sponge material can be mixed with alloying elements and formed into a wire where it may be used in an SFFF process in combination with a plasma welding torch or other high power energy beam to produce near net shaped titanium components.

[0009] Abbott *et al*. (WO 2006/133034, 2006) describes a direct metal deposition process using a laser/arc hybrid process to manufacture complex three-dimensional shapes comprising the steps of providing a substrate and depositing a first molten metal layer on the substrate from a metal feedstock using laser radiation and an electric arc. The electric arc can be provided by gas metal arc welding torch using the metal feedstock as an electrode. Abbott *et al*. teaches that the use of laser radiation in combination with gas metal arc welding stabilizes the arc and purportedly provides higher processing rates. Abbott *et al*. utilizes a consumable electrode guided by and exiting out of a wire guide. The metal of the consumable electrode is melted at the end and the molten metal is deposited by positioning the end over the deposition point. The required heat for melting the consumable electrode can be supplied by an electric arc expanding between the tip of the electrode and the workpiece/deposition substrate, and by a laser irradiating the deposition area. Welding by melting a consumable electrode heated by an electric arc is known as gas metal arc welding (GMAW), of which in the case of using non-reactive gases to make the arc is also denoted as metal inert gas welding (MIG-welding).

[0010] In order to effectively deposit metal from a metal wire unto the surface of a work piece using a welding torch, it is necessary to maintain the metal wire in the correct position relative to the welding torch. If the metal wire is not maintained within the arc, it will not melt properly or be deposited in the correct position.

[0011] Accordingly, there exists a need in this art for an economical method of performing direct metal deposition at an increased rate of metal deposition while maintaining

the metal wire in the proper position within the arc of the welding torch.

[0012] **SUMMARY**

[0012a] In an aspect, the present disclosure refers to a metal wire positioning system, comprising:

a plate containing an internally threaded opening, the plate fixedly attached to a main frame;

a holding unit attached to the main frame, the holding unit comprising a rotatable support piston engaged with a pivot joint, and a connector connected to the rotatable support piston and pivotably supporting the rotatable support piston;

an adjustable guide support frame rotatably connected to the main frame by the holding unit via the pivot joint and suspended by the rotatable support piston;

a wire guide attached to the adjustable guide support frame;

a motor attached to the adjustable guide support frame, the motor attached to a threaded member that is engaged with the internally threaded opening in the plate such that the adjustable guide support frame is repositioned toward or away from the main frame in response to a rotation of the threaded member; and

a detector that detects the position of an arc of welding torch.

[0013] An example provides a system for delivery of metal wire to a welding torch and to maintain the metal wire in the heat source emitted by the welding torch, such as the arc of a plasma arc welding torch, for building metallic objects by solid freeform fabrication. The welding torch includes a heat source, such as a plasma

transferred arc (PTA) torch, an electron beam, or a laser, or a combination thereof, to melt a metal wire.

[0014] Provided herein is a system that maintains the metal wire in the correct position relative to the heat source emitted by the welding torch to provide a constant supply of melted metal to the molten pool on the surface of the work piece so that there are no unintentional gaps or imperfections in the layer of metal added to the work piece.

[0015] Another example provides a method for rapid layered manufacture of objects in titanium or titanium alloys, or nickel or nickel alloys, using a metal wire and one or more welding torches. This invention addresses the needs for an improved, economical method of performing direct metal deposition by providing systems and methods for delivery of metal wire to a welding torch to a desired location with respect to the welding torch, which can result in increased speeds of deposition of metal in solid freeform fabrication. This invention further addresses the need for a method of increasing throughput and yield of distortion-free direct metal deposition formed parts with smooth, well-defined deposition boundaries. It is noted that although the invention is described in correlation with the use of a metal wire, any conductive structure that can be guided and melted to deposit material can be used, for example any consumable electrode of appropriate size and shape can be used.

[0016] Provided herein are metal wire positioning systems that include a fixed main support frame **900** and an adjustable guide support frame **500** rotatably connected to the main support frame **900** by a holding unit via a pivot joint **800** and suspended by a rotatable support piston **810**. A plate **920** is fixedly attached to the main support frame **900**. The plate **920** includes an internally threaded opening. A motor **570** is attached to the adjustable guide support frame **500**, and the motor **570** can be attached to a threaded member that is engaged with the internally threaded opening in plate **920**. A welding torch **600** can be fixedly attached to the main support frame **900**. A second welding torch **610** also can be fixedly attached to the main support frame **900**. The holding unit can include a support **820** containing a rotatable support piston **810** engaged with a pivot joint **800**, and a connector **830** connected to the rotatable support piston **810** and pivotably supporting the rotatable support piston **810**, the support **820** fixedly attached to the main support frame **900**. The system includes a detector **700** that detects the position of the heat source emitted by a welding torch,