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Light source device and projector

Abstract

A light source device according to the present disclosure includes a light emitting element for emitting first light, a wavelength conversion member for converting the first light into second light, and a support member. The wavelength conversion member has a first face and a second face crossing a longitudinal direction of the wavelength conversion member, a third face and a fourth face crossing the first face and the second face, and a fifth face and a sixth face crossing the first face and the second face and crossing the third face and the fourth face, and the second light is emitted from the first face. A light emitting surface of the light emitting element is opposed to the third face.

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Background/Summary

(1) The present application is based on, and claims priority from JP Application Serial Number 2021-188622, filed Nov. 19, 2021, the disclosure of which is hereby incorporated by reference herein in its entirety.

BACKGROUND

1. Technical Field

(2) The present disclosure relates to a light source device and a projector.

2. Related Art

(3) As a light source device used for a projector, there is proposed a light source device using fluorescence emitted from a phosphor when irradiating the phosphor with excitation light emitted from a light emitting element.

(4) In International Patent Publication No. WO 2020/254455, there is disclosed a light source device provided with an excitation light source for emitting excitation light, a phosphor shaped like

a rod for converting the excitation light into fluorescence, and a heat conduction member for releasing the heat generated in the phosphor. The heat conduction member is disposed so as to cover the periphery of the phosphor.

(5) However, in the light source device described above, the excitation light emitted from the excitation light source partially enters the heat conduction member, but does not sufficiently enter the phosphor in some cases. In this case, the use efficiency of the excitation light is low, and there is a possibility that it is unachievable to obtain the fluorescence having a desired intensity.

SUMMARY

(6) In view of the problems described above, a light source device according to an aspect of the present disclosure includes a light emitting element which has a light emitting surface, and which is configured to emit first light having a first wavelength band from the light emitting surface, a wavelength conversion member which includes a phosphor, and which is configured to convert the first light emitted from the light emitting element into second light having a second wavelength band different from the first wavelength band, and a support member configured to support the wavelength conversion member. The wavelength conversion member has a first face and a second face which cross a longitudinal direction of the wavelength conversion member, and which are located at respective sides opposite to each other, a third face and a fourth face which cross the first face and the second face, and which are located at respective sides opposite to each other, and a fifth face and a sixth face which cross the first face and the second face, and which cross the third face and the fourth face, and which are located at respective sides opposite to each other, and the second light is emitted from the first face. The light emitting surface is disposed so as to be opposed to the third face. The support member has a support surface opposed to the fourth face, and a first wall surface which is opposed to the fifth face, and which is separated from the fifth face. The first wall surface has a first portion located at the wavelength conversion member side, and a second portion located at the support surface side, the first portion extends in a direction perpendicular to the support surface, and the second portion is tilted so as to get away from the fifth face as proceeding toward the first portion from the support surface, and the second portion reflects at least a part of the first light.

(7) A projector according to an aspect of the present disclosure includes the light source device according to the aspect of the present disclosure, a light modulation device configured to modulate light including the second light from the light source device in accordance with image information, and a projection optical device configured to project the light modulated by the light modulation device.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

(1) FIG. 1 is a schematic configuration diagram of a projector according to a first embodiment.

(2) FIG. 2 is a schematic configuration diagram of a first illumination device according to the first embodiment.

(3) FIG. 3 is a cross-sectional view of a light source device along the line III-III shown in FIG. 2.

(4) FIG. 4 is a cross-sectional view of the light source device according to a comparative example.

(5) FIG. 5 is a cross-sectional view of a light source device according to a second embodiment.

(6) FIG. 6 is a cross-sectional view of a light source device according to a third embodiment.

(7) FIG. 7 is a cross-sectional view of a light source device according to a fourth embodiment.

(8) FIG. 8 is a cross-sectional view of a light source device according to a fifth embodiment.

DESCRIPTION OF EXEMPLARY EMBODIMENTS

First Embodiment

(9) A first embodiment of the present disclosure will hereinafter be described using FIG. 1 through

FIG. 5.

(10) A projector according to the present embodiment is an example of a projector using liquid crystal panels as light modulation devices.

(11) In the drawings described below, constituents are shown with respective dimensional scale ratios different from each other in some cases in order to make the constituents eye-friendly.

(12) FIG. 1 is a diagram showing a schematic configuration of the projector 1 according to the present embodiment.

(13) As shown in FIG. 1, the projector 1 according to the present embodiment is a projection-type image display device for displaying a color image on a screen (a projection target surface) SCR. The projector 1 is provided with three light modulation devices corresponding to respective colored light, namely red light LR, green light LG, and blue light LB.

(14) The projector 1 is provided with a first illumination device 20, a second illumination device 21, a color separation optical system 3, a light modulation device 4R, a light modulation device 4G, a light modulation device 4B, a light combining element 5, and a projection optical device 6.

(15) The first illumination device 20 emits fluorescence Y having a yellow color toward the color separation optical system 3. The second illumination device 21 emits the blue light LB toward the light modulation device 4B. The detailed configurations of the first illumination device 20 and the second illumination device 21 will be described later.

(16) Hereinafter, in the drawings, the explanation will be presented using an XYZ coordinate system as needed. A Z axis is an axis extending along a vertical direction of the projector 1. An X axis is an axis parallel to an optical axis AX1 of the first illumination device 20 and an optical axis AX2 of the second illumination device 21. A Y axis is an axis perpendicular to the X axis and the Z axis. The optical axis AX1 of the first illumination device 20 is a central axis of the fluorescence Y emitted from the first illumination device 20. The optical axis AX2 of the second illumination device 21 is a central axis of the blue light LB emitted from the second illumination device 21.

(17) The color separation optical system 3 separates the fluorescence Y having the yellow color emitted from the first illumination device 20 into the red light LR and the green light LG. The color separation optical system 3 is provided with a dichroic mirror 7, a first reflecting mirror 8a, and a second reflecting mirror 8b.

(18) The dichroic mirror 7 separates the fluorescence Y into the red light LR and the green light LG. The dichroic mirror 7 transmits the red light LR, and at the same time, reflects the green light LG. The second reflecting mirror 8b is disposed in a light path of the green light LG. The second reflecting mirror 8b reflects the green light LG, which has been reflected by the dichroic mirror 7, toward the light modulation device 4G. The first reflecting mirror 8a is disposed in a light path of the red light LR. The first reflecting mirror 8a reflects the red light LR, which has been transmitted through the dichroic mirror 7, toward the light modulation device 4R.

(19) Meanwhile, the blue light LB emitted from the second illumination device 21 is reflected by a reflecting mirror 9 toward the light modulation device 4B.

(20) A configuration of the second illumination device 21 will hereinafter be described.

(21) The second illumination device 21 is provided with a light source 81, a condenser lens 82, a diffuser plate 83, a rod lens 86, and a relay lens 87. The light source 81 is formed of at least one semiconductor laser. The light source 81 emits the blue light LB consisting of a laser beam. It should be noted that the light source 81 is not limited to the semiconductor laser, but can also be formed of an LED for emitting blue light.

(22) The condenser lens 82 is formed of a convex lens. The condenser lens 82 makes the blue light LB emitted from the light source 81 enter the diffuser plate 83 in a state in which the blue light LB emitted from the light source 81 is substantially converged. The diffuser plate 83 diffuses the blue light LB emitted from the condenser lens 82 at a predetermined diffusion angle to generate a substantially homogenous light distribution substantially the same as that of the fluorescence Y emitted from the first illumination device 20. As the diffuser plate 83, there is used, for example,

obscured glass made of optical glass.

