

Description

The invention relates to an optical assembly comprising retaining means, and an optical first element and a second element, both retained by said means.

Such an assembly, which may also be referred to as "optical device", is known from FR-A-430,551. The known optical assembly is intended for use in projection apparatus and comprises two optical lenses and three leaf springs clamped between an inner and an outer ring. The leaf springs comprise hook-shaped end portions which engage around the lens peripheries in order to keep the lenses in a specific position relative to each other.

A drawback of the known assembly is that for retaining the lenses a large number of parts are required which are secured to each other in a specific position relative to one another. Further, it to be noted that the lenses are retained by means of a clamping force, the clamping force of the leaf springs and the friction between the leaf springs and the lenses playing an essential part. Such a construction has the drawback that the friction which occurs gives rise to a specific positional inaccuracy. This inaccuracy, also referred to as "virtual play" by those skilled in the art, renders the known construction unsuitable for retaining optical elements at a predetermined location and in a predetermined position with an accuracy in the sub-micron range.

It is the object of the invention to provide an optical assembly, in which a precise and stable alignment relationship between the first and the second element is obtained.

To this end the optical assembly in accordance with the invention comprises retaining means, and an optical first element and a second element, both retained by said means, which means comprise an elongate hollow body of triangular cross-section having three deformable side walls which adjoin each other, which body extends from the first to the second element, said first element being secured to each of the side walls inside the body without play at a well-defined distance to the second element and in a well-defined orientation with regard to the second element by rigid local connections.

Connection is possible in a manner known per se, for example by the use of an adhesive, or by laser welding or thermal compression.

The use of the elongate hollow body of triangular cross-section as a retaining means has the advantage that a high torsional stiffness is achieved without taking additional steps. Another advantage is that the elongate hollow body in conjunction with the rigid connections guarantee an extra-ordinary high accuracy. This is because the optical first

element is secured in the optical assembly in a mechanically uniquely defined manner, the method of securing being free of hysteresis. Another advantage of the optical assembly in accordance with the invention is that temperature variations have only a slight and predictable influence on the fixed position of the optical element, which influences can be compensated for readily by optical measures. A further advantage is that the assembly in accordance with the invention can be manufactured rapidly and efficiently because of the small number of parts needed, which obviously reduces the manufacturing costs.

The optical assembly in accordance with the invention is very suitable for use in optical systems in which positional accuracies of the order of magnitude of a few tenths of a micron and angular accuracies of 10^{-4} to 10^{-6} radians are required. Such systems are used in, for example, optical-disc players, such as Laser Vision players or Compact-Disc players employing optical elements such as lenses and semiconductor lasers.

It is to be noted that it is known from GB-A-1,556,476 to couple optical fibres detachably to one another by inserting the ends of each of the fibres into a deformable hollow prismatic element which is surrounded by a hydrostatic medium. The pressure exerted on all sides of the prismatic element by the hydrostatic medium deforms the walls of the prismatic element in such a way that they clamp said fibre ends in position. In comparison with the optical assembly in accordance with the invention this known construction has a number of disadvantages. One of these disadvantages is that the final position of the clamped-in fibre ends depends on the deformation of the prismatic element and the dimensional accuracy of the fibre ends. In the optical assembly in accordance with the invention the optical first element can be fixed exactly in a predetermined position and the dimensional accuracy of that element is not essential. Another disadvantage of the known construction is that the fixing method is based on friction, so that said virtual play also occurs in this known construction. Yet another disadvantage is the necessity of the presence of a hydrostatic medium, which renders the construction intricate and therefore not suitable for many uses.

In an embodiment of the assembly in accordance with the invention, which enables a wide positioning range to be obtained, the elongate hollow body is constituted by a thin-wall tube of triangular cross-section.

Another embodiment, in which the optical first element is of circular cross-section, has the feature that at the location of circular cross-section the optical element has a diameter which is at least equal to the diameter of an inscribed circle of the

tube in the non-deformed condition. This assembly has the advantage that during manufacturing, when the optical first element is positioned relative to the tube of triangular cross-section that element remains in contact with each of the three side walls of the tube, which facilitates securing the optical first element to the side walls.

In another embodiment the connections constitute at least substantially point-shaped contact spots between the optical first element and the side walls of said body, which spots have dimensions which are at least one order of magnitude smaller than the diameter of the inscribed circle of the hollow body. Point-shaped contact spots enable constructional redundancy to be avoided.

In another embodiment the second element is secured in the body in a way similar to the optical first element, each of the elements occupying stable position relative to the other element. In this way an optical assembly is obtained in which at least two elements are secured relative to one another with a high accuracy.

