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54) [Title of the invention]

Light source wherein light emitting diodes have been used.

57) [Summary]

[Problem]

The situation is brought about that various light distributions can be obtained by the light source itself and that a surface light source can easily be constructed.

[Means of solution]

A number of light emitting diode elements 1 are grouped with an arrangement density that corresponds with the light distribution design. By the grouping of a number of light emitting diode elements 1, a surface light source can be obtained in a simple way. Moreover, since the grouping density of light emitting diode elements 1 is established, corresponding with the light distribution design, correspondence with the light distribution by the light source itself is possible.

[What is claimed]

[Claim 1]

A light source wherein light emitting diodes have been used, with the characteristic that a number of light emitting diode elements have been grouped with an arrangement density that corresponds with the light distribution design.

[Claim 2]

The light source wherein light emitting diodes have been used that has been described in claim 1, with the characteristic that the light emitting diode element is a bare chip.

[Claim 3]

The light source wherein light emitting diodes have been used that has been described in claim 1, with the characteristic that the grouping density of the central part of the grouping range of the light emitting diode elements has been made smaller than that of peripheral part, so that the luminance of the shining surface is fixed.

[Claim 4]

The light source wherein light emitting diodes have been used that has been described in claim 1, with the characteristic that the grouping density of the central part of the grouping range of the light emitting diode elements has been made larger than that of peripheral part.

[Claim 5]

A light source wherein light emitting diodes have been used, with the characteristic that the respective light emitting diode elements are connected with every group, so that a number of light emitting diode elements constitute a number of groups, and the situation of starting of the respective light emitting diode elements can be controlled in every group.

[Claim 6]

A light source wherein light emitting diodes have been used, with the characteristic that it has been equipped with a number of light emitting diode elements and a driving circuit that is connected with the output of a starting

circuit for discharge lamps and causes the above mentioned light emitting diode elements to start.

[Claim 7]

The light source wherein light emitting diodes have been used that has been described in claim 6, with the characteristic that the above mentioned driving circuit is equipped with a power source part that includes a rectifying circuit that is connected with the starting circuit, and a current limiting element that limits the (electric) current that is made to pass from the above mentioned power source part to the above mentioned light emitting diode elements.

[Claim 8]

The light source wherein light emitting diodes have been used that has been described in claim 6, with the characteristic that the above mentioned driving circuit is equipped with a power source part that contains a rectifying circuit and a power factor correcting means that are connected with the starting circuit, and current limiting elements that limit the (electric) current that is passed from the above mentioned power source part to the above mentioned light emitting diode elements, and that the input characteristics of the power source part imitate the load characteristics of a discharge lamp.

[Claim 9]

The light source wherein light emitting diodes have been used that has been described in claim 8, with the characteristic that the above mentioned load characteristics are current voltage characteristics at the time of stable starting of the discharge lamp.

[Claim 10]

The light source wherein light emitting diodes have been used that has been described in claim 9, with the characteristic that the above mentioned discharge lamp is a fluorescent lamp.

[Claim 11]

The light source wherein light emitting diodes have been used that has been described in claim 8, with the characteristic that light emitting diodes are connected with every group, so that a number of light emitting diode elements constitute a number of groups, and the starting state of the respective light emitting diode elements can be controlled in every group.

[Claim 12]

A light source wherein light emitting diodes have been used, with the characteristic that it is equipped with a light guiding plate whereby light that has been guided in from the light source that has been arranged opposite to peripheral surface of the plate shaped body, is leaked from at least one surface of front and back, and a light emitting diode element that is the above mentioned light source.

[Claim 13]

The light source wherein light emitting diodes have been used that has been described in claim 12, with the characteristic that light emitting diode elements are grouped in a number of groups, opposite to the peripheral surface of the light guiding plate.

[Claim 14]

The light source wherein light emitting diodes have been used that has been described in claim 13, with the characteristic that light emitting diode elements with a number of emission colours have been grouped.

[Claim 15]

The light source wherein light emitting diodes have been used that has been described in claim 13, with the characteristic that it is used in an

illumination device wherein a display pattern has been established in at least one surface of front and back of the light guiding plate, and that the light emitting diode elements have been grouped in such a way that the quantity of leaked light from the light guiding plate increases when the quantity of transmitted light in the display pattern increases.

[Claim 16]

The light source wherein light emitting diodes have been used that has been described in claim 13, with the characteristic that it is used in an illumination device wherein a display pattern has been established in at least one surface of front and back of the light guiding plate, and that light emitting diode elements with a number of emission colours have been grouped in such a way that the colour of the coloured parts in the display pattern and the colour of the light that leaks from the light guiding plate coincide.

[Claim 17]

The light source wherein light emitting diodes have been used that has been described in claim 13, with the characteristic that the light output of the respective light emitting diode elements is modulated by a light modulating means.

[Claim 18]

The light source wherein light emitting diodes have been used that has been described in claim 13, with the characteristic that the respective light emitting diode elements are connected with every group, so that a number of light emitting diode elements constitute a number of groups, and the starting state of the respective light emitting diode elements can be controlled in every group.

[Detailed description of the invention]

0001

[Field of technology whereto the invention belongs]

This invention pertains to a light source wherein light emitting diodes have been used, that is suited for illumination and for display.

