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(54) LIGHT SOURCE UNIT

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(57) **ABSTRACT**

A light source unit includes a plurality of light sources for emitting light with which an object is to be irradiated; a converging lens for converging light from the object; an optical fiber connector for holding an optical fiber that receives an incidence of the light converged by the converging lens; and a base made of metal and configured to hold the light sources, the converging lens, and the optical fiber connector. The base includes a first surface, a second surface opposite to the first surface, a first region including a center of the base when viewed in a first direction intersecting the first surface, a second region surrounding the first region when viewed in the first direction.

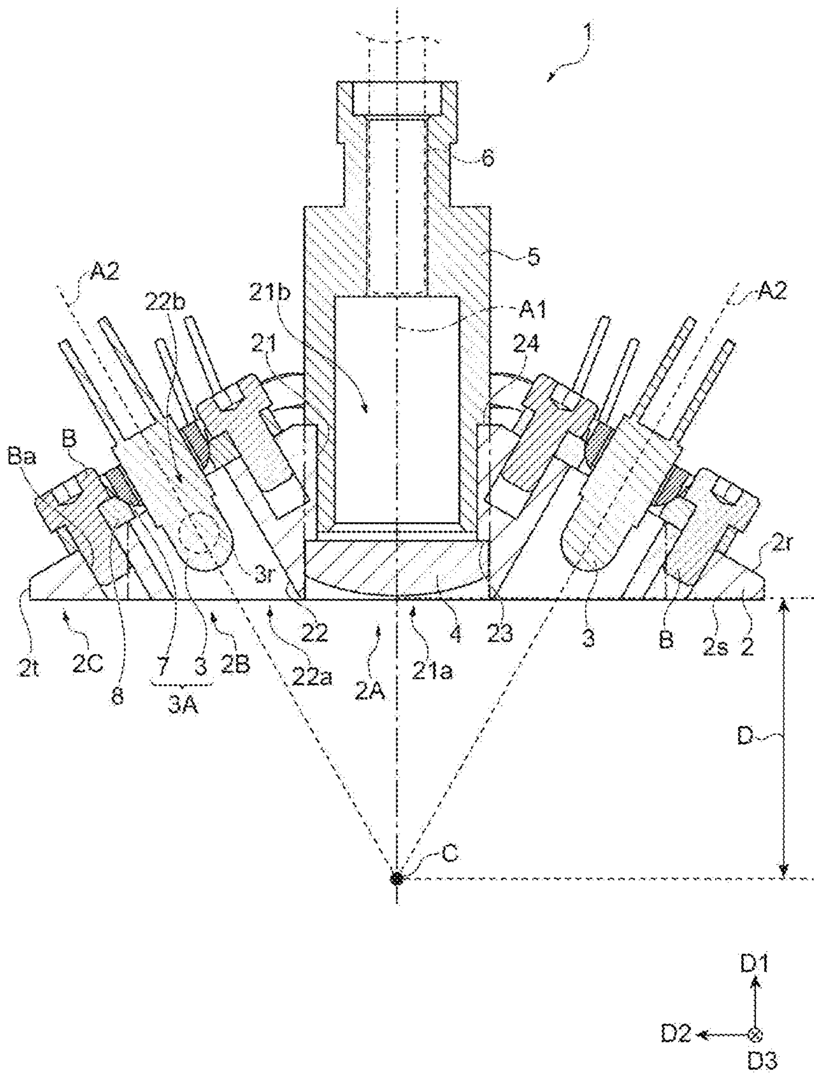


Fig.1

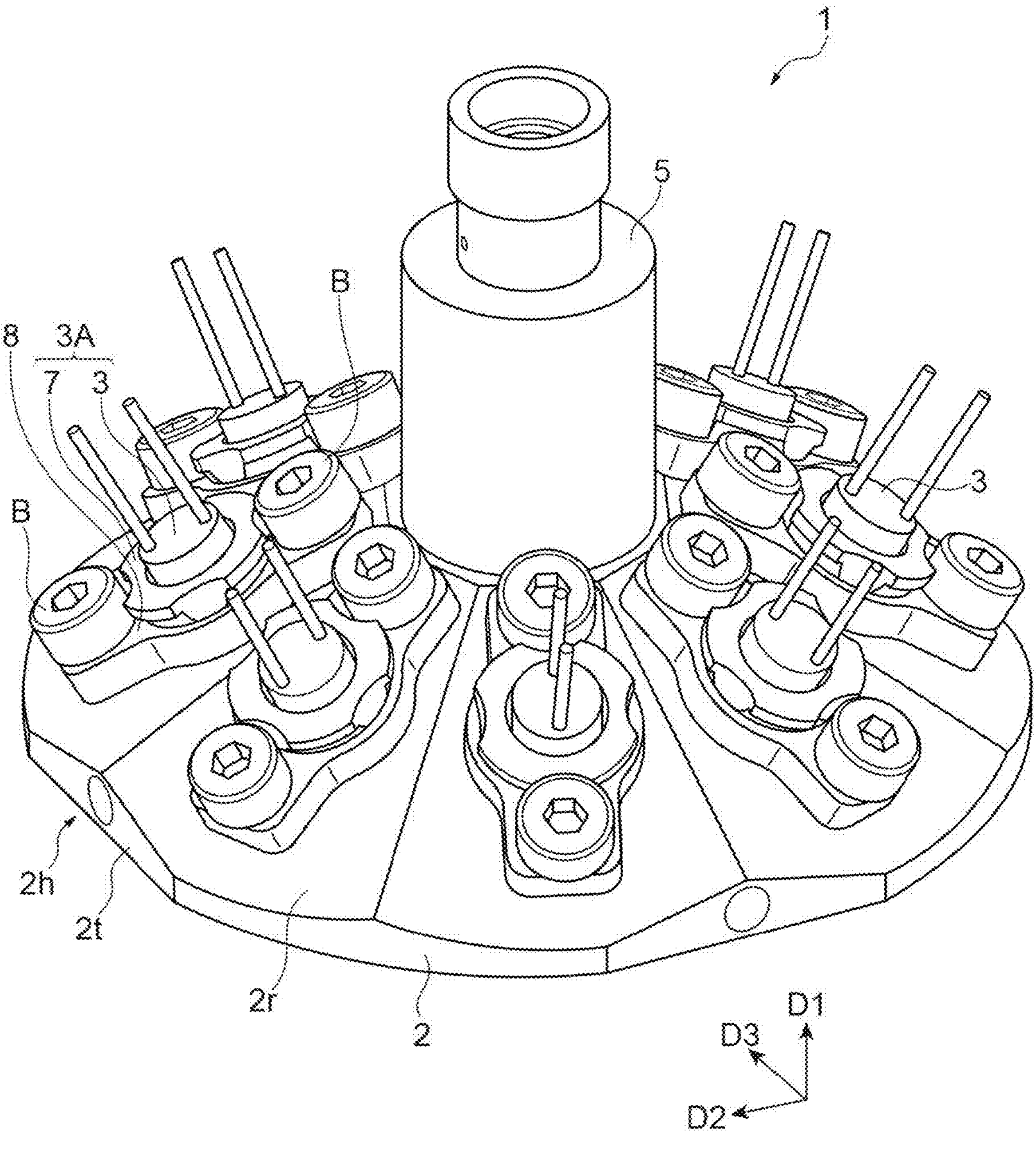
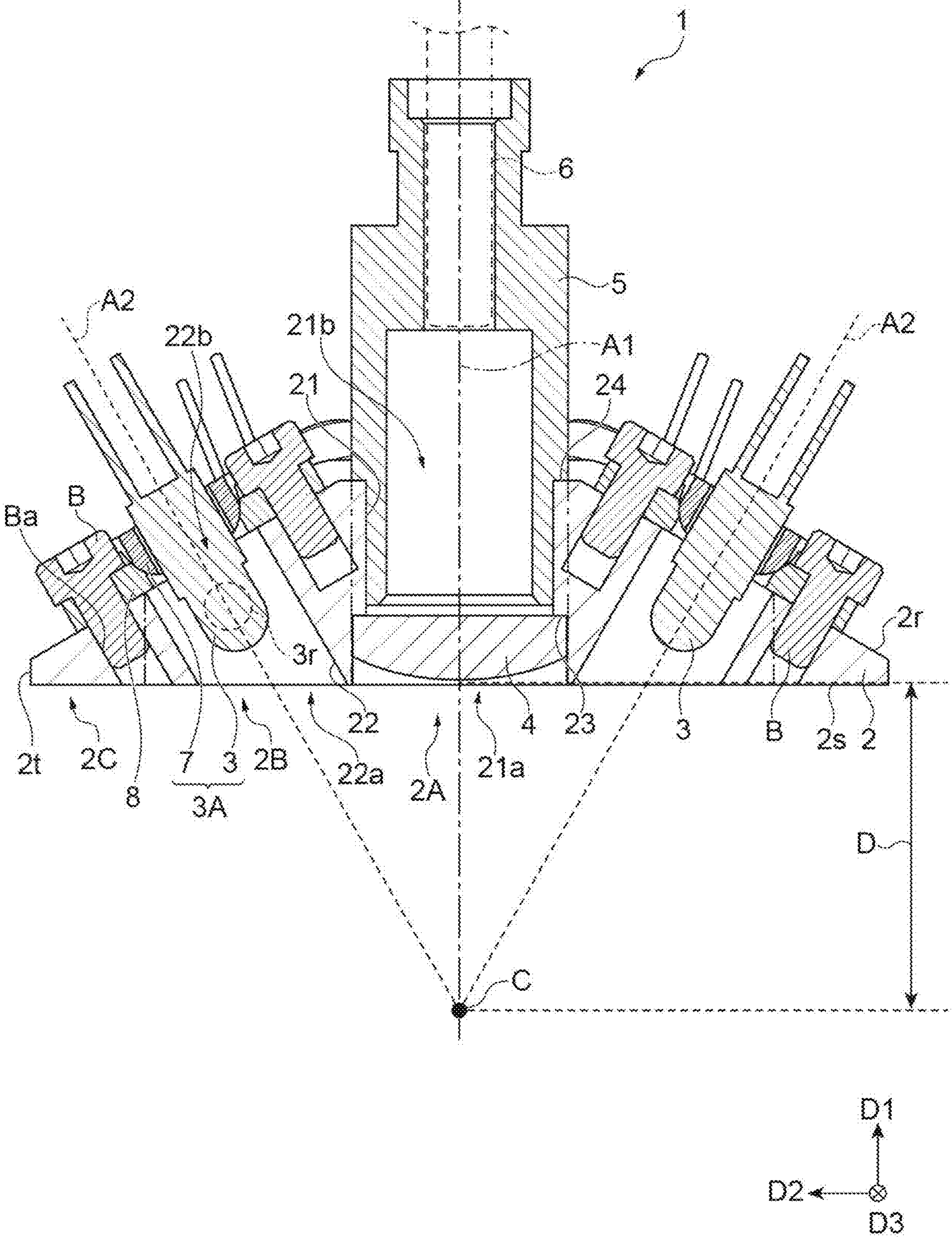


Fig.2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22b
21b
A1
A2
21
24
B
Ba
3r
2r
2t
2C
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7
3
2B
22
22a
2A
21a
4
23
3
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2s
2
3A
D
C
D1
D2
D3