In another embodiment, which is particularly suitable for positioning and securing optical elements having the same diameter relative to one another, the body is constituted by a thin-wall portion of a prismatic tube.

The invention further relates to an optical structure comprising at least two optical assemblies in accordance with the invention.

Embodiments of the invention will now be described in more detail, by way of example, with reference to the accompanying drawings.

Fig. 1 shows a first embodiment of the optical assembly in accordance with the invention in a longitudinal sectional view taken on the line I-I in Fig. 2.

Fig. 2 is a sectional view taken on the line II-II in Fig. 1.

Fig. 3 is a perspective view of a second embodiment of the optical assembly in accordance with the invention.

Fig. 4 is a perspective view of an optical structure in accordance with the invention.

The embodiment shown in Figs. 1 and 2 comprises optical elements constituted by an optical lens 1 and a laser unit 3. The laser unit 3 comprises a diode laser 5, a heat sink 7 and a base plate 9 with a cylindrical wall portion 9A. The laser unit 3, which has an optical axis 3A, and the lens 1 have the same outer diameter and are secured at a specific distance and in a well-defined position relative to one another by means of a thin-wall steel tube 11 of triangular cross-section. On account of its triangular cross-section the tube 11 has a high torsional stiffness, whilst the thin side walls 11A, 11B and 11C of the tube can act more or less as leaf springs, enabling limited laterally directed

deformations of the side walls to be obtained. During manufacture of the optical assembly this deformability may be utilized for positioning the optical elements relative to each other. Preferably, the tube 11 therefore has an inscribed circle whose diameter is slightly larger than the outer diameter of the optical elements.

In the embodiment shown in Figs. 1 and 2 the lens is secured in the tube 11 at three locations, a small amount of a UV-curable adhesive 15 being applied between the lens 1 and the side walls 11A, 11B and 11C at the contact spots 13A, 13B and 13C respectively. The laser unit 3 is secured to each of the side walls 11A, 11B and 11C by a laser weld 17, only one of said welds being visible in the Figures.

Measurements have shown that in the optical assembly constructed as described above the thermal instability of the optical assembly is smaller than 0.03 mrad in a temperature range from 20° to 60° C. In the present example the optical assembly is provided with a sleeve 19 for mechanical and chemical protection of the lens 1 and the laser 5. The sleeve 19 is provided with a transparent window 19A.

The device shown in Fig. 3 comprises two optical elements being two lenses 21 and 23 of different diameter disposed on the same optical axis and a thin-wall body 25 of triangular cross-section. The body 25 has three adjoining side walls 25A, 25B and 25C to which the lenses 21 and 23 are secured by means of small amounts of adhesive 27.

In this embodiment the mutual radial position of the optical elements is not or not significantly affected by variations in the temperature of the device or its environment, so that during operation of the device the orientation of the optical axis is not or not significantly changed. If stringent requirements are imposed on the positioning of the optical elements relative to each other, a possible axial displacement of the optical elements relative to each other under the influence of temperature variations can be reduced by a suitable choice of the expansion coefficients of the optical elements and the thin-wall portion, if applicable, in conjunction with the refractive indexes of the materials of the optical elements. The last-mentioned measure results in a high degree of omnidirectional thermal stability of the device in accordance with the invention.

The optical structure in accordance with the invention shown in Fig. 4 comprises two optical assemblies 31 and 33 in accordance with the invention, in which optical elements are secured in a manner as shown in the preceding Figures. The optical assembly 31 comprises a tube 35 of triangular cross-section, a lens 37, a semi-conductor

laser 39 and a semitransparent mirror 41. The optical assembly 33 comprises a triangular tube 43 and a detector 45. Both optical assemblies 31 and 33 are rigidly connected to one another, a plate 47 being provided for increased rigidity. To enable the assemblies 31 and 33 to cooperate optically, the optical assembly 31 is provided with a window 49 which is disposed in the side wall 35A which faces the assembly 33. Obviously, the invention is not limited to the embodiments shown herein.

