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(54) **Lézeroptika passzív varratvezetéssel**

Az európai szabadalom ellen, megadásának az Európai Szabadalmi Közlönyben való meghirdetésétől számított kilenc hónapon belül, felszólalást lehet benyújtani az Európai Szabadalmi Hivatalnál. (Európai Szabadalmi Egyezmény 99. cikk(1))

A fordítást a szabadalmas az 1995. évi XXXIII. törvény 84/H. §-a szerint nyújtotta be. A fordítás tartalmi helyességét a Szellemi Tulajdon Nemzeti Hivatala nem vizsgálta.

LASER LENS WITH PASSIVE SEAM TRACKING**Field of the invention**

5 The present invention relates to a device for guiding a laser beam, in particular along a seam or a joint, for example for use in a laser processing system. The invention is particularly suitable for use in the fields of laser joining and laser hardening.

Technical background of the invention

10 During joining, a laser processing head is intended to be guided with precision along the seam in order to produce high-quality fillet welds and flanged seams, for example. Compared with optically implemented beam guidance systems, laser processing optics which are guided in a tactile manner demonstrate several advantages that manifest themselves, for example, in compact and comparatively simple constructions and therefore in a precisely guided laser beam.

15 The principle of tactile seam tracking and a corresponding device are described in EP 1762328 A1. To track the beam, the mechanical sensor is coupled there to a beam deflection module by means of a rotary module. The rotary module has a resilient energy store in the form of two spiral springs in which the beam deflection module engages using so-called drivers. In the case of a pivoted-out beam deflection module, restorative forces act by means of the rotary module to return the beam deflection module to a resting position, particularly when no external forces are acting on the mechanical sensor. The rotary module is therefore
20 designed in two parts, the first of the two sub-units of the resilient energy store, i.e. the first spring, acting in one of the two deflection directions and the other sub-unit, i.e. the second spring, acting in the other deflection direction. The two springs act against each other according to the illustration in Fig. 2 and Fig. 3 of EP 1762328 A1. In this case, the range of action of each of the two sub-units ends at the middle position of the beam deflection module. The range of action of the two sub-units of the resilient energy store is limited there by a
25 stop.

 A technical problem of the present invention is that of providing an alternative device for the tactile guidance of a laser beam.

Description of the invention

30 The above-mentioned technical problem is solved according to the invention by a device for guiding a laser beam along a target path, which device comprises the following components:

- a laser beam input module that is designed to point an incident laser beam onto a pivotable beam guiding apparatus which is downstream of the laser beam input module, the beam guiding apparatus being arranged in order to project the laser beam onto the target path and comprising
- an optics that is pivotable in the direction of least one pivot axis and
- 35 - a tactile scanner, connected to the pivotable optics, which is designed to perform a tactile scan of the target path and to deflect the pivotable optics accordingly,
- an intermediate focal point being located in the beam path of the laser beam upstream of the pivotable optics and the pivot axis of the pivotable optics extending through the intermediate focal point.

40 The additional production of a stationary intermediate focal point makes it possible for the beam guiding apparatus, particularly the pivotable part, to manage with significantly fewer components than is known

in the prior art. Only the scanner and the pivotable optics firmly connected to the scanner (hereinafter also called “optics”) pivot out in the direction of a rotational line along the stationary intermediate focus. The moment of inertia of the pivoting-out parts is therefore significantly reduced, and faster and more precise tracking of the laser focus is possible.

5 This allows a more compact construction than in previously known guiding devices as well as a smoother tracking of the laser focus. It can be found for instance from EP 1762328 A1 that the incident laser beam is first directed by means of a first deflecting mirror onto a second deflecting mirror which then points the laser beam onto a focusing optics that is part of the above-mentioned beam deflection module. To track the laser focus, the entire beam deflection module must therefore be pivoted out, together with all of its components, by means of the rotary module. In addition to the focusing optics, the beam deflection module also includes, for example, a housing, a protective glass, a linear guide, etc.

In the device according to the invention, the intermediate focus is preferably reproduced by the pivotable optics on the target path. The pivotable optics is therefore a movable imaging optics. The target path corresponds, for example, to the path of a joint between workpieces to be processed.

15 The at least one pivot axis is preferably the deflection direction (y-direction) that is perpendicular, i.e. lateral, to the laser beam direction (z-direction) and the target path direction (x-direction).

In a preferred embodiment, the laser beam input module is designed to focus the laser beam onto the intermediate focal point. In this case, the pivotable optics is designed to reproduce the intermediate focal point on the target path. That is to say, the pivotable optics has an “object-side” focus that is located in the intermediate focal point and an “image-side” focus that is located on the target path.