0002

[Existing technology]

In general, a light source that is used for illumination is a spot light source or a linear light source, and for instance a spot light source has light distribution characteristics as in figure 16. In the horizontal axis of figure 16, the horizontal distance from the base point taken perpendicularly below the spot light source is standardised and expressed by dividing it by the distance from the light source to the base point.

0003

Since, as is clear from figure 16, the luminance distribution of the shining surface is not uniform if illumination is carried out with only the light source, it is general that an illumination device is constructed by the fact that the light source is installed in an apparatus that is equipped with light distribution controlling elements such as reflecting plates and lenses. Moreover, as the light source that is used for display, such a surface light source that the display contents can be recognised clearly, is necessary, but surface light sources that can easily be procured in the way of spot light sources or linear light sources do not exist, and in spot light sources and linear light sources, it is difficult to give the whole of the display contents a uniform clearness, or to give changes to the clearness in every domain of the display surface, corresponding with the display contents.

0004

[Problems that should be solved by the invention]

Since, however, in illumination devices, apparatuses that are equipped with light distribution controlling elements as is discussed above, are necessary, a problem is that relatively large apparatuses are necessary. Moreover, if the light distribution is to be changed, the illumination device has to be exchanged or the position of the illumination device has to be modified, and once the illumination device has been established, modification of the illumination design is not easy.

0005

Moreover, general surface light sources as discussed above have not penetrated the market, and cheap surface light sources are demanded for both illumination and display. This invention has taken lessons from the above mentioned facts, and its aim is to offer a light source wherein light emitting diodes have been used, wherein various light distributions can be obtained by the light source itself, and whereby a surface light source can be constructed in a simple way.

0006

[Means to solve the problems]

The invention of claim 1 is one wherein a number of light emitting diode elements have been grouped with an arrangement density that corresponds with the light distribution design. By the fact that by this construction, light emitting diode elements are grouped, a surface light source can be obtained in a simple way, and by the fact that the grouping density of the light emitting diode elements is established, corresponding with the light distribution design, the light source itself can correspond with the light distribution design. In short, since an apparatus that is equipped with light distribution controlling elements is almost not necessary, relatively small illumination devices can be constructed, and in addition, in case of exchange for light sources with different grouping densities of the light emitting diode elements, the light distribution can be easily modified, even after the execution. Moreover, since light emitting diode elements have a lifespan of the same or a longer length as light sources that are generally used, such as incandescent electric bulbs and fluorescent lamps, the number of exchanges is small.

0007

The invention of claim 2 is one wherein, in the light source of claim 1, the light emitting diode element is a bare chip. By this construction it is possible to increase the arrangement density of the light emitting diode elements and to obtain a light source with a high brightness. The invention of claim 3 is one wherein, in the invention of claim 1, the grouping density of the central part of the grouping range of the light emitting diode elements has been made smaller than that of the peripheral part, so that the luminance of the shining surface is fixed. By this construction, the luminance of the shining surface is almost uniform.

0008

The invention of claim 4 is one wherein, in the invention of claim 1, the grouping density of the central part of the grouping range of the light emitting diode elements has been made larger than that of peripheral part. By this construction, illumination wherein the luminance of the shining surface increases in the vicinity directly below it, and the luminance is partially raised, becomes possible. In short, partial illumination such as down light and spot light becomes possible. The invention of claim 5 is one wherein the respective light emitting diode elements are connected with every group, so that a number of light emitting diode elements constitute a number of groups, and the situation of starting of the respective light emitting diode elements can be controlled in every group. By the fact that by this construction, starting and light modulation are carried out in every group, changing of the light distribution becomes possible.

0009

The invention of claim 6 is one that is equipped with a number of light emitting diode elements and a driving circuit that is connected with the output of a starting circuit for discharge lamps and causes the above mentioned light emitting diode elements to start. By this construction, illumination by light emitting diode elements becomes possible if only illumination apparatuses wherein a normal discharge lamp is used, such as a fluorescent lamp, are removed and light sources are replaced. In short, by the fact that the output of the starting circuit is given to the driving circuit, the light emitting diode elements can be started in a stable way while overvoltage to the light emitting diode elements is suppressed and an overcurrent does not flow.

0010

The invention of claim 7 is one wherein, in the invention of claim 6, the above mentioned driving circuit is equipped with a power source part that includes a rectifying circuit that is connected with the starting circuit, and a current limiting element that limits the (electric) current that is made to pass from the above mentioned power source part to the above mentioned light emitting diode elements. Since by this construction the power source part is equipped with a rectifying circuit, the output of the starting circuit can be used with direct current as well as with alternating current. Moreover, by the current limiting element, flowing of overcurrent in the light emitting diode can be prevented.

0011

The invention of claim 8 is one wherein, in the invention of claim 6, the above mentioned driving circuit is equipped with a power source part that contains a rectifying circuit and a power factor correcting means that are connected with the starting circuit, and current limiting elements that limit the (electric) current that is passed from the above mentioned source part to the above mentioned light emitting diode elements, and the input characteristics of the power source part imitate the load characteristics of a discharge lamp. Since by this construction the input characteristics of the power source part imitate the load characteristics of a discharge lamp, no hindrance occurs for the starting circuit, even if it is used, substituted in a discharge lamp. Moreover, by the fact that a rectifying circuit is established in the power source part, direct current as well as alternating current can be used. and since a power factor correcting means has been established, the efficiency of use of electric power when the output of the starting circuit is an alternating current, is high. Moreover, by the current limiting element, flowing of an overcurrent in the light emitting diode can be prevented.

