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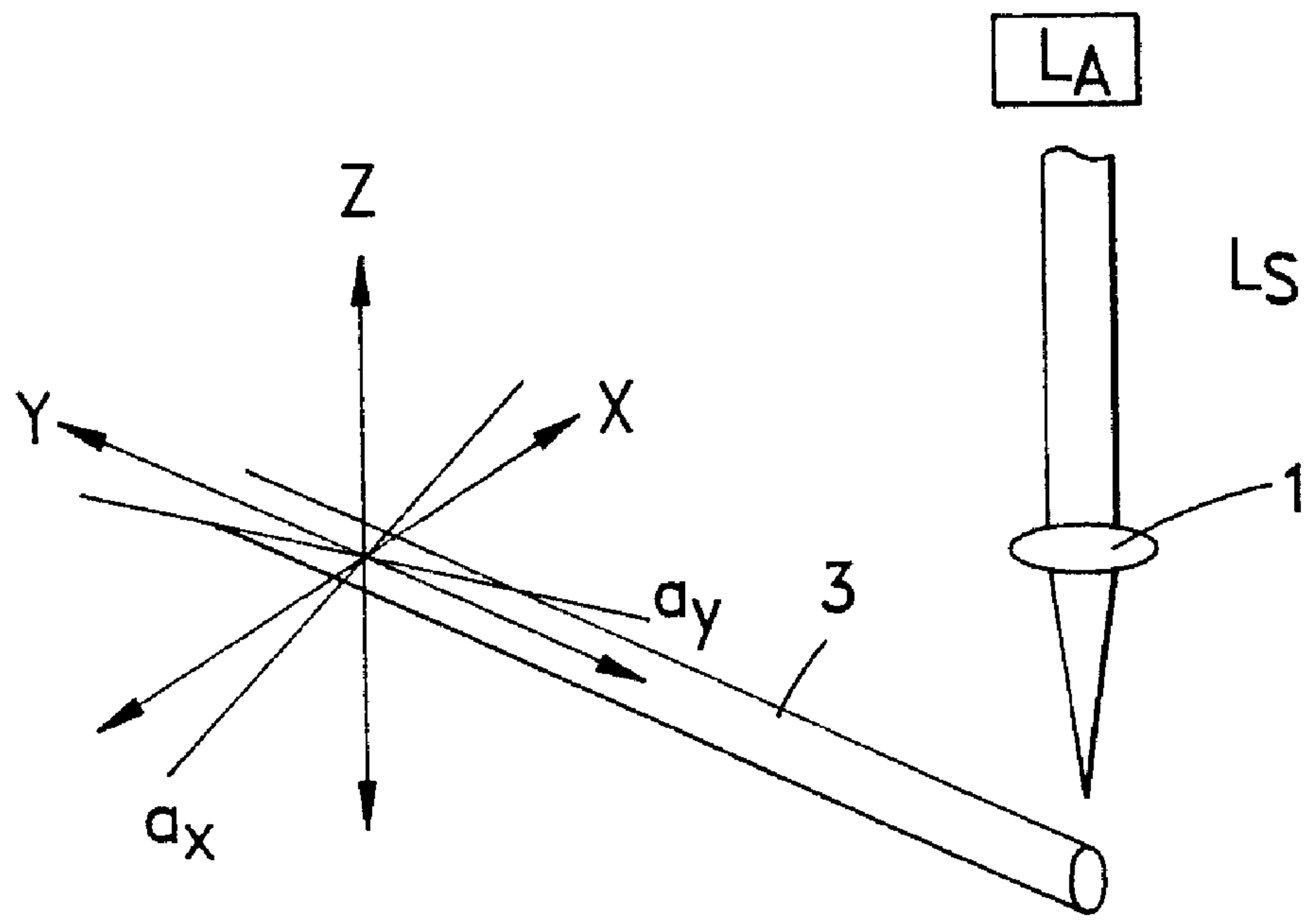
(54) Title: PROCESS FOR CUTTING AN OPTICAL FIBER



(57) Abrégé/Abstract:
A process for cutting or splitting at least one optical fiber at a predetermined angle, wherein the fiber is introduced into a holding and positioning device and is cut by a pulsed laser beam.