In another preferred embodiment, the laser beam input module is designed as an optical fibre. In this case, the intermediate focal point is located on the side of the optical fibre that faces the pivotable optics. Moreover, the pivotable optics is designed to reproduce the intermediate focal point on the target path.

25 In another preferred embodiment, the laser beam input module is designed to produce a beam path that is not focused on the intermediate focal point but rather, for example, one that is divergent, collimated or even only weakly focused. In this case, the pivotable optics has a virtual intermediate focus on the input side which forms the intermediate focal point and is located in the collimated beam path. Such an intermediate focal point can be created, for example, by a diverging lens downstream of the laser input module in the beam path. The diverging lens or even multiple-element diverging group is preferably not pivotable together with the pivotable optics but firmly connected to the laser input module.

30 In another embodiment, the tactile scanner and the pivotable optics are connected to an energy store by means of a resilient element. The resilient element of the energy store is designed to make available some of its stored energy depending on the pivotable optics being pivoted out in order to return the optics and scanner to a resting position. The optics and the scanner are coupled to the resilient element by at least two driver stops, only the first of which driver stops deforms the resilient element when the optics pivots in the positive pivot axis direction and only the second of which driver stops deforms the resilient element when the optics pivots in the negative pivot axis direction.

This embodiment includes the finding that the coupling between the mechanical scanner and the beam deflection module according to Fig. 2 and 3 of EP 1762328 A1 has to be implemented using at least two springs in each case, which is costly, impracticable and not very efficient: the two springs take up quite a large

installation space, and the susceptibility to error is not sufficiently low when at least two springs are involved. Moreover, in certain constructions, for example according to Fig. 3, when the optics is pivoted out, only one of the two springs is compressed, while the other spring is not compressed at all and, consequently, no restorative forces are developed, so one spring is useless in each instance for the return of the optics.

By contrast, in this embodiment, it is sufficient and preferred for the energy store to have only one resilient element such as a spring, in order to couple the tactile scanner to the pivotable optics in both pivot axis directions and to effect restorative/centring forces in the direction opposed to each pivot axis direction. As a result, the energy store can be integrated into the device for guiding the laser beam in a very space-saving manner without sacrificing functionality. Additionally, the energy store is more cost-effective since it can be realised with just one single resilient element, and proves to be less error-prone. Owing to the possible compact construction, space savings are achieved and accessibility is improved. Accordingly, the present invention shows how the advantages of a laser processing optics that is guided in a tactile manner as highlighted at the outset can also be achieved by means of an even more compact, more cost-effective and less error-prone construction without having to sacrifice precision.

At least some of the lateral pressing force required by the tactile scanner for scanning the target path, i.e. the joint, for example, is provided by the energy store of the beam guiding apparatus. This pressing force is dependent on the pivoting-out of the pivotable optics. Preferably, when the optics is not pivoted out or in the absence of external forces on the tactile scanner, the energy store is in a defined middle position, any deflection of the scanner or any pivoting-out of the pivotable optics leading to compression of the resilient element owing to the driver stops, that is to say to an increase in the energy stored in the energy store. With this increase in energy, the restorative forces can be provided by the energy store. In particular, these restorative forces can be provided in a continuously variable manner as a result of the resilient element.

Correspondingly, the resilient element of the energy store can thus be implemented mechanically, for example by means of a spring, but also pneumatically or electrically. For example, a piston/cylinder arrangement, in the case of a pneumatic design, or a plunger coil arrangement, in the case of an electrical design of the energy store, is conceivable. However, owing to the specific coupling of the driver stops to the energy store, only a single “resilient element” is necessary here in each case.

In an embodiment of the device for guiding a laser beam that is preferred according to the above, the resilient element is accordingly formed in one piece.

In a preferred embodiment, the above-mentioned stable middle position is achieved by the two driver stops directly contacting the resilient element when the optics is in the not-pivoted-out resting position. As soon as the optics pivots out, the resilient element is compressed by precisely one of the two driver stops, thus creating restorative forces.

In a specific embodiment of the device for guiding a laser beam, the resilient element is mounted in a housing having at least two stationary stop surfaces, the resilient element being pressed only against the first stop surface upon deflection in the positive pivot axis direction and only against the second stop surface upon deflection in the negative pivot axis direction. In this embodiment as well, the compression of the resilient element occurs only as a result of one of the two driver stops.

In the absence of external forces, the expansion of the resilient element causes the two driver stops to be oriented so as to be planar with respect to the stationary stops of the housing, as a result of which the tactile

scanner is brought into the middle position. If the tactile scanner is deflected by external seam tracking forces, the resilient element is pressed together by a driver stop and the opposing stationary stop. Owing to a preferred symmetrical arrangement of the four stop surfaces, this deflection movement is possible together with lateral force in the positive and negative deflection directions.