0012

The invention of claim 9 is one wherein, in the invention of claim 8, the above mentioned load characteristics are current voltage characteristics at the time of stable starting of the discharge lamp. By this construction, the starting circuit comes to act in the same way as in the case of stable starting of a discharge lamp, and the stress to the starting circuit is small. The invention of claim 10 is one wherein, in the invention of claim 9, the above mentioned discharge lamp is a fluorescent lamp. Since by this construction, a fluorescent lamp that is the most generally used discharge lamp for illumination, comes to be imitated, a result of high economy comes to occur by replacement with a fluorescent lamp.

0013

The invention of claim 11 is one wherein, in the invention of claim 8, light emitting diode elements are connected with each group, so that a number of light emitting diode elements constitute a number of groups, and the starting state of the respective light emitting diode elements can be controlled in every group. By this construction it becomes possible to change the light distribution by execution of starting and light modulation in every group.

0014

The invention of claim 12 is one that is equipped with a light guiding plate whereby light that has been guided in from the light source that has been arranged opposite to peripheral surface of the plate shaped body, is leaked from at least one surface of front and back, and a light emitting diode element that is the above mentioned light source. By this construction, a relatively cheap surface light source can be offered by the combination of a light guiding plate and light emitting diode elements. The invention of claim 13 is one wherein, in the invention of claim 12, light emitting diode elements are grouped in a number of groups, opposite to the peripheral surface of the light guiding plate. By this construction, it is possible to attach changes in clearness of the respective domains of the light guiding plate by arrangement and starting control of light emitting diode elements.

0015

The invention of claim 14 is one wherein, in the invention of claim 13, light emitting diode elements with a number of emission colours have been grouped. By this construction, it is possible to change the emission colour of the light emitting diode elements and the emitted colour of the light guiding plate, corresponding with the arrangement. The invention of claim 15 is one wherein, in the invention of claim 13, it is used in an illumination device wherein a display pattern has been established in at least one surface of front and back of the light guiding plate, and the light emitting diode elements have been grouped in such a way that the quantity of leaked light from the light guiding plate increases when the quantity of transmitted light in the display pattern increases. Since by this construction the situation arrives that, when parts in the display with a large quantity of transmitted light increase, the quantity of light that leaks from the transmissive plate increases, the contrast of clear parts and dark parts of the display pattern is emphasised and it is easy to recognise the display pattern.

0016

The invention of claim 16 is one wherein, in the invention of claim 13, it is used in an illumination device wherein a display pattern has been established in at least one surface of front and back of the light guiding plate, and wherein the light emitting diode elements with a number of emission colours have been grouped in such a way that the colour of the coloured parts in the display pattern and the colour of the light that leaks from the light guiding plate coincide. Since by this construction, the colour contrast in a coloured display pattern is emphasised, recognition of the pattern is easy.

0017

The invention of claim 17 is one wherein, in the invention of claim 13, the light output of the respective light emitting diode elements is modulated by a light modulating means. By this construction, adjustment of the light quantity of the light guiding plate is possible by light modulation of the light emitting diode elements. The invention of claim 18 is one wherein the respective light emitting diode elements are connected with every group, so that a number of light emitting diode elements constitute a number of groups, and the starting state of the respective light emitting diode elements can be controlled in every group. By this construction, it is possible to change the light distribution by carrying out starting and light modulation in every group.

0018

[Form of execution of the invention]

(Form of execution 1)

This form of execution is one wherein, as is shown in figure 1, a number of light emitting diode elements that have scattering light distribution characteristics, have been grouped on a plane (the dot-stripe lines in figure 1 mean that light emitting diode elements 1 have been grouped). Light emitting

diode elements 1 may be ones with a lens as well as a bare chip. Light emitting diode elements 1 are grouped, following a sine rule, so that changes of the grouping density occur in the respective domains of the arrangement range. Here, the sine rule is established in such a way that, when the distance from the centre of the arrangement range of light emitting diode element 1 is called x , the density of light emitting elements 1 is established in such a way that $a + \sin(x/b\pi)$ is satisfied. Herein a and b are constants. The light distribution in this case is as is shown by the solid line of figure 2. Figure 2 shows in the horizontal axis the distance up to shining surface that is parallel to the surface wherein light emitting diode elements 1 have been grouped, as the unit distance, dividing the distance from base point that faces the centre of the arrangement range of light emitting diode elements 1 inside the shining surface by the unit distance.

0019

In figure 2, the arrangement range of light emitting diode elements 1 is a range of ± 2 , and $a = 1.5$ and $b = 4$. It was understood that in this range the luminance differences are small in the range ± 1.5 , and that outside the range of ± 2.5 , the luminance rapidly declines. In short, it is possible to obtain a uniform luminance in the shining surface in places wherein the distance from the base point is within a prescribed range. As an example for comparison, the light distribution in the case that light emitting diode elements 1 have been grouped with a uniform density on a plane, is shown by a dotted line in figure 2. When light emitting diode elements 1 have, in the same way as mentioned above, been arranged in a range of ± 2 , a luminance that is more than the luminance that was obtained in the position of ± 2.5 in the above mentioned construction, is obtained in the range of ± 3.5 . In the above mentioned construction, however, luminance differences that depend on the distance are larger than in the above mentioned construction.

