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(54) A structure of support of a focusing head of a laser beam of a machine for working metal or non-metal parts
Eine struktur zum tragen eines Laserstrahlfokussierkopfes einer Maschine zur Bearbeitung metallischer und nicht-metallischer Teile
Une structure de support d’une tête de focalisation de faisceau laser d’une machine d’usinage de pièces métalliques et non-métalliques

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(73) Proprietor: SALVAGGINI ITALIA S.p.A.
I-36040 Sarego (Vicenza) (IT)

(72) Inventors:
• Mosca, Claudio
  38050 Tenna, Trento (IT)

• Felloni, Massimo
  38056 Levico, Trento (IT)

• Agostini, Carmelo
  38051 Borgo Valsugana, Trento (IT)

• Valli, Alberto
  38050 Villazzano, Trento (IT)

(74) Representative: Marchi, Massimo, Dr. et al
Marchi & Partners,
Via Pirelli, 19
20124 Milano (IT)

(56) References cited:
US-A- 5 004 890

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Description

[0001] The present invention relates to a structure of support of a focusing head of a laser beam of a machine for working metal or non-metal parts.

[0002] Machines are known that use a laser beam for performing workings of metal parts, such as metal sheets, or non-metal parts. Typical workings are shearing, welding and such like. The laser beam is generated by a source of laser radiations and directed toward a focusing head along an optical path wherein there are elements of deviation of the beam consisting of mirrors and a focusing lens.

[0003] In order to perform the workings, it is necessary to make a relative movement between the laser beam emitted by the focusing head in a direction orthogonal to a surface of the part and the part to be worked resting on a substantially rectangular working plane. The relative movement can be obtained with the movement of the piece (fixed optics), with the combined movement of the laser beam in one direction and of the part in another direction (mixed optics) or, lastly, with the movement of the laser beam only (mobile optics).

[0004] In machines with mobile optics a first requirement is a high mechanical stability of the structures of support of the elements devoted to the moving laser beam (mirrors) present along the optical path.

[0005] Thus, the embodiment most frequently adopted is the so-called portal one wherein a girder structure is slidably supported at the ends on two parallel pathways obtained in two portals situated on two long sides of the machine. In addition, a carriage, that houses the focusing head, is driven to move along the girder, in a direction orthogonal to the pathways, that is in a direction parallel to two short sides of the machine. Such a device is known from US-A- 5 004 890, on which the preamble of claim 1 is based.

[0006] This solution has the disadvantage of limiting accessibility to the working plane along the long sides of the machine penalising in such a way the steps of adjustment, maintenance and operation.

[0007] Another known embodiment is the so-called cantilever one, wherein a structure with a projecting (cantilever) girder is mobile along just one pathway obtained in a shoulder situated along one long side of the machine. In this case again, the carriage, that houses the focusing head, is driven to move along the girder, in a direction orthogonal to the pathway of the girder.

[0008] This solution improves accessibility to the working plane because it leaves free three sides of the machine, but it does force a limitation of the dynamic performances of the movement of the cantilever girder and/or of the stroke of the carriage along the girder. Or, again, it forces the adoption of complex mechanical solutions in order to compensate for the deflections and torsions that the cantilever girder inevitably involves.

[0009] The object of the present invention is a structure of support of a focusing head of a laser beam that has a high structural stability, great accuracy in the movement and a high degree of accessibility to the working plane.

[0010] The above-mentioned object is attained, according to the invention, with a structure of support of a focusing head of a laser beam of a machine for working parts provided with a carriage capable of supporting said focusing head sliding in a vertical direction with respect to a working plane, said structure of support comprising a first girder capable of supporting said carriage sliding along an axis transversal with respect to said working plane and a pair of portals located on two opposite sides of said working plane, characterized in that it comprises a second load bearing bridge-type girder, integral with said portals, capable of supporting said first girder like a yoke, sliding in the direction of a longitudinal axis with respect to said working plane, said first girder forming a sleeve slipped over said second load bearing girder so that the mass of said first girder is distributed in a balanced manner throughout said second load bearing girder and the deformations of said first girder determined by inertial loads are minimized.

[0011] According to a preferred embodiment, said portals are formed in the shape of an inverted "U" and they are arranged along the short sides of said working plane.

[0012] The structure of support according to the invention has a high rigidity that ensures a high degree of accuracy in the movement of the focusing head.

