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Engelhardt

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(54) **APPARATUS FOR SLEWING A LIGHT BEAM**

(75) Inventor: **Johann Engelhardt**, Bad Schoenborn (DE)

(73) Assignee: **Leica Microsystems Heidelberg GmbH**, Mannheim (DE)

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(30) **Foreign Application Priority Data**

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(51) **Int. Cl.**[7] **G02B 6/00**; G02B 7/182
(52) **U.S. Cl.** **385/25**; 359/872
(58) **Field of Search** 385/25, 52, 90, 385/16, 22; 359/811, 813, 871, 872, 881

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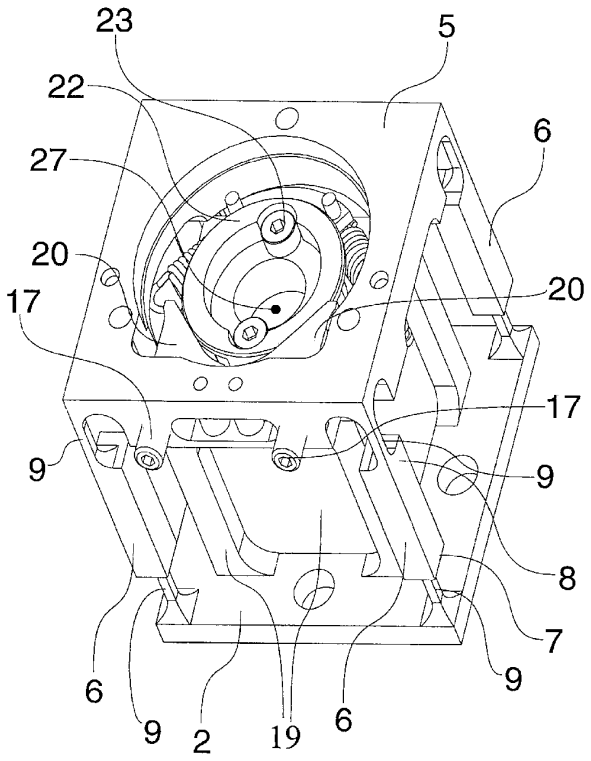
Primary Examiner—Akm Enayet Ullah
Assistant Examiner—Mike Stahl
(74) *Attorney, Agent, or Firm*—Simpson & Simpson, PLLC

(57) **ABSTRACT**

The present invention concerns an apparatus for slewing a light beam, having a base element and a support element carrying a light source or an optical component, wherein connecting elements which allow movement of the support element relative to the base element extend between the base element and the support element. The apparatus according to the present invention eliminates or at least reduces the disadvantages of additionally used optical components. The apparatus is characterized in that the connecting elements are spaced apart differently at their ends facing toward the base element and their ends facing toward the support element.