Fig.3

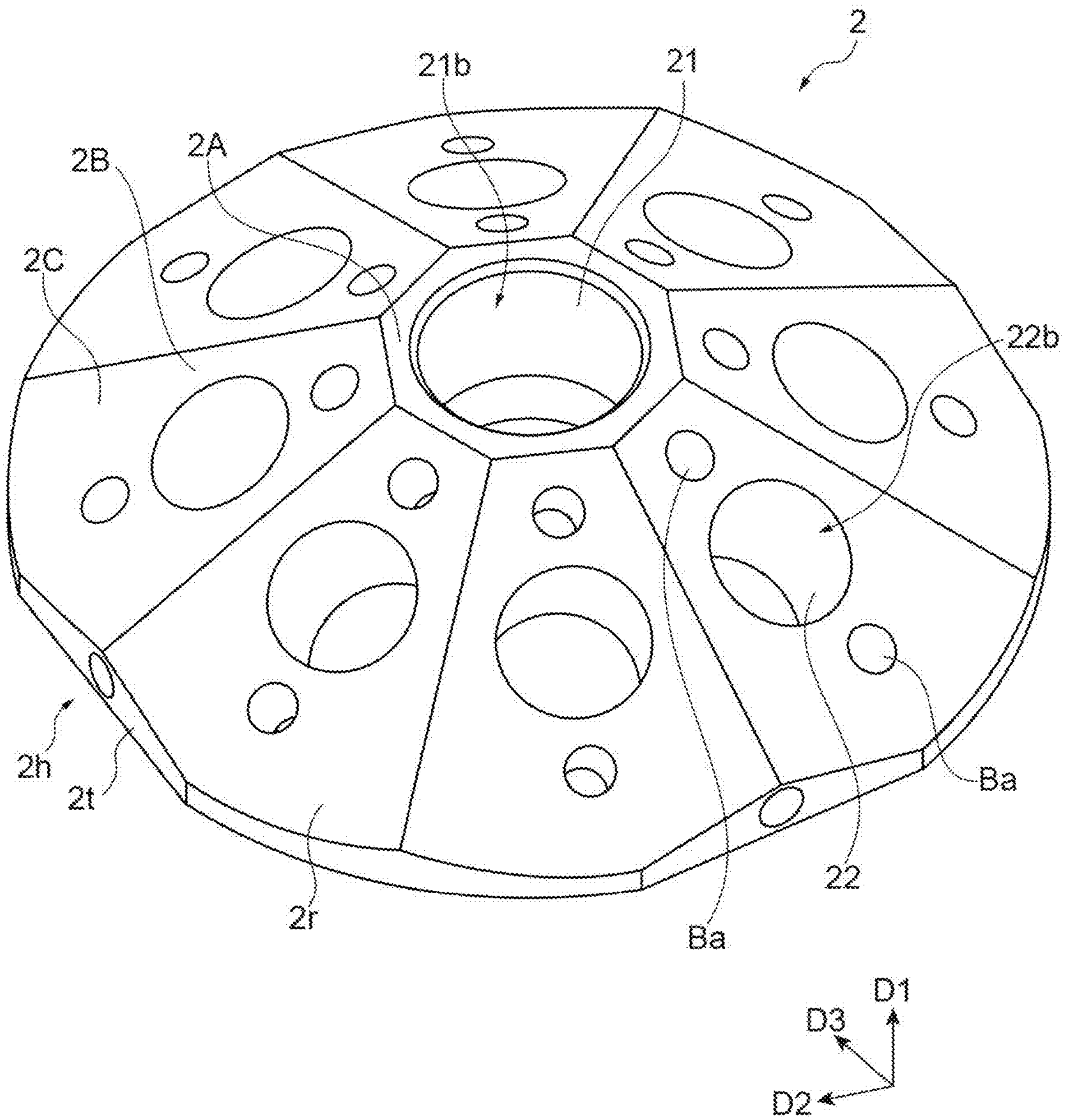


Fig.4

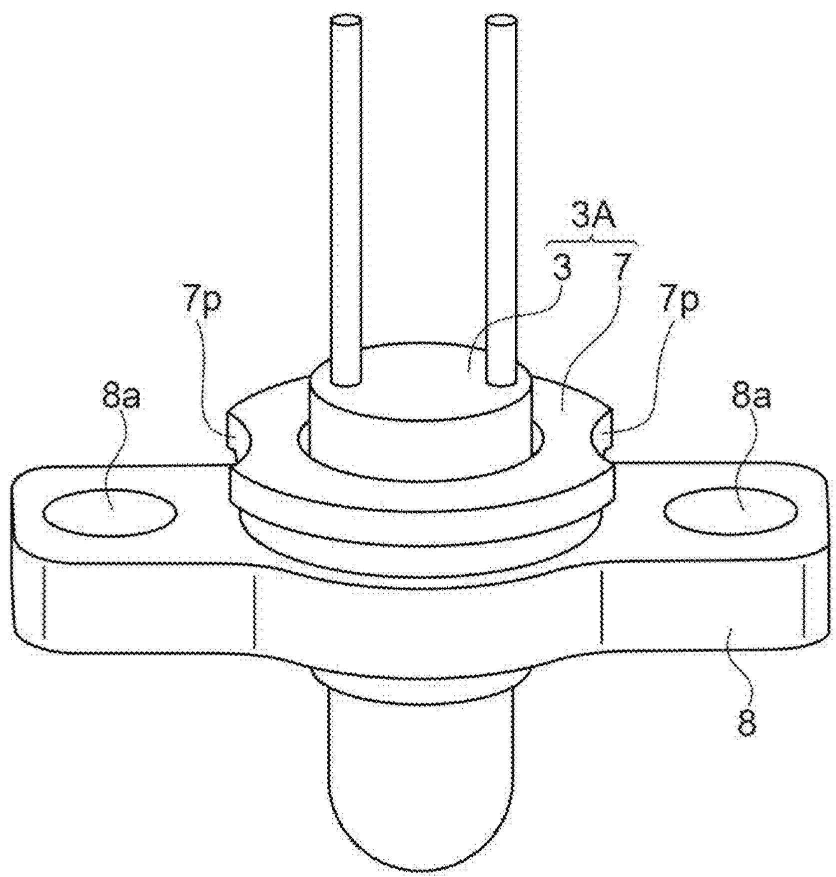
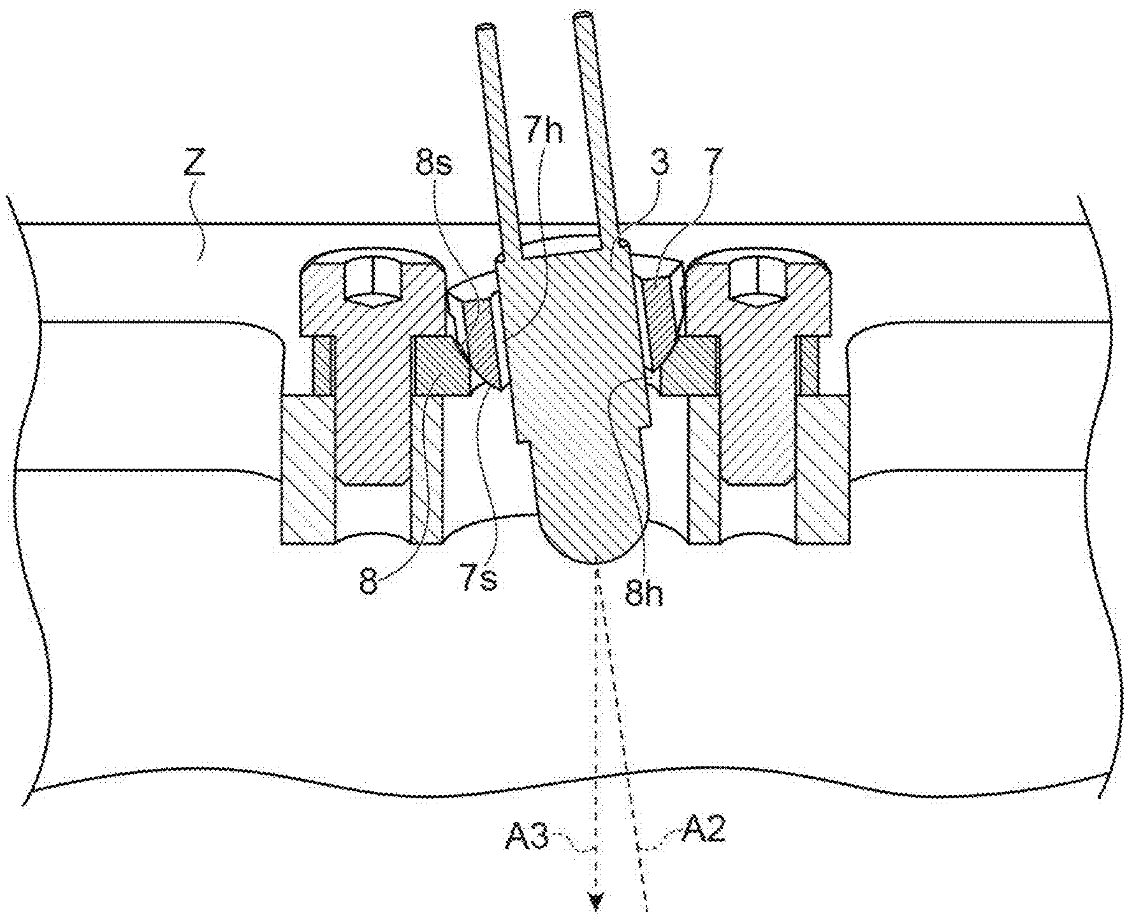
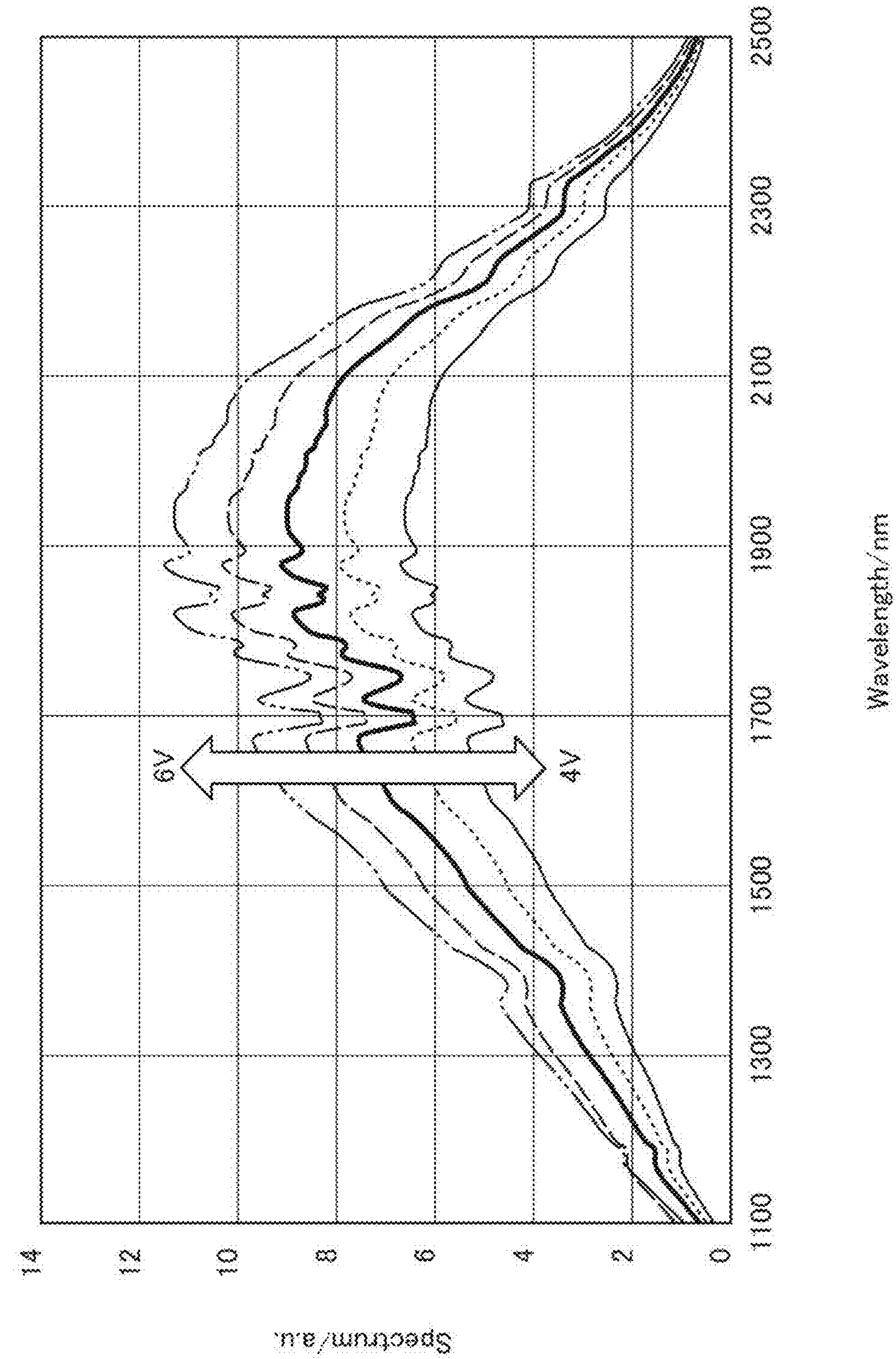


Fig.5




Spectrum/a.u.
Wavelength/nm
0
2
4
6
8
10
12
14
1100
1300
1500
1700
1900
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2300
2500
6V
4V

Fig.6

Fig.7

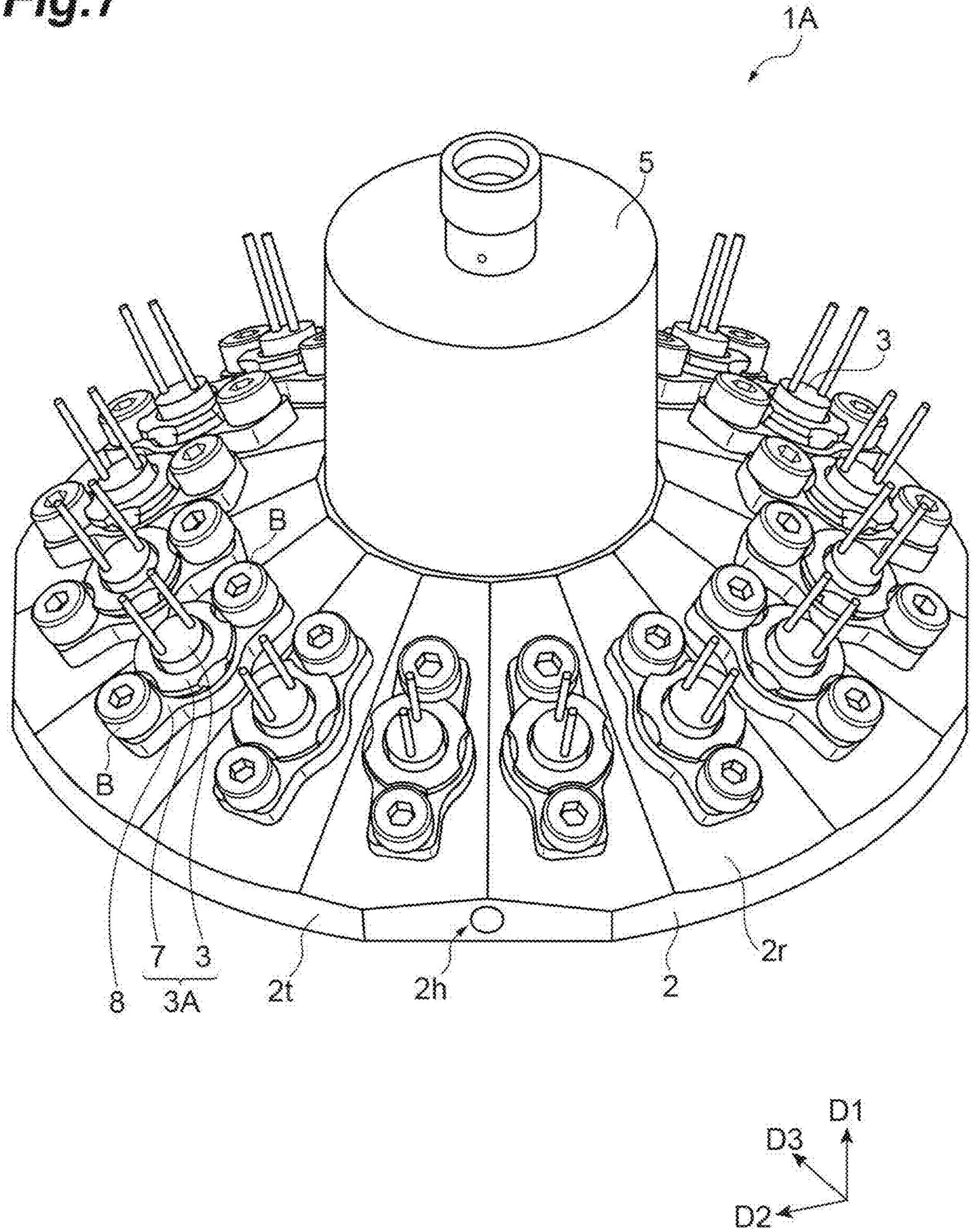
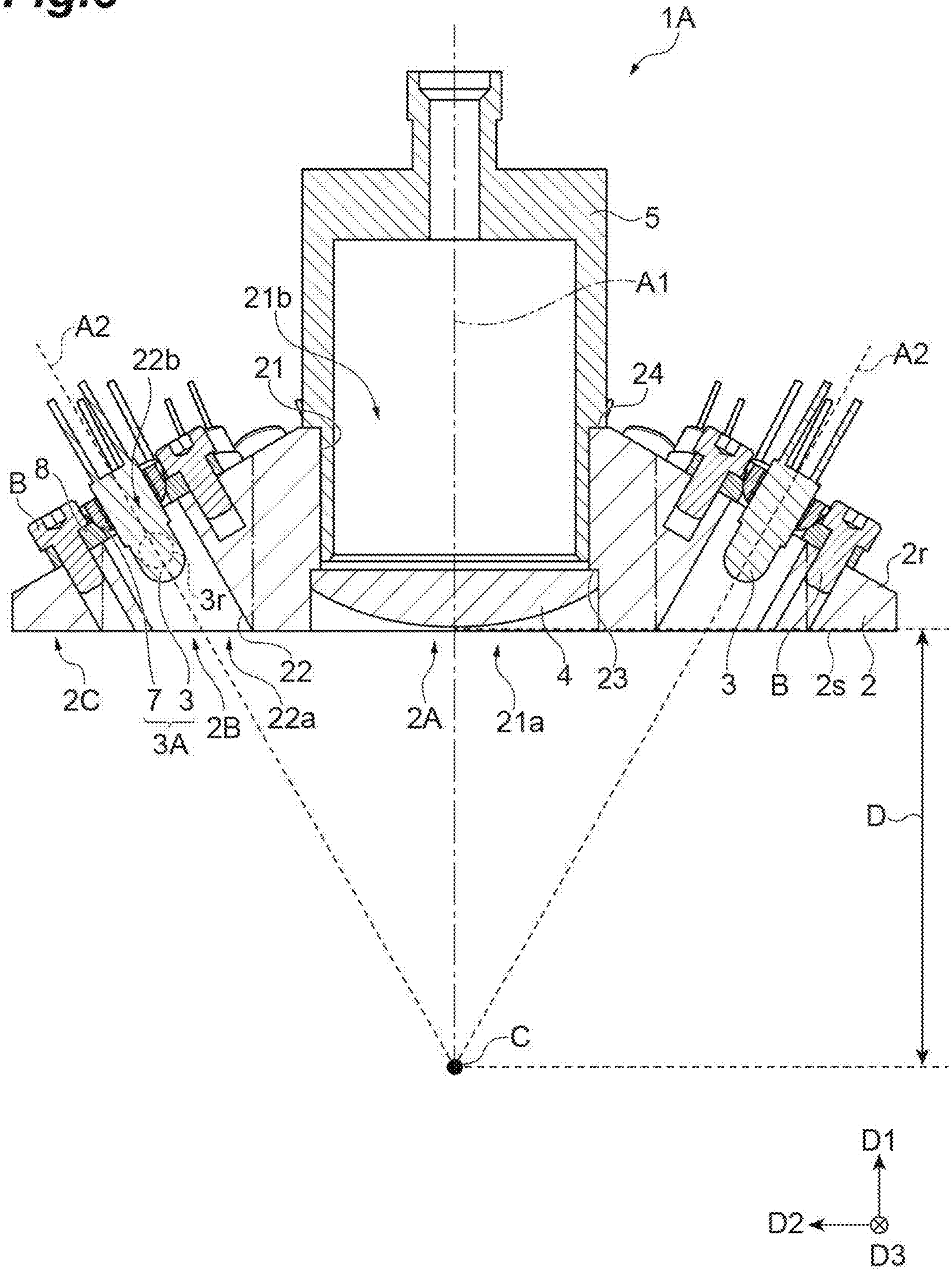