5 In another preferred embodiment, one of the two stop surfaces and one of the two driver stops are arranged such that they can move in a direction of deformation of the resilient element. Using one of the two movable stops, the tensile force of the resilient element can thus be adjusted, and any play between the stationary stop surfaces and the driver stops can be reduced using the second movable stop. The adjustment can be made in the middle position of the tactile scanner, for example in the design of a filler wire necessary for the seam formation during joining. As a result, a further increase in the precision of the laser beam guidance is achieved.

10 If the resilient element is a spring, then, in a preferred embodiment of the device for guiding a laser beam, said spring has thrust washers at both ends, the thrust washers, the driver stops and the stop surfaces each being dome-shaped. As a result, pivoting movements can be absorbed by the spring arrangement without separate joints.

15 In another preferred embodiment, the scanner is spring-mounted by means of a resilient component approximately in the direction of the laser beam. In this way, constant contact of the scanner with the target path, e.g. with a joint, can be ensured. For example, a telescopic arm and an autofocus of the imaging optics enable tracking of the focus when the target path changes in the z-direction, i.e. approximately in the direction of the laser beam.

20 In this embodiment, it is also preferred for the laser beam input module to be coupled to the resilient component. In this way, the laser focus can be tracked in the direction of the laser beam.

25 Preferably, the device for guiding a laser beam is designed such that the pivotable optics is rigidly connected to the tactile scanner. As a result, it is ensured that the distance between the pivotable optics and the scanner is constant, which is advantageous particularly in the event that the scanner comprises a filler wire necessary for seam formation and is therefore constituted by same, since, in this case, the laser beam is always correctly focused.

30 In a preferred embodiment, the filler wire therefore forms a part of the tactile scanner. The seam tracking then occurs in a wear-free manner directly in the working point by means of tactile movement of the filler wire. Even in the case of small radii and three-dimensional contours, scanning can be done in this manner. Owing to this special mechanical scanner, no advance and hence no advance compensation is necessary. Moreover, the scanning process is resistant to the greatest possible extent to interference factors such as dirt or heat, for example. Additionally, the simultaneous tracking and joining enables an increase in the clock frequency and hence shortening of the laser processing time. Furthermore, the device for guiding a laser beam can be designed to be a stand-alone device, which gives it a modular character.

35 In this embodiment, the tracking of the filler wire is ensured, for example, by a wire feed device, for example of the type described in EP 1762328 A1.

40 In a preferred embodiment, the laser beam input module is designed to focus the incident laser beam on an intermediate focal point between the laser beam input module and the beam guiding apparatus. In this embodiment, the beam guiding apparatus is designed to guide the laser beam by means of the pivotable optics

without moving the intermediate focal point. The intermediate focal point therefore forms the constant starting point of an imaginary rotation axis.

The incident laser beam is, for example, a collimated laser beam or a beam made available by a fibre laser, i.e. an output beam of a fibre-optic cable. In the latter case, the end of the fibre can form the intermediate focus. Alternatively, an intermediate imaging optics for focusing is installed between the end of the fibre and the intermediate focal point. If the laser beam is a collimated laser beam, it can be focused (actual intermediate focus) on the intermediate focal point by a fixed focusing lens, which can be part of the laser beam input module or, alternatively, by a diverging lens downstream of the laser beam input module and the focal point, which diverging lens is arranged in a fixed manner in the pivotable beam guiding apparatus, for example (virtual intermediate focus).

For example, the laser beam can be generated by a solid-state laser, a diode laser or a fibre laser.

According to a second aspect of the present invention, the technical problem is solved by a laser processing system having a device according to the first aspect of the invention.

All types of lasers may be considered for the laser processing system according to the invention. The device according to the invention can be advantageously used in particular as a guidance module in seam-tracked laser welding and soldering, for example for steel and aluminium alloys. To begin with, laser technology is outstandingly suited to joining processes. One particular advantage is the narrow and uniform seam geometry that is made possible. The joining process can be controlled precisely and carried out at high speed. The introduction of heat into the component and the distortion resulting therefrom are significantly reduced by laser joining. Due to the resulting high-quality joints, re-working of the seam can be omitted in most cases. The seam itself can be reproduced having consistently high quality. Owing to the device according to the invention for guiding a laser beam, this laser joining process can now be carried out even more precisely, more cost-effectively and using more compact and more reliable devices.