Claims

1. An optical assembly comprising retaining means and an optical first element (1; 21; 37; 45) and a second element, both retained by said means, which means comprise an elongate hollow body (11; 25; 35,43) of triangular cross-section having three deformable side walls (11A, 11B, 11C; 25A, 25B, 25C; 35A) which adjoin each other, which body extends from the first to the second element, said first element being secured to each of the side walls inside the body without play at a well-defined distance to the second element and in a well-defined orientation with regard to the second element by rigid local connections (13A, 13B, 13C; 27). 15
2. An assembly as claimed in Claim 1, wherein the body (11; 25; 35,43) is constituted by a thin-wall tube of triangular cross-section. 20
3. An assembly as claimed in Claim 2, wherein the optical first element (1; 21; 37; 43) is of circular cross-section and wherein at the location of circular cross-section the optical element has a diameter which is at least equal to the diameter of the inscribed circle of said tube in the non-deformed condition. 25
4. An assembly as claimed in Claim 1, 2 or 3, wherein said connections (13A, 13B, 13C; 27) constitute at least substantially point-shaped contact spots between the optical first element and the side walls of said body, which spots have dimensions which are at least one order of magnitude smaller than the diameter of an inscribed circle of the hollow body. 30
5. An assembly as claimed in Claim 1, 2, 3 or 4, wherein the second element (3; 23; 39; 41) is secured in the body in a way similar to the optical first element, each of the elements occupying stable position relative to the other element. 35
6. An assembly as claimed in Claim 1, wherein 40

the body is constituted by a thin-wall portion of a prismatic tube.

7. An optical structure comprising at least two optical assemblies (31, 33) as claimed in any one of the preceding Claims. 45

Patentansprüche

1. Optisches Gebilde mit Haltemitteln und einem optischen ersten Element (1; 21; 37; 45) und einem zweiten Element, die beide von den genannten Mitteln festgehalten werden, wobei diese Mittel einen länglichen Hohlkörper (11; 25; 35; 43) dreieckigen Querschnitts mit drei verformbaren aneinander anschließenden Seitenwänden (11A, 11B, 11C; 25A, 25B, 25C; 35A) aufweisen, wobei dieser Körper sich von dem ersten Element zum zweiten Element erstreckt, wobei dieses erste Element innerhalb des Körpers ohne Spielraum in einem gut definierten Abstand von dem zweiten Element und in einer gut definierten Lage in bezug auf das zweite Element durch feste örtliche Befestigungen (13A, 13B, 13C; 27) an jeder der Seitenwände befestigt ist. 10
2. Gebilde nach Anspruch 1, wobei der Körper (11; 25; 35,43) durch eine dünnwandige Röhre dreieckigen Querschnitts gebildet wird. 15
3. Gebilde nach Anspruch 2, wobei das optische erste Element (1; 21; 37; 43) einen kreisförmigen Querschnitt hat und wobei an der Stelle des kreisförmigen Querschnitts das optische Element einen Durchmesser hat, der dem Durchmesser des Inkreises der genannten Röhre in dem nicht verformten Zustand mindestens entspricht. 20
4. Gebilde nach Anspruch 1, 2 oder 3, wobei die genannten Verbindungen (13A, 13B, 13C; 27) wenigstens im wesentlichen punktförmige Kontaktstellen zwischen dem optischen ersten Element und den Seitenwänden des genannten Körpers bilden, wobei diese punktförmigen Kontaktstellen Abmessungen aufweisen, die um wenigstens eine Größenordnung kleiner sind als der Durchmesser des Inkreises des Hohlkörpers. 25
5. Gebilde nach Anspruch 1, 2, 3 oder 4, wobei das zweite Element (3; 23; 39; 41) auf dieselbe Art und Weise in dem Körper befestigt ist wie das erste optische Element, wobei die beiden Elemente eine stabile Lage gegenüber einander einnehmen. 30

laser 39 and a semitransparent mirror 41. The optical assembly 33 comprises a triangular tube 43 and a detector 45. Both optical assemblies 31 and 33 are rigidly connected to one another, a plate 47 being provided for increased rigidity. To enable the assemblies 31 and 33 to cooperate optically, the optical assembly 31 is provided with a window 49 which is disposed in the side wall 35A which faces the assembly 33. Obviously, the invention is not limited to the embodiments shown herein.

Claims

1. An optical assembly comprising retaining means and an optical first element (1; 21; 37; 45) and a second element, both retained by said means, which means comprise an elongate hollow body (11; 25; 35,43) of triangular cross-section having three deformable side walls (11A, 11B, 11C; 25A, 25B, 25C; 35A) which adjoin each other, which body extends from the first to the second element, said first element being secured to each of the side walls inside the body without play at a well-defined distance to the second element and in a well-defined orientation with regard to the second element by rigid local connections (13A, 13B, 13C; 27).
2. An assembly as claimed in Claim 1, wherein the body (11; 25; 35,43) is constituted by a thin-wall tube of triangular cross-section.
3. An assembly as claimed in Claim 2, wherein the optical first element (1; 21; 37; 43) is of circular cross-section and wherein at the location of circular cross-section the optical element has a diameter which is at least equal to the diameter of the inscribed circle of said tube in the non-deformed condition.
4. An assembly as claimed in Claim 1, 2 or 3, wherein said connections (13A, 13B, 13C; 27) constitute at least substantially point-shaped contact spots between the optical first element and the side walls of said body, which spots have dimensions which are at least one order of magnitude smaller than the diameter of an inscribed circle of the hollow body.
5. An assembly as claimed in Claim 1, 2, 3 or 4, wherein the second element (3; 23; 39; 41) is secured in the body in a way similar to the optical first element, each of the elements occupying stable position relative to the other element.
6. An assembly as claimed in Claim 1, wherein

the body is constituted by a thin-wall portion of a prismatic tube.