29 Claims, 10 Drawing Sheets



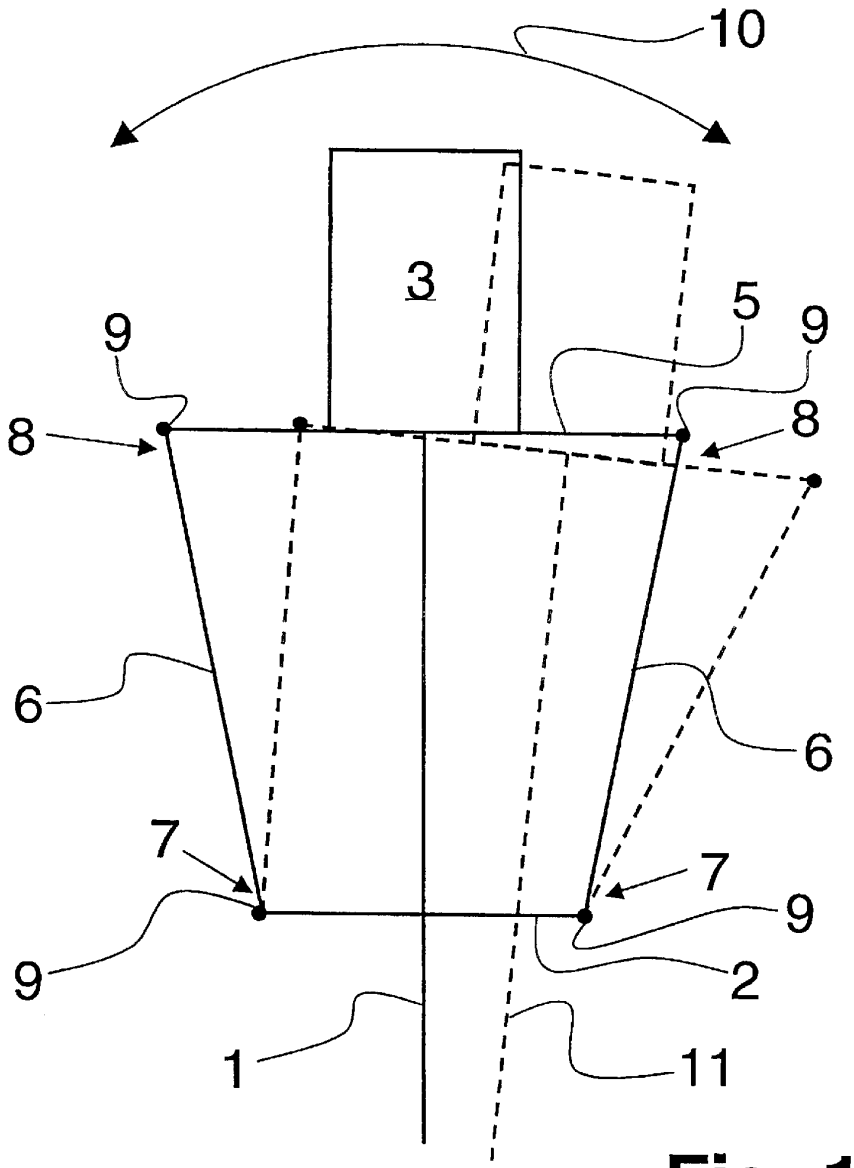


Fig. 1

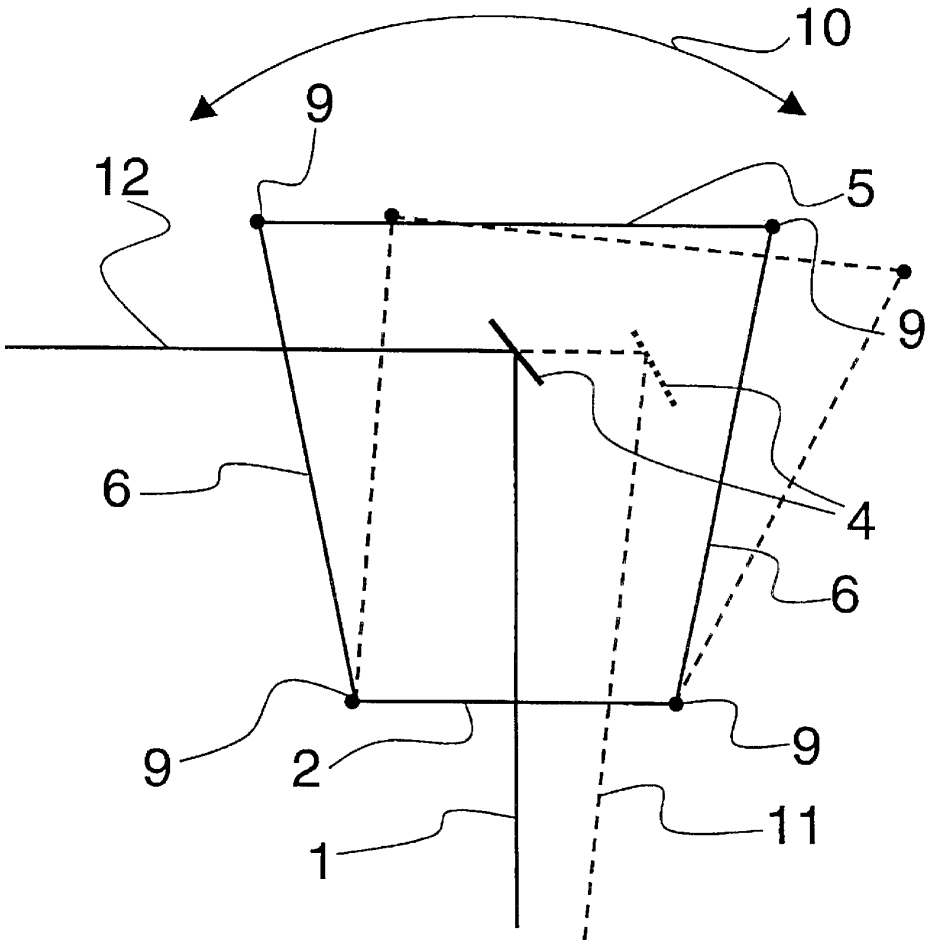