0020

Because, as is clear from the above mentioned explanation, however, a uniform luminance is obtained within the target range of the shining surface, it can be said that it is wanted that light emitting diode elements 1 are, as in this form of execution, grouped, following the sine rule. Moreover, in the case that light emitting diode elements 1 have been arranged so that they are placed close together, it is possible that by the generation of heat by light emitting diode elements 1, the temperature of the central part is higher than in the peripheral part, but by making the arrangement density of the central part smaller than in the peripheral part, the temperature difference of the central part and the peripheral part can be reduced. Such a grouping can also be obtained by the sine rule, as discussed above. Now, for the light emitting diode elements 1, the light emission characteristics change when the temperature rises, and depending on the case, collapse is sometimes reached, but by reducing the temperature difference of central part and peripheral part in the arrangement range as discussed above, the fluctuations of light emission characteristics decline, and reliability rises.

0021

(Form of execution 2)

In form of execution 1, light emitting diode elements that have scattering light distribution characteristics were used, but in this form of execution, light emitting diode elements 1 that have light distribution characteristics of a spot light source are used. The light distribution in the case that such light emitting diode elements 1 have been grouped in the same way as in form of execution 1, is shown in figure 3. The solid line in figure 3 shows the light distribution of this form of execution with an arrangement following the sine rule, and the dotted line shows the light distribution of an example for comparison with an arrangement with a uniform density.

0022

Since according to figure 3, there is no wide difference of uniformity of luminance between this form of execution and the example for comparison, but since the rate of decline of the luminance outside the specific range is larger in this form of execution, this form of execution is preferably used in applications such as illumination of only a specific range with a uniform luminance. The other structures are the same as in form of execution 1. Now, to obtain a light source wherein locally luminance is raised, as in this form of execution, the arrangement density in the central part of the arrangement range of light emitting diode elements 1 may be made higher than in the peripheral part.

0023

(Form of execution 3)

By the fact that in this form of execution, as is shown in figure 4, light emitting diode elements 1 are arranged on concentric circles as shown by the dot-stripe lines in figure 4, and that light emitting diode elements 1 that have been arranged on the concentric circles have a shared connection, the light emitting diode elements 1 on the respective circumferences are split in respective groups G1, G2, Herein, ones that have scattering light distribution characteristics are used as light emitting diode elements 1.

0024

The starting state of light emitting diode elements 1 is controlled in every group G1, G2, ... by controlling circuit 2. The starting state of light emitting diode elements 1 means the separation of starting and extinction, and light modulation, and by the fact that the starting state is separately controlled in every group G1, G2, ..., light modulation can be changed. If for instance the light output of light emitting diode elements 1 in the central part of the arrangement range is made smaller than that of light emitting diode elements 1 in the peripheral parts, it is equivalent to making the arrangement density of the central part smaller than in the peripheral part. Consequently, it is possible to obtain the light distribution that has been shown by the solid lines in figure 2 and the light distribution that has been shown by the dotted lines in figure 2 in form of execution 1, by simply controlling the light output of light emitting diode elements 1 by control circuit 2. If now ones that have the light distribution of a spot light source in the same way as in form of execution 2, are used as light emitting diode elements 1, the light distribution that has been shown by the solid line and the light distribution that has been shown by the dotted line in figure 3 can be obtained. Since moreover, the starting state of light emitting diode elements 1 can be optionally changed by control circuit 2, it can also be established in another light distribution than the light distribution that has been shown in figure 3.

0025

(Form of execution 4)

As is shown in figure 5, in this form of execution, a number of light emitting diode elements 1 have been accommodated in cylindrical tube 3 that has been formed with the same form and same dimensions as a ready-made fluorescent lamp. In both end parts of tube 3, bases 4 that can be attached and detached in a socket for fluorescent lamps, are established. In short, for the external observation, it is formed in the same way as a ready-made fluorescent lamp. In the interior of tube 3, light emitting diode elements 1 and a driving circuit as is shown in figure 6 are accommodated. The driving circuit is constructed in such a way that light emitting diode elements 1 are started by the output of the starting circuit for fluorescent lamps. In short, rectifying circuit RE that consists of a diode bridge, is provided as a power source part, and between the direct current output terminals of rectifying circuit RE, a serial circuit of resistance R as a current limiting element, and a number of diode elements 1 have been connected. The alternating current input terminals of rectifying

circuit RE are respectively connected to respectively 1 terminal pin 5 of base 4 that has been established in the respective ends of tube 3.

0026

By such a construction, it can be used instead of a fluorescent lamp for an existing illumination device for fluorescent lamps. Moreover, since light emitting diode elements 1 are serially connected and resistance R is serially connected, light emitting diode elements 1 can be started without establishing a voltage reducing circuit. Moreover, since resistance R is current limiting, an overcurrent does not flow in light emitting diode elements 1, even if a relatively high voltage is applied between alternating current input terminals of rectifying circuit RE. Moreover, since rectifying circuit RE is established, it is possible that an electricity source that supplies electricity is used, irrespective of being a direct current source or an alternating current source. Moreover, since rectifying circuit RE is a full wave rectifying circuit, it is depolarising, and the polarity of an electricity source is no problem, even in the case that an alternating current power source is used.