Fig.8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A2
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21
24
A2
B
8
2r
3r
2C
7 3
3A
2B
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22a
2A
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21a
23
3
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2s
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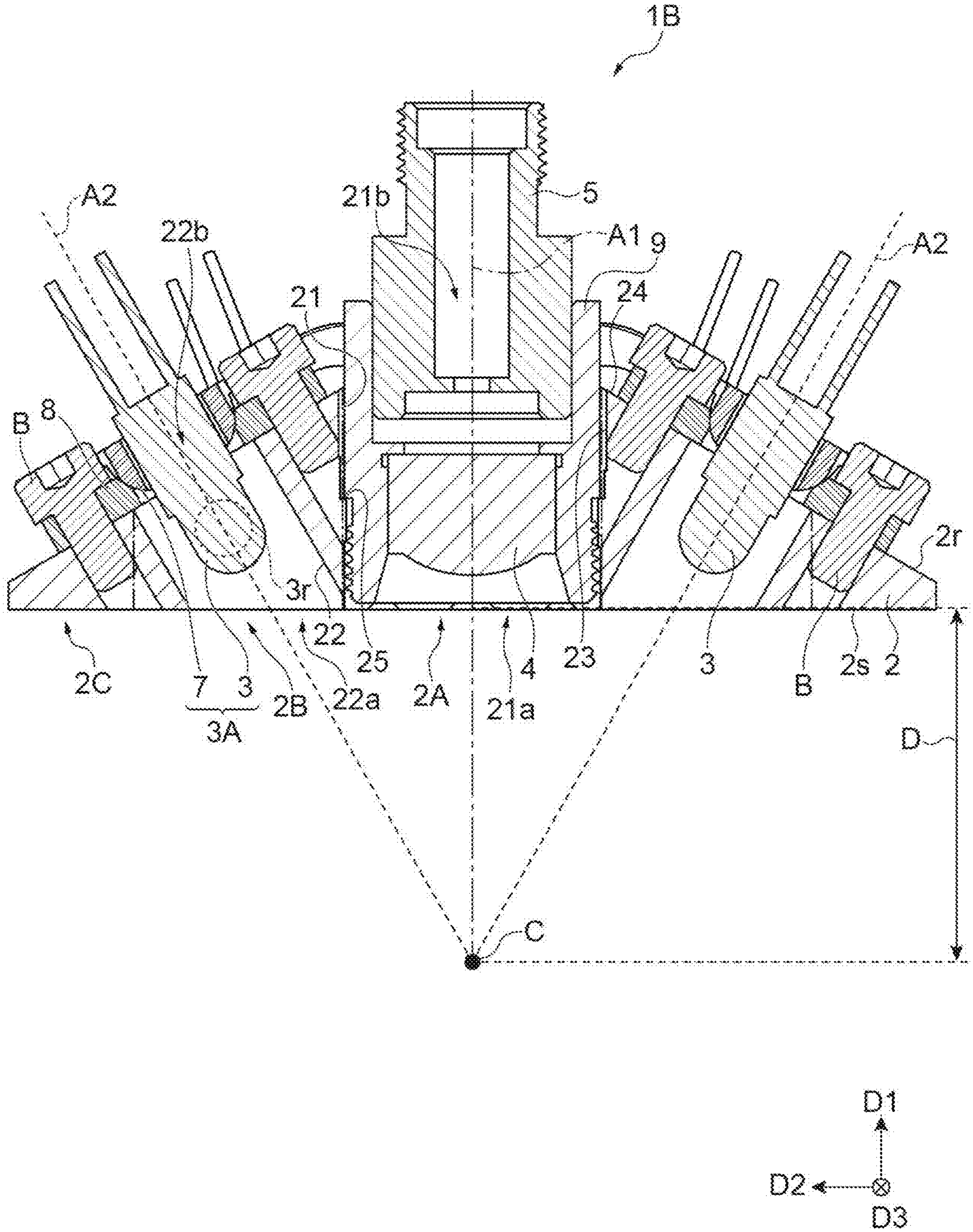
D2
D3

Fig.9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A2
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D1
D2
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Fig.10

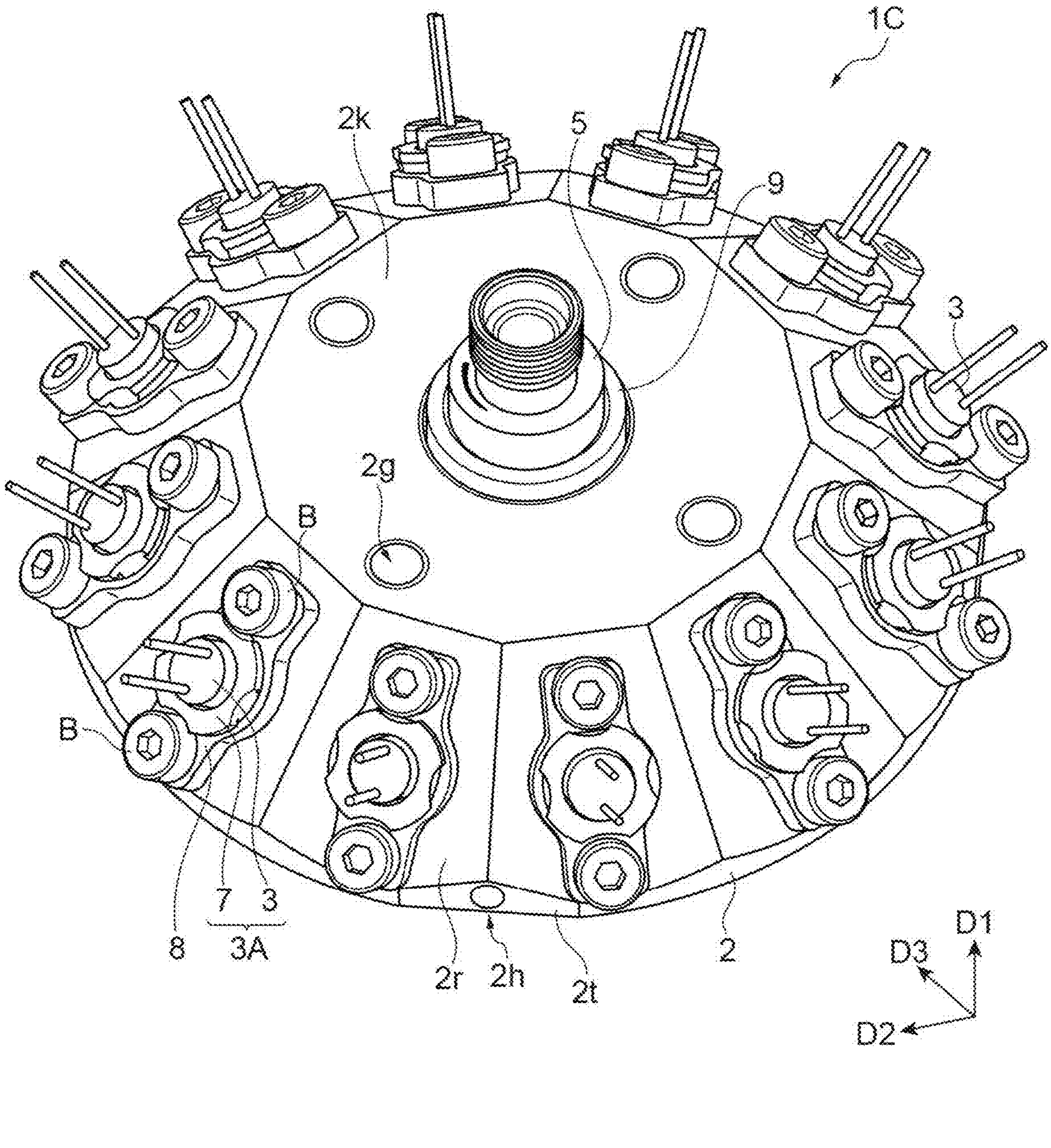
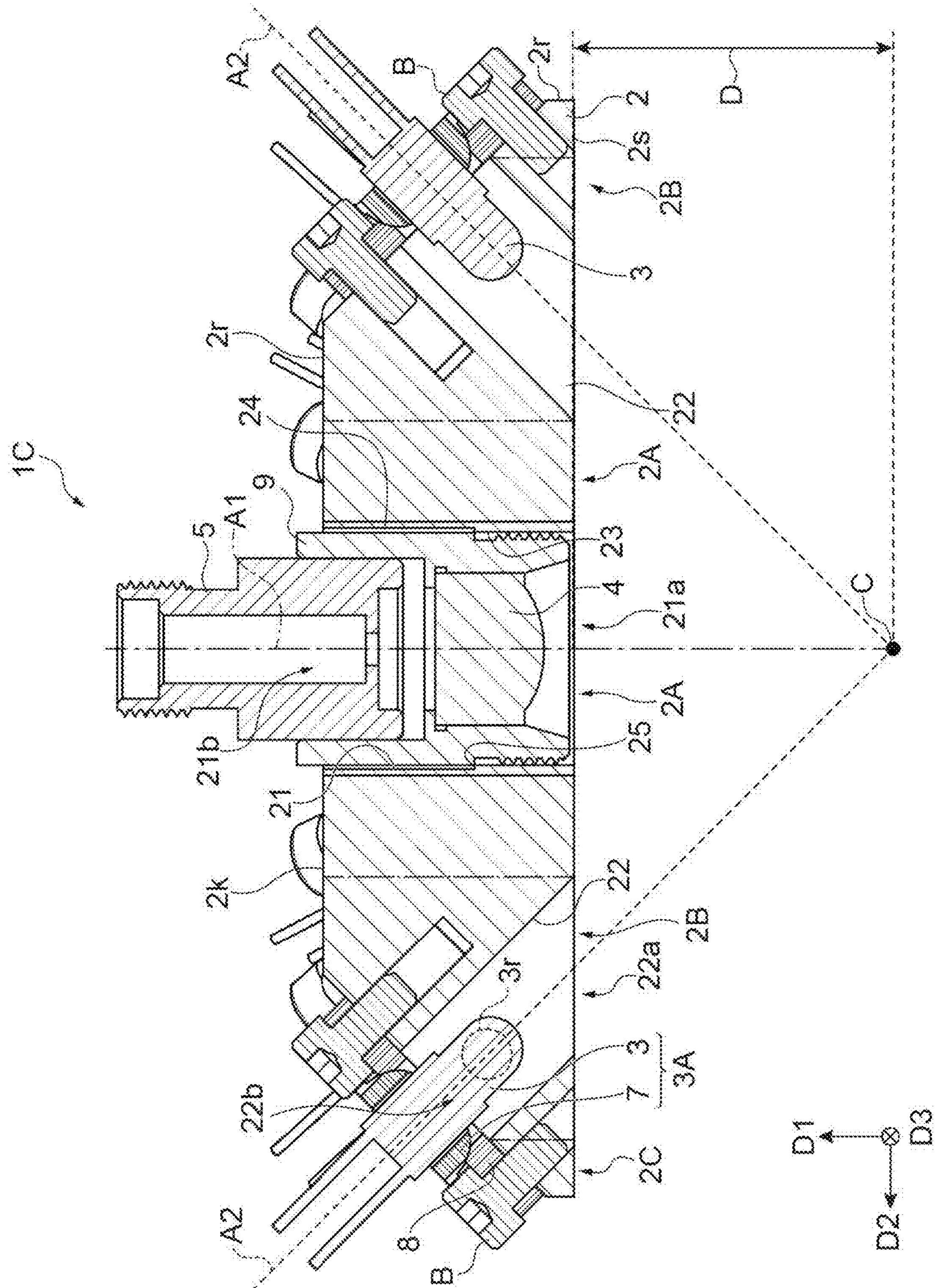


