Claims

1. A method of laser processing of a metallic material (WP), in particular for laser cutting, drilling or welding of said material, by means of a focused laser (B) beam having a predetermined transverse power distribution at at least one working plane (Π) of the metallic material (WP), comprising the steps of:

- providing a laser beam emitting source (10);
- leading the laser beam (B) emitted by said emitting source (10) along a beam transport optical path to a working head (14) arranged in proximity of said metallic material (WP);
- collimating the laser beam (B) along an optical axis of propagation incident on the metallic material (WP);
- focusing said collimated laser beam (B) in an area of a working plane (Π) of said metallic material (WP); and
- conducting said focused laser beam (B) along a working path (T) on the metallic material (WP) comprising a succession of working areas (T1, T2),

the method comprising shaping the laser beam (B), wherein shaping the laser beam (B) comprises:

- reflecting said collimated beam (B) by means of a deformable, controlled surface reflecting element (200) having a reflecting surface with a continuous curvature including a plurality of independently movable reflection areas (200a-200r), and
- controlling the arrangement of said reflection areas (200a-200r) to establish a predetermined transverse power distribution of the beam (B) at at least one working plane (Π) of the metallic material (WP) as a function of the area of the current working plane (Π) and/or the current direction of the working path (T) on the metallic material (WP), **characterised in that** the method further comprises the steps of:
- delivering a flow of assist gas towards said area of the working plane (Π) of the metallic material (WP) along an axis of the assist gas flow,
- when the predetermined working path (T) on the metallic material (WP) varies from a first to a second working direction (T1; T2), controlling the relative translation of said axis of the assist gas flow according to intermediate directions along a predetermined fitting curve (R) between said first and second working direction (T1; T2), wherein said fitting curve (R) has a distance from the predetermined working path (T) not greater than the radius of the delivering area (G1, G2, G3, G4) of said flow;
- detecting the current position of the axis of the assist gas flow; and
- automatically adjusting the position of the optical axis of propagation of the laser beam (B) as a function of the detected current position and/or of the detected current translation direction of the axis of the assist gas flow so as to maintain the optical axis of propagation of the laser beam (B) directed along said predetermined working path (T),
wherein the arrangement of said reflection areas (200a-200r) is controlled to establish said position of the optical axis of propagation of the laser beam (B) in an area of the working plane (Π) on the metallic material (WP) comprised in a predetermined neighborhood around the axis of the assist gas flow and within a delivering zone (G1, G2, G3, G4) of said flow.

2. The method according to claim 1, wherein controlling the arrangement of said reflection areas (200a-200r) of the controlled surface reflecting element (200) comprises controlling a combination of moves of said areas (200a-200r) with respect to a reflecting reference flat surface.

3. The method according to claim 2, wherein controlling a combination of moves of said reflection areas (200a-200r) of the controlled surface reflecting element (200) comprises controlling the translation movement of said areas (200a-200r) along the optical axis of the reflecting element (200) and/or the rotation of said areas (200a-200r) to obtain an inclination with respect to the optical axis of the reflecting element (200).

4. The method according to any one of the preceding claims, wherein the automatic adjustment of the position of the optical axis of propagation of the laser beam (B) as a function of the detected current position and/or of the detected current direction of translation of the axis of the assist gas flow is performed by reference to a predetermined adjustment pattern or program.

5. The method according to any one of the preceding claims, comprising providing a deformable controlled surface reflecting element (200) having a reflecting surface with a continuous curvature including a plurality of independently movable reflection areas (200a-200r) by means of a corresponding plurality of movement modules which include a central area and a plurality of ranks of circular crown sectors concentric to said central area.

6. The method according to claim 5, wherein said ranks of concentric circular crown sectors are in number of 6, the circular crown sectors are in number of 8 for each rank, and the height of the circular crown sectors is increasing from the first to the third rank and from the fourth to the sixth rank in the radial direction towards the outside of the reflecting element, the height of the circular crown sectors of the fourth rank being intermediate between the height of circular crown sectors of the first and second rank.