Fig. 2

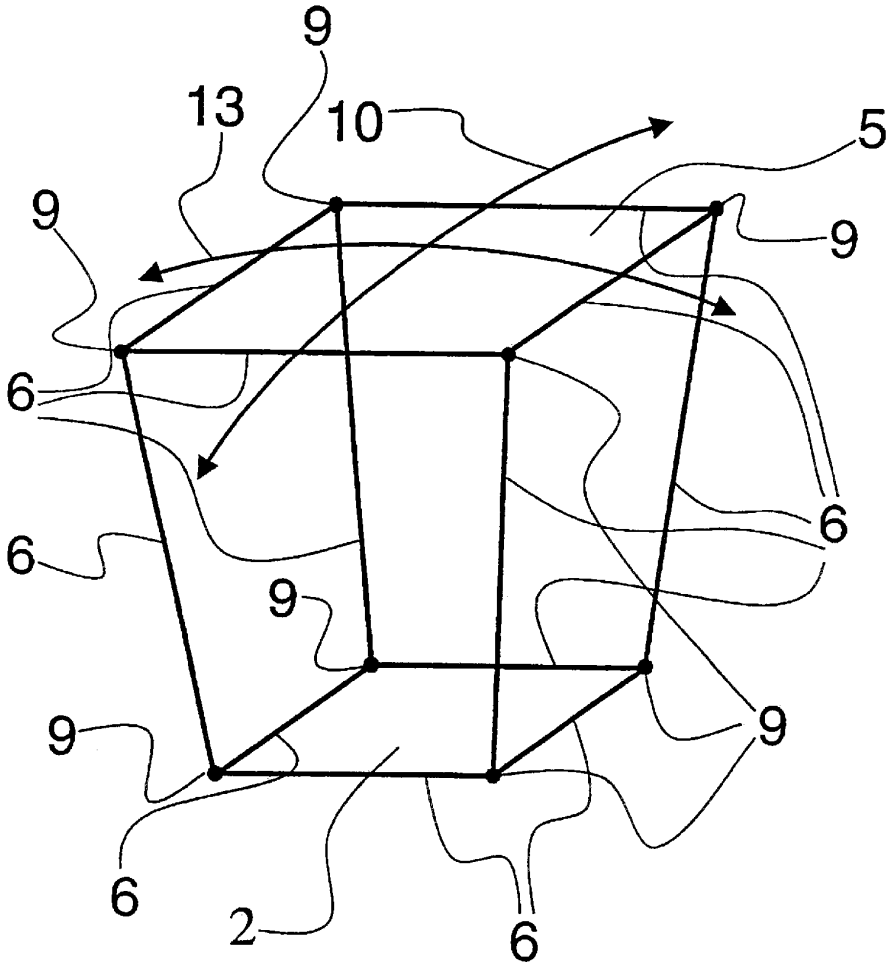


Fig. 3

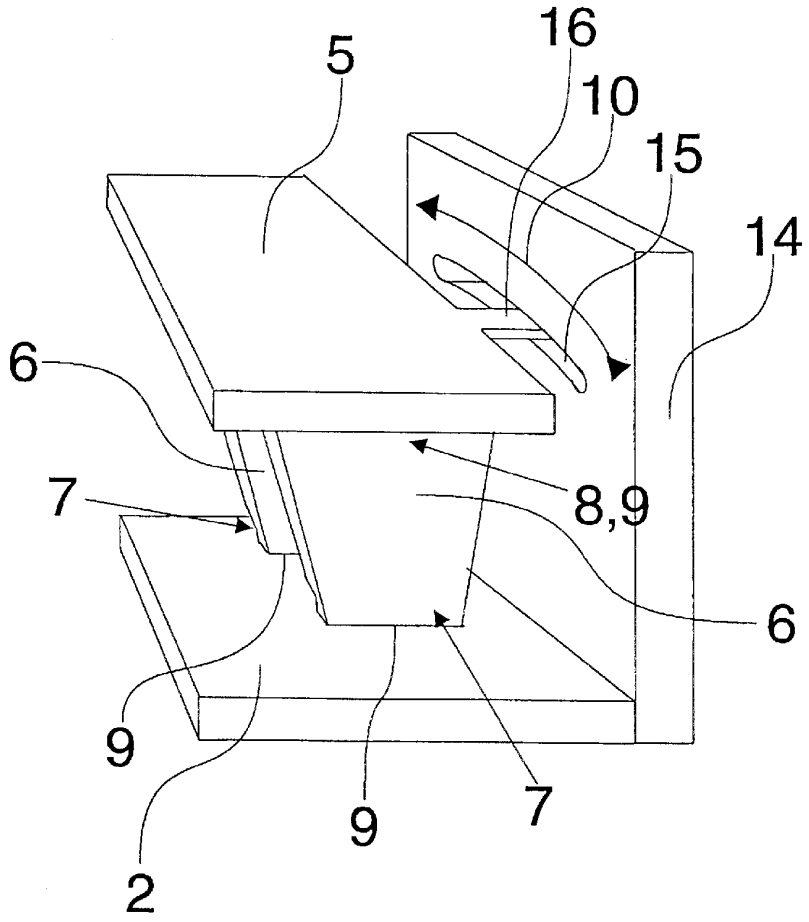


Fig. 4