Fig.11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2r
A2
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2r
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2s
2B
3
22
2A
23
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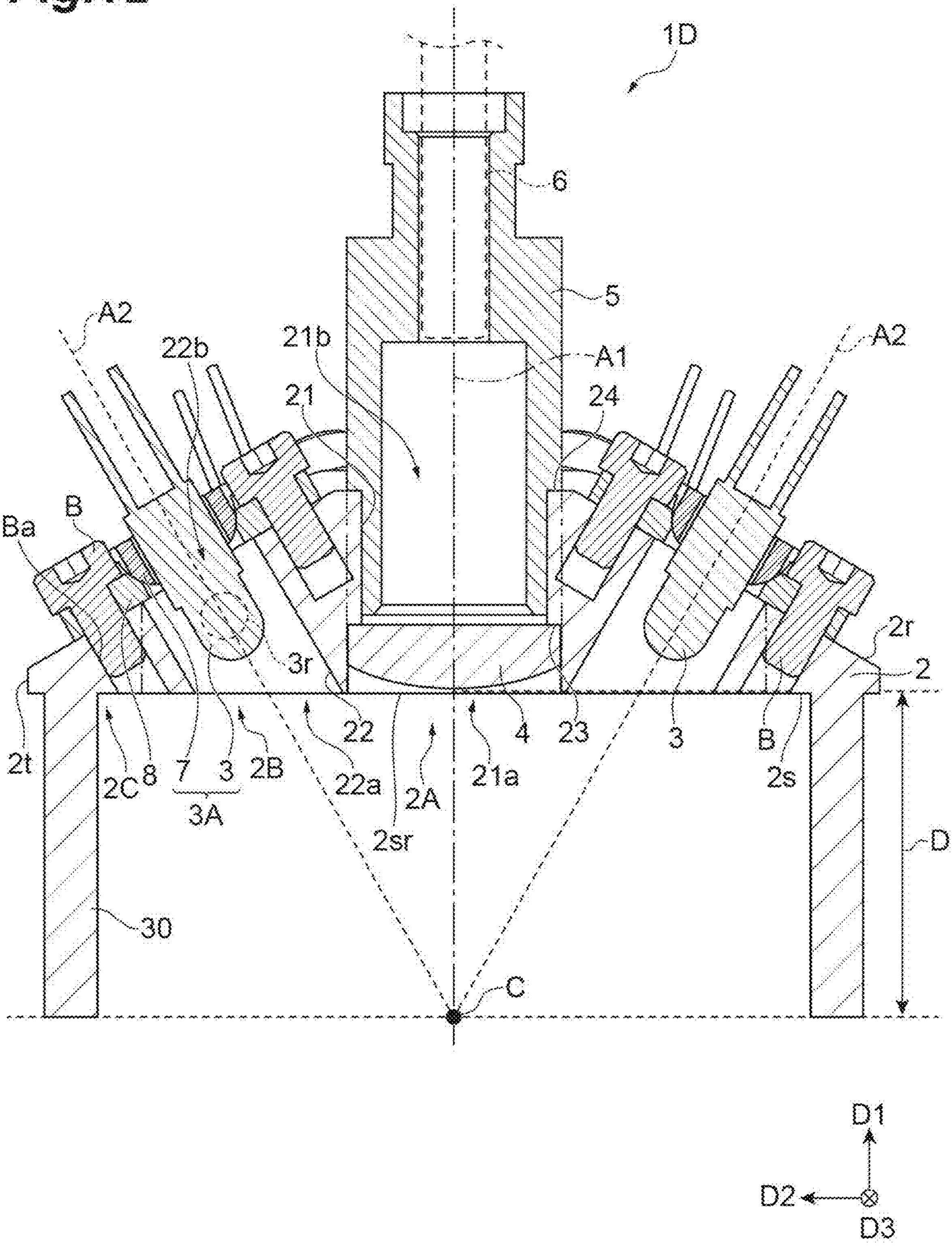
2A
25
C
D
21b
21
2k
22
2B
22a
3r
3
3A
7
22b
2C
A2
8
B
D1
D3
D2

Fig.12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5
A2
22b
21b
A1
A2
21
24
B
Ba
2r
3r
2
2t
2C
8
7
3
2B
22
22a
4
23
3
B
2s
3A
2A
21a
2sr
D
30
C
D1
D2
D3

Fig.13A

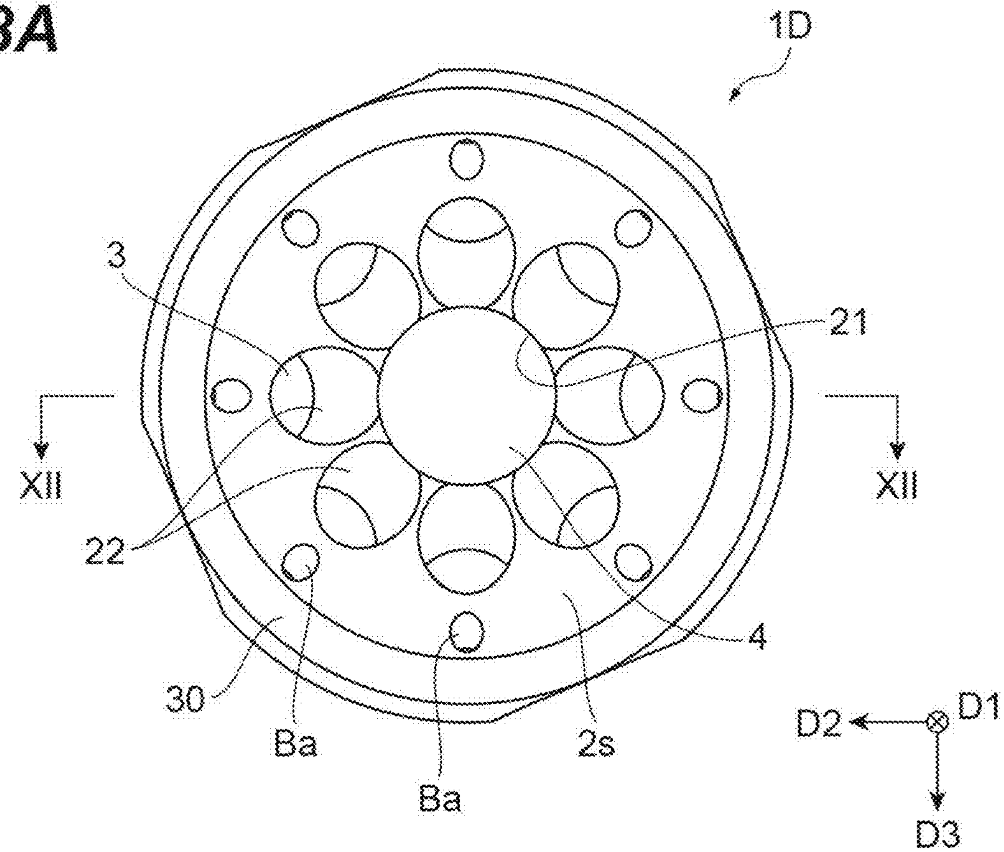
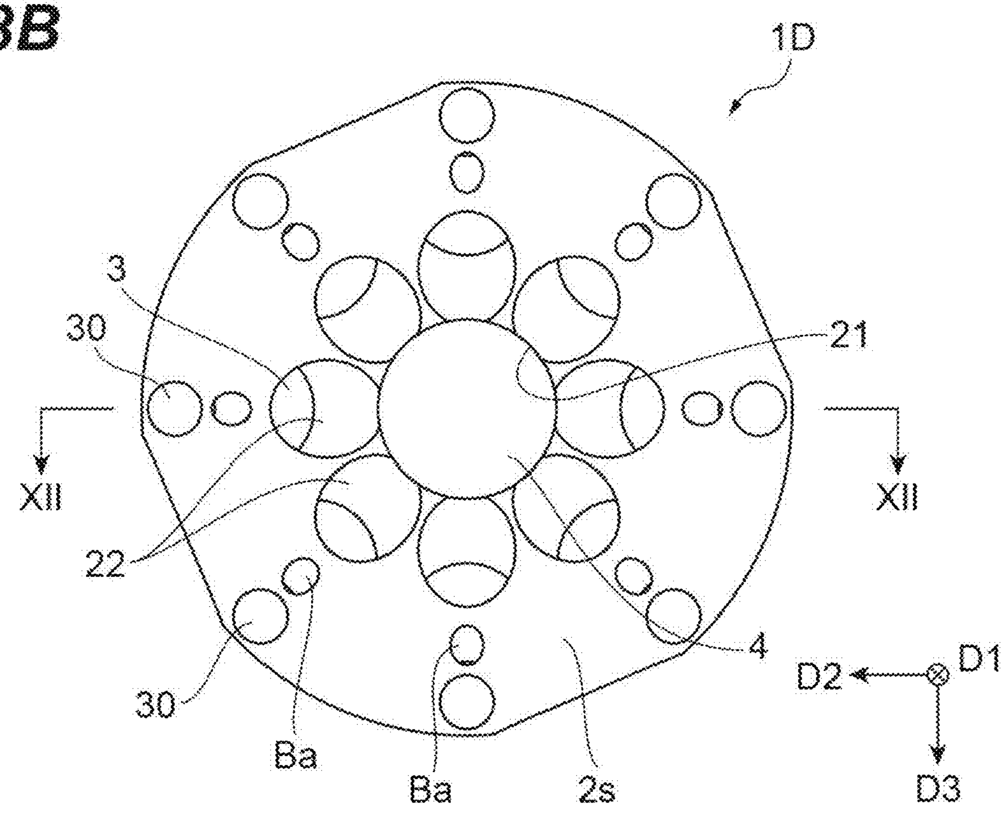


Fig.13B



LIGHT SOURCE UNIT

TECHNICAL FIELD

[0001] The present disclosure relates to a light source unit.

BACKGROUND

[0002] Patent Literature 1 (Japanese Unexamined Patent Publication No. 2009-115669) describes a meat fatty acid content measurement device. The device includes a probe and a device body. The probe includes a plurality of light sources; a holder that holds the plurality of light sources such that the surface of meat is irradiated with light from the plurality of light sources; and an optical fiber of which an incident end is disposed at a position where reflected light from the meat is incident. The light sources and the incident end of the optical fiber are provided inside a housing of the probe. A measurement opening is formed at the center of a bottom plate portion of the housing. A right-angle prism is provided on a central axis of the housing above the measurement opening.

[0003] The incident end of the optical fiber is located at the same height position as the right-angle prism. An optical axis when the light from the meat is captured passes through the center of a total reflecting surface of the right-angle prism. A converging lens that converges the light from the meat and that allows the light to be incident on the optical fiber is provided on the optical axis. The holder is a member having a disk shape as a whole, and is provided with five holding holes for holding the light sources.

SUMMARY

[0004] In the above-described technical field, there is a demand to enable light from an object to be more efficiently incident on an optical fiber while ensuring the amount of light from a light source with which the object is to be irradiated. Therefore, in the device described in Patent Literature 1, for example, it is considered that the converging lens is disposed closer to the object by holding the converging lens together with the light sources using the holder.

[0005] However, in this case, the converging lens and the light sources are close to each other, so that heat generated in the light sources is easily transferred to the converging lens. As a result, the converging lens expands due to heat, the focal position is misaligned due to the thermal lens effect, or damage occurs in the converging lens, which is a risk. In addition, for example, when the converging lens is fixed to the holder using resin, fixing strength decreases due to the heat, so that optical axis misalignment of the converging lens occurs, which is a risk.

[0006] Therefore, an object of the present disclosure is to provide a light source unit capable of reducing the influence of heat on a converging lens.

[0007] [1]A light source unit according to the present disclosure is "a light source unit including: a plurality of light sources configured to emit light with which an object is to be irradiated; a converging lens configured to converge light from the object; an optical fiber connector configured to hold an optical fiber that receives an incidence of the light converged by the converging lens; and a base made of metal and configured to hold the light sources, the converging lens, and the optical fiber connector. The base includes a first surface, a second surface opposite to the first surface, a first region including a center of the base when viewed in a first direction intersecting the first surface, a second region surrounding the first region when viewed in the first direction, a first space provided in the first region and penetrating through the base to have a first opening on the first surface and a second opening on the second surface, and a plurality of second spaces provided in the second region and having third openings on the first surface. The optical fiber connector is held by the base while at least a part of the optical fiber connector is accommodated in the first space. The converging lens is held by the base while at least a part of the converging lens is accommodated in the first space on a first opening side with respect to an end surface on the first opening side of the optical fiber held by the optical fiber connector. Each of the plurality of light sources is held by the base while at least a light emitting region of the light source is accommodated in the second space. A thickness of the first region in the first direction is thicker than a thickness of the second region in the first direction."

[0008] In the light source unit, the plurality of light sources that emit the light with which the object is to be irradiated, the converging lens for converging the light from the object, and the optical fiber connector for holding the optical fiber that receives the incidence of the light converged by the converging lens are held by the same base. The base has the first surface and the second surface opposite to the first surface, and when viewed in first direction intersecting the first surface, includes the first region including the center of the base, and the second region surrounding the first region. The first space that is a through-hole that opens to the first surface and the second surface is formed in the first region, and the second spaces that open to at least the first surface are formed in the second region. The light source is held by the base such that at least the light emitting region is accommodated in the second space.

[0009] Therefore, the object is irradiated from the first surface side of the base with the light emitted from the light emitting region of the light source. In other words, the light from the object is incident on the first surface of the base. Meanwhile, the converging lens is held by the base while at least a part of the converging lens is accommodated in the first space that opens to the first surface of the base. Therefore, by locating the converging lens closer to the object, the light from the object that is incident from the first surface side of the base can be made to be more efficiently incident on the optical fiber (held by the optical fiber connector).

[0010] Here, in the light source unit, by making the base using metal having a relatively high thermal conductivity, heat dissipation is improved. Further, by making the first region of the base thicker than the second space of the base that accommodates the light emitting region of the light source, the first space that accommodates the converging lens and the like being provided in the first region, the thermal capacity of the first region is ensured. As a result, the transfer of heat generated in the light emitting region of the light source to the converging lens can be suppressed, and the influence of heat on the converging lens can be reduced.

