provided with a spring exerting a pressure on the movable element in order to move it in the direction of the part to be cut and to hold it against the surface of said part.

However, this solution proposes several major problems, in particular in the context of industrial use.

First of all, the force exerted by the spring, added to the pressure of the cutting gas, leads the movable element to exert a high force on the part to be cut. The result is a risk of deformation of the metal sheet from which the part is cut, friction and scratches on the surface of the sheet, or even entrainment, i.e. movement, of the sheet, which is in general simply placed on the table of the industrial cutting machine. These risks are all the greater, the thinner the metal sheet.

The presence of an O-ring seal between the end of the movable element and the surface of the part further contributes to increasing the friction forces on the metal sheet and poses a problem in terms of service life of the movable element, because of the very high temperatures encountered at this level of the nozzle, where the laser beam has its highest power density and where the risks of splashing of molten metal are great.

Finally, this solution also poses a problem during phases of rapid movements of the cutting head above the metal sheet, without a cutting gas or a beam delivered, in particular in the context of cuts of contiguous parts, or during phases of piercing the metal sheet that generate significant splashes of molten metal. In these situations, permanent contact of the nozzle with the sheet is therefore to be proscribed.

The problem that is posed is consequently that of being able to improve the efficacy of the gas used in laser cutting by increasing the proportion of gas having an action on the expulsion of the molten metal and consequently reducing the total quantity of gas used and the gas pressure necessary while limiting the proportion of gas lost, and this by proposing a solution that can be implemented on an industrial level and does not make the laser cutting device excessively complex.

A first aspect~~The solution~~ of the present invention provides~~is~~ a laser nozzle comprising:

- a nozzle body comprising an axial housing passing axially through said nozzle body and comprising a first outlet orifice situated at the front face of the nozzle body, and
- a movable element comprising a front part forming a skirt, arranged in the axial housing of the nozzle body, said movable element being capable of translational movement in the axial housing of the nozzle body and comprising an axial passage with a second outlet orifice~~ (12)~~ emerging at the front part forming a skirt, characterised in that:
- the movable element is able to move translationally in the axial housing in the direction of the first outlet orifice under the effect of a gas pressure exerted on the movable element

until the front part forming a skirt of the movable element comes to project outside the axial housing through the first outlet orifice in the front face of the nozzle body, and

- an elastic element is arranged in the axial housing, between the nozzle body and the movable element, said elastic element exerting an elastic return force on the movable element tending to oppose the translation movement in the axial housing in the direction of the first outlet orifice.

According to embodiments of the inventioncircumstances, the nozzle ~~of the invention~~ may comprise one or more of the following technical features:

- when the movable element moves translationally in the axial housing in the direction of the first outlet ~~or~~ifice situated at the front face of the nozzle body, the front part forming a skirt of the movable element projects outside the axial housing through the first outlet orifice of the front face of the nozzle body;

- the bottom of the axial housing of the nozzle body comprises a shoulder, and the peripheral wall of the movable element comprises a stop, the elastic element being positioned between the shoulder and the stop;

- at least one sealing element is arranged between the nozzle body and the movable element, for example one or more O-ring seals;

- said at least one sealing element is arranged in a peripheral groove provided in the external peripheral wall of the movable element;

- the movable element is able to move between several positions comprising:

. an idle position in which the skirt of the front part is completely or almost completely retracted in the axial housing of the nozzle body, and

. a working position in which the skirt of the front part projects completely or almost completely outside the axial housing of the nozzle body, through the first outlet orifice;

- the axial passage of the movable element has a profile with a conical, frustoconical or convergent/divergent shape;

- the nozzle body is made from an electrically conductive material, in particular copper, brass or the like;

- the movable element is formed wholly or partly from an electrically insulating material;

- alternatively, a movable element is made from a material that is electrically conductive and resistant to temperature/heat, in particular copper, brass or the like, said insulating element comprising at least one insulating interface arranged between the nozzle and the wall of the movable insert. The insulating interface is either a sleeve arranged in the nozzle body or an insulating cladding carried by the nozzle body or the movable element.

A second aspect of t~~T~~he invention provides~~also relates to~~ a laser focusing head comprising at least one focusing optic, for example one or more lenses or mirrors, in particular a focusing lens and a collimation lens, characterised in that it also comprises a laser nozzle according to the first aspect~~invention~~.

Moreover, a third aspect of the invention provides~~also concerns~~ a laser installation comprising a laser generator, a laser focusing head and a laser beam conveying device connected to said laser generator and to said laser focusing head, characterised in that said laser focusing head is in accordance with the second aspect~~invention~~.

Preferably, the laser generator or source is of the CO_2, YAG, fibre or disc type, preferably of the fibre or disc type, in particular an ytterbium fibre laser source.

According to yet another aspect, the invention also relates to a laser beam cutting method in which use is made of a nozzle according the first aspect~~invention~~, a laser focusing head according to the second aspect~~invention~~ or an installation according to the third aspect~~invention~~.

The invention will now be better understood by means of the following description given with reference to the accompanying figures, among which:

- figure 1A shows schematically a focusing head of a conventional laser cutting installation,
- figure 1B shows schematically the size of the laser spot compared with the size of the nozzle orifice,
- figure 2 is a diagram in cross section of the body of a nozzle according to the invention,
- figure 3 is a diagram in cross section of a nozzle according to the invention,
- figures 4A and 4B show the nozzle of the invention with the movable element in two different positions.

