The claims defining the invention are as follows

1. A method of manufacturing a metallic part in a weldable material by solid freeform fabrication unrestricted in size and open to the ambient atmosphere, wherein the method comprises:

generating a computer-generated, three dimensional model of the part, slicing the computer-generated three dimensional model into a set of computer-generated, parallel, sliced layers and then dividing each layer into a set of computer-generated, virtual, one-dimensional pieces and, with reference to layered weld-bead geometry data, forming a computer-generated, direction specific, layered model of the part,

uploading the direction specific, layered model of the part into a welding control system able to control the position and activation relative to a support substrate, of an electric arc delivered by a high energy tungsten arc welding torch, a plasma transferred arc welding torch, and/or a gas metal arc welding torch, and a system for feeding a consumable wire placed in an open area build space relevant to the substrate unrestricted in size and open to the ambient atmosphere,

directing the welding control system to deposit a sequence of one-dimensional weld beads of the weldable material onto the supporting substrate in a pattern required to form a first layer of the computer-generated, direction specific, layered model of the part,

depositing a second welded layer by sequencing one- dimensional weld beads of the weldable material onto the previous deposited layer in a configuration the same as the second layer of the computer-generated direction specific layered model of the part, and

repeating each successive weld bead layer of the computer-generated, direction specific, layered model of the part until the entire part is completed;

wherein the method further includes ~~one or both of~~:

displacing the atmosphere within the immediate vicinity of the heat source with an inert gas atmosphere which produces a required flow rate, and in which that inert atmosphere contains a maximum oxygen concentration, wherein the inert gas is

delivered by an apparatus through a matrix of individual gas diffusers and/or a filter; and

engaging an induction heating and closed loop cooling apparatus synergic to a welding control system and pre-heating the substrate material including the deposited weld beads, relevant to the type of weldable material, wherein induction heating and cooling cycles are applied constantly or pulsed from the first layer to the final layer, where optimal heating and/or cooling cycles of the weldable material are relative to the final desired part shape and microstructure.

2. A method according to claim 1, wherein the weldable material is a weldable metal, or a weldable alloyed metal, of ferrous or non-ferrous nature.

3. A method according to claim 2, wherein the weldable material is carbon steel or carbon manganese alloys, nickel or nickel alloys, stainless steels, aluminium or aluminium alloys, titanium or alloyed titanium, ferrous or non-ferrous, or a mixture of dissimilar weldable materials.

4. A method according to any one of claims 1 to 3, wherein the inert gas is one of argon, helium, hydrogen, nitrogen, or a mixture of these.

5. A method according to any one of claims 1 to 3, wherein the inert gas shielding the electric arc and heat-affected material is argon or an argon mixture, and where the flow rate of the argon or argon mixture is constant or pulsed and above 20 or 25 liters per minute, and wherein the distribution of the inert gas is delivered through a series of gas diffusers.

6. A method according to any one of claims 1 to 5, wherein the required flow rate is greater than 20 l/min.

7. A method according to any one of claims 1 to 6, wherein the maximum oxygen concentration is less than 500ppm oxygen or is less than 100ppm oxygen.

8. A method according to any one of claims 1 to 7, wherein there are less than 25 individual gas diffusers.

9. Production apparatus for a part made of a weldable material by solid freeform fabrication, where there is no enclosure or reactor required, and the part is built in an unrestricted build environment open to the ambient atmosphere by an apparatus which distributes an inert gas flow, the production apparatus including:

a robotic multiple-axis mechanism controlling the position and movement of a welding torch with a wire feeder relative to a stationary support substrate placed upon a fixed support, the welding torch being an electric arc welding process, a tungsten arc welding torch, a gas metal arc welding torch, or a plasma transferred arc welding torch;

a support mechanism controlling the position and movement of the welding torch and the wire feeder relative to the support substrate an actuator controlling the position and movement relative to the support mechanism; and

a control system able to read a computer-generated, three dimensional, direction specific, layered model of the part and employ the computer-generated model to control the position and movement of the robot, and the operation of the welding torch and wire , feeder such that a part is built by welding in a layer-by-layer sequence according to one-dimensional slices of the weldable material onto the substrate structure in agreement with the computer-generated, three dimensional, direction specific, layered model of the part;

the apparatus also including ~~one or both of~~ a localised purging apparatus and an induction heating and closed loop cooling apparatus.

10. Apparatus according to claim 9 wherein the localised purging apparatus includes a manifold filled with argon or argon mixture as inert gas and where the gas inlet is equipped with means for regulating the gas flow rate.

11. Apparatus according to claim 9 or claim 10 wherein the induction heating apparatus is electrically attached to the substrate and subsequent weld bead layers.