0027

(Form of execution 5)

As is shown in figure 7, in this form of execution, power source part 6 that contains a rectifying circuit as driving circuit, and a power factor correction circuit, and resistance R as current limiting element, are established. The rectifying circuit that constitutes power source part 6 is a full wave rectifying circuit that consists of a diode bridge in the same way as form of execution 4, and the power factor correction circuit is for instance constructed by a chopper circuit, and outputs a direct current voltage. The structure of the chopper circuit has no special limitations and various types of chopper circuits, such as a voltage reducing type, voltage rising type, and polarity inverting type can be used. Irrespective of the type, such chopper circuits include a serial circuit of an inductance and switching element and because, by switching the switching element ON and OFF with a high frequency, the output of the rectifying circuit flows with a high frequency in the inductance, an input current flows with a high frequency and a rise of input current strain is prevented, in the case that an alternating current power source has been connected, and since in addition the enveloping coil of the input current can be compared with the input voltage, the input power factor rises.

0028

Between the output terminals of this power source part 6, a serial circuit of resistance R and a number of light emitting diode elements 1 is connected, and the input terminal of power source part 6 is connected each time with 1 terminal pin 5 of the respective bases 4 in the same way as in form of execution 4. Since, however, a power factor correction circuit with a structure as discussed above is established in power source part 6, the input characteristics can be changed by proper control of the switching element. Here, in this form of execution, the input characteristics of power source part 6 are established in such a way that they imitate the load characteristics of a discharge lamp. Particularly because this form of execution is used instead of a fluorescent lamp, it is matched with the load characteristics of a fluorescent lamp, and is especially made to coincide with the current voltage characteristics at the time of stable starting (at the time of regular starting) of a fluorescent lamp. The other structures and actions are the same as in form of execution 4.

0029

Now, in form of execution 4 and form of execution 5, light emitting diode elements 1 are split in groups in the same way as in form of execution 3, and in each group, the starting state may be controlled. Moreover, in the respective above mentioned forms of execution, it is preferred that a white emission colour is obtained by using light emitting diode elements 1 with different emission colours and colour mixing, and by using white light emitting diodes (that

radiate white light by shining blue light to a fluorescent substance with yellow light emission).

0030

(Form of execution 6)

This form of execution is mainly used for displays, and as is shown in figure 8, a number of light emitting diode elements 1r, 1g and 1b are grouped in such a way that they face the terminal surface of light guiding plate 7 with the form of a flat plate. As light emitting diode elements 1r, 1g and 1b, red, green and blue ones are used. In this way, the situation is brought about that the light of mixed colours by the use of light emitting diode elements 1r, 1g and 1b with different emission colours becomes almost white. Light guiding plate 7 is a transmissive plate, and it has been formed in such a way that the light is guided while a part of the light that has been introduced from the end surface is reflected, and the rest is leaked from at least one surface of the front and the back surface. Consequently, light leakage is helped by establishment of a scattering plate that has scattering transmissivity in the surface with light leakage in light guiding plate 7, and in the surface without light leakage, a reflecting plate is established. The reflecting plate is one wherein mirror surfaces have been stacked in the back surface side of a small reflecting plate with a small surface area that has a scattering reflectivity, and surface area and arrangement of the small reflecting plate are considered in such a way that the leaking light quantity is almost uniform, irrespective of the place of light guiding plate 7. If necessary, the surface area of the small reflecting plate per unit of surface area is made small in the vicinity of light emitting diode elements 1r, 1g and 1b, and the longer the distance from light emitting diode elements 1r, 1g and 1b, the larger the surface area of the small reflecting plate per unit of surface area.

0031

In the example that is shown in figure 8, light emitting diode elements 1r, 1g and 1b are grouped in one row in the end surface of light guiding plate 7, and if, as is shown in figure 9, again a larger number of light emitting diode elements 1r, 1g and 1b are grouped, light can be emitted with a high brightness. Moreover, as is shown in figure 10, it is possible to raise the brightness and to raise the uniformity of the brightness by grouping light emitting diode elements (1r, 1g and 1b) in all end surfaces of light guiding plate 7.

0032

Light emitting diode elements 1r, 1g and 1b in this form of execution are serially connected as groups for every emission colour, and as is shown in figure 11, they are serially connected between collector-emitter of switching transistors Qr, Qg and Qb in every serial circuit of light emitting diode elements 1r, 1g and 1b of the respective colours. Switching transistors Qr, Qg and Qb are separately controlled by control circuit 2. Consequently, the brightness of the respective light emitting diode elements 1r, 1g and 1b can be regulated by changing the ON-OFF duty of switching transistors Qr, Qg and Qb. In short, it is possible to change the light colour by changing the colour mixing rate of the respective colours, and to change the brightness of the whole. In short, it is possible to use control circuit 2 as a light regulating means and as a colour regulating means.

0033

(Form of execution 7)

In carrying out a display with the use of light guiding plate 7 that has been explained in form of execution 6, display panel 8 wherein a display pattern has been established, is, as is shown in figure 12, arranged, piled on light guiding plate 7. In figure 12, light guiding plate 7 is sandwiched by display panel 8 and reflecting plate 9. Reflecting plate 9 is the same as has been explained in form of execution 6.

