this embodiment, the shutters **28** and **29** are not electrically driven via the shutter driver **30**, but are operated by hand via the shutter operation **80**, as schematically represented by arrows **82**. Either the shutter **28** or the shutter **29** may be omitted, if desired.

In operation, the operator manually turns on the power supply switch **44** of the ballast box **14** assigned to the lighting unit **10** to be controlled and turns on, turns off or blinks the lighting unit **10**. In addition, the operator positions the mode switch **52**, FIG. **2**, of the above ballast box **14** for the local operation mode (handy fader side). In this condition, the operator is capable of opening or closing the shutters **28** and **29** to a desired degree via the shutter operation **80** for a dimming purpose.

In summary, it will be seen that the present invention provides a lighting apparatus capable of allowing an operator to controllably dim a plurality of lighting units each including a discharge lamp in various ways. This unprecedented advantage is derived from the combination of a douser shutter, iris shutter or similar mechanical dimming device and a metal halide lamp or similar discharge lamp.

The entire disclosure of Japanese patent application No. 277494/1998 filed on Sep. 30, 1998 and including the specification, claims, accompanying drawings and abstract of the disclosure is incorporated herein by reference in its entirety.

While the present invention has been described with reference to the illustrative embodiments, it is not to be restricted by the embodiments. It is to be appreciated that those skilled in the art can change or modify the embodiments without departing from the scope and spirit of the present invention.

What is claimed is:

1. A lighting apparatus comprising:

a housing accommodating a removable discharge lamp;

a first shutter mechanism positioned on an optical path of said discharge lamp in front of said discharge lamp for mechanically opening or closing said optical path to thereby adjust a size of the optical path of light issuing from said discharge lamp;

a lens for converging the light passed through said first shutter mechanism;

a second shutter mechanism positioned on said optical path for physically opening or closing an optical path on which the light converged by said lens is propagated to thereby dim said light;

a casing accommodating said housing, said first shutter mechanism, said second shutter mechanism and said lens;

a power supply section for feeding power to said discharge lamp; and

a control means operative in response to a control signal for controlling said power supply section to thereby set up or interrupt power feed from said power supply section to said discharge lamp, and controlling at least one said first shutter mechanism and said second shutter mechanism to thereby dim the light.

2. The lighting apparatus in accordance with claim **1**, wherein said discharge lamp comprises a metal halide lamp.

3. The lighting apparatus in accordance with claim **2**, wherein said first shutter mechanism and said second shutter mechanism include an iris shutter and a douser shutter, respectively.

4. The lighting apparatus in accordance with claim **1**, further comprising:

a power supply switch for selectively setting up or interrupting the power feed to said power supply section; and

a mode switch for selecting either one of a remote operation mode responsive to the control signal and a local operation mode not responsive to the control signal.

5. A lighting system comprising:

a plurality of lighting devices capable of being cascaded to each other;

a first control means connected to at least one of said plurality of lighting devices for controlling said plurality of lighting devices; and

a manual input means connected to said first control means for sending a manually input command to said first control means;

each of said plurality of lighting devices comprising:

a housing accommodating a removable discharge lamp;

a first shutter mechanism positioned on an optical path of said discharge lamp in front of said discharge lamp for physically opening or closing said optical path to thereby adjust a size of the optical path of light issuing from said discharge lamp;

a lens for converging the light passed through said first shutter mechanism;

a second shutter mechanism positioned on the optical path of said discharge lamp for physically opening or closing an optical path on which light converged by said lens is propagated;

a first casing accommodating said housing, said first shutter mechanism, said second shutter mechanism and said lens;

a power supply section for feeding power to said discharge lamp;

a second control means operative in response to a control signal for controlling said power supply section to thereby turn on or turn off power feed from said power supply section to said discharge lamp, and controlling at least one of said first shutter mechanism and said second shutter mechanism to thereby dim the light; and

a second casing accommodating said power supply section and said second control means:

said power supply section and said second control means being respectively cascaded to a corresponding power supply section and a corresponding second control means throughout second casings of said plurality of lighting devices;

said first control means generating, in response to the command, a control signal meant for a designated one of said plurality of lighting devices, whereby said second control means of the designated lighting device controls dimming in accordance with said control signal.

6. The lighting system in accordance with claim **5**, wherein said power supply section of each of said plurality

of lighting devices is connected to a shared power supply, said second control means of each of said plurality of lighting devices being cascaded to a second control means of another one of said plurality of lighting devices.

7. The lighting apparatus in accordance with claim **5**, wherein said discharge lamp comprises a metal halide lamp.

8. A lighting apparatus in accordance with claim **1**, wherein said power supply is 100 V power supply.

9. Lighting systems in accordance with claim **5**, wherein said power supply is a 100 V power supply.

* * * * *