(23) The blue light LB diffused by the diffuser plate **83** enters the rod lens **86**. The rod lens **86** has a prismatic shape extending along a direction of the optical axis AX2 of the second illumination device **21**. The rod lens **86** has an end plane of incidence of light **86a** disposed at one end, and a light exit end surface **86b** disposed at the other end. The diffuser plate **83** is fixed to the end plane of incidence of light **86a** of the rod lens **86** via an optical adhesive (not shown). It is desirable to make the refractive index of the diffuser plate **83** and the refractive index of the rod lens **86** coincide with each other as precise as possible.

(24) The blue light LB is emitted from the light exit end surface **86b** in the state in which homogeneity of an illuminance distribution is enhanced by propagating through the rod lens **86** while being totally reflected. The blue light LB emitted from the rod lens **86** enters the relay lens **87**. The relay lens **87** makes the blue light LB enhanced in homogeneity of the illuminance distribution by the rod lens **86** enter the reflecting mirror **9**.

(25) The shape of the light exit end surface **86b** of the rod lens **86** is a rectangular shape substantially similar to a shape of an image formation area of the light modulation device **4B**. Thus, the blue light LB emitted from the rod lens **86** efficiently enters the image formation area of the light modulation device **4B**.

(26) The light modulation device **4R** modulates the red light LR in accordance with image information to form image light corresponding to the red light LR. The light modulation device **4G** modulates the green light LG in accordance with the image information to form image light corresponding to the green light LG. The light modulation device **4B** modulates the blue light LB in accordance with the image information to form image light corresponding to the blue light LB.

(27) As each of the light modulation devices **4R**, **4G**, and **4B**, there is used, for example, a transmissive liquid crystal panel. Further, on the incident side and the exit side of each of the liquid crystal panels, there are respectively disposed polarization plates (not shown). The polarization plate transmits linearly-polarized light of a specific direction.

(28) At the incident side of the light modulation device **4R**, there is disposed a field lens **10R**. At the incident side of the light modulation device **4G**, there is disposed a field lens **10G**. At the incident side of the light modulation device **4B**, there is disposed a field lens **10B**. The field lens **10R** collimates a principal ray of the red light LR entering the light modulation device **4R**. The field lens **10G** collimates a principal ray of the green light LG entering the light modulation device **4G**. The field lens **10B** collimates a principal ray of the blue light LB entering the light modulation device **4B**.

(29) The light combining element **5** combines the image light corresponding respectively to the red light LR, the green light LG, and the blue light LB with each other in response to incidence of the image light respectively emitted from the light modulation device **4R**, the light modulation device **4G**, and the light modulation device **4B**, and then emits the image light thus combined toward the projection optical device **6**. As the light combining element **5**, there is used, for example, a cross dichroic prism.

(30) The projection optical device **6** is constituted by a plurality of projection lenses. The projection optical device **6** projects the image light having been combined by the light combining element **5** toward the screen SCR in an enlarged manner. Thus, an image is displayed on the screen SCR.

(31) A configuration of the first illumination device **20** will hereinafter be described.

(32) FIG. 2 is a schematic configuration diagram of the first illumination device **20**.

(33) As shown in FIG. 2, the first illumination device **20** is provided with a light source device **100**, an integrator optical system **70**, a polarization conversion element **102**, and a superimposing optical system **103**.

(34) The light source device **100** is provided with a wavelength conversion member **50**, a light source **51**, an angle conversion member **52**, a mirror **53**, and a support member **54**. The light source **51** is provided with a substrate **55** and light emitting elements **56**.

(35) The wavelength conversion member **50** has a quadrangular prismatic shape extending in the X-axis direction, and has six faces. A side extending in the X-axis direction of the wavelength conversion member **50** is longer than a side extending in the Y-axis direction and a side extending in the Z-axis direction. Therefore, the X-axis direction corresponds to a longitudinal direction of the wavelength conversion member **50**. The length of the side extending in the Y-axis direction and the length of the side extending in the Z-axis direction are equal to each other. In other words, a cross-sectional shape of the wavelength conversion member **50** cut by a plane perpendicular to the X-axis direction is a square. It should be noted that the cross-sectional shape of the wavelength conversion member **50** cut by the plane perpendicular to the X-axis direction can be a rectangle.

(36) The wavelength conversion member **50** has a first face **50a** and a second face **50b** which cross the longitudinal direction (the X-axis direction) of the wavelength conversion member **50**, and which are located at respective sides opposite to each other, a third face **50c** and a fourth face **50d** which cross the first face **50a** and the second face **50b**, and which are located at respective sides opposite to each other, and a fifth face **50e** and a sixth face **50f** which cross the third face **50c** and the fourth face **50d**, and which are located at respective sides opposite to each other. In the following description, the third face **50c**, the fourth face **50d**, the fifth face **50e**, and the sixth face **50f** are referred to as side surfaces in some cases.

(37) The wavelength conversion member **50** includes at least a phosphor, and converts excitation light E having a first wavelength band into the fluorescence Y having a second wavelength band different from the first wavelength band. The excitation light E enters the wavelength conversion member **50** from the third face **50c**. The fluorescence Y is guided inside the wavelength conversion member **50**, and is then emitted from the first face **50a**. The excitation light E in the present embodiment corresponds to first light in the appended claims. The fluorescence Y in the present embodiment corresponds to second light in the appended claims.

(38) The wavelength conversion member **50** includes a ceramic phosphor made of a polycrystalline phosphor for performing the wavelength conversion on the excitation light E into the fluorescence Y. The second wavelength band which the fluorescence Y has is a yellow wavelength band of, for example, 490 through 750 nm. Therefore, the fluorescence Y is yellow fluorescence including a red light component and a green light component.

(39) It is also possible for the wavelength conversion member **50** to include a single-crystal phosphor instead of the polycrystalline phosphor. Alternatively, the wavelength conversion member **50** can also be formed of fluorescent glass. Alternatively, the wavelength conversion member **50** can also be formed of a material obtained by dispersing a number of phosphor particles in a binder made of glass or resin. The wavelength conversion member **50** made of such a material converts the excitation light E into the fluorescence Y having the second wavelength band.

(40) Specifically, the material of the wavelength conversion member **50** includes, for example, an yttrium aluminum garnet (YAG) phosphor. Citing YAG:Ce including cerium (Ce) as an activator agent as an example, as the material of the wavelength conversion member **50**, there is used a material obtained by mixing raw powder including constituent elements such as Y_2O_3 , Al_2O_3 and CeO to cause the solid-phase reaction, Y—Al—O amorphous particles obtained by a wet process such as a coprecipitation process or a sol-gel process, and YAG particles obtained by a gas-phase process such as a spray drying process, a flame heat decomposition process or a thermal plasma process.

(41) The light source **51** is provided with the light emitting elements **56** each having a light emitting surface **56a** for emitting the excitation light E in the first wavelength band. The light emitting elements **56** are each formed of, for example, a light emitting diode (LED). The light emitting surface **56a** of the light emitting element **56** is opposed to the third face **50c** of the wavelength conversion member **50**, and emits the excitation light E toward the third face **50c**. The first wavelength band is, for example, a wavelength band from a blue color to a violet color of 400 nm through 480 nm, and has a peak wavelength of, for example, 445 nm. As described above, the

light source **51** is disposed so as to be opposed to the third face **50c** as one of the four side surfaces along the longitudinal direction of the wavelength conversion member **50**.

