from a single sheet are arranged very close to one another, and some parts can even have common edges.

The document JP-A-7251287 proposes a laser nozzle including a mobile element and a spring exerting a force tending to press said element against the sheet. Furthermore, this nozzle uses the force exerted by the cutting gas leaking beneath the surface of said element facing the sheet to be cut to cause a slight distancing of the movable element from the sheet.

However, this solution is difficult to implement since it requires precise control of the different forces in play to adjust and maintain the desired distance. Furthermore, this distancing reduces the effectiveness of the gas injection into the groove. It creates further problems during the steps of the method in which no cutting gas is supplied by the nozzle, or when only a low cutting gas pressure is supplied to the nozzle.

This is in particular the case when drilling the sheet, which is done at low gas pressures, typically less than 4 bar, or when the nozzle is moved quickly above the sheet, at a typical distance of 0.5 mm to several mm which is done without any cutting gas or beam, in particular when several nested parts are cut out of a single sheet. To improve production rate and speed, these operations are usually performed without lifting the device holding the nozzle away from the cutting position thereof.

Under these circumstances, the solution provided in JP-A-7251287 does not enable the mobile element to be moved away from the sheet, and the aforementioned problems become relevant, with the mobile element permanently protruding outside the nozzle body. This also causes a problem in the drilling phases, since the nozzle should not be too close to the sheet on account of the significant quantities of molten metal projected.

Consequently, the problem addressed is proposing a laser-beam cutting nozzle for which the aforementioned problems are significantly reduced or even eliminated, in particular a laser nozzle the movement of which over the cut sheet is significantly less disturbed by any obstacles found on the surface of said sheet, and for which the impacts resulting from the nozzle hitting said obstacles are significantly reduced in relation to the existing solutions.

Furthermore, it must be possible to implement the laser nozzle according to embodiments of the present invention industrially, and the robustness and service life thereof must be better than the existing solutions, and it must not affect operation of the cutting machine on which said nozzle is installed.

~~The solution in~~According to a first aspect of the present invention, ~~is therefore~~there is provided a laser nozzle including:

- a nozzle body having an axial seat and a first output orifice located at the front face of the nozzle body,

- a mobile element placed in the axial seat of the nozzle body, having a front skirt-shaped portion and having a second output orifice, said mobile element being movable in translation in the axial seat towards the first output orifice under the effect of a gas pressure exerted on the mobile element until the front skirt-shaped portion of the mobile element protrudes outside the axial seat through the first output orifice, and

- an elastic element placed in the axial seat between the nozzle body and the mobile element exerting an elastic return force on the mobile element,

characterized in that the front portion has an end portion in which the external diameter decreases progressively in the direction of the second output orifice.

As applicable, the nozzle according to embodiments of the invention may have one or more of the following technical features:

- the front portion also has a cylindrical portion of substantially constant external diameter.

- the end portion has at least one bevel forming an angle (α) with the front face of the nozzle body.

- the angle of the bevel is between 0.1° and 80°, and preferably between 10° and 45°.

- the external profile of the end portion is truncated-cone-shaped.

- the external profile of the end portion has at least one curved portion.

- the external profile of the end portion has at least one convex portion.

- the at least one convex portion has a radius of curvature of between 0.1 mm and 2 mm.

- the cylindrical portion has an external diameter of between 3 mm and 8 mm.

- the end portion has an external diameter of between 2.5 mm and 7 mm at the second output orifice.

- when the mobile element moves in translation in the axial seat towards the first output orifice located at the front face of the nozzle body, the front skirt-shaped portion of the mobile element protrudes outside the axial seat through the first output orifice of the front face of the nozzle body.

- the bottom of the axial seat of the nozzle body has a shoulder, and the peripheral wall of the mobile element has a stop, the elastic element being positioned between the shoulder and the stop.

- at least one sealing element is placed between the nozzle body and the mobile element, for example one or more O-rings.

- said at least one sealing element is placed in a peripheral slot made in the external peripheral wall of the mobile element.

- the mobile element can be moved between several different positions including:

. an idle position in which the skirt of the front portion is completely or almost completely withdrawn into the axial seat of the nozzle body, and

. a working position in which the skirt of the front portion protrudes completely or almost completely outside the axial seat of the nozzle body through the first output orifice.

- the axial passage of the mobile element has a conical, truncated-cone or convergent/divergent shape

- the nozzle body is made of an electrically conductive material, in particular copper, brass or similar.

- the mobile element is made in full or in part of an electrically isolating material.

- alternatively, a mobile element is made of an electrically conductive material that is temperature/heat resistant, specifically copper, brass or similar, said isolating element having at least one isolating interface arranged between the nozzle and the wall of the mobile insert. The isolating interface is either a sleeve placed in the nozzle body, or an isolating lining attached to the nozzle body or the mobile element.