[0013] In addition, the presence of the two portals allows accessibility to a working plane on all four sides. If, for particular requirements of rigidity, it is necessary to further strengthen the structure, it is possible, for example, to make recourse to a brace that closes one long side of the working plane, with this leaving accessibility to it from three sides.

[0014] Features and advantages of the invention will now be illustrated with reference to an embodiment represented as a non-limiting example in the enclosed figures, wherein:

Fig. 1 is a front view of a structure of support of a focusing head of a laser beam made according to the invention;
Fig. 2 is a plan view from above of the structure of support of Fig. 1;
Fig. 3 is a cross-sectional view taken along the plane III-III of Fig. 1;
Fig. 4 is a rear view of the structure of support of Fig. 1.

[0015] There is shown in Figs. 1-4 a structure of support of a focusing head of a laser beam, made according to the invention. The structure 1 belongs to a machine for working parts, particularly metal sheets, capable of performing shearing, welding and such like. The machine comprises a substantially rectangular working plane 4 on which the metal sheet to be worked is placed.
The working plane 4 is provided with its own base, not shown, and it is placed within the structure 1. The focusing head of the laser beam, not shown, is slidable supported by a carriage 5 by means of actuators, also not shown, that drive it to translate in a vertical direction.

[0016] The structure of support 1 comprises two portals 6 formed in the shape of an inverted "U", formed by uprights 3 and cross-girders 9, placed along transversal short sides 7 of the working plane 4. The portals 6 are connected by an bridge-type load bearing girder 10 having a longitudinal axis 11 parallel to the long sides 8 of the working plane 4 (Fig. 2). The load bearing girder 10 is made integral with the cross-girders 9 of the portals 6, in a position slightly misaligned with respect to a longitudinal axis of symmetry of the working plane 4. The portals 6 are also connected by means of a front brace 35 and a rear brace 36 arranged along longitudinal long sides 8 of the working plane 4. The braces 35 and 36 are formed by metal sheets reinforced by ribs and tubular elements.

[0017] A yoke-type girder 13 is slidable supported by the load bearing girder 10 by means of a sleeve 15 and a plate 14 (Figs. 2 and 3). The sleeve 15 is formed in the yoke-type girder 13 and is slipped over the load bearing girder 10 and over the plate 14. The plate 14, that is integral with the girder 10 and extends in the direction of the longitudinal axis 11, supports two longitudinal linear guides 16 that constitute the pathways for four ball-circulation shoes 18, that guide the yoke-type girder 13 in its longitudinal sliding movements along the load bearing girder 10.

[0018] The yoke-type girder 13, by means of the sleeve 15, envelops the load bearing girder 10, so that the mass of its casing is distributed in a balanced manner over the girder 10 and the deformations of the yoke-type girder 13 determined by inertial loads are minimized.

[0019] The yoke-type girder 13 is driven to translate along the linear guides 16 by a transmission of motion comprising a helical-tooth rack 20, integral with the plate 14, which meshes with two helical-tooth pinions 21 rotatably supported by the girder 13. The pinions 21 receive the motion of rotation through respective helical-toothed wheels 22 coaxial with the pinions 21, that mesh with a central helical-tooth pinion 23 (Fig. 2). The pinion 23 is placed in rotation by an electric motor 27 through a reduction gear formed by toothed wheels 24 and 25 and by a belt 26.

[0020] The rack 20 can be replaced by a ball-circulation screw.

[0021] The linear guides 16 and the rack 20 are protected by bellows-type sheaths 37.

[0022] At least one of two pinions 21 that mesh with the rack 20 is axially preloaded by Belleville washers not shown. Such axial preload, given the inclination of the teeth of the rack, provides a counter-rotation of the pinions 21, that is a preload of the torque applied to the pinions such as to completely compensate for the clearance of the pinion-rack unit and all errors of alignment of the rack 20.

[0023] The carriage 5 supporting the focusing head is slidable supported in the yoke-type girder 13 by means of ball-circulation shoes and linear guides, not shown, coaxial with a transversal axis 29 of the girder 13. The carriage 5 is driven to translate in a transversal direction by an electric motor and by a transmission of motion comprising a ball-circulation screw, not shown. The transmission of motion to the focusing head could be made with a pinion-rack unit similar to that described earlier for the longitudinal translations of the yoke-type girder 13.