(42) The substrate **55** supports the light emitting elements **56**. The plurality of light emitting elements **56** is disposed on one surface **55a** of the substrate **55**. The light source **51** is constituted by the light emitting elements **56** and the substrate **55** in the case of the present embodiment, but can also be provided with other optical members such as a light guide plate, a diffuser plate, or a lens. Further, the number of the light emitting elements **56** is not particularly limited.

(43) The support member **54** is disposed so as to surround the wavelength conversion member **50**. The support member **54** supports the wavelength conversion member **50**, and at the same time, diffuses the heat generated in the wavelength conversion member **50** to release the heat to the outside. Therefore, it is desirable for the support member **54** to be formed of a material which has predetermined strength and is high in thermal conductivity. As the material of the support member **54**, there is used metal such as aluminum or stainless steel, and in particular, an aluminum alloy such as 6061 aluminum alloy is preferably used. A specific shape of the support member **54** will be described later.

(44) The mirror **53** is provided to the second face **50b** of the wavelength conversion member **50**. The mirror **53** reflects the fluorescence Y which has been guided inside the wavelength conversion member **50**, and has reached the second face **50b**. The mirror **53** is formed of a metal film or a dielectric multilayer film formed on the second face **50b** of the wavelength conversion member **50**.

(45) In the first illumination device **20**, when the excitation light E emitted from the first light source **51** enters the wavelength conversion member **50**, the phosphor included in the wavelength conversion member **50** is excited, and the fluorescence Y is emitted from an arbitrary light emitting point. The fluorescence Y proceeds from the arbitrary light emitting point toward all directions, but the fluorescence Y having proceeded toward one of the four side surfaces **50c**, **50d**, **50e**, and **50f** proceeds toward the first face **50a** or the second face **50b** while repeating total reflection at a plurality of positions on the side surfaces **50c**, **50d**, **50e**, and **50f**. The fluorescence Y proceeding toward the first face **50a** enters the angle conversion member **52**. The fluorescence Y having proceeded toward the second face **50b** is reflected by the mirror **53**, and then proceeds toward the first face **50a**.

(46) A part of the excitation light E which has not been used for the excitation of the phosphor out of the excitation light E having entered the wavelength conversion member **50** is reflected by a member on the periphery of the wavelength conversion member **50** including the light emitting element **56** of the light source **51**, or the mirror **53** disposed on the second face **50b**. Therefore, the part of the excitation light E is confined inside the wavelength conversion member **50** to be reused.

(47) The angle conversion member **52** is disposed on the light exit side of the first face **50a** of the wavelength conversion member **50**. The angle conversion member **52** is formed of, for example, a taper rod. The angle conversion member **52** has a plane of incidence of light **52a** which the fluorescence Y emitted from the wavelength conversion member **50** enters, a light exit surface **52b** for emitting the fluorescence Y, and a side surface **52c** for reflecting the fluorescence Y toward the light exit surface **52b**.

(48) The angle conversion member **52** has a truncated quadrangular pyramid-like shape, and the area of a cross-section perpendicular to an optical axis J increases along the proceeding direction of the light. Therefore, the area of the light exit surface **52b** is larger than the area of the plane of incidence of light **52a**. An axis which passes through the center of the light exit surface **52b** and the center of the plane of incidence of light **52a**, and is parallel to the X axis is defined as the optical axis J of the angle conversion member **52**. It should be noted that the optical axis J of the angle conversion member **52** coincides with the optical axis AX1 of the first illumination device **20**.

(49) The fluorescence Y having entered the angle conversion member **52** changes the direction so as to approximate to a direction parallel to the optical axis J every time the fluorescence Y is totally reflected by the side surface **52c** while proceeding inside the angle conversion member **52**. In such

a manner, the angle conversion member **52** converts an exit angle distribution of the fluorescence Y emitted from the first face **50a** of the wavelength conversion member **50**. Specifically, the angle conversion member **52** makes a maximum exit angle of the fluorescence Y in the light exit surface **52b** smaller than a maximum incident angle of the fluorescence Y in the plane of incidence of light **52a**.

(50) In general, since an etendue of light defined by a product of the area of the light exit region and a solid angle (the maximum exit angle) of the light is conserved, the etendue of the fluorescence Y is also conserved before and after the transmission through the angle conversion member **52**. As described above, the angle conversion member **52** in the present embodiment has the configuration in which the area of the light exit surface **52b** is made larger than the area of the plane of incidence of light **52a**. Therefore, from a viewpoint of the conservation of the etendue, it is possible for the angle conversion member **52** in the present embodiment to make the maximum exit angle of the fluorescence Y in the light exit surface **52b** smaller than the maximum incident angle of the fluorescence Y entering the plane of incidence of light **52a**.

(51) The angle conversion member **52** is fixed to the wavelength conversion member **50** via an optical adhesive (not shown) so that the plane of incidence of light **52a** is opposed to the first face **50a** of the wavelength conversion member **50**. Specifically, the angle conversion member **52** and the wavelength conversion member **50** have contact with each other via the optical adhesive, and no air gap (no air layer) is disposed between the angle conversion member **52** and the wavelength conversion member **50**. If an air gap is disposed between the angle conversion member **52** and the wavelength conversion member **50**, the fluorescence Y having entered the plane of incidence of light **52a** of the angle conversion member **52** at an angle no smaller than a critical angle out of the fluorescence Y having reached the plane of incidence of light **52a** is totally reflected by the plane of incidence of light **52a**, and fails to enter the angle conversion member **52**. In contrast, when such an air gap is not disposed between the angle conversion member **52** and the wavelength conversion member **50** as in the present embodiment, it is possible to reduce the fluorescence Y which cannot enter the angle conversion member **52**. From this point of view, it is desirable to make the refractive index of the angle conversion member **52** and the refractive index of the wavelength conversion member **50** coincide with each other as precisely as possible.

(52) It is also possible to use a compound parabolic concentrator (CPC) instead of the taper rod as the angle conversion member **52**. Even when using the CPC as the angle conversion member **52**, it is also possible to obtain substantially the same advantages as those when using the taper rod. It should be noted that the light source device **100** is not necessarily required to be provided with the angle conversion member **52**.

(53) The integrator optical system **70** has a first lens array **61** and a second lens array **101**. The integrator optical system **70** constitutes a homogenous illumination optical system for homogenizing an intensity distribution of the fluorescence Y emitted from the light source device **100** in each of the light modulation devices **4R**, **4G** as the illumination target area in cooperation with the superimposing optical system **103**. The fluorescence Y emitted from the light exit surface **52b** of the angle conversion member **52** enters the first lens array **61**. The first lens array **61** constitutes the integrator optical system **70** together with the second lens array **101** disposed in a posterior stage of the light source device **100**.

(54) The first lens array **61** has a plurality of first small lenses **61a**. The plurality of first small lenses **61a** is arranged in a matrix in a plane parallel to a Y-Z plane perpendicular to the optical axis AX1 of the first illumination device **20**. The plurality of first small lenses **61a** divides the fluorescence Y emitted from the angle conversion member **52** into a plurality of partial light beams. A shape of each of the first small lenses **61a** is a rectangular shape substantially similar to a shape of each of the image formation areas of the light modulation devices **4R**, **4G**. Thus, each of partial light beams emitted from the first lens array **61** efficiently enters each of the image formation areas of the light modulation devices **4R**, **4G**.