[0011] Incidentally, by making the first region of the base relatively thick, the first space that accommodates the converging lens and the optical fiber connector being provided in the first region, the optical fiber connector can be inserted deeper into the first space, or a fixing region for the converging lens in the first region can be sufficiently ensured. Therefore, optical axis misalignment in the converging lens and the optical fiber connector can be suppressed. Further, at least a part of the converging lens and at least the light emitting region of the light source are accommodated in the first space and the second space, respectively. For this reason, the converging lens and the light emitting region of the light source can be reliably protected by the base. Further, by making the second region relatively thin, the second space that accommodates at least the light emitting region of the light source being provided in the second region, the light emitting region can be located closer to the object, so that the amount of light per unit area with which the object is to be irradiated can be ensured.

[0012] [2] The light source unit according to the present disclosure may be "the light source unit described in the above [1], in which a first positioning portion configured to position the converging lens in the first direction is formed in the base, and the converging lens is fixed to and held by the base in a state where the converging lens is positioned by the first positioning portion." In this case, the converging lens can be accurately fixed to the base.

[0013] [3] The light source unit according to the present disclosure may be "the light source unit described in the above [1] or [2], in which a second positioning portion configured to position the optical fiber connector in the first direction is formed in the base, and the optical fiber connector is fixed to and held by the base in a state where the optical fiber connector is positioned by the second positioning portion." In this case, the optical fiber connector can be accurately fixed to the base.

[0014] [4] The light source unit according to the present disclosure may be "the light source unit described in any one of the above [1] to [3], further including: the optical fiber held by the optical fiber connector. The light emitting region of each of the plurality of light sources is located closer to a first surface side than the end surface on a converging lens side of the optical fiber." In this case, the light emitting region of the light source and the converging lens can be disposed closer to the object. For this reason, the amount of light per unit area with which the object is to be irradiated can be ensured, and the light from the object can be more efficiently incident on the optical fiber.

[0015] [5] The light source unit according to the present disclosure may be "the light source unit described in any one of the above [1] to [4], in which each of the plurality of second spaces penetrates through the base to have a fourth opening on the second surface." In this case, in addition to the first space, the second space is also formed as a through-hole. For this reason, the light source can be mounted on the base from both the first surface side and the second surface side, so that the light source can be easily mounted on the base.

[0016] [6] The light source unit according to the present disclosure may be "the light source unit described in any one of the above [1] to [5], further including: a plurality of holding members that hold the plurality of respective light sources to constitute light source assemblies together with the light sources; and a plurality of support members configured to support a plurality of the respective light source assemblies via the holding members. Each of the plurality of light sources is held on the base by fixing the support member, which supports the light source assembly, to the second surface. Each of the plurality of support members includes a sliding surface configured to support the holding member so as to be slidable around an axis intersecting an optical axis of the light source." In this case, the light source assembly is slidable along the sliding surface of the support member to change the angle of the optical axis of the light source. Therefore, it becomes easier to adjust the optical axis of the light source.

[0017] [7] The light source unit according to the present disclosure may be "the light source unit described in the above [6], in which the support members are detachably fixed to the base." In this case, if any of the plurality of light sources fails, the failed light source can be removed and replaced for each support member that supports the light source assembly.

[0018] [8] The light source unit according to the present disclosure may be "the light source unit described in any one of the above [1] to [7], in which an entirety of the converging lens is accommodated in the first space." In this case, the protrusion of the converging lens from the first surface of the base can be avoided, and the converging lens can be reliably protected.

[0019] [9] The light source unit according to the present disclosure may be "the light source unit described in any one of the above [1] to [8], in which the first surface is a flat surface." In such a manner, by forming the first surface on an object side of the base as a flat surface, the object can be irradiated with light while bringing the first surface into contact with, for example, a glass window or the like.

[0020] [10] The light source unit according to the present disclosure may be "the light source unit described in any one of the above [1] to [9], in which the base includes a third region surrounding the second region when viewed in the first direction, and a spacer portion protruding from a surface on the first surface in the third region, the first opening and the third openings being provided on the surface." In this case, when the light source unit is disposed such that the spacer portion comes into contact with the object, the irradiation position of the light from the light source on the object in the first direction can be aligned according to the length of the spacer portion in the first direction. Particularly, when the optical axes of the plurality of light sources intersect each other at one point, by setting the length of the spacer portion in the first direction, the intersection point of the optical axes of the plurality of light sources can be easily and reliably positioned at a desired position on the object. For example, by setting the length of the spacer portion in the first direction to coincide with a length from the surface on the first surface to the intersection point, the first opening and the third openings being provided on the surface, positioning can be easily and reliably performed such that the intersection point is located on the surface of the object. In addition, compared to when a spacer formed separately from the base is disposed and used on the first surfaces, the accuracy of alignment can be improved.

[0021] According to the present disclosure, it is possible to provide the light source unit capable of reducing the influence of heat on the converging lens.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] FIG. **1** is a perspective view of a light source unit according to the present embodiment.

[0023] FIG. **2** is a cross-sectional view showing a cross section of the light source unit shown in FIG. **1**, which includes a first direction D**1** and a second direction D**2**.

[0024] FIG. **3** is a perspective view showing a base shown in FIGS. **1** and **2**.

[0025] FIG. **4** is a perspective view of a light source assembly including a light source shown in FIGS. **1** and **2**, and a support member.

[0026] FIG. **5** is a cross-sectional view showing a mode of optical axis adjustment of the light source in the light source assembly shown in FIG. **4**.

[0027] FIG. **6** is a graph showing changes in the amount of detected light when the voltage applied to the light source is changed.

[0028] FIG. **7** is a perspective view of a light source unit according to a first modification example.

[0029] FIG. **8** is a cross-sectional view showing a cross section of the light source unit shown in FIG. **7**, which includes the first direction D**1** and the second direction D**2**.

[0030] FIG. **9** is a cross-sectional view showing a cross section of a light source unit according to a second modification example, which includes the first direction D**1** and the second direction D**2**.

[0031] FIG. **10** is a perspective view of a light source unit according to a third modification example.

[0032] FIG. **11** is a cross-sectional view showing a cross section of the light source unit shown in FIG. **10**, which includes the first direction D**1** and the second direction D**2**.

[0033] FIG. **12** is a cross-sectional view of a light source unit according to a fourth modification example.

[0034] FIGS. **13**A and **13**B are bottom views of the light source unit shown in FIG. **12**.

DETAILED DESCRIPTION

[0035] Hereinafter, one embodiment of a light source unit according to the present invention will be described with reference to the drawings. Incidentally, in the description of each drawing, the same or corresponding elements are denoted by the same reference signs, and duplicate descriptions may be omitted. In addition, each drawing may show an orthogonal coordinate system consisting of a first axis defining a first direction D**1**, a second axis defining a second direction D**2** intersecting the first direction D**1**, and a third axis defining a third direction D**3** intersecting the first direction D**1** and the second direction D**2**.

[0036] FIG. **1** is a perspective view of the light source unit according to the present embodiment. FIG. **2** is a cross-sectional view showing a cross section of the light source unit shown in FIG. **1**, which includes the first direction D**1** and the second direction D**2**. FIG. **3** is a perspective view showing a base shown in FIGS. **1** and **2**. A light source unit **1** shown in FIGS. **1** to **3** is provided, for example, inside an optical head of a measurement device including a spectrometer and the optical head. The spectrometer is, for example, a Fourier transform infrared spectrometer. In this case, the spectrometer includes, for example, an optical interferometer. The optical interferometer includes, for example, a light incident unit, a beam splitter, a fixed mirror, a movable mirror, and a photodetector. The photodetector acquires, for example, a light intensity signal that changes depending on the position of the movable mirror.

[0037] In addition, the optical head can also be optically connected to the spectrometer by an optical fiber. The optical head is disposed in the vicinity of an object to be measured, and receives electric power via a power supply cable to irradiate the object with light (using the light source unit **1**). Some of the light with which the object is irradiated from the optical head is specularly reflected from the surface of the object, and the remaining light enters the inside of the object. The light that has entered the inside of the object is diffused while repeating refractive transmission, light scattering, and surface reflection inside the object, and some of the light is again emitted from the surface of the object to the outside of the object.

[0038] Since the light repeatedly transmits through the object multiple times during the optical diffusion process, a diffuse reflectance spectrum of the light is a measurement similar to a transmission spectrum. Therefore, the light is incident on the optical head (light source unit **1**), and is provided to the spectrometer via the optical fiber, so that the object can be analyzed using an absorbance. In such a manner, the optical head (namely, the light source unit **1**) is for irradiating the object with light and for receiving the incidence of return light from the object to provide the return light to the spectrometer (eventually to the photodetector of the spectrometer). Incidentally, examples of the object include medicines, plastics, plants, and the like.

[0039] The light source unit **1** includes a base **2**, a plurality of (here, eight) light sources **3**, a converging lens **4**, an optical fiber connector **5**, and an optical fiber **6**. The base **2** holds the light sources **3**, the converging lens **4**, the optical fiber connector **5**, and the optical fiber **6**. The optical fiber **6** includes a fiber body and a coating material (ferrule) having a cylindrical shape and covering the fiber body, and can be held by the optical fiber connector **5** via the ferrule.

[0040] The light source **3** is for emitting light with the object is to be irradiated. The light source **3** is, as one example, a halogen lamp. However, any light source can be used as the light source **3**. For example, the light source **3** may be a thermal light source or an incandescent light bulb such as a halogen lamp, a tungsten lamp, or a graphene light source, or may be a light emitting diode or a semiconductor laser such as a light emitting diode (LED), a laser diode (LD), a super luminescent diode (SLD) or a vertical cavity surface emitting laser (VCSEL).

[0041] The converging lens **4** is for converging the light (the return light) from the object. In the present embodiment, the converging lens **4** is a hemispherical lens that is convex to the side opposite to the optical fiber **6**. A diameter (width in the second direction D**2** in FIG. **2**) of the converging lens **4** is larger than or equal to a diameter (width in the second direction D**2** in FIG. **2**) of the optical fiber **6**. In addition, the diameter of the converging lens **4** may be larger than or equal to a width (width in a direction perpendicular to an optical axis direction of the light source **3**) of a second space **22** to be described later, or may be larger than or equal to a minimum thickness of the base **2** (corresponding to a thickness of an end portion of the base **2** in the second direction D**2** in the case of FIG. **2**). By increasing the diameter of the converging lens **4**, the light (return light) from the object can be made to be efficiently incident thereon. The diameter of the converging lens **4** (namely, a width of a first space **21** in the second direction D**2** in FIG. **2** which will be described later) is, as one example, approximately 10 mm. The maximum value of a thickness of the converging lens **4** in the first direction D**1** is, as one example, approximately 3 mm. A diameter of the optical fiber **6** (diameter of the ferrule) is, as one example, approximately 3 mm. The width of the second space **22** is, as one example, approximately 6 mm. The optical fiber connector **5** is for holding the optical fiber **6** that receives the incidence of the light converged by the converging lens **4**.

[0042] The base **2** is made of, for example, metal such as aluminum. The base **2** has a first surface **2***s* and a second surface **2***r* opposite to the first surface **2***s*. The first surface **2***s* is a surface facing an object side when the light source unit **1** is in use (namely, when the object is irradiated with light). The first surface **2***s* is a flat surface extending to intersect (be perpendicular to) the first direction D**1**. The second surface **2***r* includes an inclined surface that is inclined in directions intersecting the first direction D**1** (for example, the second direction D**2** and the third direction D**3**) such that the distance from the first surface **2***s* increases as the inclined surface extends from a peripheral edge toward the center of the base **2**.

[0043] Namely, the base **2** has a first region **2**A including the center of the base **2** when viewed in the first direction D**1** intersecting the first surface **2***s* (in the present embodiment, located at the center); a second region **2**B surrounding the first region **2**A when viewed in the first direction D**1**; and a third region **2**C surrounding the second region **2**B when viewed in the first direction D**1**, and including a peripheral edge portion of the base **2**. The second region **2**B is a continuous annular region including a region overlapping the second space **22** to be described later when viewed in the first direction D**1**. The first region **2**A is a region inside the second region **2**B when viewed in the first direction D**1**, and the third region **2**C is a region outside the second region **2**B when viewed in the first direction D**1**. Incidentally, in FIGS. **2**, **8**, **9**, **11** and **12**, a boundary between the first region **2**A and the second region **2**B and a boundary between the second region **2**B and the third region **2**C are indicated by one-dot chain lines.

[0044] A thickness of the first region **2**A in the first direction D**1** is thicker than thicknesses of the second region **2**B and the third region **2**C in the first direction D**1**. In the present embodiment, the thickness of the first region **2**A in the first direction D**1** is constant in the directions intersecting the first direction D**1** (for example, the second direction D**2** and the third direction D**3**), and the thickness of the second region **2**B in the first direction D**1** gradually increases in the directions intersecting the first direction D**1** (for example, the second direction D**2** and the third direction D**3**) to reach the thickness of the first region **2**A as the second region **2**B approaches the first region **2**A. In addition, the thickness of the third region **2**C in the first direction D**1** gradually increases in the directions intersecting the first direction D**1** (for example, the second direction D**2** and the third direction D**3**) to reach the thickness of the second region **2**B as the third region **2**C approaches the second region **2**B. Accordingly, the cross-sectional shape of the base **2** is a substantially trapezoidal shape.

[0045] Incidentally, the thickness of the first region **2**A in the first direction D**1** being thicker than the thickness of the second region **2**B in the first direction D**1** refers to at least one of a case where an average thickness of the first region **2**A in the first direction D**1** is thicker than an average thickness of the second region **2**B in the first direction D**1** and a case where a maximum thickness of the first region **2**A in the first direction D**1** is thicker than a maximum thickness of the second region **2**B in the first direction D**1**. In the present embodiment, the average thickness of the first region **2**A in the first direction D**1** is thicker than the average thickness of the second region **2**B in the first direction D**1**. The same applies to the relationship between the thickness of the second region **2**B and the thickness of the third region **2**C.

[0046] In addition, the thickness of the second region **2**B in the first direction D**1** is not limited to the case where the thickness of the second region **2**B gradually increases as the second region **2**B approaches the first region **2**A. Namely, the second region **2**B may have a constant thickness section in which the thickness of the second region **2**B in the first direction D**1** is constant on the way to the first region **2**A. In addition, the thickness of the first region **2**A and the second region **2**B may be formed in two stages (in a step shape) (namely, the entirety of the second region **2**B may be the constant thickness section described above). In addition, the second region **2**B may have a section in which the thickness of the second region **2**B in the first direction D**1** decreases on the way to the first region **2**A. In such a manner, the second region **2**B may be configured such that the average thickness of the first region **2**A is larger than the average thickness of the second region **2**B. Similarly to the second region **2**B, the thickness of the third region **2**C in the first direction D**1** is not also limited to the case where the thickness of the third region **2**C gradually increases as the third region **2**C approaches the second region **2**B, and may be configured in the same manner as the second region **2**B.