0034

In this form of execution, light emitting diode elements 1 are, in the same way as in form of execution 1, grouped by the sine rule, so that one surface of light guiding plate 7 whereon display panel 8 has been piled, gets a uniform clearness. In short, the arrangement density in the central part in longitudinal direction of the end surface of light guiding plate 7 is lower than in the peripheral part. By adopting such a structure, the uniformity of the clearness of the front surface of light guiding plate 7 can be raised. Moreover, light emitting diode elements 1 may be split in a number of groups, and in every group, the starting state may be controlled. In this case, a difference in clearness of the respective domains of light guiding plate 7 can be established. By the fact that here in the control of the starting state of light emitting diode elements 1, the same structure is adopted as in control circuit 2 of form of execution 6, control circuit 2 can be used as a light modulating means.

0035

Now, by the fact that terminal pins 5 that, as is shown in figure 13, have been arranged in the same way as a fluorescent lamp, is established, a normal socket for fluorescent lamps can be used. In short, it can be used, substituting a display device wherein fluorescent lamps and light guiding plates are used. Other structures and actions are the same as in form of execution 6.

(Form of execution 8)

In order to facilitate the recognition of display patterns when display panel 8 is established as in form of execution 7, it is considered to raise the contrast of the display panel. As a technique that raises the contrast, it is preferred that light emitting diode elements 1 are grouped in such a way that the quantity of light that leaks from light guiding plate 7 increases when the number of sites with a large quantity of transmitted light in the display pattern increases. Now, the increase or decline of the quantity of leaked light can also be controlled by reflecting plate 9.

0036

Moreover, in the case that the display pattern is coloured, as is shown in figure 14 (in the example that is shown in the figure, domains Dr, Dg and Db are ones that respectively have been coloured red, green and blue), it is preferred that in the vicinity of the respective domains Dr, Dg and Db, light emitting diode elements 1r, 1g and 1b that are emission colours with colours of the same system as these domains Dr, Dg and Db, are arranged, as is shown in figure 15. By this construction, the colour of a coloured site of the display pattern becomes clear, and the contrast of colours is emphasised, and the recognisability of the display pattern can be raised. Now, this structure may be used if necessary.

0037

[Results of the invention]

In the invention of claim 1, a number of light emitting diode elements have been grouped with an arrangement density that corresponds with the light distribution design, and an advantage is that by the fact that the light emitting diode elements have been grouped, a surface light source can be obtained in a simple way, and in addition, that correspondence with the colour distribution design by the light source itself is possible, by the fact that the grouping density of light emitting diode elements is established, corresponding with the light distribution design. In short, because an apparatus that is equipped with a light distribution controlling element, is almost not necessary, an advantage is that a relatively small type of illuminating device can be constructed, and in addition that, if it is replaced for a light source with a different grouping density of the light emitting diode elements, the light distribution can be modified in a simple way, even after the execution. Moreover, another advantage is that the number of exchanges is small, since the light emitting diode elements have a lifespan that is the same or longer as that

of light sources that are generally used, such as incandescent electric bulbs and fluorescent lamps.

0038

In the case that the light emitting diode elements are bare chips, as in the invention of claim 2, an advantage is that a light source with a high brightness is obtained by raising the arrangement density of the light emitting diode elements. In the case that the grouping density of light emitting diode elements in the central part is lower than in the peripheral part, so that the luminance of the shining surface is fixed, as in the invention of claim 3, an advantage is that the luminance of the shining surface is almost uniform.

0039

In the case that the grouping density of light emitting diode elements in the central part is higher than in the peripheral part, as in the invention of claim 4, an advantage is that the luminance of the shining surface is more in the vicinity directly below it, and illumination with a partially raised luminance is possible. In the invention of claim 5, the respective light emitting diode elements are connected with every group, so that a number of light emitting diode elements constitute a number of groups, and the situation of starting of the respective light emitting diode elements can be controlled in every group. and it has the advantage that by the fact that starting and light modulation are carried out in every group, it is possible to cause a change of the light distribution.

0040

The invention of claim 6 is equipped with a number of light emitting diode elements and a driving circuit that is connected with the output of a starting circuit for discharge lamps and causes the above mentioned light emitting diode elements to start, and it has the advantage that illumination by light emitting diode elements is possible if an illumination apparatus wherein normal discharge lamps such as a fluorescent lamp are used, are removed and only the light source is exchanged. In short, an advantage is that by giving the output of the starting circuit to the driving circuit, light emitting diode elements can be started in a stable way without application of an overvoltage to the light emitting diode elements, and the flowing of an overcurrent in the light emitting diode elements.

0041

Since, as in the invention of claim 7, the above mentioned driving circuit is equipped with a power source part that includes a rectifying circuit that is connected with the starting circuit, and a current limiting element that limits the (electric) current that is made to pass from the above mentioned power source part to the above mentioned light emitting diode elements, an advantage is that a rectifying circuit is provided in the electric power part, and that the output of the starting circuit can be used, be it direct current or alternating current. Moreover, an advantage is that flowing of an overcurrent in the light emitting diode elements is prevented by a current limiting element.

0042

Since, in the case that, as in the invention of claim 8, the above mentioned driving circuit is equipped with a power source part that contains a rectifying circuit and a power factor correction means that are connected with the starting circuit, and current limiting elements that limit the (electric) current that is passed from the above mentioned power source part to the above mentioned light emitting diode elements, and the input characteristics of the power source part imitate the load characteristics of a discharge lamp, and the input characteristics of the power source part imitate the load characteristics of a discharge lamp, it has the advantage that no hindrance is produced for the starting circuit, even if it is used, substituted in a discharge lamp, and by the fact that a rectifying circuit is established in the power source part, the

output of the starting circuit can be used, in the case of direct current as well as an alternating current, and in addition, it has the advantage that, since a power factor correction circuit has been established, the efficiency of use of electric power when the output of the starting circuit is an alternating current, is high. Moreover, by a current limiting element, it also has the effect that the flow of an overcurrent in the light emitting diode elements can be prevented.