(55) The fluorescence Y emitted from the first lens array **61** proceeds toward the second lens array **101**. The second lens array **101** is arranged so as to be opposed to the first lens array **61**. The second lens array **101** has a plurality of second small lenses **101a** corresponding to the plurality of first small lenses **61a** of the first lens array **61**. The second lens array **101** focuses an image of each of the first small lenses **61a** of the first lens array **61** in the vicinity of each of the image formation areas of the light modulation devices **4R**, **4G** in cooperation with the superimposing optical system **103**. The plurality of second small lenses **101a** is arranged in a matrix in a plane parallel to the Y-Z plane perpendicular to the optical axis AX1 of the first illumination device **20**.

(56) Each of the first small lenses **61a** of the first lens array **61** and each of the second small lenses **101a** of the second lens array **101** have respective sizes the same as each other in the present embodiment, but can have respective sizes different from each other. Further, the first small lenses **61a** of the first lens array **61** and the second small lenses **101a** of the second lens array **101** are arranged at positions where respective optical axes coincide with each other in the present embodiment, but can be arranged in a state in which the axes are shifted from each other.

(57) The polarization conversion element **102** converts the polarization direction of the fluorescence Y emitted from the second lens array **101**. Specifically, the polarization conversion element **102** converts each of the partial light beams of the fluorescence Y which is divided by the first lens array **61**, and is emitted from the second lens array **101** into linearly polarized light.

(58) The polarization conversion element **102** has a polarization splitting layer (not shown) for transmitting one of the linearly polarized components included in the fluorescence Y emitted from the light source device **100** without modification while reflecting the other of the linearly polarized components toward a direction perpendicular to the optical axis AX1, a reflecting layer (not shown) for reflecting the other of the linearly polarized components reflected by the polarization splitting layer, toward a direction parallel to the optical axis AX1, and a wave plate (not shown) for converting the other of the linearly polarized components reflected by the reflecting layer into the one of the linearly polarized components.

(59) A cross-sectional configuration of the light source device **100** will hereinafter be described.

(60) FIG. 3 is a cross-sectional view of the light source device **100** along a line III-III shown in FIG. 2.

(61) As shown in FIG. 3, the support member **54** has a recess **54h** for housing the wavelength conversion member **50**, and has a substantially U-shaped cross-sectional shape. The support member **54** has a support surface **54s**, a first wall surface **54a**, and a second wall surface **54b**. The support surface **54s** corresponds to a bottom surface of the recess **54h**, and is opposed to the fourth face **50d** of the wavelength conversion member **50**. In the case of the present embodiment, the support surface **54s** extends in parallel to the X-Z plane.

(62) The wavelength conversion member **50** is fixed in a state of being pressed against the support member **54** by a fixation member (not shown) such as plate springs disposed at a plurality of places on the third face **50c**. According to this configuration, since the wavelength conversion member **50** surely adheres to the support surface **54s**, the heat generated in the wavelength conversion member **50** is sufficiently transferred to the support member **54**.

(63) The first wall surface **54a** corresponds to one of the side surfaces of the recess **54h**, and is opposed to the fifth face **50e** of the wavelength conversion member **50**, and is separated from the fifth face **50e**. The second wall surface **54b** corresponds to the other of the side surfaces of the recess **54h**, and is opposed to the sixth face **50f** of the wavelength conversion member **50**, and is separated from the sixth face **50f**. In other words, a gap S1 is disposed between the first wall surface **54a** and the fifth face **50e** of the wavelength conversion member **50**. The gap S1 is disposed between the second wall surface **54b** and the sixth face **50f** of the wavelength conversion member **50**.

(64) The first wall surface **54a** has a first portion **54a1** located at a side relatively far from the support surface **54s**, and a second portion **54a2** located at a side relatively near to the support

surface **54s**. The first portion **54a1** extends in a direction perpendicular to the support surface **54s**, namely in parallel to the X-Y plane. The second portion **54a2** extends in a direction tilted with respect to the support surface **54s**. The second portion **54a2** is tilted in a direction of getting closer to the fifth face **50e** of the wavelength conversion member **50** as getting closer to a side near to the support surface **54s** from a side far from the support surface **54s**. In other words, a distance between the second portion **54a2** and the fifth face **50e** at a side relatively near to the support surface **54s** is shorter than a distance between the second portion **54a2** and the fifth face **50e** at a side relatively near to the first portion **54a1**. Here, the distance between the second portion **54a2** and the fifth face **50e** at the side relatively near to the support surface **54s** means the shortest distance between a part of the second portion **54a2** at the side relatively near to the support surface **54s** and the fifth face **50e**. The distance between the second portion **54a2** and the fifth face **50e** at the side relatively near to the first portion **54a1** means the shortest distance between a part of the second portion **54a2** at the side relatively near to the first portion **54a1** and the fifth face **50e**. In the case of the present embodiment, the second portion **54a2** is formed of a plane. In other words, the first wall surface **54a** has the first portion **54a1** located at the wavelength conversion member **50** side and the second portion **54a2** located at the support surface **54s** side, wherein the first portion **54a1** extends in a direction perpendicular to the support surface **54s**, the second portion **54a2** is tilted so as to get away from the fifth face **50e** as proceeding toward the first portion **54a1** from the support surface **54s**, and the second portion **54a2** reflects at least a part of the excitation light E.

(65) The second wall surface **54b** has substantially the same configuration as that of the first wall surface **54a**. Specifically, the second wall surface **54b** has a third portion **54b3** located at a side relatively far from the support surface **54s**, and a fourth portion **54b4** located at a side relatively near to the support surface **54s**. The third portion **54b3** extends in a direction perpendicular to the support surface **54s**, namely in parallel to the X-Y plane. The fourth portion **54b4** extends in a direction tilted with respect to the support surface **54s**. The fourth portion **54b4** is tilted in a direction of getting closer to the sixth face **50f** of the wavelength conversion member **50** as getting closer to a side near to the support surface **54s** from a side far from the support surface **54s**. In other words, a distance between the fourth portion **54b4** and the sixth face **50f** at a side relatively near to the support surface **54s** is shorter than a distance between the fourth portion **54b4** and the sixth face **50f** at a side relatively near to the third portion **54b3**. In the case of the present embodiment, the fourth portion **54b4** is formed of a plane. In other words, the second wall surface **54b** has the third portion **54b3** located at the wavelength conversion member **50** side and the fourth portion **54b4** located at the support surface **54s** side, wherein the third portion **54b3** extends in a direction perpendicular to the support surface **54s**, the fourth portion **54b4** is tilted so as to get away from the sixth face **50f** as proceeding toward the third portion **54b3** from the support surface **54s**, and the fourth portion **54b4** reflects at least a part of the excitation light E.

(66) In the case of the present embodiment, each of the first wall surface **54a** and the second wall surface **54b** is formed of a surface of metal such as aluminum or stainless steel as the constituent material of the support member **54**. More specifically, each of the first wall surface **54a** and the second wall surface **54b** is formed of a processed surface obtained by performing mirror finish on the metal surface described above. Therefore, each of the first wall surface **54a** and the second wall surface **54b** has light reflectivity, and reflects the excitation light E having entered the first wall surface **54a** or the second wall surface **54b** in good condition. It should be noted that each of the first wall surface **54a** and the second wall surface **54b** can be formed of another metal film or another dielectric multilayer film formed on a surface of metal such as aluminum or stainless steel. In the first wall surface **54a** and the second wall surface **54b**, at least the second portion **54a2** and the fourth portion **54b4** need to reflect at least a part of the excitation light E.