[0047] In addition, in the present embodiment, the minimum value of the thickness of the third region **2**C in the first direction D**1** is larger than 0. Accordingly, a third surface **2***t* connecting the first surface **2***s* and the second surface **2***r* is formed at an outer edge of the base **2**. Accordingly, strength of the base **2** can be increased. Further, when viewed in the first direction D**1**, the center of the base **2** and the center of the first region **2**A coincide with each other in the present embodiment, but may not coincide with each other.

[0048] A plurality of spaces for accommodating the plurality of light sources **3**, the converging lens **4**, and at least a part of the optical fiber connector **5** are formed in the base **2**. Namely, the base **2** has one first space **21** provided in the first region **2**A, and a plurality of (here, the same number as the light sources **3**) the second spaces **22** provided in the second region **2**B. Each of the first space **21** and the second spaces **22** is a through-hole penetrating through the base **2** from the first surface **2***s* to the second surface **2***r*.

[0049] Therefore, the first space **21** has a first opening **21***a* on the first surface **2***s* and a second opening **21***b* on the second surface **2***r*. In addition, the second space **22** has a third opening **22***a* on the first surface **2***s* and a fourth opening **22***b* on the second surface **2***r*.

[0050] The converging lens **4** and the optical fiber connector **5** are held by the base **2** while at least parts thereof are accommodated in the first space **21**. In the present embodiment, a width of a portion of the optical fiber connector **5** in the first direction D**1**, the portion being inserted into the base **2**, is larger than the thickness of the converging lens **4** in the first direction D**1**, and is larger than the minimum value of a thickness of the base **2** in the first direction D**1** (in FIG. **2**, a thickness of an outer edge portion of the base **2** in the first direction D**1**, and a length of the third surface **2***t* in the first direction D**1**). Accordingly, since the optical fiber connector **5** can be inserted deeply into the base **2**, optical axis misalignment of the optical fiber connector **5** can be prevented. Incidentally, a width of the base **2** in the second direction D**2** and the third direction D**3** is, as one example, approximately 40 mm. The minimum value of the thickness of the base **2** in the first direction D**1** is, as one example, approximately 1 mm. The maximum value of the thickness of the base **2** in the first direction D**1** is, as one example, approximately 10 mm. The insertion width of the optical fiber connector **5** into the base **2** (the length of a portion of the optical fiber connector **5** in the first direction D**1**, the portion being inserted into the base **2**) is, as one example, approximately 6 mm.

[0051] In the present embodiment, a part on a tip side of the optical fiber connector **5** is accommodated in the first space **21**, and the entirety of the converging lens **4** is accommodated in the first space **21** on a first opening **21***a* side with respect to an end surface on the first opening **21***a* side of the optical fiber **6** held by the optical fiber connector **5**. In the present embodiment, the converging lens **4** is located closer to the first opening **21***a* side than the optical fiber connector **5**. A tapered surface that widens such that the inner diameter of the tapered surface increases as the tapered surface extends toward the tip side is formed on an inner surface of the tip of the optical fiber connector **5**. By forming the tapered surface, some of the light traveling from an end portion side of the converging lens **4** toward the optical fiber **6** can be prevented from being shielded by the tip portion of the optical fiber connector **5**. The converging lens **4** and the optical fiber connector **5** are arranged along the first direction D**1** such that optical axes A**1** of the optical fiber **6** held by the optical fiber connector **5** and the converging lens **4** coincide with each other, and are fixed in the first space **21**.

[0052] In the present embodiment, the converging lens **4** and the optical fiber connector **5** are directly fixed to the base **2**. In the present embodiment, the converging lens **4** is formed from glass, and is fixed to the base **2** using a resin adhesive (not illustrated). Specifically, in the first space **21**, an adhesive is disposed between the base **2** and a side surface of the converging lens **4** that faces the base **2**. In addition, an adhesive is also disposed between the converging lens **4** and a step surface **23** to be described later. Namely, in the present embodiment, a side surface of the base **2** that faces the converging lens **4** in the first space **21** and the step surface **23** correspond to a fixing region. By increasing the first space **21** and the fixing region, fixing strength can be ensured, and optical axis misalignment of the converging lens **4** with respect to the base **2** can be suppressed.

[0053] In addition, in the present embodiment, the optical fiber connector **5** is formed from metal, and is fixed to the base **2** by being press-fitted thereinto. Therefore, in the present embodiment, a side surface of the base **2** that faces the optical fiber connector **5** in the first space **21** and a region **24** to be described later correspond to a fixing region. By increasing the fixing region, fixing strength can be ensured, and optical axis misalignment of the optical fiber connector **5** with respect to the base **2** can be suppressed. Incidentally, the optical fiber connector **5** may be fixed to the base **2** using an adhesive. In this case, for example, in the first space **21**, an adhesive is disposed between the base **2** and a side surface of the optical fiber connector **5** that faces the base **2** and between the optical fiber connector **5** and the region **24**. In this case as well, the side surface of the base **2** that faces the optical fiber connector **5** in the first space **21** and the region **24** correspond to a fixing region. By increasing the fixing region, fixing strength can be ensured, and optical axis misalignment of the optical fiber connector with respect to the base can be suppressed.

[0054] A first positioning portion configured to position the converging lens **4** in the first direction D**1** is formed in the base **2**, and the converging lens **4** is fixed to the base **2** in a state where the converging lens **4** is positioned by the first positioning portion. More specifically, the step surface **23** intersecting an inner surface of the base **2** in the first direction D**1**, the inner surface forming the first space **21**, and facing the first opening **21***a* side is formed, and the converging lens **4** is abutted against the step surface **23**, so that the converging lens **4** is positioned in the first direction D**1**. Namely, in the present embodiment, the step surface **23** is the first positioning portion. A width of the step surface **23** in a direction from the first region **2**A toward the second region **2**B in the second direction D**2** (or the third direction D**3**) may be smaller than the maximum value of the thickness of the converging lens **4** in the first direction D**1**, or may be smaller than the minimum value of the thickness of the converging lens **4** in the first direction D**1**. By reducing the width of the step surface **23**, the shielding of light, which is incident on the converging lens **4** and which travels toward the optical fiber **6**, by the step surface **23** can be suppressed as much as possible.

[0055] In addition, a second positioning portion configured to position the optical fiber connector **5** in the first direction D**1** is formed in the base **2**, and the optical fiber connector **5** is fixed to the base **2** in a state where the optical fiber connector **5** is positioned by the second positioning portion. Here, the optical fiber connector **5** includes a small-diameter portion on the tip side accommodated in the first space **21**, and a large-diameter portion that is larger in diameter than the small-diameter portion, and a step surface between the small-diameter portion and the large-diameter portion is abutted against the region **24** around the second opening **21***b* of the second surface **2***r*, so that the optical fiber connector **5** is positioned in the first direction D**1**. Namely, in the present embodiment, the region **24** of the second surface **2***r* is the second positioning portion. Incidentally, the width of the step surface **23** and the region **24** in the second direction D**2** and the third direction D**3** is, for example, approximately 0.5 mm.

[0056] Incidentally, flat surfaces are formed on parts of an outer surface (the third surface **2***t* connecting the first surface **2***s* and the second surface **2***r*) of the base **2**, and a plurality of (four in the light source unit **1**) holes **2***h* for fixing the light source unit **1** to an external member are formed on the flat surfaces (refer to FIGS. **1** and **3**). By forming the flat surfaces on the outer surface of the base **2**, the flat surfaces can be pressed against and fixed to the external member. Incidentally, the same applies to light source units **1**A to **1**C to be described later.

[0057] Each of the plurality of light sources **3** is held by the base **2** while at least a light emitting region (for example, a filament and a lens portion) **3***r* is accommodated in the second space **22**. When the light source **3** includes a filament, the temperature of the filament reaches 2200° C. when the light source unit **1** is in use. Further, in the present embodiment, since the small base **2** holds the plurality of light sources **3**, as will be described later, the configuration of the present embodiment that can suppress heat generation of the base **2** and the influence of heat on the converging lens **4** is effective.

[0058] In the present embodiment, a part on a tip side of the light source **3** that includes the light emitting region **3***r* is accommodated in the second space **22**, and the remaining portion of the light source **3** protrudes from the second space **22** toward a second surface **2***r* side. The light emitting region **3***r* of the light source **3** is located closer to a first surface **2***s* side than the end surface on a converging lens **4** side of the optical fiber **6**, and the light source **3** does not protrude from the second space **22** toward the first surface **2***s* side. Therefore, in the present embodiment, the first surface **2***s* of the base **2** does not include a protruding portion and is flat. The light source **3** is disposed such that the light emitting region **3***r* thereof faces the first surface **2***s* side. Therefore, the object is irradiated from the first surface **2***s* side with light emitted from the light emitting region **3***r*. In addition, light from the object is incident on the converging lens **4** from the first surface **2***s* side.

[0059] Incidentally, an insertion hole Ba into which a fixing member B such as a screw for fixing the light source **3** to the base **2** is inserted is formed in the base **2**. The insertion hole Ba is open to at least the second surface **2***r*. In the present embodiment, a pair of the insertion holes Ba are provided for one light source **3**. The pair of insertion holes Ba are formed to sandwich one second space **22** therebetween along a direction (radial direction of the base **2**) intersecting an arrangement direction of the second spaces **22** (circumferential direction of the base **2**). For example, when the insertion holes Ba penetrate through the base **2**, the insertion holes Ba can be formed such that the tips of the fixing members B do not protrude from the first surface **2***s*. Accordingly, the first surface **2***s* of the base **2** can be brought into contact with, for example, a glass or the like to perform measurement. In addition, when the insertion holes Ba are open only to the second surface **2***r* (namely, when the insertion holes Ba is recesses), the insertion holes Ba can be formed (with a margin) such that the tip portions of the fixing members B do not reach terminals (bottoms of the recesses) on the first surface **2***s* side of the insertion holes Ba. Accordingly, the light source **3** can be reliably fixed by the fixing members B.

[0060] Here, FIG. **4** is a perspective view of a light source assembly including the light source shown in FIGS. **1** and **2**, and a support member. FIG. **5** is a cross-sectional view showing a mode of optical axis adjustment of the light source in the light source assembly shown in FIG. **4**. FIG. **5** shows a state where the light source assembly and the support member are attached to a jig Z for adjusting an optical axis. As shown in FIGS. **1**, **2**, **4**, and **5**, the light source unit **1** includes a plurality of (the same number as the light sources **3**) holding members **7** that hold the respective light sources **3** to constitute light source assemblies **3**A together with the light sources **3**, and a plurality of (the same number as the light source assemblies **3**A) support members **8** configured to support the light source assemblies **3**A via the holding members **7**.

[0061] The holding member **7** has a through-hole **7***h*, and holds the light source **3** by inserting the light source **3** into the through-hole **7***h*. The support member **8** has a through-hole **8***h*, and supports the light source assembly **3**A via the holding member **7** by inserting the light source assembly **3**A into the through-hole **8***h*. A pair of insertion holes **8***a* are formed in the support member **8** to sandwich the through-hole **8***h* therebetween, the light source assembly **3**A being inserted into the through-hole **8***h*. The support member **8** is formed in an elongated shape in a direction in which the pair of insertion holes **8***a* are aligned, and a width of the support member **8** in a longitudinal direction is, for example, approximately 15 mm. The support member **8** is fixed to the base **2** by inserting (for example, screwing) the common fixing members B into the insertion holes **8***a* and the insertion holes Ba of the base **2**. Namely, the light source **3** is held on the base **2** by fixing the support member **8**, which supports the light source assembly **3**A, to the second surface **2***r* of the base **2**. In addition, the support member **8** (namely, the light source assembly **3**A) is detachably fixed to the base **2**. Incidentally, cutout portions **7***p* for preventing interference of the holding member **7** with the fixing member B (screw) are formed in the holding member **7**. Accordingly, the distance between the holding member **7** and the fixing member B can be reduced, and the downsizing of the light source unit **1** can be realized.

[0062] The holding member **7** and the support member **8** are in contact with each other. More specifically, an outer surface of the holding member **7** that surrounds the through-hole **7***h* and an inner surface of the through-hole **8***h* of the support member **8** are in contact with each other. A contact surface **7***s* of the holding member **7** with the support member **8** and a contact surface **8***s* of the support member **8** with the holding member **7** are sliding surfaces that are slidable against each other. As one example, the contact surface **7***s* and the contact surface **8***s* have hemispherical shapes that intersect an optical axis A**2** of the light source **3** and that are complementary to each other, and accordingly, are slidable against each other around an axis intersecting the optical axis A**2**.

[0063] Namely, the support member **8** includes the contact surface **8***s* serving as a sliding surface configured to support the holding member **7** so as to be slidable around the axis intersecting the optical axis A**2**. Accordingly, by sliding the holding member **7** in a state where the holding member **7** is inserted into the through-hole **8***h* of the support member **8**, the orientation of the optical axis A**2** of the light source **3** can be adjusted. The optical axis A**2** in FIG. **5** indicates the optical axis of the light source **3** when no optical axis misalignment occurs, and an optical axis A**3** indicates the optical axis that is adjusted by sliding of the holding member **7** when an optical axis misalignment occurs.

[0064] The optical axis misalignment of the light source **3** can occur due to, for example, manufacturing errors of the filament in the light emitting region **3***r* of the light source **3** or the like. If an optical axis misalignment occurs, light cannot be emitted to the object at an angle that is intended when the holding member **7** is fixed to the base **2**, which is not preferable. Therefore, in the present embodiment, the optical axis misalignment of the light source **3** is corrected using the jig Z. For example, in FIG. **5**, the optical axis of the light source **3** is misaligned from A**2** to A**3**. The photodetector (not illustrated) that receives the light emitted from the light source **3** is disposed on a lower side of the jig Z, and the orientation of the light source **3** is adjusted by sliding the light source assembly **3**A (holding member **7**) with respect to the support member **8** such that the light is emitted perpendicularly to a surface (surface with which the support member **8** is brought into contact) of the jig Z. After the adjustment, the support member **8** is removed from the jig Z, and the support member **8** is fixed to the base **2** using the fixing members B. In such a manner, the light can be emitted perpendicularly to the second surface **2***r* of the base **2**, and as will be described later, a configuration in which the optical axes A**2** of the light sources **3** intersect each other at an intersection point C can be reliably realized. In addition, in the present embodiment, the optical axis is adjusted using the jig Z; however, the optical axis may be adjusted by fixing the support member **8** to the base **2** and then sliding the light source assembly **3**A. In a state where optical axis adjustment is performed, the holding member **7** is fixed to the support member **8** using a resin such as a UV-curable resin or a thermosetting resin. However, the holding member **7** and the support member **8** may be fixed to each other using laser welding.