0043

In the case that, as in the invention of claim 9, the above mentioned load characteristics are used as current voltage characteristics at the time of stable starting of the discharge lamp, it comes to the same action as when the starting circuit has caused stable starting of a discharge lamp, and stress to the starting circuit is small, there is no need to design a separate starting system, and it can be used as a light source of ready-made illumination apparatuses. Since, in the case that the above mentioned discharge lamp is a fluorescent lamp as in the invention of claim 10, it comes to imitate a fluorescent lamp that is the discharge lamp that is most often used in general illumination, a high economic result comes to be produced by exchange with a fluorescent lamp.

0044

In the case wherein, as in the invention of claim 11, the respective light emitting diode elements are connected with every group, so that a number of light emitting diode elements constitute a number of groups, and the starting state of the respective light emitting diode elements can be controlled in every group, an advantage is that light distribution can be changed by the fact that starting and light modulation are carried out for every group.

0045

The invention of claim 12 is equipped with a light guiding plate whereby light that has been guided in from the light source that has been arranged opposite to the peripheral surface of the plate shaped body, is leaked from at least one surface of front and back, and a light emitting diode element that is the above mentioned light source, and it has the advantage that it can offer a relatively cheap surface light source by the combination of a light guiding plate and a light emitting diode element. In the case that, as in the invention of claim 13, light emitting diode elements are grouped in a number of groups, opposite to the peripheral surface of the light guiding plate, it has the advantage that it is possible to give changes of clearness of the respective domains of the light guiding plate by arrangement of light emitting diode elements and starting control.

0046

Since, in the case that, as in the invention of claim 14, light emitting diodes with a number of emission colours have been grouped together, the advantage is that emission colour of the light guiding plate can be changed, corresponding with the emission colour and the arrangement of the light emitting diode elements. In the case that, as in the invention of claim 15, it is used in an illumination device wherein a display pattern has been established in at least one surface of front and back of the light guiding plate, and the light emitting diode elements have been grouped in such a way that the quantity of leaked light from the light guiding plate increases when the quantity of transmitted light in the display pattern increases, the situation arrives that the quantity of leaked light from the light guiding plate increases when parts with a large quantity of transmitted light in the display pattern increases, and an advantage is that the contrast of clear parts and dark parts of the display pattern is emphasized, and the display pattern is easily recognised.

0047

In the case that, as in the invention of claim 16, it is used in an illumination device wherein a display pattern has been established in at least one surface of front and back of the light guiding plate, and light emitting diode elements with a number of emission colours have been grouped in such a way that the colour of the coloured parts in the display pattern and the colour of the light that leaks from the light guiding plate coincide, an advantage is that, since it is possible to emphasise the contrast of colours in the coloured display pattern, the display pattern becomes easy to recognise.

0048

Ones wherein, as in the invention of claim 17, the light output of the respective light emitting diode elements is modulated by a light modulating means, have the advantage that the light quantity of the light guiding plate can be modulated by light modulation of the light emitting diode elements.

The invention of claim 18 is one wherein the respective light emitting diode elements are connected with every group, so that a number of light emitting diode elements constitute a number of groups, and the starting state of the respective light emitting diode elements can be controlled in every group, and it has the advantage is that the light distribution can be changed by carrying out starting and light modulation in each group.

[Brief description of the figures]

[Figure 1]

is an outline structure that shows form of execution 1.

[Figure 2]

is an explanatory drawing thereof.

[Figure 3]

is an explanatory drawing of the action of form of execution 2.

[Figure 4]

is an outline structure that shows form of execution 3.

[Figure 5]

is a perspective view that shows form of execution 4.

[Figure 6]

is a circuit drawing thereof.

[Figure 7]

is a circuit drawing that shows form of execution 5.

[Figure 8]

is a perspective view that shows form of execution 6.

[Figure 9]

is a perspective view of essential parts that shows another example of form of execution 6.

[Figure 10]

is a perspective view of essential parts that shows a separate example of form of execution 6.

[Figure 11]

is a circuit drawing thereof.

[Figure 12]

is a plane view that shows form of execution 7.

[Figure 13]
is a front view thereof.

[Figure 14]
is an analytical perspective view that shows form of execution 8.

[Figure 15]
is a perspective view thereof.

[Figure 16]
is an explanatory drawing of the action that shows an existing example.