(67) In the present embodiment, a dimension **W1** along the Z-axis direction of the light emitting surface **56a** of the light emitting element **56** is larger than a dimension **W2** along the Z-axis direction of the wavelength conversion member **50**. Thus, in the Z-axis direction, both ends of the

light emitting surface **56a** of the light emitting element **56** protrude outside the third face **50c** of the wavelength conversion member **50**. Specifically, the both ends of the light emitting surface **56a** of the light emitting element **56** protrude to positions where the ends respectively overlap the gap **S1** between the fifth face **50e** and the first wall surface **54a** and the gap **S1** between the sixth face **50f** and the second wall surface **54b**. In other words, when viewing the light emitting surface **56a** from the support surface **54s** along the Y-axis direction, a part of the light emitting surface **56a** overlaps the third face **50c**, and another part of the light emitting surface **56a** overlaps the gap **S1** between the fifth face **50e** and the first wall surface **54a** and the gap **S1** between the sixth face **50f** and the second wall surface **54b**.

(68) Further, when a position where the excitation light **E1** passing through a corner at the +Z side of the third face **50c** of the wavelength conversion member **50** and proceeding toward the first wall surface **54a** enters the first wall surface **54a** is defined as **P1**, a distance from the end at the -Y side of the first wall surface **54a** to the position **P1** is defined as **T1**. In this case, it is desirable for a dimension **T2** along the Y-axis direction of the first portion **54a1** to be larger than at least the distance **T1**.

(69) In the case of the present embodiment, a dimension **W3** along the Z-axis direction of the support surface **54s** of the support member **54** is larger than the dimension **W2** along the Z-axis direction of the wavelength conversion member **50**. Thus, in the Z-axis direction, both ends of the support surface **54s** protrude outside the fourth face **50d** of the wavelength conversion member **50**. In other words, when viewing the support surface **54s** from the light emitting surface **56a** along the Y-axis direction, a part of the support surface **54s** overlaps the fourth face **50d**, and another part of the support surface **54s** is exposed outside the fourth face **50d**. As described above, in the present embodiment, the support surface **54s** has an exposed part **54r** exposed outside the wavelength conversion member **50**.

COMPARATIVE EXAMPLE

(70) Here, a light source device according to a comparative example will be described.

(71) FIG. 4 is a cross-sectional view of the light source device **200** according to the comparative example.

(72) As shown in FIG. 4, the light source device **200** according to the comparative example is provided with the light emitting element **56**, the wavelength conversion member **50**, and a support member **254**. The light source device **200** according to the comparative example is different from the light source device **100** according to the present embodiment only in the configuration of the support member **254**. Therefore, in FIG. 4, the light emitting element **56** and the wavelength conversion member **50** are denoted by reference numerals common to FIG. 3, and the description thereof will be omitted.

(73) In the light source device **200** according to the comparative example, the support member **254** has a support surface **254s**, a first wall surface **254a**, and a second wall surface **254b**. The first wall surface **254a** extends in a direction perpendicular to the support surface **254s**, but does not have the second portion **54a2** tilted in such a manner as in the present embodiment. Similarly, the second wall surface **254b** extends in a direction perpendicular to the support surface **254s**, but does not have the fourth portion **54b4** tilted in such a manner as in the present embodiment.

(74) In the light source device of this kind, taking a production tolerance into consideration, it is common that a width of a recess in the support member for housing the wavelength conversion member is formed larger than a width of the wavelength conversion member. As a result, in the state in which the members are assembled, a gap is formed at least one of between the first wall surface and the fifth face, and between the second wall surface and the sixth face.

(75) Further, in order to increase an amount of the excitation light which is made to enter the wavelength conversion member from the light emitting element, a light emitting element having a width larger than the width of the wavelength conversion member is used in some cases. In this case, a part of the light emitting surface of the light emitting element is located so as to protrude

from the gap between the first wall surface outside the wavelength conversion member and the fifth face, and the gap between the second wall surface and the sixth face, as a result.

(76) As a result, in the light source device **200** according to the comparative example, the excitation light **E2** emitted from a part of the light emitting surface **56a** enters the support surface **254s** through the gap **S1**, and is reflected by the support surface **254s**, and then returns toward the light source **51** passing through the gap **S1** once again to be emitted in some cases. Such excitation light **E2** does not enter the wavelength conversion member **50**, and therefore does not make a contribution to the excitation of the phosphor. In this case, the use efficiency of the excitation light is low even when increasing the amount of the excitation light from the light emitting element **56**, and there is a possibility that it is unachievable to obtain the fluorescence having a desired intensity.

Advantages of First Embodiment

(77) The light source device **100** according to the present embodiment is provided with the light emitting element **56** which has the light emitting surface **56a** to emit the excitation light **E** having the first wavelength band from the light emitting surface **56a**, the wavelength conversion member **50** which includes the phosphor to convert the excitation light **E** emitted from the light emitting element **56** into the fluorescence **Y** having the second wavelength band different from the first wavelength band, and the support member **54** for supporting the wavelength conversion member **50**. The wavelength conversion member **50** has the first face **50a** and the second face **50b** which cross the longitudinal direction of the wavelength conversion member **50**, and which are located at respective sides opposite to each other, the third face **50c** and the fourth face **50d** which cross the first face **50a** and the second face **50b**, and which are located at respective sides opposite to each other, and the fifth face **50e** and the sixth face **50f** which cross the third face **50c** and the fourth face **50d**, and which are located at respective sides opposite to each other. The fluorescence **Y** is emitted from the first surface **50a**. The light emitting surface **56a** is disposed so as to be opposed to the third face **50c**. The support member **54** has the support surface **54s** opposed to the fourth face **50d**, and the first wall surface **54a** which is opposed to the fifth face **50e**, and is separated from the fifth face **50e**. The first wall surface **54a** has the first portion **54a1** which is located at the side relatively far from the support surface **54s**, and extends in the direction perpendicular to the support surface **54s**, and the second portion **54a2** which is located at the side relatively near to the support surface **54s**, and extends so as to be tilted with respect to the support surface **54s**. The second portion **54a2** reflects at least a part of the excitation light **E**. The distance between the second portion **54a2** and the fifth face **50e** at the side relatively near to the support surface **54s** is shorter than the distance between the second portion **54a2** and the fifth face **50e** at the side relatively near to the first portion **54a1**, and when viewing the light emitting surface **56a** from the support surface **54s**, a part of the light emitting surface **56a** overlaps the third face **50c**, and another part of the light emitting surface **56a** overlaps the gap **S1** between the fifth face **50e** and the first wall surface **54a**.

(78) According to the light source device **100** related to the present embodiment, as shown in FIG. 3, excitation light **E2** as a part of the excitation light **E** emitted from the light emitting surface **56a** of the light emitting element **56** proceeds through the gap **S1** between the fifth face **50e** of the wavelength conversion member **50** and the first portion **54a1**, and then enters the second portion **54a2** tilted with respect to the support surface **54s**. On this occasion, the excitation light **E2** is reflected by the second portion **54a2**, and then enters the fifth face **50e** of the wavelength conversion member **50**. Thus, it is possible to reduce the amount of the excitation light which is reflected by the support surface and then returns toward the light source as in the light source device **200** according to the comparative example.