ABSTRACT

A process for cutting or splitting at least one optical fiber at a predetermined angle, wherein the fiber is introduced into a holding and positioning device and is cut by a pulsed laser beam.

PROCESS FOR CUTTING AN OPTICAL FIBER

BACKGROUND OF THE INVENTION

Field of the Invention

The invention relates to a process for cutting at least one optical fiber at one or more predetermined angles to form angled or shaped end faces that require no polishing.

Description of the Prior Art

Optical fibers made of glass are often used in optical transmission systems and other optical systems. The machining of the end face of these fibers plays a crucial role during the use of these monomode or multimode fibers. It is important that the end faces have a particularly uniform surface so that the transition from one fiber end to another or to an active element can be carried out with damping values which are as low as possible. It is also important that the end faces of the fibers can be produced at predetermined angles and that these angles are reliable and reproducible.

Various mechanical processes are currently known for severing optical fibers. With all processes, the fiber is essentially fixed in a holding device consisting of two holders which are then mutually offset, for example, so that the correct angle is ensured during the cutting operation. Diamond cutters, for example, are used. It is also known to twist the fiber or begin to cut and then break the fibers which are to be cut. All these processes are expensive. In addition, they are also applicable to the parallel fibers of a ribbon cable only under certain conditions.

It is known from EP 531,225 that in order to sever an optical fiber, the optical fiber may be fixed between two carriers of a holding and positioning device, then one of the carriers is offset perpendicularly to the optical axis of the fibers and a cutting blade is used to cut the fibers at a desired angle. This process can also be used for the number of fibers in a ribbon cable which are arranged parallel to one another.

SUMMARY OF THE INVENTION

It is an object of the invention to provide a process for cutting at least one optical fiber at one or more particular angles or with a particular shape with a high degree of accuracy.

The object is achieved by a process having the characteristics of claim 1. The sub-claims provide advantageous developments.

With the process according to the invention for the cutting of at least one optical fiber at one or more predetermined angles, the fiber is held in a holding and positioning device and the fiber is then cut by means of a laser which delivers short, high-power pulses while the holding and positioning device moves the fiber relative to the laser. As a result, a fiber end face can be produced accurately with a predetermined angle or shape and with such surface uniformity that additional machining of the fiber end face is unnecessary.

It is also particularly advantageous that only a minimal quantity of glass is melted during the cutting of the fiber.

The holding and positioning device of the present invention is designed so that the fiber is fastened therein. Preferably, the device is configured to move the fiber at one or more predetermined angles relative to the laser beam, although it is within the scope of the present invention to move the laser beam relative to the fiber.

The angle at which the beam crosses the fiber can be selected to shape the end face of the fiber. For example, in a simple configuration, the device moves the fiber across the beam in a single pass to form a planar end face. The planar end face may be normal to the axis of the fiber, or it may be angled to the axis such that the end face of the fiber serves to change the direction of the light exiting or entering the fiber. In more complex configurations, the device moves the fiber across the beam at different angles in one or more passes to form a multifaceted or curved end face. Preferred end face shapes include, for example, a wedge shape formed by two opposing cuts. In practice, the wedge shaped will tend to be blunted due to surface tension of the softened fiber during cutting. The blunted wedge shape therefore acts a cylinder-type lens at the fiber end. Such a configuration is well suited for optically coupling the fiber with a laser having an elliptical beam.

The laser beam used for cleaving the fibers is preferably provided by a CO_2 laser, although other lasers, such as excimer lasers, may be used. CO_2 lasers have proven particularly advantageous due to the high speed at which they can operate and the resultant cost effectiveness. The fiber material is removed by ablation by the CO_2 laser during the cutting process, such that, rather than melting, the glass is sublimated.

The CO_2 laser is operated preferably in a pulsed mode for cutting the fiber. The pulse energy is very high. The pulses are very short and have very steep edges, thus, the maximum pulse energy is achieved very rapidly. For example, suitable results have been achieved in which the peak power of the pulse is between about 0.1 and about 1000 watts and the pulse length is greater than about 50 fs. Very good results are achieved with a CO_2 laser (wavelength 10.6 µm) having a pulse length of 35 µs and a peak power of 600 watts. Other lasers with wavelengths between 0.1 and 1.5 µm and 8.5 µm to 10 µm can also be used.