Brief description of the figures

In the drawings:

Fig. 1 is a schematic view of a beam path for lateral compensation showing a lens system for the optical imaging of an actual intermediate focus pivoted about an axis through or near the actual intermediate focus;

Fig. 2 is a schematic view of a beam path for lateral compensation showing a lens system for the optical imaging of a virtual intermediate focus pivoted about an axis through or near the virtual intermediate focus;

Fig. 3 is a schematic view of a beam path for lateral compensation showing a lens system for the optical imaging of an actual intermediate focus after intermediate imaging of a fibre end surface pivoted about an axis through or near the actual intermediate focus;

Fig. 4 is a schematic view of a beam path for lateral compensation showing a lens system for the optical imaging of a virtual intermediate focus, represented by a fibre end surface, pivoted about an axis through or near the virtual intermediate focus; and

Fig. 5 is a schematic view of an embodiment of the energy store for generating centring forces/restorative forces.

Description of embodiments

Fig. 1 is a schematic view of a beam path for lateral compensation in the y-direction (running direction of deflection) by pivoting a pivotable optics 5, which optically reproduces an actual intermediate focal point 3 onto a target path on a workpiece 17.

On the input side, a collimated laser beam 1 strikes a fixed focusing lens 2 which forms a laser beam input module. The laser beam input module 2, 10 in the form of the fixed and focusing lens 2 focuses the collimated laser beam onto the actual intermediate focal point 3. Arranged downstream of the laser beam input module 2, 10 and the actual intermediate focal point 3 is a pivotable beam guiding apparatus which comprises a tactile scanner 6 and an optics 5 that can be pivoted in at least one pivot axis 4. The tactile scanner 6 and the pivotable optics 5 are rigidly interconnected, and both are connected to an energy store 18 by means of a resilient element not shown in further detail in Fig. 1. The energy store 18 and the mechanical connection of the pivotable optics 5 and the tactile scanner 6 thereto are shown in further detail by way of example in Fig. 5.

The target path is scanned by the scanner 6. As a result of the rigid connection and the deflections of the scanner, the laser beam 1 is constantly projected and focused by the pivotable optics 5 onto the target path, for example a joint. The device is designed here such that, upon a deflection Δy of the scanner 6 and a resulting pivoting-out of the optics 5 by the angle α , as is shown, for example, in the illustration to the right in Fig. 1, the actual intermediate focal point 3 is not shifted, but remains stationary. The pivot axis 4 therefore always leads through this intermediate focal point 3. As can be seen directly in Fig. 1, the pivotally mounted parts of the device are substantially limited to the optics 5, the scanner 6, and the rigid mechanical connection provided therebetween. As a result of the consequently reduced moment of inertia of the pivotable parts, even faster and smoother processing of the workpiece 17 is possible when the laser beam is constantly focused.

For example, the scanner 6 is formed by a filler wire that is necessary for seam formation during joining. The filler wire therefore serves simultaneously as a mechanical sensor. The energy store 18 presses the filler wire into the joint. There, it is melted by the laser beam. If external forces act on the scanner 6, for example as a result of bending or raising of the joint, then the pivotable optics 5 is pivoted out by the pivot angle α as a result of the rigid connection. The position of the actual intermediate focal point 3 does not change in the process. As a result of the rigid connection between scanner 6 and pivotable optics 5, the laser remains pointed at the scanner 6, i.e. optionally at the filler wire. By means of the energy store 18, restorative forces are generated which act on the pivotable optics 5 and the mechanical scanner 6 and, in the absence of external forces on the mechanical scanner 6, return these two components to the resting position shown in the left-hand part of Fig. 1. This energy store 18 is explained in further detail in the following with reference to Fig. 5:

Fig. 5 is a schematic view of an embodiment of the energy store 18 for generating the aforementioned restorative forces/centring forces. The energy store 18 comprises a single resilient element in the form of a spiral pressure spring 13 which makes some of its stored energy available depending on an amplitude of the pivoting-out of the pivotable optics 5 in order to return the optics 5 and scanner 6 to a resting position.

The spiral pressure spring 13 is arranged in a housing 12 having a cylindrical hole. The housing 12 has at each longitudinal end of the cylinder a collar as stationary stop surfaces 12-1 and 12-2. The pivotable optics 5 and the scanner 6 are coupled to the spiral pressure spring 13 by means of at least two driver stops 14-1 and 14-2. The two driver stops 14-1 and 14-2 can be connected, for example, by means of a kind of tappet 15 to the pivotable optics 5 and thus to the scanner 6.

In the two lower drawings of Fig. 5, it is shown that, when the optics 5 is pivoted in the $-y$ direction, only the first driver stop 14-1 deforms the spiral spring 13 (middle drawing) and, in the opposite case (lower drawing), that is to say when the optics 5 is pivoted in the $+y$ direction, only the second driver stop 14-2 deforms the spiral spring in the other direction. In the depicted example, the tensile force (F) of the spring 13 acts by means of thrust washers 16 on the stationary stops 12-1 and 12-2 and the driver stops 14-1 and 14-2. As a result of this arrangement of the energy store 18, restorative forces can be generated both in the negative and in the positive pivot direction by means of just one resilient element 13. Therefore, if the scanner 6 slides over a bend in the joint, for example, this results in both a direct pivoting-out of the optics 5 corresponding to the deflection of the scanner 6 and compression of the spiral pressure spring 13 in one of the two possible directions.