(79) Further, in the case of the present embodiment, the excitation light **E1** which is emitted from an end at the $-Z$ side of the light emitting surface **56a**, then passes through the corner at the $+Z$ side of the third face **50c** of the wavelength conversion member **50**, and then proceeds toward the first wall surface **54a** is reflected by the first portion **54a1** extending perpendicularly to the support

surface **54s**, and then enters the fifth face **50e** of the wavelength conversion member **50**. Thus, it is possible to reduce the amount of the excitation light which is reflected by the first wall surface tilted, and then returns toward the light source. Further, in the case of the present embodiment, by using the light emitting element **56** larger than the wavelength conversion member **50**, it is possible to sufficiently ensure the amount of the excitation light E. Thus, it is possible to increase the intensity of the fluorescence Y taken out from the light source device **100**.

(80) As described hereinabove, according to the light source device **100** related to the present embodiment, it is possible to realize the light source device **100** which is high in use efficiency of the excitation light E, and is easy to obtain the fluorescence Y having the desired intensity.

(81) In the light source device **100** according to the present embodiment, the support member **54** further has the second wall surface **54b** which is opposed to the sixth face **50f**, and is separated from the sixth face **50f**. The second wall surface **54b** has the third portion **54b3** which is located at the side relatively far from the support surface **54s**, and extends in the direction perpendicular to the support surface **54s**, and the fourth portion **54b4** which is located at the side relatively near to the support surface **54s**, and extends so as to be tilted with respect to the support surface **54s**. The fourth portion **54b4** reflects at least a part of the excitation light E. The distance between the fourth portion **54b4** and the sixth face **50f** at the side relatively near to the support surface **54s** is shorter than the distance between the fourth portion **54b4** and the sixth face **50f** at the side relatively near to the third portion **54b3**.

(82) According to this configuration, regarding the second wall surface **54b**, there occurs substantially the same action as in the first wall surface **54a** described above. Specifically, a part of the excitation light E emitted from the light emitting surface **56a** of the light emitting element **56** proceeds through the gap S1 between the sixth face **50f** of the wavelength conversion member **50** and the third portion **54b3**, and then enters the fourth portion **54b4** tilted with respect to the support surface **54s**. The excitation light E is reflected by the fourth portion **54b4**, and then enters the sixth face **50f** of the wavelength conversion member **50**. Further, the excitation light which is emitted from an end at the +Z side of the light emitting surface **56a**, then passes through the corner at the -Z side of the third face **50c** of the wavelength conversion member **50**, and then proceeds toward the second wall surface **54b** is reflected by the third portion **54b3** extending perpendicularly to the support surface **54s**, and then enters the sixth face **50f** of the wavelength conversion member **50**. Thus, it is possible to realize the light source device **100** which is high in use efficiency of the excitation light, and is easy to obtain the fluorescence Y having the desired intensity.

(83) The light source device **100** according to the present embodiment is further provided with the angle conversion member for converting the angle distribution of the fluorescence Y emitted from the first face **50a** of the wavelength conversion member **50**.

(84) According to this configuration, by the fluorescence Y emitted from the first face **50a** of the wavelength conversion member **50** being transmitted through the angle conversion member **52**, the angle distribution of the fluorescence Y is narrowed. Thus, it is possible to increase the light use efficiency in the optical system in the posterior stage of the light source device **100**.

(85) The projector **1** according to the present embodiment is equipped with the light source device **100** according to the present embodiment, and is therefore excellent in light use efficiency.

Second Embodiment

(86) Then, a second embodiment of the present disclosure will be described using FIG. 5.

(87) A basic configuration of a projector and a light source device according to the second embodiment is substantially the same as that in the first embodiment, and a configuration of a support member is different from that in the first embodiment. Therefore, the description of the basic configuration of the projector and the light source device will be omitted.

(88) FIG. 5 is a cross-sectional view of the light source device **110** according to the second embodiment.

(89) In FIG. 5, the constituents common to the drawing used in the first embodiment are denoted

by the same reference symbols, and the description thereof will be omitted.

(90) As shown in FIG. 5, in the light source device **110** according to the present embodiment, the support member **64** has a base member **640**, a first reflecting member **641**, and a second reflecting member **642**. The support member **64** has a support surface **64s**, a first wall surface **64a**, and a second wall surface **64b**. The first wall surface **64a** has a first portion **64a1** extending perpendicularly to the support surface **64s**, and a second portion **64a2** extending obliquely to the support surface **64s**. The second wall surface **64b** has a third portion **64b3** extending perpendicularly to the support surface **64s**, and a fourth portion **64b4** extending obliquely to the support surface **64s**.

(91) The base member **640** has a recess **64h** for housing the wavelength conversion member **50**. Out of two corners of the recess **64h**, the first reflecting member **641** is disposed on one of the corners, and the second reflecting member **642** is disposed on the other of the corners. The base member **640** includes the support surface **64s**, the first portion **64a1**, and the third portion **64b3**. The first reflecting member **641** includes the second portion **64a2**. The second reflecting member **642** includes the fourth portion **64b4**. In other words, in the support member **64** in the present embodiment, the second portion **64a2** and the fourth portion **64b4** tilted with respect to the support surface **64s** are respectively formed of the reflecting members **641**, **642** separated from the base member **640**.

(92) Each of the first reflecting member **641** and the second reflecting member **642** can be formed of the same material as the material of the base member **640**, or can also be formed of a different material from the material of the base member **640**. When each of the first reflecting member **641** and the second reflecting member **642** is formed of the same material as the material of the base member **640**, it is possible to adopt a configuration in which a metal film or a dielectric multilayer film is formed on a surface of a material. The rest of the configuration of the light source device **110** is substantially the same as in the first embodiment.

Advantages of Second Embodiment

(93) Also in the present embodiment, it is possible to obtain substantially the same advantages as in the first embodiment such as an advantage that it is possible to realize the light source device **110** which is high in use efficiency of the excitation light E, and is easy to obtain the fluorescence Y having the desired intensity.

(94) Further, in the light source device **110** according to the present embodiment, the support member **64** has the base member **640** including the support surface **64s**, the first portion **64a1**, and the third portion **64b3**, the first reflecting member **641** including the second portion **64a2**, and the second reflecting member **642** including the fourth portion **64b4**.

(95) According to this configuration, since each of the second portion **64a2** and the fourth portion **64b4** is formed of a member separated from the base member **640**, it is easy to perform a cutting work of the recess **64h** to be provided to the base member **640**, and the manufacturing of the light source device **110** becomes easy in some cases. Further, by forming the first reflecting member **641** and the second reflecting member **642** from the material different from the material of the base member **640**, the freedom of selection of the material of the first reflecting member **641** and the second reflecting member **642** increases, and it becomes easy to control the reflectivity of the second portion **64a2** and the fourth portion **64b4**.

Third Embodiment

(96) A third embodiment of the present disclosure will hereinafter be described using FIG. 6.

(97) A basic configuration of a projector and a light source device according to the third embodiment is substantially the same as that in the first embodiment, and a configuration of a support member is different from that in the first embodiment. Therefore, the description of the basic configuration of the projector and the light source device will be omitted.

(98) FIG. 6 is a cross-sectional view of the light source device **120** according to the third embodiment.

(99) In FIG. 6, the constituents common to the drawing used in the first embodiment are denoted by the same reference symbols, and the description thereof will be omitted.