Whereas former mechanical systems have typical angle tolerances of +/- 0.5µ, angle tolerances of less than 0.2µ can be achieved with the process according to the invention. With the present process it is possible to cut not only individual fibers at an angle, but also fibers of a ribbon cable. Furthermore, whereas former mechanical systems were relegated to just straight cuts, the process of the present invention enables the fiber ends to be cut into any desired shape.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a schematic view of an optical waveguide with a coordinate system and a laser beam;

Figure 2 is a cross section through one end of an optical waveguide;

Figure 3 is a schematic view of optical waveguides of a ribbon cable fastened in a holding and positioning device; and

Figure 4 is a schematic view of a wedged-shaped end of a fiber prepared using the laser cleaving of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

A laser L_A from which a laser beam L_S issues is initially required for carrying out the process of cutting a fiber 3. The laser beam L_S is concentrated by a lens 1. The laser beam L_S, once concentrated in this way, impinges on the optical fiber 3. The optical fiber 3 is a glass fiber, for example a monomode or multimode fiber. As shown in Fig. 2, the fiber 3 consists of a fiber core 4 and a fiber sheath 5 so that the light is guided substantially in the fiber core 4. The fiber 3 is arranged in a holding and positioning device and is positionable relative to the laser L_A. For example, it can be orientated along the axis a_Y and then be moved along the axis X relative to the laser beam L_S using microtranslators on the holding and positioning device. However, it is also possible for microtranslators of the holding and positioning device to move the fiber 3 along the axis a_X or any other angle or combination of angles and curves relative to the laser beam. As shown in Fig. 2, a surface 6 of the fiber 3 is produced at an inclination angle to the fiber axis. The angle of inclination should be accurately reproducible, and this is achieved by the proposed process. For carrying out the process, the laser transmits short high-energy pulses of laser light, so that the material of the fiber is sublimated.

A very accurate and high quality surface of the fiber is achieved by "laser cutting", so additional machining of the fiber surface after cutting, as is normal with mechanical cutting processes, is no longer necessary. The fiber end face 6 is finished sufficiently after cutting with the laser

As shown in Fig. 3, with the process according to the invention, it is possible to cut not only an individual fiber and adequately finish the end surface at the same time, but also a bundle of fibers 3 orientated parallel to one another (for example, a ribbon cable) simultaneously with the same surface qualities. For this purpose, the fibers 3 that make up a bundle are introduced into a positioning device 7. The positioning device 7 ensures that the fibers 3 are arranged parallel to one another. The longitudinal axis of the fibers 3 coincides, for example, with the X-axis of a coordinate system. The positioning device 7 can now be driven along the direction of the Y-axis in a manner that ensures that the fibers 3 remain in parallel orientation.

A laser beam L_S, which in this embodiment is inclined by an angle α to the Z-axis, is concentrated onto the fibers 3 by means of a lens 1 and operated in a mode with short high-energy pulses described above. The fibers 3 pass through the laser beam L_S and are thus cut and the end faces simultaneously finished.

As shown in Figure 4, laser cleaving of the present invention can be used to form a wedged-shaped fiber end 41. This wedge shape was formed by passing the fiber through the laser beam at different angles. The wedge shaped fiber end 41 is slightly blunted presumably due to surface tension of the softened fiber during laser ablation. The blunted wedge shape therefore presents a cylinder-type lens 42 at the fiber end. Such a configuration is well suited for optically coupling the fiber with pump-type lasers or other devices which emit or receive an elliptical beam of light.

Advantageously, this process ensures that all fibers of the ribbon cable are cut at the same angle with an equally high end face quality

We claim:

1. A process for cutting at least one optical fiber, the process comprising the steps of:

introducing the fiber into a holding and positioning device;

actuating a laser device to deliver the beam in short high-power pulses; and

effecting the relative movement of the beam across the fiber at one or more predetermined angles.

2. The process according to claim 1 wherein a plurality of fibers are introduced into the holding and positioning device parallel to one another and moving the beam across the plurality so that the fibers are cut in succession.