In the absence of external forces on the tactile scanner 6, the two driver stops 14-1/14-2 are oriented in so as to be planar with respect to the stationary stops 12-1/12-2 of the housing 12 owing to the expansion of the spring 13, as a result of which the scanner 6 is brought into the middle position. If the scanner 6 is deflected by external seam tracking forces, then the spring 13 is pressed together by one of the driver stops and the opposing stationary stops. Owing to the symmetrical arrangement of the four stop surfaces 12-1/12-2 and 14-1/14-2, this deflection movement is possible in the positive and negative direction of deflection.

Three additional possible embodiments of the device according to the invention for guiding a laser beam are shown schematically in Fig. 2 to 4, the fact common to these embodiments being that the pivotable optics 5, together with the tactile scanner 6, can be moved back into a resting position in the absence of external seam tracking forces by an energy store 18 shown by way of example in Fig. 5.

Fig. 2 shows a variant in which the collimated laser beam 1 does not strike a fixed focusing lens 2, but instead strikes a fixed diverging lens 7 located in the beam path between intermediate focal point 8 and workpiece surface 17. According to this variant, the intermediate focal point 8 is a virtual intermediate focal point. Unlike the pivotable optics 5, the fixed diverging lens 7 is not rigidly connected to the scanner 6 and thus not rigidly connected to the energy store 18 either. Rather, the diverging lens 7 is installed firmly in the beam path. However, in this embodiment as well, the position of the virtual intermediate focal point 8 does not change when the pivotable optics 5 pivots out by the pivot angle α , according to the drawing on the right-hand side in Fig. 2.

In the embodiment according to Fig. 3, the laser beam 1 is provided by a fibre laser 9. This laser beam 1 first strikes an intermediate imaging optics 10, which then focuses the laser beam 1 onto the actual intermediate focal point 3. In this example, the pivotable optics 5 is achieved by a dual-lens arrangement that enables better tracking of the focus on the workpiece 17 in the z -direction. The dual-lens arrangement is firmly connected to the scanner 6 and arranged axially, i.e. in the spacing direction z , in a sprung manner. This ensures that the scanner 6 is in constant contact with the joint and the laser focus is continuously tracked as a result of the rigid connection between scanner 6 and pivotable optics 5.

Finally, Fig. 4 shows a variant in which the laser beam 1, in turn, is provided by a fibre laser 9 and in which the intermediate focal point 3 strikes a point in a fibre end surface 11. Accordingly, no intermediate imaging of the laser beam 1 is performed. The left and middle view each show a non-deflected state, the pivotable optics 5 being pivoted out by the pivot angle α in the right-hand view, which results in a lateral deflection Δy .

List of reference numerals

	1	collimated laser beam
	2	fixed focusing lens
5	3	actual intermediate focal point
	4	pivot axis
	5	movable imaging optics
	6	tactile scanner
	7	fixed diverging lens
10	8	virtual intermediate focal point
	9	fibre-optic cable
	10	intermediate imaging optics
	11	fibre end surface
	12	spring housing having stops
15	12-1, 12-2	stationary stop surfaces
	13	spiral pressure spring
	14	driver stops
	14-1	first driver stop
	14-2	second driver stop
20	15	tappet for force-coupling
	16	thrust washers
	17	workpiece surface
	18	energy store
	α	pivot angle
25	Δy	resulting lateral deflection
	F	lateral force
	x	direction of travel
	y	lateral direction of deflection
	z	beam direction

30

LÉZEROPTIKA PASSZÍV VARRATVEZETÉSEL*Szabadalmi igénypontok*

1. Berendezés lézernyaláb célpálya mentén vezetéséhez, amely tartalmaz
- 35 – lézernyaláb betápláló modult (2; 7; 10), amely beeső lézernyalábot (1) egy a lézernyaláb betápláló modul (10) után elrendezett és tengely körül elforduló nyalábterelő szerkezetre (4, 5, 6) irányítón van kialakítva, ahol a nyalábterelő szerkezet (4, 5, 6) a lézernyalábot (1) a célpályára projektálón van elrendezve és tartalmaz
- legalább egy elfordulási tengely (4) körül elfordítható optikát (5) és

– egy az elfordítható optikával (5) összekapcsolt taktilis letapogatóeszközt (6), amely a célpálya érintőn letapogatására és az elfordítható optika (5) ennek megfelelő kiterítésére alkalmasan van kiképezve,

azzal jellemezve, hogy a lézernyaláb (1) nyalábútjában az elfordítható optikai (5) előtt közbenső fókuszpont (3; 8) van kiképezve, továbbá az elfordítható optika (5) elfordulási tengelye (4) a közbenső fókuszponton (3; 8) keresztül terjed.