7. An optical structure comprising at least two optical assemblies (31, 33) as claimed in any one of the preceding Claims.

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1. Optisches Gebilde mit Haltemitteln und einem optischen ersten Element (1; 21; 37; 45) und einem zweiten Element, die beide von den genannten Mitteln festgehalten werden, wobei diese Mittel einen länglichen Hohlkörper (11; 25; 35; 43) dreieckigen Querschnitts mit drei verformbaren aneinander anschließenden Seitenwänden (11A, 11B, 11C; 25A, 25B, 25C; 35A) aufweisen, wobei dieser Körper sich von dem ersten Element zum zweiten Element erstreckt, wobei dieses erste Element innerhalb des Körpers ohne Spielraum in einem gut definierten Abstand von dem zweiten Element und in einer gut definierten Lage in Bezug auf das zweite Element durch feste örtliche Befestigungen (13A, 13B, 13C; 27) an jeder der Seitenwände befestigt ist.
2. Gebilde nach Anspruch 1, wobei der Körper (11; 25; 35,43) durch eine dünnwandige Röhre dreieckigen Querschnitts gebildet wird.
3. Gebilde nach Anspruch 2, wobei das optische erste Element (1; 21; 37; 43) einen kreisförmigen Querschnitt hat und wobei an der Stelle des kreisförmigen Querschnitts das optische Element einen Durchmesser hat, der dem Durchmesser des Inkreises der genannten Röhre in dem nicht verformten Zustand mindestens entspricht.
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5. Gebilde nach Anspruch 1, 2, 3 oder 4, wobei das zweite Element (3; 23; 39; 41) auf dieselbe Art und Weise in dem Körper befestigt ist wie das erste optische Element, wobei die beiden Elemente eine stabile Lage gegenüber einander einnehmen.



6. Gebilde nach Anspruch 1, wobei der Körper durch einen dünnwandigen Teil einer prismatischen Röhre gebildet ist.
7. Optische Struktur mit mindestens zwei optischen Gebilden (31,33) nach einem der vorstehenden Ansprüche.

le corps est constitué par une partie à paroi mince d'un tube prismatique.

7. Structure optique comportant au moins deux ensembles optiques (31,33) selon l'une quelconque des revendications précédentes.

Revendications

1. Ensemble optique comportant des moyens de retenue et des premier (1; 21; 37;45) et second éléments optiques, retenus tous les deux par ces moyens, moyens comportant un corps creux allongé (11; 25; 35,43) de section transversale triangulaire présentant trois parois latérales déformables (11A, 11B, 11C; 25A, 25B, 25C; 35A) qui se joignent, ledit corps s'étendant à partir du premier élément vers le deuxième élément, premier élément qui, à l'intérieur du corps, est fixé sans jeu à chacune des parois latérales par des fixations locales rigides (13A, 13B, 13C; 27), à une distance bien définie du deuxième élément et dans une orientation bien définie par rapport au deuxième élément.
2. Ensemble selon la revendication 1, dans lequel le corps (11; 25; 35,43) est constitué par un tube à paroi mince de section transversale triangulaire.
3. Ensemble selon la revendication 2, dans lequel le premier élément optique (1; 21; 37; 43) est de section transversale circulaire et dans lequel, à l'endroit de la section transversale circulaire, l'élément optique a un diamètre au moins égal au diamètre du cercle inscrit dudit tube dans l'état non déformé.
4. Ensemble selon la revendication 1,2 ou 3, dans lequel lesdites fixations (13A, 13B, 13C; 27) constituent au moins sensiblement des endroits de contact ponctuels entre le premier élément optique et les parois latérales dudit corps, endroits qui présentent des dimensions qui sont au moins d'un ordre de grandeur plus faible que le diamètre d'un cercle inscrit du corps creux.
5. Ensemble selon la revendication 1,2,3 ou 4, dans lequel le deuxième élément (3; 23; 39; 41) est fixé dans le corps d'une manière analogue à celle du premier élément optique, chacun des éléments occupant une position stable l'un par rapport à l'autre.
6. Ensemble selon la revendication 1, dans lequel