3. The process according to claim 1 wherein the fiber is a ribbon fiber having multiple fibers therein.

4. The process according to claim 1 wherein the laser is a CO_2 laser.

5. The process according to claim 4, wherein the laser device delivers pulses with peak power between about 0.1 and about 1000 watts and the pulse length is greater than 50 fs.

6. The process according to claim 4, wherein the laser device delivers pulses at a wavelength of 10.6 μm having a peak power of 600 watts and a pulse length of 35 μs

7. The process according to claim 1, wherein said beam is moved across the fiber at only one predetermined angle.

8. The process according to claim 1, wherein said beam is moved across the fiber at two or more predetermined angles to shape the end face of the fiber

9. The process according to claim 8, wherein said beam is moved across the fiber at two predetermined angles to shape a wedge on the end face of the fiber.

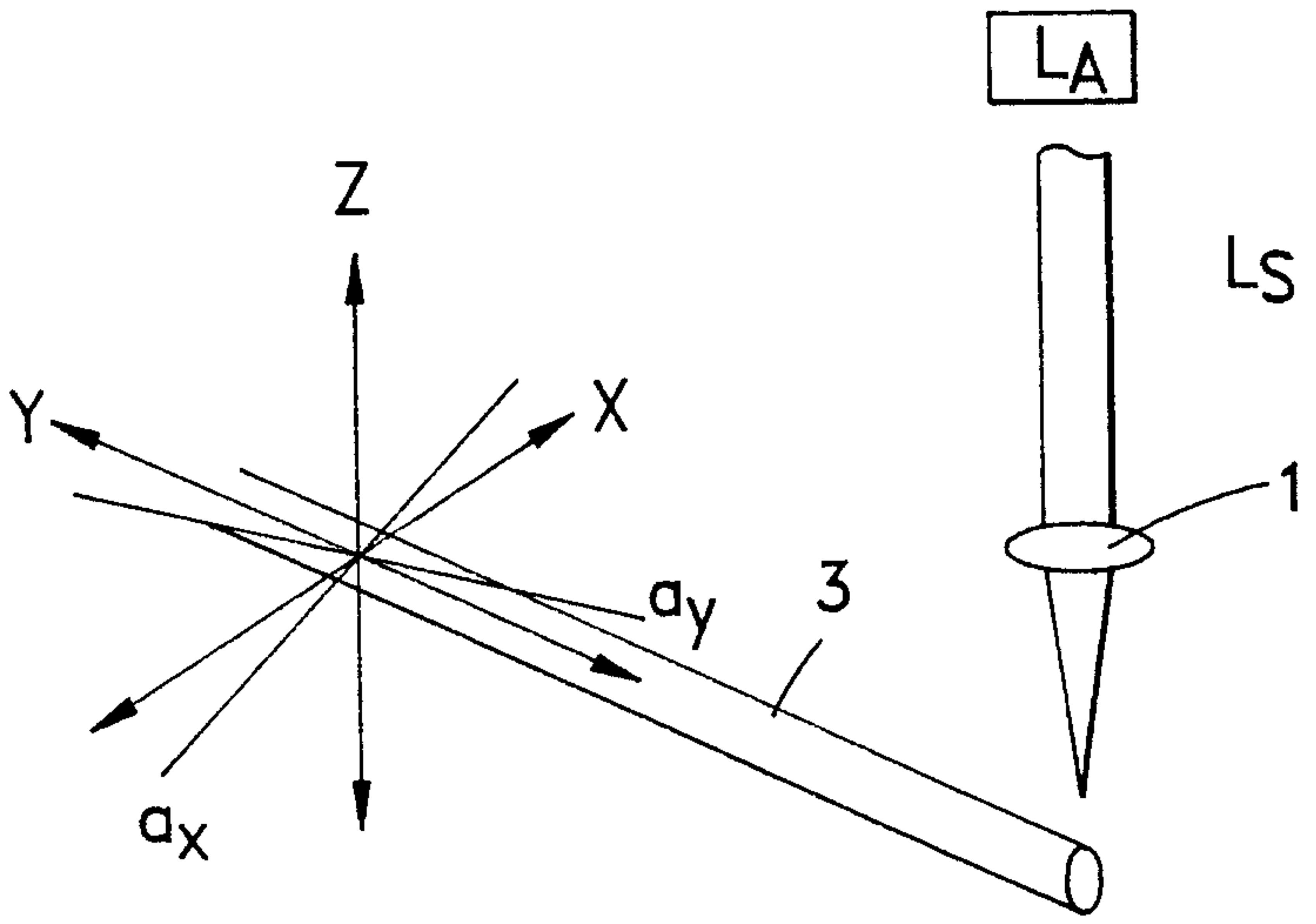
10. The process according to claim 8, wherein said beam is moved across the fiber at predetermined angles to effectively shape a curve on the end face of the fiber.