[0024] In the structure of support 1 there is mounted a bellows-type conduit 30 (Fig. 4) that guides toward the focusing head the laser beam, represented by a dash-dot line 31, emitted by a suitable source, not shown. The laser beam is directed by a mirror 33 in the bellows-type conduit 30 by means of another mirror, not shown, guides it toward the focusing head.

[0025] An articulated sheath 34 houses, among other things, conductors for the supply of electrical energy to actuators and probes present in the focusing head.

[0026] By operating the respective motors and actuators, the yoke-type girder 13, the carriage 5 and the focusing head are driven to perform respective longitudinal translations along the load bearing girder 10, transversal translations along the yoke-type girder 13 and vertical translations with respect to the carriage 5. Through the combination of these three movements of translation it is possible to position with the highest accuracy the focusing head of the laser beam 31 with respect to the part to be worked, for example a metal sheet.

[0027] The load bearing girder 10 and the braces 35 and 36 ensure a particularly high rigidity of the structure of support 1, while retaining accessibility to the working plane 4 along three sides.

Claims

1. A structure of support (1) of a focusing head of a laser beam of a machine for working parts provided with a carriage (5) capable of supporting said focusing head sliding in a vertical direction with respect to a working plane (4), said structure of support (1) comprising a first girder (13) capable of supporting said carriage (5) sliding in the direction of an axis (29) transversal with respect to said working plane (4) and a pair of portals (6) located on two opposite sides (7) of said working plane (4), characterized in that it comprises a single second load bearing bridge-type girder (10), integral with said portals (6), capable of supporting said first girder (13) like a yoke, sliding in the direction of a longitudinal axis (11) with respect to said working plane (4), said first
1. A structure according to claim 1, characterized in that said second load bearing girder (10) so that the mass of said first girder (13) is distributed in a balanced manner throughout said second load bearing girder (10) and the deformations of said first girder (13) determined by inertial loads are minimized.

2. A structure according to claim 1, characterized in that said portals (6) are formed in the shape of an inverted "U" and are arranged along the short sides (7) of said working plane (4).

3. A structure according to claim 1, characterized in that said first girder (13) is slidably supported by said second load bearing girder (10) by means of said sleeve (15) and linear guides (16) supported by a plate (14) that is integral with said second girder (10) and extends in the direction of said longitudinal axis (11), shoes (18) integral with said first girder (13) being in engagement with said linear guides (16).

4. A structure according to claim 3, characterized in that said first girder (13) is driven to translate along said linear guides (16) by a transmission of motion comprising a helical-tooth rack (20) integral with said plate (14), which meshes with two helical-tooth pinions (21) rotatably supported by said first girder (13), said pinions (21) receiving the motion of rotation through respective helical-toothed wheels (22) coaxial with said pinions (21), that mesh with a central helical-tooth pinion (23), said pinion (23) being placed in rotation by a motor (27) through a reduction gear formed by toothed wheels (24, 25) and by a belt (26).

Patentansprüche

1. Lageraufbau (1) eines Fokussierkopfes eines Laserstrahls einer Maschine zur Bearbeitung von Bauteilen, welche mit einem Schlitten (5) versehen ist, welcher den Fokussierkopf gleitend in vertikaler Richtung bezüglich einer Arbeits ebene (4) lagern kann, wobei der Lageraufbau (1) einen ersten Träger (13) aufweist, welcher den Schlitten (5) gleitend in Richtung einer Achse (29) lagern kann, welche quer zur Arbeits ebene (4) liegt, sowie ein Paar von Portalen (6), welche an zwei gegenüberliegenden Seiten (7) der Arbeits ebene (4) vorgesehen sind, dadurch gekennzeichnet, dass der Halteaufbau einen einzelnen zweiten lasttragenden Träger (10) vom Brückentyp aufweist, welcher integral mit den Portalen (6) ausgebildet ist und den ersten Träger (13) wie ein Joch gleitend in Richtung einer Längsachse (11) bezüglich der Arbeits ebene (4) lagern kann, wobei der erste Träger (13) eine Hüse (15) ausbildet, welche über den zweiten lasttragenden Träger (10) hingegestützt ist, so dass die Masse des ersten Trägers (13) gleichmäßig über den zweiten lasttragenden Träger (10) verteilt ist und die De formation des ersten Trägers (13), welche durch Trägheitsbelastungen bestimmmt sind, minimiert werden.