2. Az 1. igénypont szerinti berendezés, **azzal jellemezve**, hogy a lézernyaláb betápláló modul (2; 10) a lézernyalábot (1) a közbenső fókuszpontra (3) fókuszálón van kiképezve, továbbá az elfordítható optika (5) a közbenső fókuszpontot (3) a célpályára leképezőn van kiképezve.

3. A 2. igénypont szerinti berendezés, **azzal jellemezve**, hogy a lézernyaláb betápláló modul (2; 10) fényvezető szálat (9) és közbenső leképező optikát (10) tartalmaz, ahol a közbenső leképező optika (10) a fényvezető szál (9) közbenső leképező optikával (10) szemközti végét a közbenső fókuszpontra (3) leképezőn van kiképezve.

4. Az 1. igénypont szerinti berendezés, **azzal jellemezve**, hogy a lézernyaláb betápláló modul (2; 10) fényvezető szálként (9) van kialakítva és a közbenső fókuszpont (3, 8) a fényvezető szál (9) elfordítható optikával (5) szemközti oldalán helyezkedik el, továbbá az elfordítható optika (5) a közbenső fókuszpontot (3, 8) a célpályára leképezőn van kiképezve.

5. Az 1. igénypont szerinti berendezés, **azzal jellemezve**, hogy a lézernyaláb betápláló modul (2; 7; 10) fókuszálatlan nyalábterjedési utat létrehozón van kiképezve, továbbá az elfordítható optika (5) belépőoldalán egy a közbenső fókuszpontot (3, 8) képező és a kollimált nyalábúton lévő látszólagos közbenső fókusszal (8) rendelkezik.

6. Az 1-5. igénypontok bármelyike szerinti berendezés, amelynél

– a taktilis letapogatóeszköz (6) és az elfordítható optika (5) rugalmas elem (13) útján energiatárolóhoz (18) vannak csatlakoztatva,

– az energiatároló (18) rugalmas eleme (13) a benne tárolt energia egy részét az elfordítható optika (5) elfordulása (α) esetén az optika (5) és a letapogatóeszköz (6) nyugalmi helyzetbe való visszajuttatására biztosítón van kiképezve, továbbá amelynél

– az optika (5) és a letapogatóeszköz (6) a rugalmas elemmel (13) legalább két menesztőütköző (14-1, 14-2) révén csatolásban van, melyek közül a rugalmas elemet (13) az optika (5) pozitív elfordulási tengelyirányú első elfordulása esetén csupán az első menesztőütköző (14-1) deformálja, továbbá negatív elfordulási tengelyirányú elfordulás esetén csupán a második menesztőütköző (14-2) deformálja.

7. A 6. igénypont szerinti berendezés, ahol a rugalmas elem (13) egyetlen darabként van kialakítva.

8. A 6. vagy a 7. igénypont szerinti berendezés, ahol a rugalmas elem (13) legalább két rögzített ütközőfelülettel (12-1, 12-2) rendelkező házban (12) van elrendezve, ahol a rugalmas elem (13) pozitív elfordulási tengelyirányú kitérés esetén csupán az első ütközőfelületnek (12-1) nyomódik neki, továbbá negatív elfordulási tengelyirányú kitérés esetén csupán a második ütközőfelületnek (12-2) nyomódik neki.

9. A 8. igénypont szerinti berendezés, ahol a két ütközőfelület (12-1; 12-2) egyike, valamint a két menesztőütköző (14-1; 14-2) egyike a rugalmas elem (13) deformálódási irányában állíthatón van elrendezve.

10. A 8. vagy a 9. igénypont szerinti berendezés, ahol a rugalmas elemet mechanikai rúgó (13) képezi, melynek mindkét végén nyomótárcsa (16) van, ahol a nyomótárcsák (16), a menesztőütközők (14-1, 14-2) és a rögzített ütközőfelületek (12-1, 12-2) mindegyike gömbsiüveg alakkal rendelkezik.

5 11. Az előző igénypontok bármelyike szerinti berendezés, ahol a letapogatóeszköz (6) rugalmas komponens révén nagyjából a lézernyaláb irányában (z) rugózón van elhelyezve.

12. A 11. igénypont szerinti berendezés, ahol a lézernyaláb betápláló modul (2; 10) a rugalmas komponenssel csatolásban van.

13. Az előző igénypontok bármelyike szerinti berendezés, ahol az elfordítható optika (5) a letapogatóeszközzel (6) mereven van összekapcsolva.

10 14. Az előző igénypontok bármelyike szerinti berendezés, ahol a letapogatóeszköz varratépítéshez szükséges töltőhuzalt (6) tartalmaz.