[0065] The light source unit **1** is configured such that the optical axes A**2** of the light sources **3** intersect each other at the intersection point C by fixing the plurality of light source assemblies **3**A, the optical axes of which have been adjusted as described above, to the base **2** via the support members **8**. The distance between the intersection point C and the first surface **2***s* of the base **2** in the first direction D**1** defines a measurement distance D (distance to the object) in the light source unit **1**. In the present embodiment, an angle between the optical axis A**2** of the light source **3** and the optical axis A**1** of the converging lens **4** and the optical fiber **6** (an inclination angle of the optical axis A**2**) is, as one example, approximately 30°, and the measurement distance D is, as one example, approximately 15 mm. In the light source unit **1**, the angle of the inclined surface of the second surface **2***r* with respect to the first surface **2***s* is set such that the inclination angle of the optical axis A**2** is approximately 30°.

[0066] In such a manner, when the measurement distance D is relatively large, a problem in which the amount of light per unit area on the object attenuates due to the directional characteristics of the light source **3** can occur. To address this problem, as shown in FIG. **6**, when the voltage applied to the light source **3** is increased, the amount of detected light is also increased. However, in this case, increasing the applied voltage may cause a failure of the light source **3**, and the lifespan of the light source **3** is shortened, which is a risk. Meanwhile, in the light source unit **1**, by increasing the number of (eight in the present embodiment) the light sources **3**, the amount of light per unit area on the object can be ensured, and the problem is solved. In addition, when the measurement distance D is relatively large, a problem in which the diffused light from the object diverges and becomes less likely to be guided to the optical fiber **6** can occur. Meanwhile, in the light source unit **1**, by fixing the converging lens **4**, which converges the diffused light from the object toward the incident end surface of the optical fiber **6**, to the base **2**, the diffused light from the object can be efficiently guided to the optical fiber **6**, and the problem is solved.

[0067] As described above, in the light source unit **1** according to the present embodiment, the plurality of light sources **3** that emit light with which the object is to be irradiated, the converging lens **4** for converging the light from the object, and the optical fiber connector **5** for holding the optical fiber **6** that receives the incidence of the light converged by the converging lens **4** are held by the same base **2**. The base **2** has the first surface **2***s* and the second surface **2***r* opposite to the first surface **2***s*, and when viewed in the first direction D**1** intersecting the first surface **2***s*, includes the first region **2**A including the center of the base **2**, and the second region **2**B surrounding the first region **2**A. The first space **21** that is a through-hole that opens to the first surface **2***s* and the second surface **2***r* is formed in the first region **2**A, and the second space **22** that opens to at least the first surface **2***s* is formed in the second region **2**B. The light source **3** is held by the base **2** such that at least the light emitting region **3***r* is accommodated in the second space **22**.

[0068] Therefore, the object is irradiated from the first surface **2***s* side of the base **2** with the light emitted from the light emitting region **3***r* of the light source **3**. In other words, the light from the object is incident on the first surface **2***s* of the base **2**. Meanwhile, the converging lens **4** is held by the base **2** while at least a part of the converging lens **4** is accommodated in the first space **21** that opens to the first surface **2***s* of the base **2**. Therefore, by locating the converging lens **4** closer to the object, the light from the object that is incident from the first surface **2***s* side of the base **2** can be made to be more efficiently incident on the optical fiber **6** (held by the optical fiber connector **5**).

[0069] Here, in the light source unit **1**, by making the base **2** using metal having a relatively high thermal conductivity, heat dissipation is improved. Further, by making the first region **2**A of the base **2** thicker than the second space **22** of the base **2** that accommodates the light emitting region **3***r* of the light source **3**, the first space **21** that accommodates the converging lens **4** and the like being provided in the first region **2**A, the thermal capacity of the first region **2**A is ensured. As a result, the transfer of heat generated in the light emitting region **3***r* of the light source **3** to the converging lens **4** can be suppressed, and the influence of heat on the converging lens **4** can be reduced.

[0070] The influence of heat on the converging lens **4** includes, for example, as described above, the risk of expansion of the converging lens **4** due to heat, misalignment of the focal position due to the thermal lens effect, and occurrence of damage to the converging lens **4**, and when the converging lens **4** is fixed to a holder using resin, the fixing strength decreases due to the heat, so that an optical axis misalignment of the converging lens occurs, which is a risk. Particularly, in the present embodiment, since the base **2** is formed from metal and the converging lens **4** is formed from glass, when heat is transferred to the converging lens **4**, damage is likely to occur in the converging lens **4** due to a difference in thermal expansion coefficient. As described above, since such influence of heat on the converging lens **4** becomes more pronounced when many light sources **3** are used to ensure the amount of light per unit area on the object, it becomes more important to suppress the influence of heat.

[0071] Incidentally, by making the first region **2**A of the base **2** relatively thick, the first space **21** that accommodates the converging lens **4** and the optical fiber connector **5** being provided in the first region **2**A, the optical fiber connector **5** can be inserted deeper into the first space **21**, or the fixing region for the converging lens **4** in the first space **21** can be sufficiently ensured. Therefore, optical axis misalignment in the converging lens **4** and the optical fiber connector **5** can be suppressed. Further, at least a part of the converging lens **4** and at least the light emitting region **3***r* of the light source **3** are accommodated in the first space **21** and the second space **22**, respectively. For this reason, the converging lens **4** and the light emitting region **3***r* of the light source **3** can be reliably protected by the base **2**. Further, by making the second region **2**B relatively thin, the second space **22** that accommodates at least the light emitting region **3***r* of the light source **3** being provided in the second region **2**B, the light emitting region **3***r* can be located closer to the object, so that the amount of light per unit area with which the object is to be irradiated can be ensured.

[0072] In addition, in the light source unit **1** according to the present embodiment, the first positioning portion (step surface **23**) configured to position the converging lens **4** in the first direction D**1** is formed in the base **2**, and the converging lens **4** is fixed to and held by the base **2** in a state where the converging lens **4** is positioned by the step surface **23**. For this reason, the converging lens **4** can be accurately fixed to the base **2**.

[0073] In addition, in the light source unit **1** according to the present embodiment, the second positioning portion (region **24** around the second opening **21***b* of the second surface **2***r*) configured to position the optical fiber connector **5** in the first direction D**1** is formed in the base **2**, and the optical fiber connector **5** is fixed to and held by the base **2** in a state where the optical fiber connector **5** is positioned by the region **24**. For this reason, the optical fiber connector **5** can be accurately fixed to the base **2**.

[0074] In addition, the light source unit **1** according to the present embodiment includes the optical fiber **6** held by the optical fiber connector **5**. Furthermore, the light emitting region **3***r* of each of the plurality of light sources **3** is located closer to the first surface **2***s* side than the end surface on the converging lens **4** side of the optical fiber **6**. For this reason, the light emitting region **3***r* of the light source **3** and the converging lens **4** can be disposed closer to the object. Therefore, the amount of light per unit area with which the object is to be irradiated can be ensured, and the light from the object can be more efficiently incident on the optical fiber **6**.

[0075] In addition, in the light source unit **1** according to the present embodiment, each of the plurality of second spaces **22** penetrates through the base **2** to have the fourth opening **22***b* on the second surface **2***r*. In such a manner, by forming the second space **22** as a through-hole, the light source **3** can be mounted on the base **2** from both the first surface **2***s* side and the second surface **2***r* side, so that the light source **3** can be easily mounted on the base **2**.

[0076] In addition, the light source unit **1** according to the present embodiment includes the plurality of holding members **7** that hold the plurality of respective light sources **3** to constitute the light source assemblies **3**A together with the light sources **3**, and the plurality of support members **8** configured to support the plurality of respective light source assemblies **3**A via the holding members **7**. Each of the plurality of light sources **3** is held on the base **2** by fixing the support member **8**, which supports the light source assembly **3**A, to the second surface **2***r*. Furthermore, each of the plurality of support members **8** includes the contact surface **8***s* configured to support the holding member **7** so as to be slidable around an axis intersecting the optical axis A**2** of the light source **3**. For this reason, the light source assembly **3**A is slidable along the contact surface **8***s* of the support member **8** to change the angle of the optical axis A**2** of the light source **3**. Therefore, it becomes easier to adjust the optical axis of the light source **3**.

[0077] In addition, in the light source unit **1** according to the present embodiment, the support member **8** is detachably fixed to the base **2**. For this reason, if any of the plurality of light sources **3** fails, the failed light source **3** can be removed and replaced for each support member **8** configured to support the light source assembly **3**A.

[0078] In addition, in the light source unit **1** according to the present embodiment, the entirety of the converging lens **4** is accommodated in the first space **21**. For this reason, the protrusion of the converging lens **4** from the first surface **2***s* of the base **2** can be avoided, and the converging lens **4** can be reliably protected.

[0079] Further, in the light source unit **1** according to the present embodiment, the first surface **2***s* of the base **2** is a flat surface. In such a manner, by forming the first surface **2***s* on the object side of the base **2** as a flat surface, the object can be irradiated with light while bringing the first surface **2***s* into contact with, for example, a glass window or the like.

[0080] The above embodiment has described one aspect of the light source unit according to the present invention. Therefore, the light source unit according to the present invention is not limited to the light source unit **1** according to the above-described embodiment, and can be modified in any manner. Subsequently, modification examples will be described.

[0081] FIG. **7** is a perspective view of a light source unit according to a first modification example. FIG. **8** is a cross-sectional view showing a cross section of the light source unit shown in FIG. **7**, which includes the first direction D**1** and the second direction D**2**. A light source unit **1**A shown in FIGS. **7** and **8** differs from the light source unit **1** according to the above-described embodiment mainly in the measurement distance D and the number of the light sources **3**.

[0082] More specifically, the measurement distance D in the light source unit **1**A is set to be longer than the measurement distance D in the light source unit **1**. As one example, the measurement distance D in the light source unit **1**A is approximately 30 mm. As a result, in light source unit **1**A, a problem in which the amount of light per unit area on the object is reduced compared to the light source unit **1** occurs. Meanwhile, by providing a larger number of the light sources **3** in the light source unit **1**A than the light source unit **1**, the problem is solved. As one example, the light source unit **1**A includes 16 light sources **3**.

[0083] In addition, in the light source unit **1**A, since the measurement distance D is long, the range where light from the object diverges is also widened. Therefore, the light source unit **1**A employs the converging lens **4** that is larger in a plane intersecting the first direction D**1** compared to the light source unit **1**. In the light source unit **1**A, the diameter (width in the second direction D**2**) of the converging lens **4** may be larger than the thickness of the first region **2**A of the base **2** in the first direction D**1**. Accordingly, the light from the object can be efficiently captured.

[0084] One example of dimensions of each portion of the light source unit **1**A according to the first modification example will be shown. Namely, the diameter of the converging lens **4** (namely, a width of the first space **21** in the second direction D**2** in FIG. **8**) is, as one example, approximately 20 mm. The maximum value of the thickness of the converging lens **4** in the first direction D**1** is, as one example, approximately 5 mm. The width of the base **2** in the second direction D**2** and the third direction D**3** is, as one example, approximately 60 mm. The width of the second space **22** is, as one example, approximately 6 mm. The minimum value of the thickness of the base **2** in the first direction D**1** is, as one example, approximately 2 mm. The maximum value of the thickness of the base **2** in the first direction D**1** is, as one example, approximately 15 mm. The insertion width of the optical fiber connector **5** into the base **2** (the length of a portion of the optical fiber connector **5** in the first direction D**1**, the portion being inserted into the base **2**) is, as one example, approximately 10 mm. The width of the step surface **23** and the region **24** in the second direction D**2** and the third direction D**3** is, for example, approximately 0.5 mm.

[0085] Here, in the light source unit **1**A according to the first modification example, the average thickness of the first region **2**A in the first direction D**1** is thicker than the average thickness of the second region **2**B in the first direction D**1**, and the maximum thickness of the first region **2**A in the first direction D**1** is thicker than the maximum thickness of the second region **2**B in the first direction D**1**. In addition, the average thickness of the second region **2**B in the first direction D**1** is made thicker than the average thickness of the third region **2**C in the first direction D**1**. The maximum thickness of the first region **2**A is, for example, approximately 15 mm, and the maximum thickness of the second region **2**B is, for example, approximately 13 mm.

[0086] FIG. **9** is a cross-sectional view showing a cross section of a light source unit according to a second modification example, which includes the first direction D**1** and the second direction D**2**. As shown in FIG. **9**, a light source unit **1**B differs from the light source unit **1** according to the above-described embodiment in that the converging lens **4** and the optical fiber connector **5** are fixed to the base **2** via a connector **9**.

[0087] More specifically, the light source unit **1**B includes the connector **9** that integrally holds the converging lens **4** and the optical fiber connector **5** in a state where the converging lens **4** and the optical fiber connector **5** are positioned with respect to each other. Furthermore, by inserting the connector **9**, which holds the converging lens **4** and the optical fiber connector **5**, into the first space **21**, the converging lens **4** and the optical fiber connector **5** are held by and fixed to the base **2** via the connector **9**. As one example, the connector **9** is fixed to the base **2** by being screwed into the first space **21**.

[0088] In the light source unit **1**B, a step surface **25** intersecting the inner surface of the base **2** in the first direction D**1**, the inner surface forming the first space **21**, and facing the second opening **21***b* is formed. When the screwing of the connector **9** into the first space **21** progresses, the connector **9** abuts against the step surface **25**, so that the connector **9** is positioned in the first direction D**1**. At this time, the converging lens **4** and the optical fiber connector **5** are also positioned at the same time. Namely, the step surface **25** is a first positioning portion configured to position the converging lens **4** in the first direction D**1**, and is a second positioning portion configured to position the optical fiber connector **5** in the first direction D**1**. Incidentally, the step surface **25** is formed at a position where a tip of the connector **9** does not protrude from the first surface **2***s* when the connector **9** is butted against the step surface **25**.