[Explanation of the symbols]

1 light emitting diode element
1r, 1g, 1b light emitting diode elements
2 control circuit
3 tube body
4 base
5 terminal pin
6 (electric) power source part
7 light guiding plate
8 display panel
9 reflecting plate
Dr, Dg, Db domains
G1, G2 groups
R resistance
RE rectifying circuit

Figure 1.
1 light emitting diode element

Figure 2.
vertical axis relative luminance
horizontal axis distance

Figure 3.
vertical axis relative luminance
horizontal axis distance

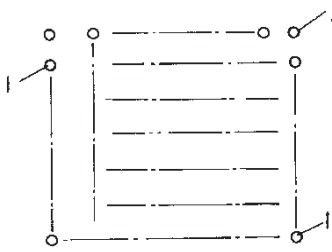
Figure 4.
2 control circuit

Figure 7.
6 power source part

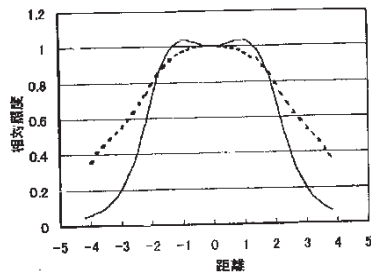
Figure 11.
2 control circuit

Figure 16.
vertical axis relative luminance
horizontal axis distance

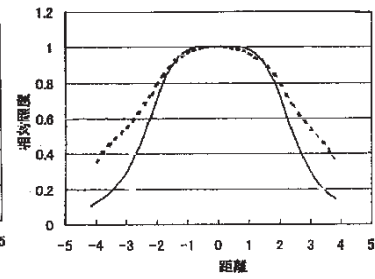
【図1】



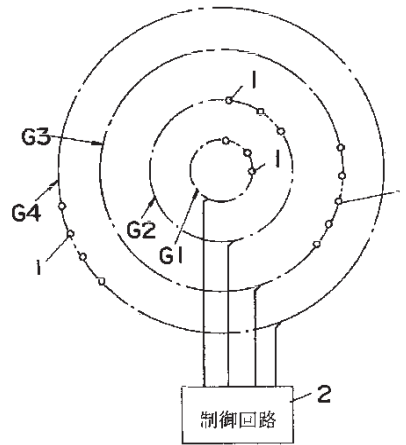
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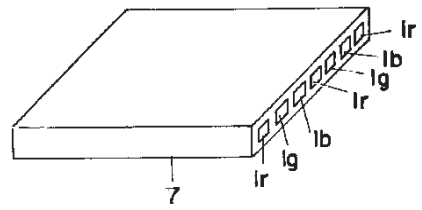
【図3】



【図4】

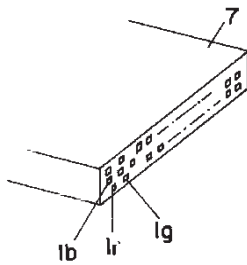


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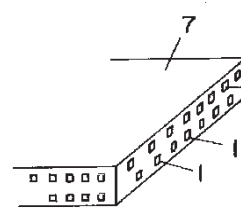


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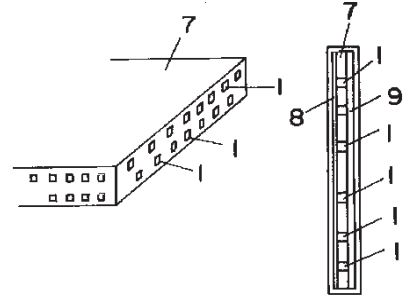
【図9】



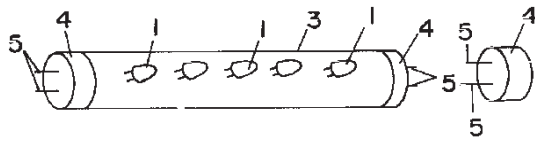
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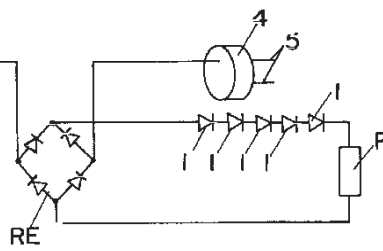
【図12】



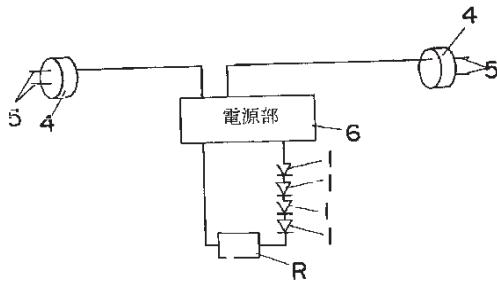
【図5】



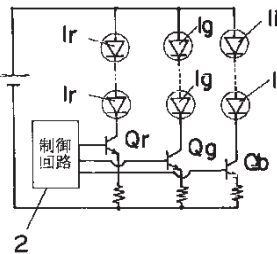
【図6】



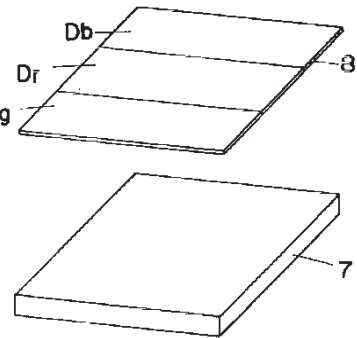
【図7】



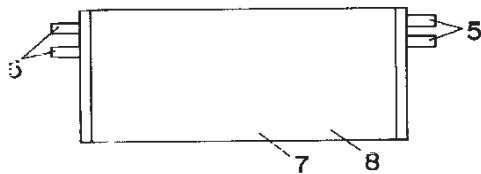
【図11】



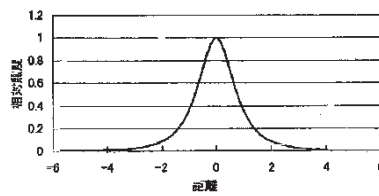
【図14】



【図13】



【図16】



【図15】

