separate from the laser welding head and because the nozzles in FIGS. 15 and 16 may not provide a large enough shielding effect.

[0005] A larger shielding effect may be needed, for example, when scanning a laser beam to provide wobble patterns or for certain welding applications. When welding alloys like aluminum, copper and titanium, for example, better shielding is needed because these alloys are very reactive with oxygen, nitrogen and carbon dioxide. If these hot metals are not adequately protected from air, the welding may cause a brittle structure that reduces the mechanical properties of the welding joint and may cause discolorations in the seam. Titanium, in particular, is extremely reactive with gases in the air and should be protected while the temperature is above 350º C.

SUMMARY

[0006] Consistent with one aspect of the present disclosure, a gas shielding device is provided for use with a laser processing head. The gas shielding device includes a neck defining a central aperture extending from a first end to a second end of the neck. The central aperture is configured to receive a laser beam passing from the first end through the second end to a workpiece. A shielding plate is coupled to the neck proximate the second end such that the neck extends from a first side of the shielding plate and the shielding plate extends circumferentially around the central aperture. The shielding plate includes a plurality of gas outlets on a second side of the shielding plate opposite the first side, which are fluidly coupled to at least one gas inlet and are configured to direct a flow of gas in a direction toward a surface of the workpiece at a plurality of locations. Wherein the at least one gas inlet is located on the first side of the shielding plate, and wherein the shielding plate defines a gas diffusion region that fluidly couples the at least one gas inlet to the plurality of gas outlets.

[0007] Consistent with another aspect of the present disclosure, a shielded laser welding head includes a scanning laser welding head device configured to be coupled to an output fiber of a fiber laser and configured to move a laser beam within only a limited field of view and a gas shielding device is coupled to the laser welding head device. The gas shielding device includes a neck defining a central aperture extending from a first end to a second end of the neck. The central aperture is configured to receive the moving laser beam passing from the first end through the second end to the workpiece. A shielding plate is coupled to the neck such that the neck extends

from a first side of the shielding plate and the shielding plate extends circumferentially around the central aperture. The shielding plate includes a plurality of gas outlets on a second side of the shielding plate opposite the first side, which are fluidly

coupled to at least one gas inlet and are configured to direct a flow of gas in a direction toward a surface of the workpiece at a plurality of locations. The at least one gas inlet is located on the first side of the shielding plate, and wherein the shielding plate defines a gas diffusion region that fluidly couples the at least one gas inlet to the plurality of gas outlets.

[0008] Consistent with a further aspect of the present disclosure, a laser welding system includes a fiber laser including an output fiber, a scanning laser welding head coupled to an output fiber of the fiber laser and comprising movable mirrors configured to move a laser beam within only a limited field of view, and a gas shielding device coupled to the laser welding head. The gas shielding device includes a neck defining a central aperture extending from a first end to a second end of the neck. The central aperture is configured to receive the moving laser beam passing from the first end through the second end to the workpiece. A shielding plate is coupled to the neck such that the neck extends from a first side of the shielding plate and the shielding plate extends circumferentially around the central aperture. The shielding plate includes a plurality of gas outlets on a second side of the shielding plate opposite the first side, which are fluidly coupled to at least one gas inlet and are configured to direct a flow of gas in a direction toward a surface of the workpiece at a plurality of locations. The at least one gas inlet is located on the first side of the shielding plate, and wherein the shielding plate defines a gas diffusion region that fluidly couples the at least one gas inlet to the plurality of gas outlets. The laser welding system further comprising a control system for controlling at least the fiber laser and positions of the movable mirrors.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] These and other features and advantages will be better understood by reading the following detailed description, taken together with the drawings wherein:

[0010] FIG. 1 is a schematic block diagram of a system including a laser welding head with a gas shielding device, consistent with an embodiment of the present disclosure.

[0011] FIG. 2 is a schematic diagram of a focused laser beam with a relatively small range of movement provided by dual mirrors for purposes of wobbling, consistent with an embodiment of the present disclosure.

[0012] FIGS. 3A-3D are schematic diagrams illustrating different wobble patterns capable of being produced by a welding head including dual mirrors for beam movement, consistent with an embodiment of the present disclosure.

[0013] FIGS. 4 and 5 are perspective views of an example embodiment of a laser welding head with a collimator module, wobbler module, and core block module assembled together and emitting a focused beam.

[0014] FIG. 6 is a bottom perspective view of a gas shielding device, consistent with an embodiment of the present disclosure.

[0015] FIG. 7 is a side view of the gas shielding device shown in FIG. 6.

[0016] FIG. 8 is a bottom view of the gas shielding device shown in FIG. 6.

CLAIMS

What is claimed is:

1. A gas shielding device for use with a laser processing head, the gas shielding device comprising:

a neck defining a central aperture extending from a first end to a second end of the neck, wherein the central aperture is configured to receive a laser beam passing from the first end through the second end to a workpiece; and

a shielding plate coupled to the neck proximate the second end such that the neck extends from a first side of the shielding plate and the shielding plate extends circumferentially around the central aperture,

the shielding plate including a plurality of gas outlets on a second side of the shielding plate opposite the first side,

wherein the plurality of gas outlets are fluidly coupled to at least one gas inlet and are configured to direct a flow of gas in a direction toward a surface of the workpiece at a plurality of locations.