15. Lézeres megmunkáló rendszer, mely egy az előző igénypontok bármelyike szerinti berendezést tartalmaz.

Fig. 1

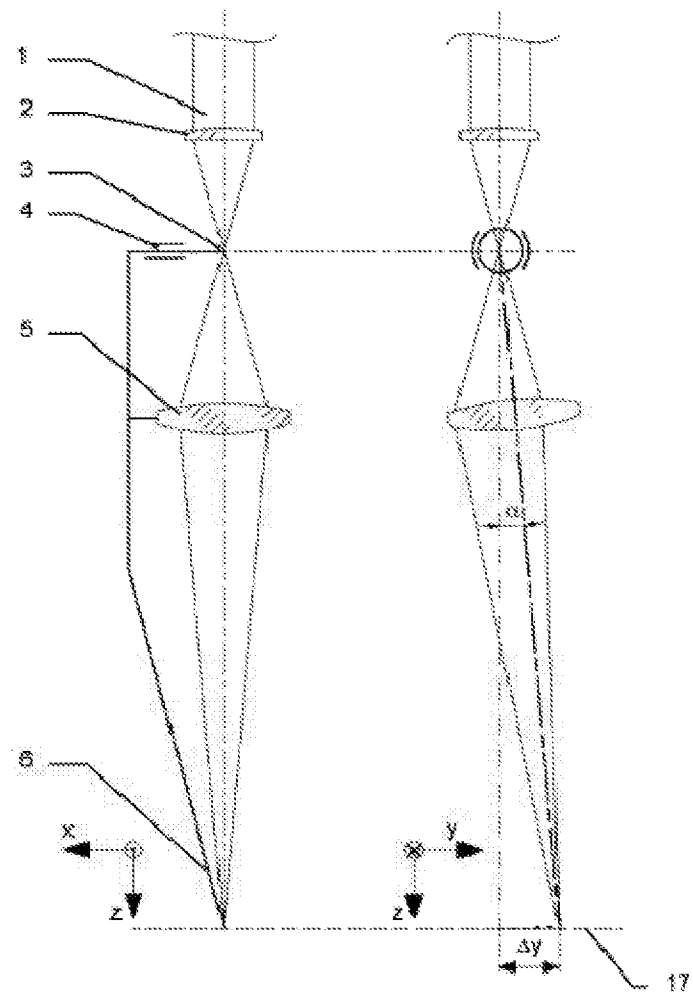