(100) As shown in FIG. 6, in the light source device **120** according to the present embodiment, the support member **74** has a support surface **74s**, a first wall surface **74a**, and a second wall surface **74b**. The first wall surface **74a** has a first portion **74a1** extending perpendicularly to the support surface **74s**, and a second portion **74a2** extending obliquely to the support surface **74s**. The second wall surface **74b** has a third portion **74b3** extending perpendicularly to the support surface **74s**, and a fourth portion **74b4** extending obliquely to the support surface **74s**.

(101) A dimension **W3** along the Z-axis direction of the support surface **74s** of the support member **74** is equal to the dimension **W2** along the Z-axis direction of the third face **50c** of the wavelength conversion member **50**. Therefore, in the case of the present embodiment, unlike the first embodiment, the support surface **74s** does not have the exposed part exposed outside the wavelength conversion member **50**. The rest of the configuration of the light source device **120** is substantially the same as in the first embodiment.

Advantages of Third Embodiment

(102) Also in the present embodiment, it is possible to obtain substantially the same advantages as in the first embodiment such as an advantage that it is possible to realize the light source device **120** which is high in use efficiency of the excitation light **E**, and is easy to obtain the fluorescence **Y** having the desired intensity.

(103) Further, in the case of the present embodiment, since the dimension **W3** along the Z-axis direction of the support surface **74s** of the support member **74** coincides with the dimension **W2** along the Z-axis direction of the wavelength conversion member **50**, it is easy to easily perform alignment of the wavelength conversion member **50** with the support surface **74s** when manufacturing the light source device **120**.

Fourth Embodiment

(104) A fourth embodiment of the present disclosure will hereinafter be described using FIG. 7.

(105) A basic configuration of a projector and a light source device according to the fourth embodiment is substantially the same as that in the first embodiment, and a configuration of a support member is different from that in the first embodiment. Therefore, the description of the basic configuration of the projector and the light source device will be omitted.

(106) FIG. 7 is a cross-sectional view of the light source device according to the fourth embodiment.

(107) In FIG. 7, the constituents common to the drawing used in the first embodiment are denoted by the same reference symbols, and the description thereof will be omitted.

(108) As shown in FIG. 7, in the light source device **130** according to the present embodiment, the support member **84** has a support surface **84s**, a first wall surface **84a**, and a second wall surface **84b**. The first wall surface **84a** has a first portion **84a1** extending perpendicularly to the support surface **84s**, and a second portion **84a2** extending obliquely to the support surface **84s**. The second wall surface **84b** has a third portion **84b3** extending perpendicularly to the support surface **84s**, and a fourth portion **84b4** extending obliquely to the support surface **84s**.

(109) In the case of the first embodiment, the second portion and the fourth portion are each formed of a plane. In contrast, in the case of the present embodiment, as shown in FIG. 7, the first portion **84a2** and the fourth portion **84b4** are each formed of an aspheric surface. In other words, each of the second portion **84a2** and the fourth portion **84b4** includes a curved surface. It should be noted that, each of the second portion **84a2** and the fourth portion **84b4** can be formed of a curved surface other than the aspheric surface such as a spherical surface. The rest of the configuration of the light source device **130** is substantially the same as in the first embodiment.

Advantages of Fourth Embodiment

(110) Also in the present embodiment, it is possible to obtain substantially the same advantages as in the first embodiment such as an advantage that it is possible to realize the light source device

130 which is high in use efficiency of the excitation light E, and is easy to obtain the fluorescence Y having the desired intensity.

(111) Further, in the case of the present embodiment, each of the second portion **84a2** and the fourth portion **84b4** includes a curved surface. According to this configuration, it is possible to precisely control a reflection direction of the excitation light E2 which enters each of the second portion **84a2** and the fourth portion **84b4** compared to when each of the second portion and the fourth portion is formed of a plane. Therefore, according to the present embodiment, it is easy to further increase the use efficiency of the excitation light E2.

Fifth Embodiment

(112) A fifth embodiment of the present disclosure will hereinafter be described using FIG. 8.

(113) A basic configuration of a projector and a light source device according to the fifth embodiment is substantially the same as that in the first embodiment, and a configuration of a support member is different from that in the first embodiment. Therefore, the description of the basic configuration of the projector and the light source device will be omitted.

(114) FIG. 8 is a cross-sectional view of the light source device **140** according to the fifth embodiment.

(115) In FIG. 8, the constituents common to the drawing used in the first embodiment are denoted by the same reference symbols, and the description thereof will be omitted.

(116) As shown in FIG. 8, in the light source device **140** according to the present embodiment, the support member **94** has a support surface **94s**, a first wall surface **94a**, and a second wall surface **94b**. Similarly to the first embodiment, the first wall surface **94a** has a first portion **94a1** extending perpendicularly to the support surface **94s**, and a second portion **94a2** extending obliquely to the support surface **94s**. In contrast, the whole of the second wall surface **94b** extends perpendicularly to the support surface **94s** unlike the first embodiment. The second wall surface **94b** is not separated from the sixth face **50f** of the wavelength conversion member **50** but has contact with the sixth face **50f**. The rest of the configuration of the light source device **140** is substantially the same as in the first embodiment.

Advantages of Fifth Embodiment

(117) Also in the present embodiment, it is possible to obtain substantially the same advantages as in the first embodiment such as an advantage that it is possible to realize the light source device **140** which is high in use efficiency of the excitation light E, and is easy to obtain the fluorescence Y having the desired intensity.

(118) When the power of the excitation light emitted from the light emitting element is high, since the heat generated in the wavelength conversion member becomes great, there is a possibility that the wavelength conversion efficiency decreases due to a rise in temperature of the wavelength conversion member. To cope with this problem, in the light source device **140** according to the present embodiment, since the second wall surface **94b** of the support member **94** has contact with the sixth face **50f**, the heat of the wavelength conversion member **50** is transferred to the support member **94** also from the second wall surface **94b** in addition to the support surface **94s**. Thus, it is possible to efficiently cool the wavelength conversion member **50**, and it is possible to ensure the wavelength conversion efficiency.

(119) It should be noted that the scope of the present disclosure is not limited to the embodiments described above, and a variety of modifications can be provided thereto within the scope or the spirit of the present disclosure. Further, one aspect of the present disclosure can be provided with a configuration obtained by arbitrarily combining characterizing portions of the respective embodiments described above with each other.

(120) For example, in the light source devices according to the embodiments described above, the dimension along the Z-axis direction of the light emitting surface of the light emitting element is larger than the dimension along the Z-axis direction of the third face of the wavelength conversion member. It should be noted that the dimension along the Z-axis direction of the light emitting

surface of the light emitting element can be equal to the dimension along the Z-axis direction of the third face of the wavelength conversion member, or can also be smaller than the dimension along the Z-axis direction of the third face of the wavelength conversion member.

(121) Besides the above, the specific descriptions of the shape, the number, the arrangement, the material, and so on of the constituents of the light source device and the projector are not limited to those in the embodiments described above, and can arbitrarily be modified. Further, although in the embodiments described above, there is described the example of installing the light source device according to the present disclosure in the projector using the liquid crystal panels, the example is not a limitation. The light source device according to the present disclosure can also be applied to a projector using digital micromirror devices as the light modulation devices. Further, the projector is not required to have a plurality of light modulation devices, and can be provided with just one light modulation device.