11. A fiber prepared in accordance with the process of claim 1.

12. A fiber prepared in accordance with the process of claim 7.

13. A fiber prepared in accordance with the process of claim 8.

Fig. 1



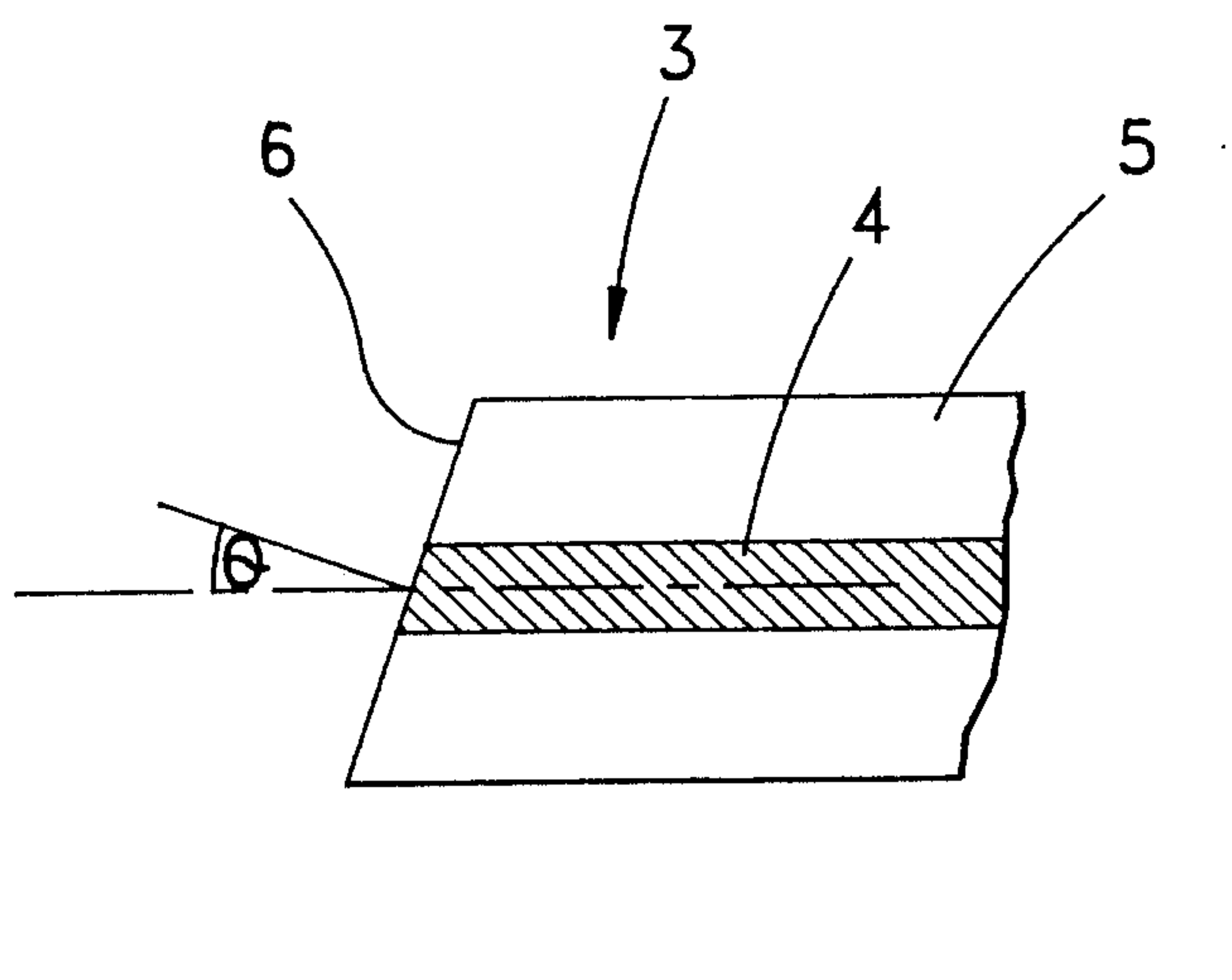


Fig. 2

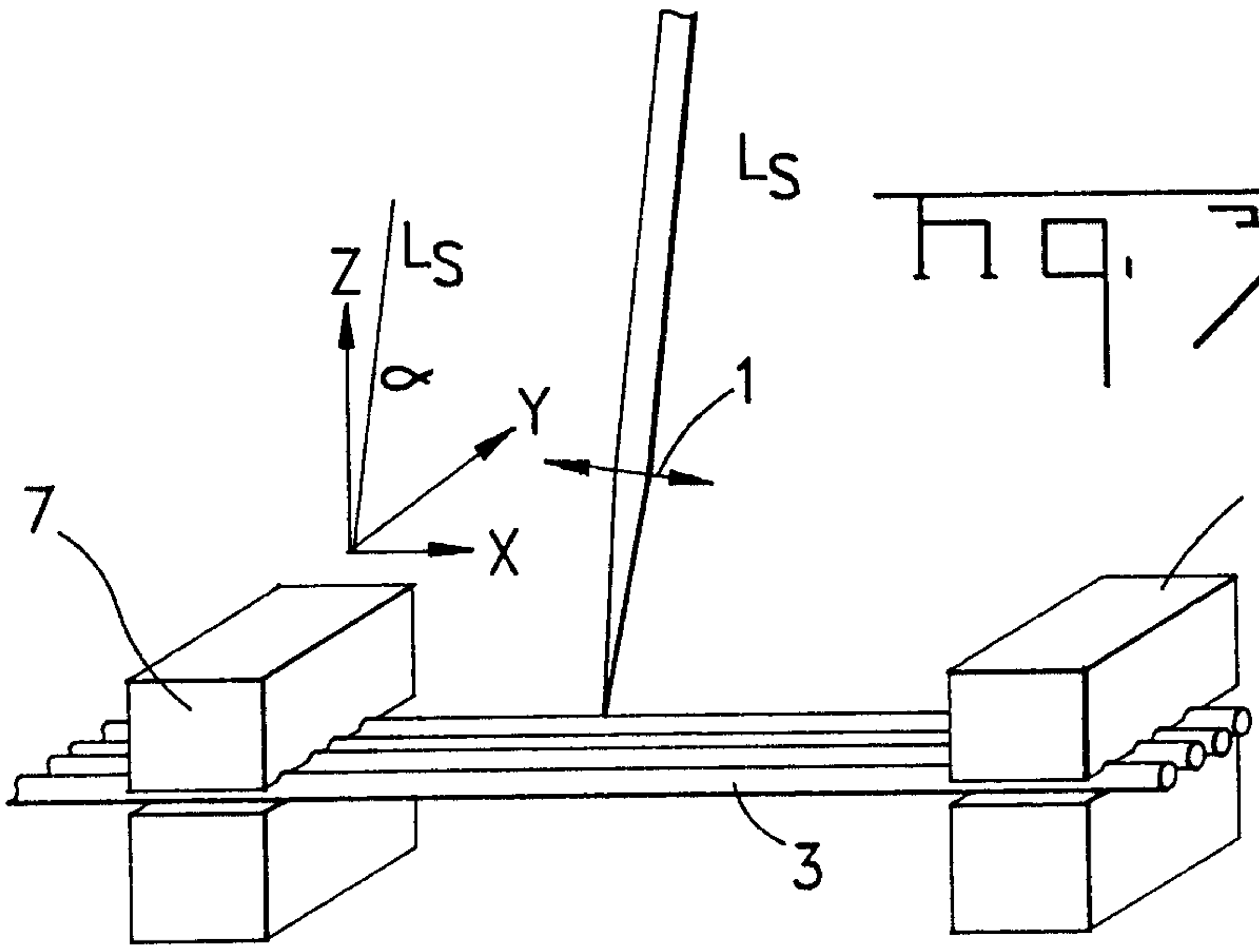


Fig. 3