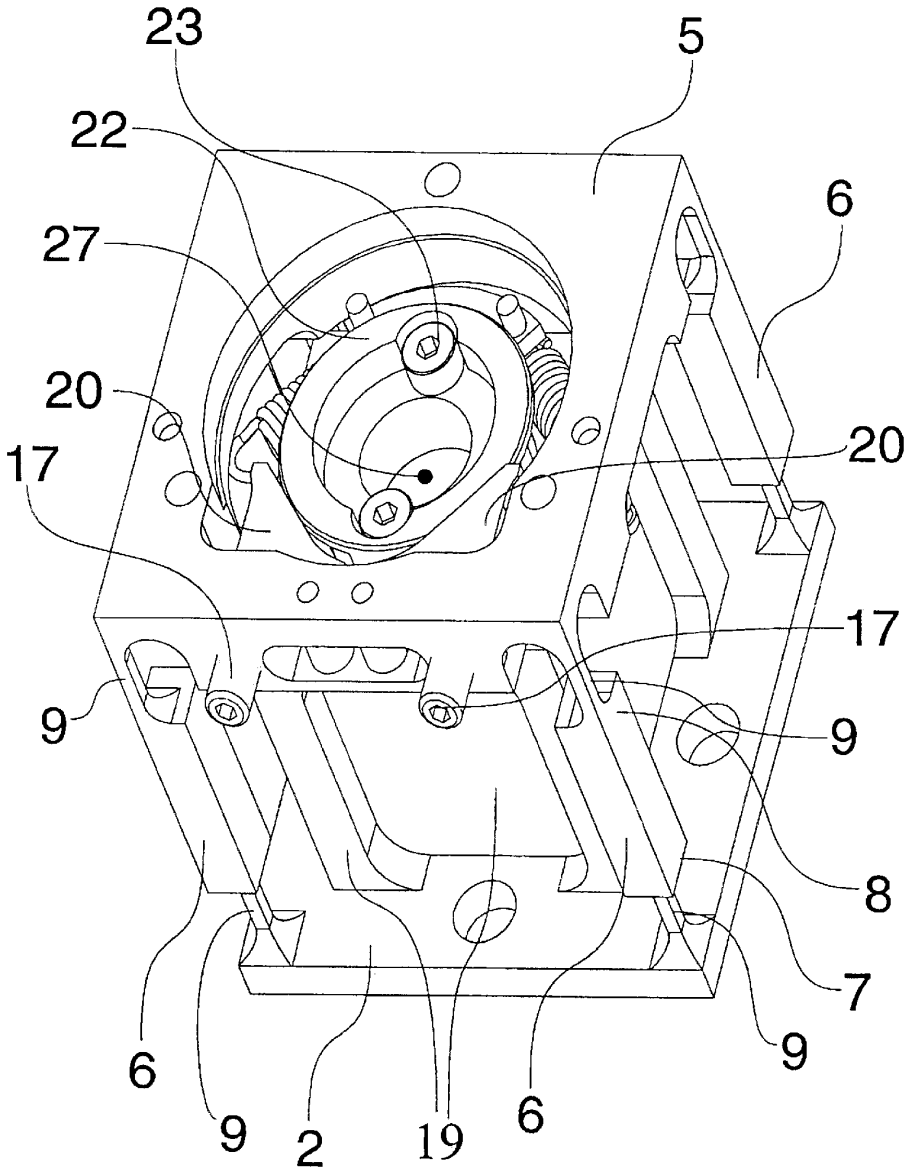


Fig. 5

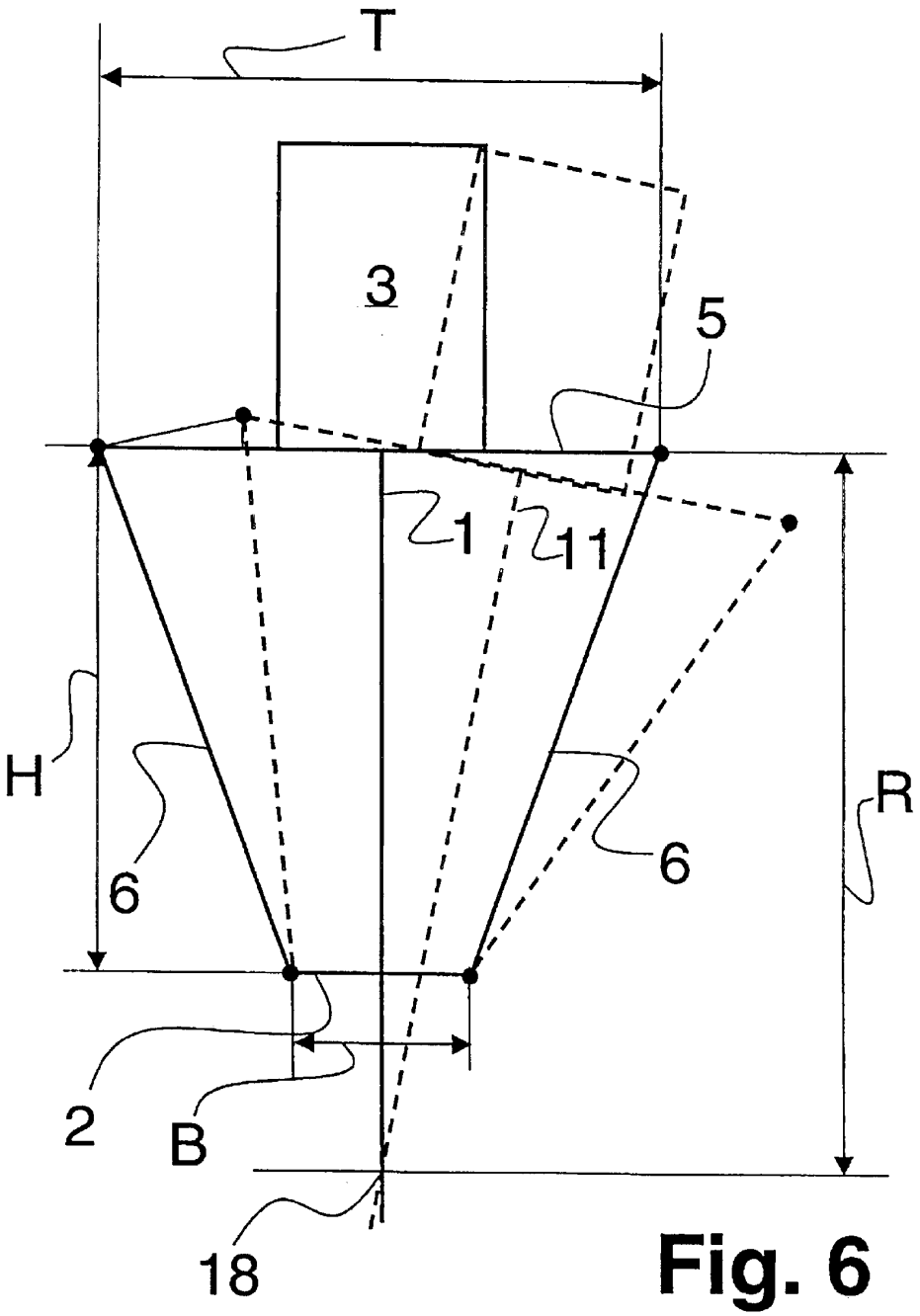


Fig. 6

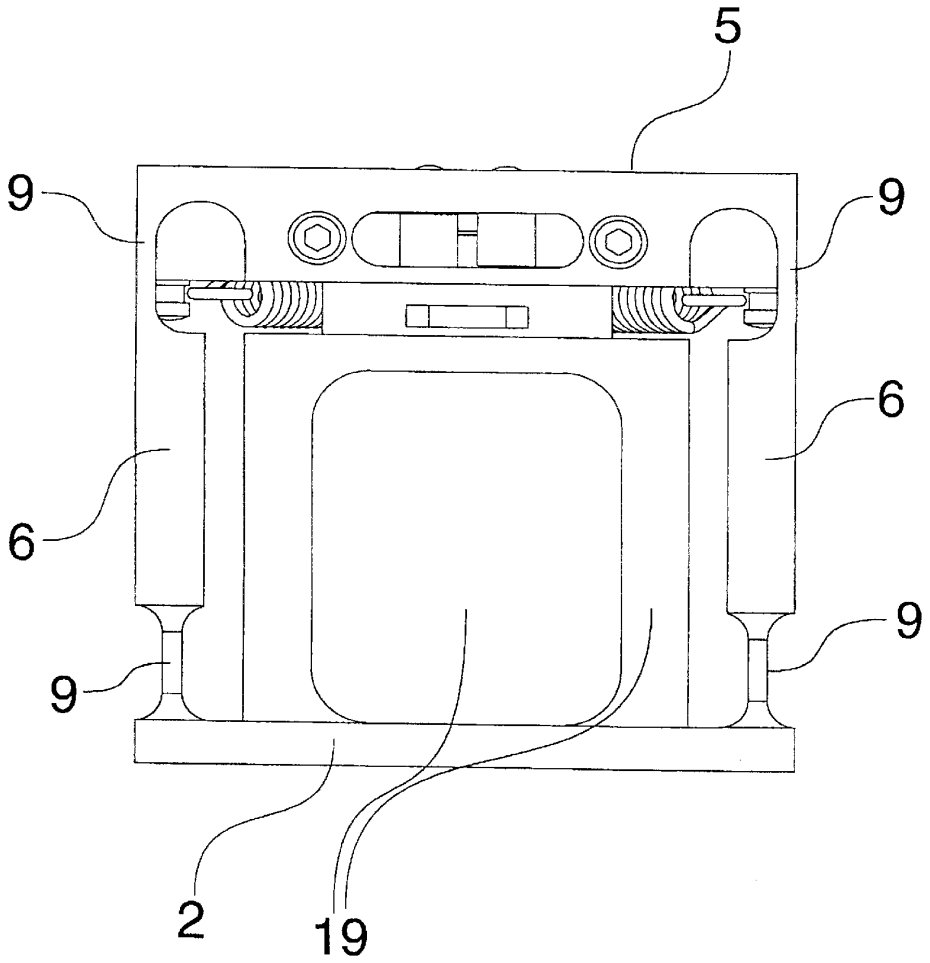