Fig. 2

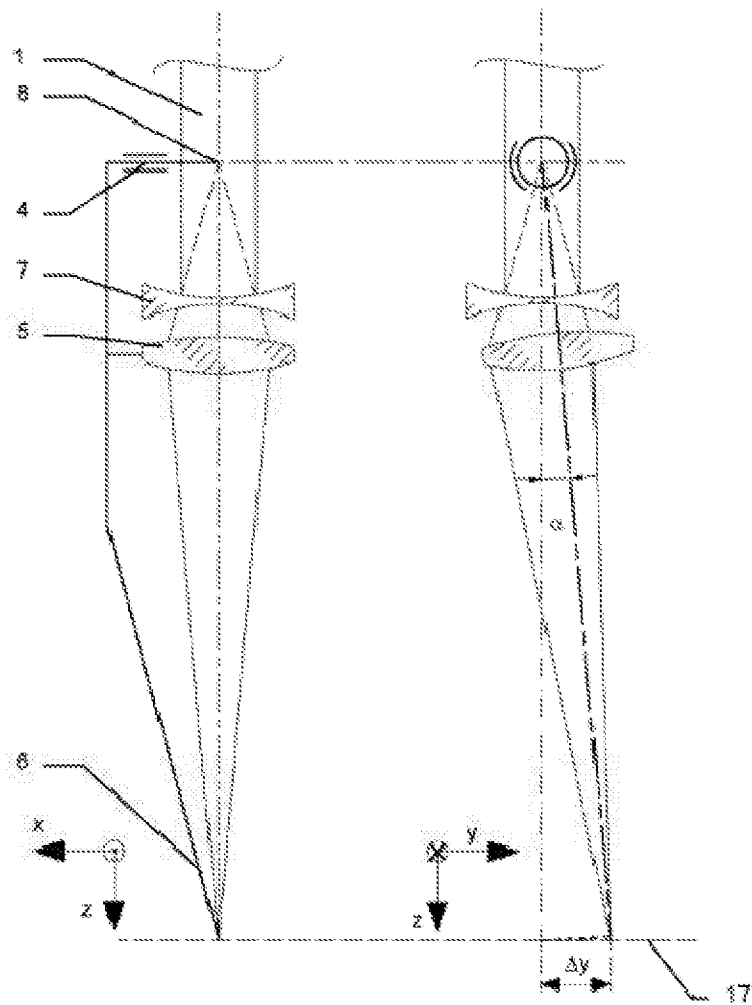


Fig. 3

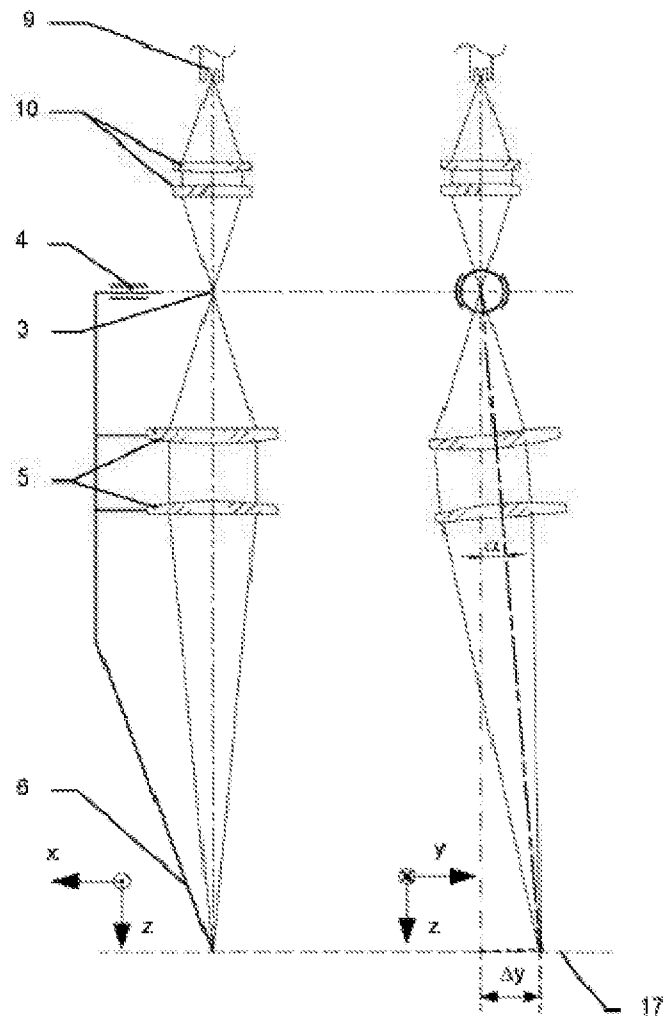


Fig. 4

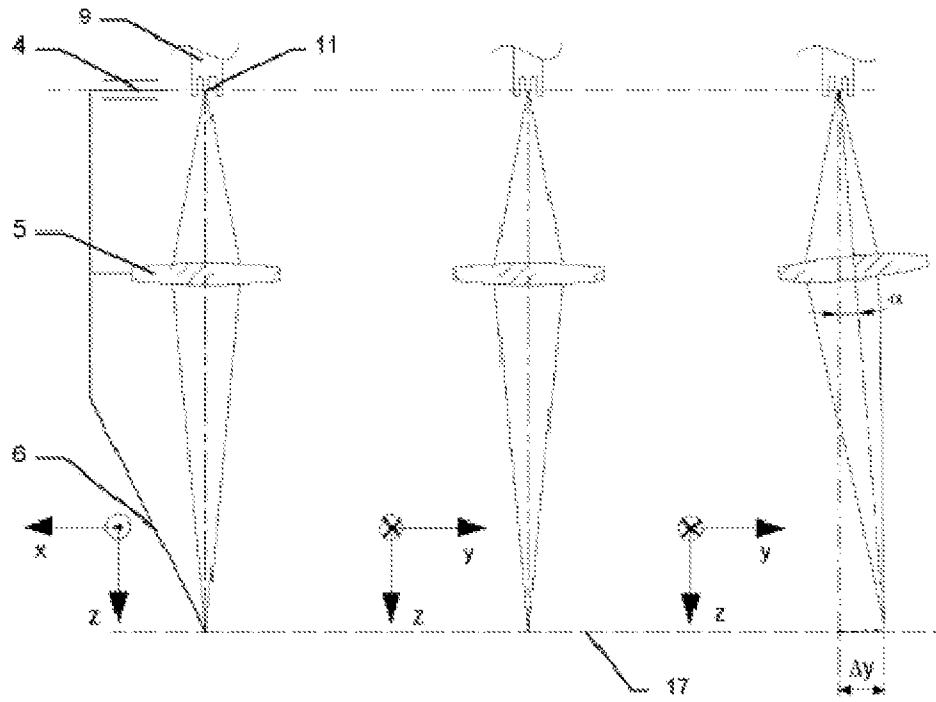


Fig. 5