Figure 1A shows the focusing head 20 of a conventional laser cutting installation, to which there is fixed a conventional laser nozzle 21 through which there pass a focused laser beam and assistance gas (arrow 23) serving to expel the metal melted by the beam out of the cutting kerf 31 formed by the beam 22 in the metal part to be cut 30, for example a steel or stainless steel sheet.

The assistance gas may be an active gas, such as oxygen, air, CO_2 or hydrogen, or an inert gas such as argon, nitrogen or helium, or a mixture of several of these active and/or inert gases. The composition of the gas is chosen in particular according to the nature of the part to be cut.

The beam that impacts the part will melt therein the metal, which will be expelled below the part by the pressure of the assistance gas.

Claims

1. Laser nozzle ~~(1, 2)~~ comprising:

- a nozzle body ~~(1)~~ comprising an axial housing ~~(5)~~ passing axially through said nozzle body ~~(1)~~ and comprising a first outlet orifice ~~(11)~~ situated at the front face ~~(1a)~~ of the nozzle body ~~(1)~~, and

- a movable element ~~(2)~~ comprising a front part ~~(2a)~~ forming a skirt, arranged in the axial housing ~~(5)~~ of the nozzle body ~~(1)~~, said movable element ~~(2)~~ being capable of translational movement in the axial housing ~~(5)~~ of the nozzle body ~~(1)~~ and comprising an axial passage ~~(4)~~ with a second outlet orifice ~~(12)~~ emerging at the front part ~~(2)~~ forming a skirt, characterised in that:

- the movable element ~~(2)~~ is able to move translationally in the axial housing ~~(5)~~ in the direction of the first outlet orifice ~~(11)~~ under the effect of a gas pressure exerted on the movable element ~~(2)~~ until the front part ~~(2a)~~ forming a skirt of the movable element ~~(2)~~ comes to project outside the axial housing ~~(5)~~ through the first outlet orifice ~~(11)~~ in the front face ~~(1a)~~ of the nozzle body ~~(1)~~, and

- an elastic element ~~(8)~~ is arranged in the axial housing ~~(5)~~, between the nozzle body ~~(1)~~ and the movable element ~~(2)~~, said elastic element ~~(8)~~ exerting an elastic return force on the movable element ~~(2)~~ tending to oppose the translation movement in the axial housing ~~(5)~~ in the direction of the first outlet orifice ~~(11)~~.

2. Nozzle according to the preceding claim, characterised in that, when the movable element ~~(2)~~ moves translationally in the axial housing ~~(5)~~ in the direction of the first outlet orifice ~~(11)~~ situated at the front face ~~(1a)~~ of the nozzle body ~~(1)~~, the front part ~~(2a)~~ forming a skirt of the movable element ~~(2)~~ projects outside the axial housing ~~(5)~~ through the first outlet orifice ~~(11)~~ in the front face ~~(1a)~~ of the nozzle body ~~(1)~~,

3. Nozzle according to one of the preceding claims, characterised in that the bottom ~~(15)~~ of the axial housing ~~(5)~~ of the nozzle body ~~(1)~~ comprises a shoulder ~~(9)~~, and the peripheral wall of the movable element ~~(2)~~ comprises a stop ~~(10)~~, the elastic element ~~(8)~~ being positioned between the shoulder ~~(9)~~ and the stop ~~(10)~~.

4. Nozzle according to one of the preceding claims, characterised in that at least one sealing element ~~(7)~~ is arranged between the nozzle body ~~(1)~~ and the movable element ~~(2)~~.

5. Nozzle according to one of the preceding claims, characterised in that said at least one sealing element ~~(7)~~ is arranged in a peripheral groove ~~(14)~~ provided in the external peripheral wall of the movable element ~~(2)~~,

6. Nozzle according to one of the preceding claims, characterised in that the movable element ~~(2)~~ is able to move between several positions comprising:

- an idle position in which the skirt of the front part ~~(2a)~~ is completely or almost completely retracted in the axial housing ~~(5)~~ of the nozzle body ~~(1)~~, and
- a working position in which the skirt of the front part ~~(2a)~~ projects completely or almost completely outside the axial housing ~~(5)~~ of the nozzle body ~~(1)~~, through the first outlet orifice ~~(11)~~.

7. Nozzle according to one of the preceding claims, characterised in that the axial passage ~~(4)~~ of the movable element ~~(2)~~ has a profile with a conical, frustoconical or convergent/divergent shape;

8. Laser focusing head comprising at least one focusing optic, characterised in that it also comprises a laser nozzle according to one of the preceding claims.

9. Laser installation comprising a laser generator, a laser focusing head and a laser beam conveying device connected to said laser generator and to said laser focusing head, characterised in that the laser focusing head is in accordance with claim 8.

10. Installation according to claim 9, characterised in that the laser generator is of the CO_2, YAG, fibre or disc type.

11. Method for cutting by laser beam, in which a nozzle according to one of claims 1 to 7, a laser focusing head according to claim 8 or an installation according to one of the claims 9 or 10 is used.