2. Aufbau nach Anspruch 1, dadurch gekennzeichnet, dass die Portale (6) in Gestalt eines umgekehrten U ausgeformt sind und entlang der kurzen Seiten (7) der Arbeitsebene (4) angeordnet sind.

3. Aufbau nach Anspruch 1, dadurch gekennzeichnet, dass der erste Träger (13) gleitbar durch den zweiten lasttragenden Träger (10) mittels der Hüse (15) und linearen Führungen (16) gelagert ist, welche durch eine Platte (14) gelagert sind, welche integral mit dem zweiten Träger (10) ausgebildet ist und sich in Richtung der Längsachse (11) erstreckt, wobei Schuhe (18), welche integral mit dem ersten Träger (13) ausgebildet sind, im Eingriff mit den linearen Führungen (16) sind.

4. Aufbau nach Anspruch 3, dadurch gekennzeichnet, dass der erste Träger (13) angetrieben ist, um sich entlang der linearen Führungen (16) translatisch zu bewegen, und zwar mittels eines Getriebes, welches eine Schraubenzahnstange (20) aufweist, welche integral mit der Platte (14) ausgebildet ist und mit zwei Schraubenzahnradern (21) kämmten, welche drehbar mittels des ersten Trägers (13) gelagert sind, wobei die Zahnräder (21) die Drehbewegung durch entsprechende Schraubenzahnrad (22) aufnehmen, welche koaxial mit den Zahnrädern (21) sind, und welche mit einem zentralen Schraubenzahnrad (23) kämmen, wobei dieses Zahnrad (23) mittels eines Motors (27) in Drehbewegung versetzt wird durch ein Reduktionsgetriebe, welches durch zwei Zahnräder (24, 25) und einen Riem en (26) ausgebildet wird.

Revindicaciones

1. Structure de support (1) d'une tête de focalisation d'un faisceau laser d'une machine d'usinage de pièces pourvue d'un chariot (5) pouvant supporter ladite tête de focalisation coulissant dans une direction verticale par rapport à un plan (4) de travail, ladite structure de support (1) comprenant une première poutre (13) capable de supporter ledit chariot (5) coulissant dans la direction d'un axe (29) transversal audit plan (4) de travail et deux portiques (6) situés sur deux côtés opposés (7) dudit plan (4), caractérisée en ce qu'elle comprend une seconde poutre (10) de type pont de support de charge d'un seul tenant avec lesdits portiques (6), pouvant supporter ladite première poutre (13) à la manière d'une
mâchoire, coulissant dans la direction d'un axe longitudinal (11) par rapport audit plan (4) de travail, ladite première poutre (13) formant un manchon (15) glissé sur ladite seconde poutre (10) de support de charge de façon à répartir la masse de ladite première poutre (13) de manière équilibrée d'un bout à l'autre de ladite seconde poutre (10) de support de charge et à minimiser les déformations de ladite première poutre (13) déterminées par des charges d'inertie.

2. Structure selon la revendication 1, caractérisée en ce que lesdits portiques (6) sont formés sous la forme d'un « U » inversé et sont agencés le long des côtés courts (7) du plan (4) de travail.

3. Structure selon la revendication 1, caractérisée en ce que ladite première poutre (13) est supportée coulissante par ladite seconde poutre (10) de support de charge au moyen dudit manchon (15) et de guides rectilignes (16) supportés par une plaque (14) qui est d'un seul tenant avec ladite seconde poutre (10) et s'étend dans la direction dudit axe longitudinal (11), des patins (18) d'un seul tenant avec ladite première poutre (13) étant engagés par lesdits guides rectilignes (16).

4. Structure selon la revendication 3, caractérisée en ce que ladite première poutre (13) est entraînée pour se déplacer le long desdits guides rectilignes (16) par transmission d'un mouvement comprenant une crémaillère à denture hélicoïdale (20) d'un seul tenant avec ladite plaque (14), qui engrène avec deux pignons à denture hélicoïdale (21) supportés mobiles en rotation par ladite première poutre (13), lesdits pignons (21) recevant le mouvement de rotation par l'intermédiaire de roues à denture hélicoïdale respectives (22) coaxiales auxdits pignons (21), qui engrènent avec un pignon central à denture hélicoïdale (23), ledit pignon (23) étant entraîné en rotation par un moteur (27) par l'intermédiaire d'un réducteur formé par des roues dentées (24, 25) et par une courroie (26).