Fig. 7 a

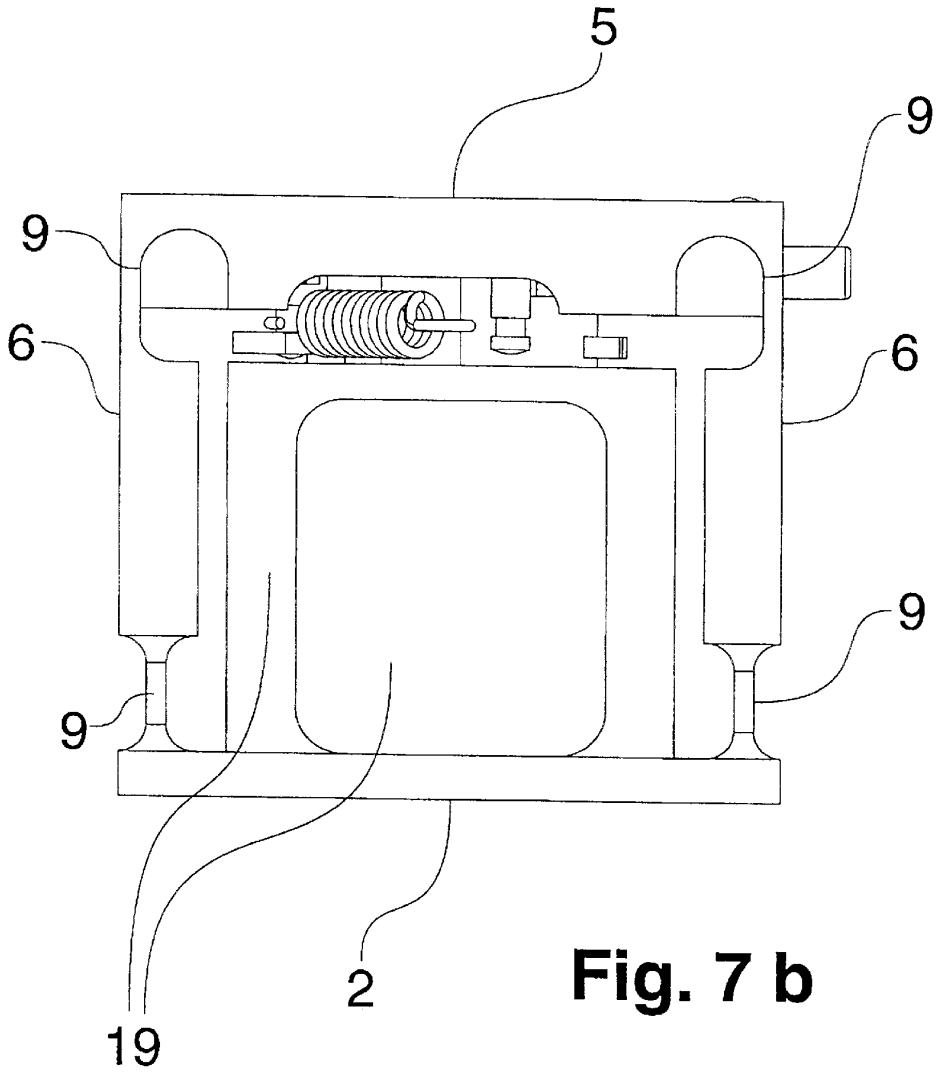


Fig. 7 b

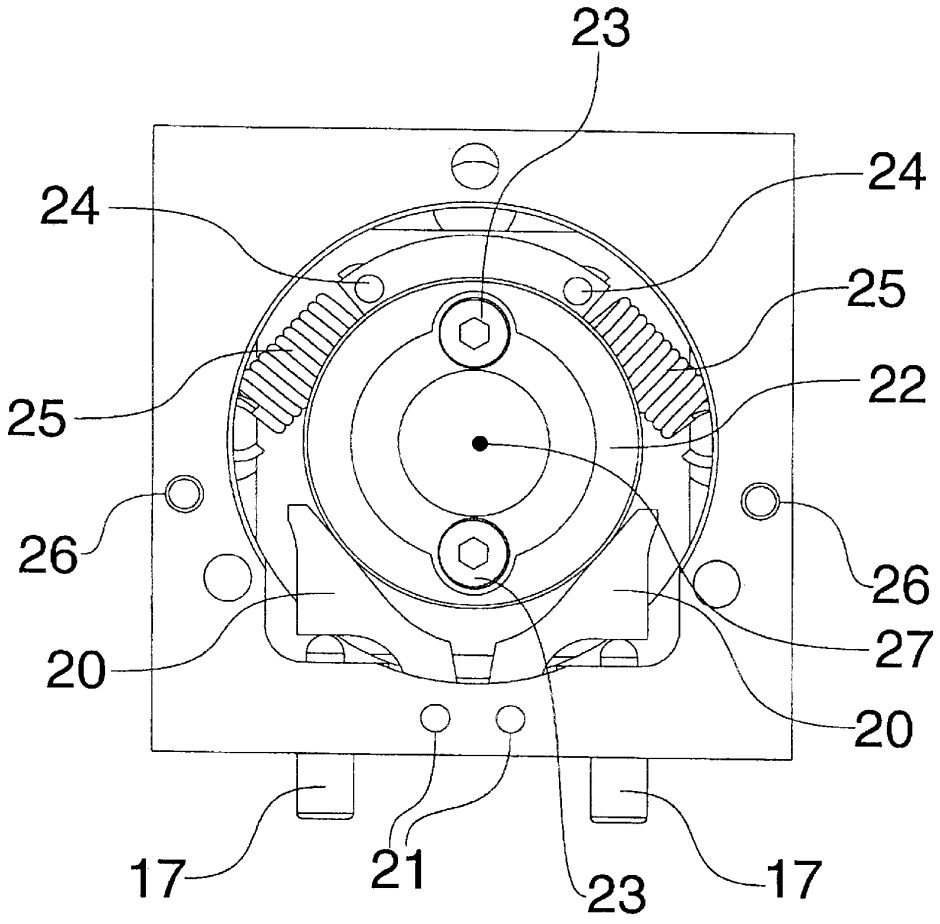


Fig. 7 c