~~The~~ According to a second aspect of the present invention, ~~also relates to~~there is provided a laser focusing head having at least one focusing optic, ~~for example one or more lenses or mirrors, in particular a focusing lens and a collimation lends,~~ characterized in that it also includes a laser nozzle according to the ~~invention~~first aspect.

~~The~~ According to a third aspect of the present invention, ~~also relates to~~there is provided a laser facility including a laser generator, a laser focusing head and a laser-beam conveying device linked to said laser generator and to said laser focusing head, characterized in that the laser focusing head is ~~as claimed in the invention~~defined in the second aspect.

Preferably, the laser source or generator is a CO_2, YAG, fiber or disk type, preferably fiber or disc, in particular an ytterbium-fiber laser source.

According to ~~another~~ a fourth aspect, ~~of~~ the present invention ~~also relates to~~there is provided a laser-beam cutting method ~~in which~~implementing a nozzle according to the ~~invention~~first aspect, a laser focusing head according to the ~~invention~~ second aspect or a facility according to the ~~invention is used~~third aspect.

The invention can be better understood from the description given below with reference to the attached figures, in which:

- Figure 1A is a schematic representation of a focusing head of a conventional laser cutting facility,

- Figure 1B is a schematic representation of the size of the laser spot in relation to the size of the nozzle orifice,

- Figure 2 is a schematic cross-section of the body of a nozzle according to the invention,

Claims

1. A laser nozzle ~~(1, 2)~~ including:

- a nozzle body ~~(1)~~ having an axial seat ~~(5)~~ and a first output orifice ~~(11)~~ located at the front face ~~(1a)~~ of the nozzle body ~~(1)~~,

- a mobile element ~~(2)~~ placed in the axial seat ~~(5)~~ of the nozzle body ~~(1)~~, having a front skirt-shaped portion ~~(2a)~~ and having a second output orifice ~~(12)~~, said mobile element ~~(2)~~ being movable in translation in the axial seat ~~(5)~~ towards the first output orifice ~~(11)~~ under the effect of a gas pressure exerted on the mobile element ~~(2)~~ until the front skirt-shaped portion ~~(2a)~~ of the mobile element ~~(2)~~ protrudes outside the axial seat ~~(5)~~ through the first output orifice ~~(11)~~, and

- an elastic element ~~(8)~~ placed in the axial seat ~~(5)~~ between the nozzle body ~~(1)~~ and the mobile element ~~(2)~~ exerting an elastic return force on the mobile element ~~(2)~~,

~~characterized in that~~wherein the front portion ~~(2a)~~ has an end portion ~~(17)~~ in which the external diameter decreases progressively in the direction of the second output orifice ~~(12)~~.

2. The nozzle as claimed in the preceding claim, ~~characterized in that~~wherein the front portion ~~(2a)~~ also has a cylindrical portion ~~(16)~~ of substantially constant external diameter.

3. The nozzle as claimed in one of claims 1 or 2, ~~characterized in that~~wherein the end portion ~~(17)~~ has at least one bevel ~~(18)~~ forming an angle ~~(α)~~ with the front face ~~(1a)~~ of the nozzle body ~~(1)~~.

4. The nozzle as claimed in one of the preceding claims, ~~characterized in that~~wherein the angle ~~(α)~~ of the bevel ~~(18)~~ is between 0.1° and 80°, and preferably between 10° and 45°.

5. The nozzle as claimed in one of the preceding claims, ~~characterized in that~~wherein the external profile of the end portion ~~(17)~~ is truncated-cone-shaped.

6. The nozzle as claimed in one of the preceding claims, ~~characterized in that~~wherein the external profile of the end portion ~~(17)~~ has at least one curved portion.

7. The nozzle as claimed in one of the preceding claims, ~~characterized in that~~wherein the external profile of the end portion ~~(17)~~ has at least one convex portion.

8. The nozzle as claimed in claim 7, ~~characterized in that~~wherein the at least one convex portion has a radius of curvature of between 0.1 mm and 2 mm.

9. The nozzle as claimed in one of the preceding claims, ~~characterized in that~~wherein the cylindrical portion ~~(16)~~ has an external diameter of between 3 mm and 8 mm.

10. The nozzle as claimed in one of the preceding claims, ~~characterized in that~~wherein the end portion ~~(17)~~ has an external diameter of between 2.5 mm and 7 mm at the second output orifice ~~(12)~~.

11. A laser focusing head having at least one focusing optic, ~~characterized in that~~wherein it also includes a laser nozzle according to one of the preceding claims.

12. A laser facility including a laser generator, a laser focusing head and a laser-beam conveying device linked to said laser generator and to said laser focusing head, ~~characterized in that~~wherein the laser focusing head is as claimed in claim 11.

13. The facility as claimed in claim 12, ~~characterized in that~~wherein the laser generator is a CO_2, YAG, fiber or disk laser generator.

14. A laser beam cutting method implementing a nozzle as claimed in one of claims 1 to 10, a laser focusing head as claimed in claim 11 or a facility as claimed in one of claims 12 or 13.