2. The gas shielding device of claim 1 wherein the at least one gas inlet is located on the first side of the shielding plate, and

wherein the shielding plate defines a gas diffusion region that fluidly couples the at least one gas inlet to the plurality of gas outlets.

23. The gas shielding device of claim 1,

wherein the at least one gas inlet is located on a top portion of the neck.

34. The gas shielding device of claim 1, further including

at least one gas distribution tube coupled to the at least one gas inlet for distributing shielding gas to the plurality of gas outlets on the second side.

45. The gas shielding device of claim 1,

wherein the neck includes at least one cooling passageway and at least one cooling inlet/outlet coupled to the cooling passageway to allow a cooling liquid to flow through the cooling passageway.

5~~6~~. The gas shielding device of claim 1~~,~~

wherein the shielding plate is circular shaped.

6~~7~~. The gas shielding device of claim 5~~6~~~~,~~

wherein the shielding plate has a diameter in a range of 100 mm to 150 mm.

7~~8~~. The gas shielding device of claim 1~~,~~

wherein the shielding plate is coaxial with the neck and the central aperture.

8~~9~~. The gas shielding device of claim 1~~,~~

wherein the neck includes a processing head coupling mechanism at the first end of the neck for coupling to a laser processing head.

9~~10~~. The gas shielding device of claim 1~~,~~

wherein the plurality of gas outlets are formed in lines extending outward from a central portion of the shielding plate to an outer portion of the shielding plate.

10~~1~~. The gas shielding device of claim 1~~,~~

wherein the plurality of gas outlets are arranged to deliver a laminar flow of gas surrounding the ~~moving~~ laser beam passing through the shielding plate to the workpiece.

11~~2~~. The gas shielding device of claim 1~~,~~

wherein the central aperture has a diameter in a range of 10-60 mm.

12~~3~~. The gas shielding device of claim 1~~,~~

wherein the shielding plate includes a porous material between the at least one gas inlet and the gas outlets.

13~~4~~. A shielded laser welding head comprising:

a scanning laser welding head device configured to be coupled to an output fiber of a fiber laser and configured to move a laser beam within only a limited field of view; and

a gas shielding device coupled to the laser welding head device, the gas shielding device comprising:

a neck defining a central aperture extending from a first end to a second end of the neck, wherein the central aperture is configured to receive the moving laser beam passing from the first end through the second end to the workpiece; and

a shielding plate coupled to the neck such that the neck extends from a first side of the shielding plate and the shielding plate extends circumferentially around the central aperture,

the shielding plate including a plurality of gas outlets on a second side of the shielding plate opposite the first side,

wherein the plurality of gas outlets are fluidly coupled to at least one gas inlet and are configured to direct a flow of gas in a direction toward a surface of the workpiece at a plurality of locations,

wherein the at least one gas inlet is located on the first side of the shielding plate, and

wherein the shielding plate defines a gas diffusion region that fluidly couples the at least one gas inlet to the plurality of gas outlets.

145. The laser welding head of claim 134,

wherein the limited field of view is defined by a scan angle of about 1-2º

156. The laser welding head of claim 134, wherein the laser welding head device comprises:

a collimator;

at least first and second movable mirrors configured to receive a collimated laser beam from the collimator and to move the beam in the first and second axes within the limited field of view; and

a focus lens configured to focus the laser beam relative to the workpiece while the beam is moved.

167. The laser welding head of claim 156,

wherein the movable mirrors are galvanometer mirrors.

178. The laser welding head of claim 156,

wherein the movable mirrors are configured to move the collimated laser beam within only a limited field of view having a dimension less than 30 x 30 mm.

189. A laser welding system comprising:

a fiber laser including an output fiber;

a scanning laser welding head coupled to an output fiber of the fiber laser and comprising movable mirrors configured to move a laser beam within only a limited field of view;

a gas shielding device coupled to the laser welding head, the gas shielding device comprising;

a neck defining a central aperture extending from a first end to a second end of the neck, wherein the central aperture is configured to receive the moving laser beam passing from the first end through the second end to the workpiece; and

a shielding plate coupled to the neck such that the neck extends from a first side of the shielding plate and the shielding plate extends circumferentially around the central aperture,

the shielding plate including a plurality of gas outlets on a second side of the shielding plate opposite the first side,

wherein the plurality of gas outlets are fluidly coupled to at least one gas inlet and are configured to direct a flow of gas in a direction toward a surface of the workpiece at a plurality of locations,

wherein the at least one gas inlet is located on the first side of the shielding plate, and

wherein the shielding plate defines a gas diffusion region that fluidly couples the at least one gas inlet to the plurality of gas outlets; and

a control system for controlling at least the fiber laser and positions of the movable mirrors.

1920. The laser welding system of claim 189,

wherein the fiber laser includes an Ytterbium fiber laser.

201. The laser welding system of claim 189,

wherein the fiber laser includes multiple output fibers for delivering multiple laser beams.

212. The laser welding system of claim 189,

wherein the control system is configured to control movement of the moving laser beam within the limited field of view to provide a wobble pattern.