7. A machine for laser processing of a metallic material, in particular for laser cutting, drilling or welding of said material, by means of a focused laser beam (B) having a predetermined transverse power distribution at at least one working plane (Π) of the metallic material (WP), comprising:

- a laser beam emitting source (10);
- means (12a, 12b, 12c; 12d) for leading the laser beam (B) emitted by said emitting source (10) along a beam transport optical path to a working head (14) arranged in proximity of said metallic material (WP);
- optical means (120) for collimating the laser beam (B) along an optical axis of propagation incident on the metallic material (WP);
- optical means (16; 140) for focusing said collimated laser beam (B) in an area of a working plane (Π) of said metallic material (WP),

wherein at least said focusing optical means (16; 140) of said collimated laser beam (B) are carried by said working head (14) at a controlled distance from said metallic material (WP);
- means for adjusting the mutual position between said working head (14) and said metallic material (WP), adapted to conduct said focused laser beam (B) along a working path (T) on the metallic material (WP) comprising a succession of working areas (T1, T2),
- optical means (180) for shaping the laser beam (B) including a deformable controlled surface reflecting element (200) having a reflecting surface with a continuous curvature including a plurality of independently movable reflection areas (200a-200r), adapted to reflect said collimated laser beam (B), the arrangement of said reflection areas (200a-200r) being adapted to establish a predetermined transversal power distribution of the beam (B) at at least one working plane (II) of the metallic material (WP); and
- a nozzle (18) for delivering a flow of assist gas towards the working area on the material (WP), and being **characterised by** electronic processing and control means (ECU, CM1, CM2, CM3) arranged to control the arrangement of said reflection areas (200a-200r) to establish a predetermined transverse power distribution of the beam (B) at at least one working plane (Π) of

the metallic material (WP) as a function of the area of the current working plane (Π) and/or the current direction of the working path (T) on the metallic material (WP), and further arranged for:

- controlling the relative translation of the axis of the assist gas flow when the predetermined working path (T) on the metallic material (WP) varies from a first to a second working direction (T1; T2), according to intermediate directions along a predetermined fitting curve (R) between said first and second working direction (Tl; T2), wherein said fitting curve (R) has a distance from the predetermined working path (T) not greater than the radius of the delivering area (G1, G2, G3, G4) of said flow;
- detecting the current position of the axis of the assist gas flow; and
- controlling the arrangement of said reflection areas (200a-200r) to automatically adjust the position of the optical axis of propagation of the laser beam (B) as a function of the detected current position and/or of the detected current translation direction of the axis of the assist gas flow so as to maintain the optical axis of propagation of the laser beam (B) directed along said predetermined working path (T) and establish the position of the optical axis of propagation of the laser beam (B) in an area of the working plane (Π) on the metallic material (WP) comprised in a predetermined neighborhood around the axis of the assist gas flow and within a delivering zone (G1, G2, G3, G4) of said flow.

8. Computer program comprising one or more code modules for performing a step of shaping a laser beam (B) in a method of laser processing of a metallic material (WP) according to any one of claims 1 to 6 when the program is executed by electronic processing and control means (ECU, CM1, CM2, CM3) of a machine for laser processing of a metallic material (WP), according to claim 7, **characterised in that** the computer program comprises instructions, which, when executed by the electronic processing and control means (ECU, CM1, CM2, CM3), cause the electronic processing and control means (ECU, CM1, CM2, CM3) to carry out the following steps:

controlling the arrangement of said reflection areas (200a-200r) to establish a predetermined transverse power distribution of the beam (B) on at least one working plane (Π) of the metallic material (WP) as a function of the area of the current working plane (Π) and/or the current direction of the working path (T) on the metallic material (WP), controlling the arrangement of said reflection areas (200a-200r) to automatically adjust the position of the optical axis of propagation of the laser beam (B) as a function of the current position and/or of the current translation direction of the axis of an assist gas flow so as to maintain the optical axis of propagation of the laser beam (B) directed along said predetermined working path (T),
controlling the establishment of the position of the optical axis of propagation of the laser beam (B) in an area of the working plane (Π) on the metallic material (WP) comprised in a predetermined neighborhood around the axis of the assist gas flow and within a delivering zone (G1, G2, G3, G4) of said flow,
and controlling the axis of the assist gas flow in translation when the predetermined working path (T) on the metallic material (WP) varies from a first to a second working direction (T1; T2), according to intermediate directions along a predetermined fitting curve (R) between said first and second working direction (T1; T2), wherein said fitting curve (R) has a distance from the predetermined working path (T) not greater than the radius of the delivering area (G1, G2, G3, G4) of said flow.