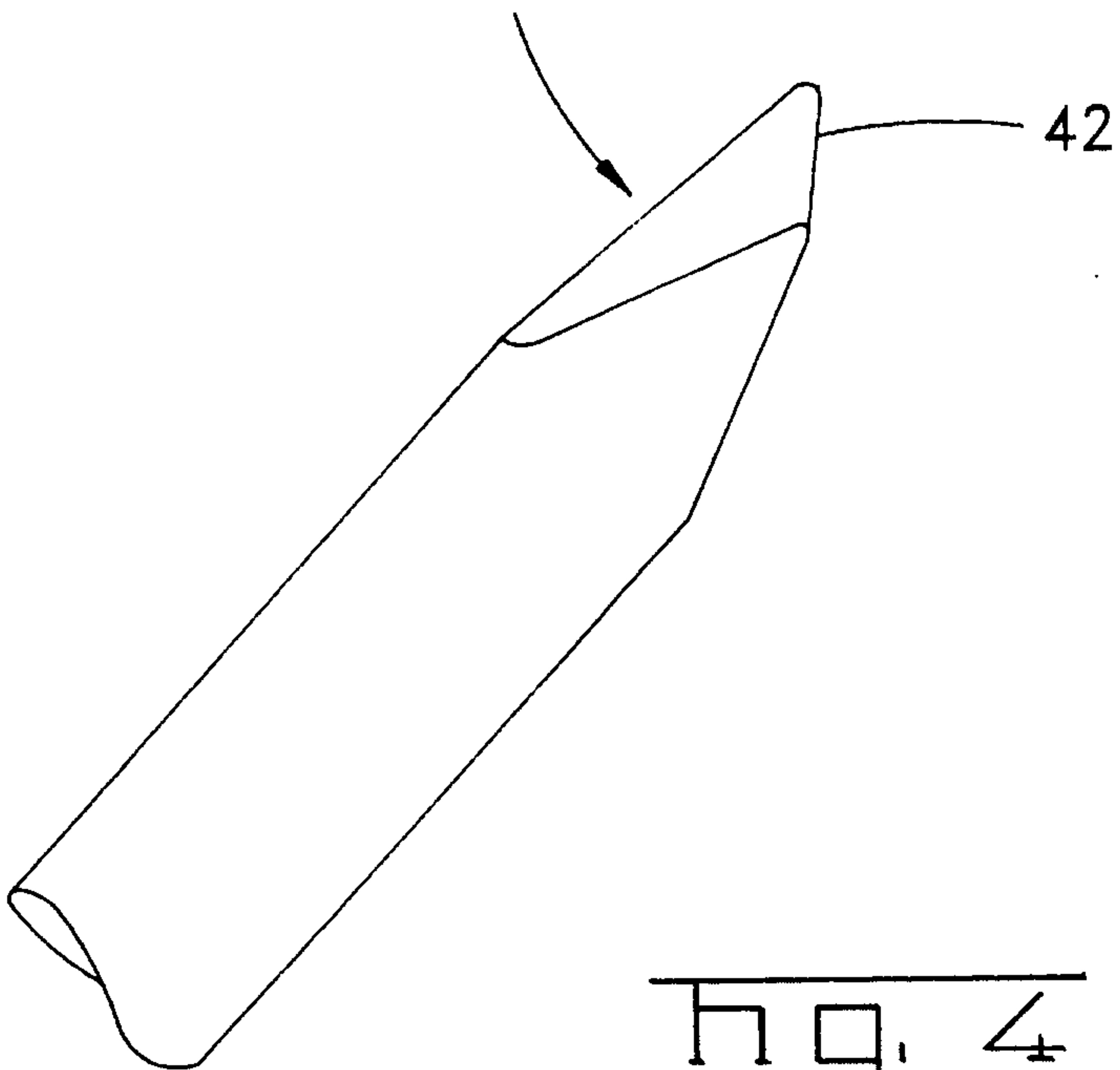
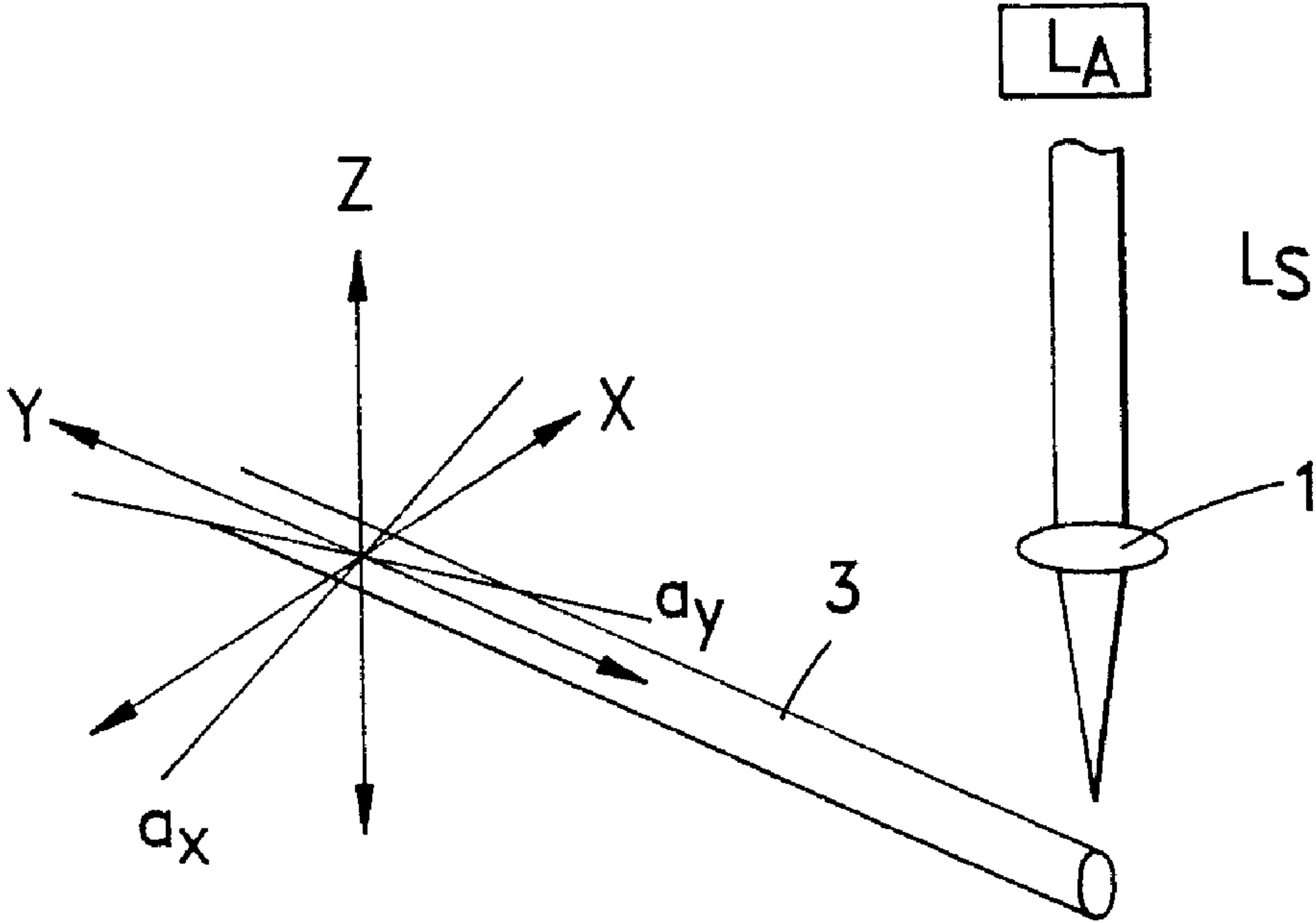


Fig. 4



L_A
L_S
Z
Y
X
1
3
a_y
a_x