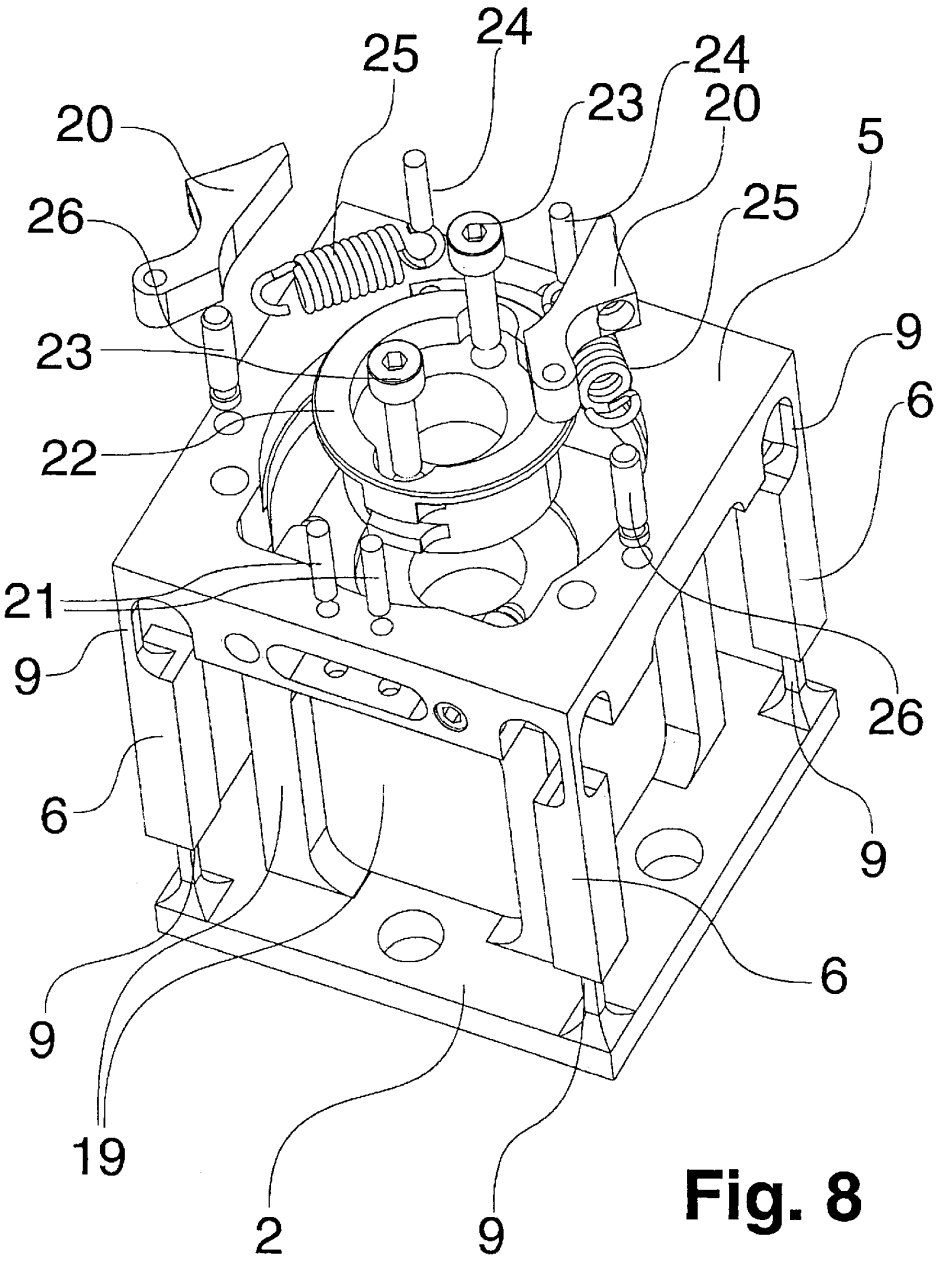


Fig. 8

APPARATUS FOR SLEWING A LIGHT BEAM

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims priority of a German patent application DE 100 04 661.4 filed Feb. 3, 2000 which is incorporated by reference herein.