(122) Although in the embodiments described above, there is described the example of applying the light source device according to the present disclosure to the projector, the example is not a limitation. The light source device according to the present disclosure can also be applied to lighting equipment, a headlight of a vehicle, and so on.

(123) A light source device according to an aspect of the present disclosure may have the following configuration.

(124) The light source device according to an aspect of the present disclosure includes a light emitting element which has a light emitting surface, and which is configured to emit first light having a first wavelength band from the light emitting surface, a wavelength conversion member which includes a phosphor, and which is configured to convert the first light emitted from the light emitting element into second light having a second wavelength band different from the first wavelength band, and a support member configured to support the wavelength conversion member, wherein the wavelength conversion member has a first face and a second face which cross a longitudinal direction of the wavelength conversion member, and which are located at respective sides opposite to each other, a third face and a fourth face which cross the first face and the second face, and which are located at respective sides opposite to each other, and a fifth face and a sixth face which cross the third face and the fourth face, and which are located at respective sides opposite to each other, and emits the second light from the first face, the light emitting surface is disposed so as to be opposed to the third face, the support member has a support surface opposed to the fourth face, and a first wall surface which is opposed to the fifth face, and which is separated from the fifth face, the first wall surface has a first portion located at the wavelength conversion member side, and a second portion located at the support surface side, the first portion extends in a direction perpendicular to the support surface, and the second portion is tilted so as to get away from the fifth face as proceeding toward the first portion from the support surface, and the second portion reflects at least a part of the first light.

(125) In the light source device according to the aspect of the present disclosure, there may be adopted a configuration in which when viewing the light emitting surface from the support surface, a part of the light emitting surface overlaps the third face, and another part of the light emitting surface overlaps a gap between the fifth face and the first wall surface.

(126) In the light source device according to the aspect of the present disclosure, there may be adopted a configuration in which the second portion includes a curved surface.

(127) In the light source device according to the aspect of the present disclosure, there may be adopted a configuration in which the support member has a base member including the support surface and the first portion, and a first reflecting member including the second portion.

(128) In the light source device according to the aspect of the present disclosure, there may be adopted a configuration in which the support member further has a second wall surface which is opposed to the sixth face, and which is separated from the sixth face, the second wall surface has a third portion located at the wavelength conversion member side, and a fourth portion located at the

support surface side, the third portion extends in a direction perpendicular to the support surface, and the fourth portion is tilted so as to get away from the sixth face as proceeding toward the third portion from the support surface, and the fourth portion reflects at least a part of the first light. (129) In the light source device according to the aspect of the present disclosure, there may be adopted a configuration in which the first portion and the third portion are planes, the second portion and the fourth portion are planes, and a following conditional expression (1) is fulfilled $W1 < W2 < W3$ (1)

wherein in a cross-sectional view connecting the first wall surface and the second wall surface to each other, $W1$ is a width of the light emitting surface, $W2$ is a width between the fifth face and the sixth face in a portion having contact with the support surface in the wavelength conversion member, and $W3$ is a width of a space between a coupling part of the support surface and the third portion, and a coupling part of the support surface and the fourth portion.

(130) In the light source device according to the aspect of the present disclosure, there may be adopted a configuration in which the fourth portion includes a curved surface.

(131) In the light source device according to the aspect of the present disclosure, there may be adopted a configuration in which the support member has a base member including the support surface and the third portion, and a second reflecting member including the fourth portion.

(132) In the light source device according to the aspect of the present disclosure, there may be adopted a configuration in which the support member further has a second wall surface having contact with the sixth face.

(133) In the light source device according to the aspect of the present disclosure, there may be adopted a configuration in which when viewing the light emitting surface from the support surface, a part of the light emitting surface overlaps the third face, and another part of the light emitting surface overlaps a gap between the fifth face and the first wall surface.

(134) In the light source device according to the aspect of the present disclosure, there may be adopted a configuration in which there is further included an angular conversion member configured to convert an angle distribution of the second light emitted from the first face.

(135) A projector according to an aspect of the present disclosure may have the following configuration.

(136) The projector according to an aspect of the present disclosure includes the light source device according to the aspect of the present disclosure, a light modulation device configured to modulate light including the second light emitted from the light source device in accordance with image information, and a projection optical device configured to project the light modulated by the light modulation device.

Claims

1. A light source device comprising: a light emitting element which has a light emitting surface, and which is configured to emit first light having a first wavelength band from the light emitting surface; a wavelength conversion member which includes a phosphor, and which is configured to convert the first light emitted from the light emitting element into second light having a second wavelength band different from the first wavelength band; and a support member configured to support the wavelength conversion member, wherein the wavelength conversion member has a first face and a second face which cross a longitudinal direction of the wavelength conversion member, and which are located at respective sides opposite to each other, a third face and a fourth face which cross the first face and the second face, and which are located at respective sides opposite to each other, and a fifth face and a sixth face which cross the first face and the second face, and which cross the third face and the fourth face, and which are located at respective sides opposite to each other, and emits the second light from the first face, the light emitting surface is disposed so as to be opposed to the third face, the support member has a support surface opposed to the fourth

face, and a first wall surface which is opposed to the fifth face, and which is separated from the fifth face, the first wall surface has a first portion located at the wavelength conversion member side, and a second portion located at the support surface side, the first portion extends in a direction perpendicular to the support surface, and the second portion is tilted so as to get away from the fifth face as proceeding toward the first portion from the support surface, and the second portion reflects at least a part of the first light.

2. The light source device according to claim 1, wherein the second portion includes a curved surface.

3. The light source device according to claim 1, wherein the support member has a base member including the support surface and the first portion, and a first reflecting member including the second portion.

4. The light source device according to claim 1, wherein the support member further has a second wall surface which is opposed to the sixth face, and which is separated from the sixth face, the second wall surface has a third portion located at the wavelength conversion member side, and a fourth portion located at the support surface side, the third portion extends in a direction perpendicular to the support surface, and the fourth portion is tilted so as to get away from the sixth face as proceeding toward the third portion from the support surface, and the fourth portion reflects at least a part of the first light.

5. The light source device according to claim 4, wherein the first portion and the third portion are planes, the second portion and the fourth portion are planes, and a following conditional expression (1) is fulfilled,

$W1 < W2 < W3$ (1) wherein in a cross-sectional view connecting the first wall surface and the second wall surface to each other, $W1$ is a width of the light emitting surface, $W2$ is a width between the fifth face and the sixth face in a portion having contact with the support surface in the wavelength conversion member, and $W3$ is a width of a space between a coupling part of the support surface and the third portion, and a coupling part of the support surface and the fourth portion.

6. The light source device according to claim 5, wherein the fourth portion includes a curved surface.

7. The light source device according to claim 5, wherein the support member has a base member including the support surface and the third portion, and a second reflecting member including the fourth portion.

8. The light source device according to claim 1, wherein the support member further has a second wall surface having contact with the sixth face.

9. The light source device according to claim 1, wherein when viewing the light emitting surface from the support surface, a part of the light emitting surface overlaps the third face, and another part of the light emitting surface overlaps a gap between the fifth face and the first wall surface.

10. The light source device according to claim 1, further comprising: an angular conversion member configured to convert an angle distribution of the second light emitted from the first face.

11. A projector comprising: the light source device according to claim 1; a light modulation device configured to modulate light including the second light emitted from the light source device in accordance with image information; and a projection optical device configured to project the light modulated by the light modulation device.