[0089] In such a manner, by using the connector **9** that integrally holds the converging lens **4** and the optical fiber connector **5** that are positioned with respect to each other, the converging lens **4** and the optical fiber connector **5** can be easily installed at desired positions. Incidentally, in the light source unit **1**B, the inclination angle of the optical axis A**2** of the light source **3** is approximately 30°, and the number of the light sources **3** is 8. In addition, in the light source unit **1**B, an adhesive is disposed between the base **2** and a ridge portion (threads) of the connector **9**, which is screwed with the base **2**. Accordingly, the connector **9** can be prevented from being misaligned with respect to the base **2** after screwing, and optical axis misalignment of the converging lens **4** and the optical fiber connector **5** with respect to the base **2** can be suppressed.

[0090] In the present modification example as well, the thickness of the first region **2**A of the base **2** in the first direction D**1** is larger than the thickness of the second region **2**B, and the first space **21** is formed large. For this reason, the connector **9** can be inserted deeply into the base **2**, and a large fixing region between the connector **9** and the base **2** can be ensured. Therefore, optical axis misalignment of the optical fiber connector **5** and the converging lens **4** with respect to the base **2** can be suppressed. Incidentally, an adhesive may be disposed over the entire region where the connector **9** and the base **2** face each other. In addition, the connector **9** and the optical fiber connector **5** may be integrally formed from, for example, metal.

[0091] One example of dimensions of each portion of the light source unit **1**B according to the second modification example will be shown. Namely, the width of the first space **21** in FIG. **9** in the second direction D**2** is, as one example, approximately 12 mm. The width of the second space **22** is, as one example, approximately 6 mm. The width of the base **2** in the second direction D**2** and the third direction D**3** is, as one example, approximately 40 mm. The minimum value of the thickness of the base **2** in the first direction D**1** is, as one example, approximately 1 mm. The maximum value of the thickness of the base **2** in the first direction D**1** is, as one example, approximately 10 mm. A width of the step surface **25** in the second direction D**2** and the third direction D**3** is, for example, approximately 0.5 mm.

[0092] Here, in the light source unit **1**B according to the second modification example, the average thickness of the first region **2**A in the first direction D**1** is thicker than the average thickness of the second region **2**B in the first direction D**1**. In addition, the average thickness of the second region **2**B in the first direction D**1** is made thicker than the average thickness of the third region **2**C in the first direction D**1**.

[0093] FIG. **10** is a perspective view of a light source unit according to a third modification example, and FIG. **11** is a cross-sectional view showing a cross section of the light source unit shown in FIG. **10**, which includes the first direction D**1** and the second direction D**2**. A light source unit **1**C shown in FIGS. **10** and **11** differs from the light source unit **1**B according to the second modification example in the inclination angle of the optical axis A**2** of the light source **3** and the number of the light sources **3**. Namely, in the light source unit **1**C, the inclination angle of the optical axis A**2** of the light source **3** is approximately 45°, and the number of the light sources **3** is 12. In such a manner, when the inclination of the optical axis A**2** of the light source **3** is increased, the intersection point C becomes closer to the first surface **2***s*, and the measurement distance D becomes shorter; however, by increasing the distance between the light sources **3** facing each other along directions intersecting the first direction D**1**, a long measurement distance D can be ensured.

[0094] Incidentally, in the light source unit **1**C, a flat surface **2***k* intersecting the first direction D**1** and parallel to the second direction D**2** and the third direction D**3** is formed on the second surface **2***r*. A plurality of (here, four) holes **2***g* for fixing the light source unit **1**C to an external member are formed on the flat surface **2***k*. By forming the flat surface **2***k* in the base **2**, the flat surface **2***k* can be pressed against and fixed to the external member. A width of the flat surface **2***k* (width in the second direction D**2** in FIG. **11**) may be larger than the thickness of the base **2** in the first direction D**1**. By ensuring a large width for the flat surface **2***k*, the light source unit **1**C can be stably fixed to the external member.

[0095] One example of dimensions of each portion of the light source unit **1**C according to the third modification example will be shown. Namely, the width of the first space **21** in FIG. **11** in the second direction D**2** is, as one example, approximately 12 mm. The width of the second space **22** is, as one example, approximately 6 mm. The width of the base **2** in the second direction D**2** and the third direction D**3** is, as one example, approximately 50 mm. The width of the flat surface **2***k* in the second direction D**2** and the third direction D**3** is, as one example, approximately 30 mm. The minimum value of the thickness of the base **2** in the first direction D**1** is, as one example, approximately 1 mm. The maximum value of the thickness of the base **2** in the first direction D**1** is, as one example, approximately 12 mm. A width of the step surface **25** in the second direction D**2** and the third direction D**3** is, for example, approximately 0.5 mm.

[0096] Here, in the light source unit **1**C according to the third modification example, the average thickness of the first region **2**A in the first direction D**1** is thicker than the average thickness of the second region **2**B in the first direction D**1**. In addition, the average thickness of the second region **2**B in the first direction D**1** is made thicker than the average thickness of the third region **2**C in the first direction D**1**.

[0097] FIG. **12** is a cross-sectional view of a light source unit according to a fourth modification example, and FIGS. **13**A, **13**B is a bottom view of the light source unit shown in FIG. **12**. The cross section of FIG. **12** corresponds to a cross section taken along line XII-XII of FIGS. **13**A, **13**B. As shown in FIGS. **12** and **13**A, **13**B, a light source unit **1**D according to the fourth modification example differs from the light source unit **1** according to the above-described embodiment in that the base **2** includes a spacer portion **30** that protrudes from a surface **2***sr* on the first surface **2***s* in the third region **2**C, the first opening **21***a* and the third openings **22***a* being formed on the surface **2***sr*. Accordingly, the first surface **2***s* is not a flat surface but a surface having a step. The spacer portion **30** is formed integrally with the base **2**. The spacer portion **30** is formed to surround the first region **2**A and the second region **2**B (namely, to surround an irradiation region of light from the light source **3**) when viewed in the first direction D**1** (when viewed from the first surface **2***s* side). The spacer portion **30** may be formed continuously in an annular shape (here, a circular ring shape) as shown in FIG. **13**A, or a plurality of the spacer portions **30** may be provided intermittently at equal spacings along an annular region as shown in FIG. **13**B. In this case, one spacer portion **30** can be formed, for example, in a columnar shape. A tip surface of the spacer portion **30** (end surface opposite to the surface **2***sr*) is a flat surface.

[0098] A length (namely, a protruding height from the surface **2***sr*) of the spacer portion **30** in the first direction D**1** can be set to coincide with, for example, a distance (measurement distance D) from the intersection point C of the optical axes A**2** of the plurality of light sources **3** to the surface **2***sr* in the first direction D**1**. In this case, by disposing the light source unit **1**D such that the flat tip surface of the spacer portion **30** is brought into contact with the object, the intersection point C can be aligned with the surface of the object. The length of the spacer portion **30** in the first direction D**1** is, for example, approximately 15 mm. Accordingly, a maximum thickness of the third region **2**C in the first direction D**1** is increased by the length of the spacer portion **30**, and is, for example, approximately 17 mm. Accordingly, in the light source unit **1**D, the average thickness of the third region **2**C in the first direction D**1** is thicker than the average thickness of the second region **2**B in the first direction D**1**, and the maximum thickness of the third region **2**C in the first direction D**1** is thicker than the maximum thicknesses of the first region **2**A and the second region **2**B in the first direction D**1**. Incidentally, the width of the spacer portion **30** in a direction intersecting the first direction D**1** (for example, a radial direction of the spacer portion **30**) is, for example, approximately 3 mm. Incidentally, as another mode, for example, by forming the spacer portion **30** such that the intersection point C is located on a side farther from the surface **2***sr* than the tip surface of the spacer portion **30** in the first direction D**1**, namely, by making the length of the spacer portion **30** shorter than the measurement distance D, the intersection point C can be aligned inside the object. In such a manner, the length of the spacer portion **30** may not coincide with the measurement distance D.

[0099] Incidentally, in the present embodiment, the surface **2***sr* on the first surface **2***s*, the first opening **21***a* and the third openings **22***a* being formed on the surface **2***sr*, can be used as a reference surface for calculating the measurement distance D. Namely, the measurement distance D can be defined as the distance from the intersection point C of the optical axes A**2** of the plurality of light sources **3** to the surface **2***sr* in the first direction D**1**. In addition, in the present embodiment, the surface **2***sr* on which the first opening **21***a* and the third openings **22***a* are formed is used as a reference surface, and the length of the spacer portion **30** is set based on the length from the surface **2***sr* to the intersection point C in the first direction (measurement distance D); however, the spacer portion **30** may be provided simply to separate the surface **2***sr* on which the first opening **21***a* and the third openings **22***a* are formed and the object from each other. In this case, the surface **2***sr* on which the first opening **21***a* and the third openings **22***a* are formed may not be used as a reference surface.

[0100] As described above, in the light source unit, the third region **2**C thicker than the first region **2**A and the second region **2**B may be provided outside the second region **2**B. In this case, as in the light source unit **1**D, such a configuration includes a case where the third region **2**C is made thicker than the first region **2**A and the second region **2**B by forming a protruding portion (spacer portion **30**) formed on the first surface **2***s* side in the third region **2**C, a case where the third region **2**C is made thicker than the first region **2**A and the second region **2**B by forming a protruding portion on the second surface **2***r* side in the third region **2**C, and a case where the third region **2**C is made thicker than the first region **2**A and the second region **2**B by combining both cases.

[0101] Namely, in the light source unit, the average thickness of the third region **2**C in the first direction D**1** may be thicker than the average thickness of the first region **2**A in the first direction D**1** or the average thickness of the second region **2**B in the first direction D**1**, and the maximum thickness of the third region **2**C in the first direction D**1** may be thicker than the maximum thickness of the first region **2**A in the first direction D**1** or the maximum thickness of the second region. In such a manner, by forming a portion, which is thicker than the second region **2**B, in the third region **2**C, the thermal capacity of the third region **2**C is increased, so that it can be made difficult for heat generated in the light emitting region **3***r* of the light source **3** to be transferred to the first region **2**A.

[0102] In the light source unit **1**D according to the fourth modification example described above, when the light source unit **1**D is disposed such that the spacer portion **30** comes into contact with the object, the irradiation position of the light from the light source **3** on the object in the first direction D**1** can be aligned according to the length of the spacer portion **30** in the first direction D**1**. Particularly, when the optical axes A**2** of the plurality of light sources **3** intersect each other at one point, by setting the length of the spacer portion **30** in the first direction D**1** to coincide with the length from the first surface **2***s* to the intersection point C (measurement distance D), positioning can be easily and reliably performed such that the intersection point C is located on the object. In addition, compared to when a spacer formed separately from the base **2** is disposed and used on the first surface **2***s*, the accuracy of alignment can be improved. Further, when the spacer portion **30** is formed continuously in an annular shape when viewed in the first direction D**1**, compared to when a plurality of columnar spacers are formed, strength can be improved and light from the outside that can become stray light during measurement can be shielded by the spacer portion **30**. In this case, the spacer portion **30** functions as a light shielding portion.

[0103] The embodiment and various modification examples have been described above; however, the light source unit according to the present invention can be modified in any other manner. For example, in the light source unit **1** according to the embodiment and the light source unit **1**A according to the first modification example, the inclination angle of the optical axis A**2** of the light source **3** may be set to 45° as in the light source unit **1**C according to the third modification example.

[0104] In addition, the second space **22** of the base **2** may not be a through-hole, and may not have an opening on the second surface **2***r* of the base **2**. In this case, the light source **3** can be fixed to the base **2** to be embedded in the base **2**. In this case, the light source **3** can be inserted into the second space **22** from the first surface **2***s* side of the base **2**, and can be fixed to the base **2**.

[0105] Further, the spacer portion **30** of the light source unit **1**D according to the fourth modification example may be applied to the light source units **1**A, **1**B, and **1**C according to the other modification examples.

What is claimed is:

1. A light source unit comprising:

a plurality of light sources configured to emit light with which an object is to be irradiated;

a converging lens configured to converge light from the object;

an optical fiber connector configured to hold an optical fiber that receives an incidence of the light converged by the converging lens; and

a base made of metal and configured to hold the light sources, the converging lens, and the optical fiber connector,

wherein the base includes a first surface, a second surface opposite to the first surface, a first region including a center of the base when viewed in a first direction intersecting the first surface, a second region surrounding the first region when viewed in the first direction, a first space provided in the first region and penetrating through the base to have a first opening on the first surface and a second opening on the second surface, and a plurality of second spaces provided in the second region and having third openings on the first surface,

the optical fiber connector is held by the base while at least a part of the optical fiber connector is accommodated in the first space,

the converging lens is held by the base while at least a part of the converging lens is accommodated in the first space on a first opening side with respect to an end surface on the first opening side of the optical fiber held by the optical fiber connector,

each of the plurality of light sources is held by the base while at least a light emitting region of the light source is accommodated in the second space, and

a thickness of the first region in the first direction is thicker than a thickness of the second region in the first direction.

2. The light source unit according to claim **1**,

wherein a first positioning portion configured to position the converging lens in the first direction is formed in the base, and

the converging lens is fixed to and held by the base in a state where the converging lens is positioned by the first positioning portion.

3. The light source unit according to claim **1**,

wherein a second positioning portion configured to position the optical fiber connector in the first direction is formed in the base, and

the optical fiber connector is fixed to and held by the base in a state where the optical fiber connector is positioned by the second positioning portion.

4. The light source unit according to claim **1**, further comprising:

the optical fiber held by the optical fiber connector,

wherein the light emitting region of each of the plurality of light sources is located closer to a first surface side than the end surface on a converging lens side of the optical fiber.

5. The light source unit according to claim **1**,

wherein each of the plurality of second spaces penetrates through the base to have a fourth opening on the second surface.

6. The light source unit according to claim **1**, further comprising:

a plurality of holding members that hold the plurality of respective light sources to constitute light source assemblies together with the light sources; and

a plurality of support members configured to support a plurality of the respective light source assemblies via the holding members,

wherein each of the plurality of light sources is held on the base by fixing the support member, which supports the light source assembly, to the second surface, and

each of the plurality of support members includes a sliding surface configured to support the holding member so as to be slidable around an axis intersecting an optical axis of the light source.

7. The light source unit according to claim **6**,

wherein the support members are detachably fixed to the base.

8. The light source unit according to claim **1**,
wherein an entirety of the converging lens is accommodated in the first space.

9. The light source unit according to claim **1**,
wherein the first surface is a flat surface.

10. The light source unit according to claim **1**,
wherein the base includes a third region surrounding the second region when viewed in the first direction, and a spacer portion protruding from a surface on the first surface in the third region, the first opening and the third openings being provided on the surface.

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