FIELD OF THE INVENTION

The present invention refers to an apparatus for slewing a light beam, having a base element and a support element carrying a light source or an optical component, wherein connecting elements which allow movement of the support element relative to the base element extend between the base element and the support element.

BACKGROUND OF THE INVENTION

Apparatuses of the generic type are used for positioning and aligning optical components. These apparatuses generally have a base plate which is joined to a support plate in such a way that the support plate performs a tilting movement about a central point relative to the base plate. The tilting movement of the support plate is usually brought about by way of adjusting screws located on the base plate, with which the spacing between the base plate and the support plate at the location of the respective adjusting screw can be changed. With these arrangement, optical components such as, for example, mirrors, prisms, lenses, or small laser light sources can be exactly and reproducibly positioned and aligned.

As already mentioned, however, these apparatuses tilt about a point that usually lies between the base plate and the support plate. For many applications, however, it is necessary for a light beam to be tilted or slewed about a point lying at a physically difficult-to-access location, for example in the intermediate image plane of an optical assemblage. An apparatus of this kind generally cannot be arranged at that location, so that slewing of the light beam about the intended point can be achieved, for example, with the aid of an intermediate image. An intermediate image makes it possible to displace the tilting point of the apparatus to the intended location. This entails a great deal of design complexity, is complex in terms of alignment, represents a source of additional imaging errors, and is moreover associated with losses of available light intensity.

SUMMARY OF THE INVENTION

It is therefore the object of the present invention to eliminate or at least reduce the disadvantages of the additionally used optical components.

The aforesaid object is achieved by way of the features of claim **1**. According to the latter, the apparatus according to the present invention for slewing a light beam has a base element and a support element carrying a light source or an optical component, wherein connecting elements which allow movement of the support element relative to the base element extend between the base element and the support element. The apparatus for slewing the light beam is characterized in that the connecting elements are spaced apart differently at their ends facing toward the base element and their ends facing toward the support element, or at the connecting points at the two ends.

What has been recognized firstly according to the present invention is that the light beam can be slewed surprisingly easily about the mechanically difficult-to-access point if the tilting point of the apparatus itself can be displaced to that location. The advantageous result is that the additional optics for intermediate imaging become superfluous, and the alignment problems of those optical components, as well as their imaging errors, are thus effectively eliminated. In addition, in particularly advantageous fashion, the decrease in the number of components means that the entire assemblage can be made smaller, manufacturing costs are reduced, and the optical beam path is (considerably, in some cases) simplified.

The slewing point of the apparatus is displaced to the intended location by the fact that the apparatus has connecting elements which extend between the base element and the support element. These connecting elements allow a relative movement between the support element and base element that is defined by the geometrical or three-dimensional arrangement of the connecting elements. According to the present invention, the connecting elements are spaced apart differently at their ends facing toward the base element and their ends facing toward the support element, or at the connecting points at the two ends. Two connecting elements and the lines between their connecting points at the two ends thus describe a trapezoid. When a relative movement of the support element occurs with respect to the base element, the guidance system of the connecting elements causes the support element to be guided on a predefined three-dimensional curve. Because of the trapezoidal arrangement of the connecting elements, when the support element moves, the latter is deflected along its movement direction; in particular, it is additionally tilted relative to the base element. As a result of the combination of these two forms of movement (deflection and tilting), the desired slewing movement of the support element about a point spaced away from the apparatus is achieved in a manner according to the present invention. An optical component or light source carried by the support element is constrained to perform this slewing movement, so that the light beam also slews about the point spaced away from the apparatus.

The base element is joined in stationary fashion to the housing of the optical beam path. A relative movement between support element and base element thus means a relative movement between the support element and the housing of the optical beam path. A stationary arrangement of the base element on an optical stage (breadboard) would also be conceivable.

Advantageously, the base element and/or the support element could themselves be assembled from connecting elements, so that, for example, the connecting elements making up the support element permit a relative movement. The number of degrees of freedom of the relative movement between the support element and base element can thereby be even further increased.

If the light beam is to be slewed only in one plane about one point, two connecting elements are provided between the base element and the support element. For that purpose, the connecting elements could have correspondingly large dimensions so that any transverse movement with respect to the intended slewing movement of the support element is prevented.

In an alternative embodiment, at least three connecting elements are provided between the base element and the support element. This makes possible a defined relative movement with more degrees of freedom between the support element and base element, so that the light beam can be slewed not just in one plane about one point.