

[CLAIMS]

[Claim 1]

A machine tool adapted ~~which is disposed to remove and arranged to carry out removal and addition of~~ add a material on a work piece located workpiece positioned in a work station,

5 the machine ~~having~~ tool comprising:

a plurality of exchangeable heads comprising a first head arranged disposed to remove a material from the work piece and workpiece positioned at least in the work station, and a second head arranged disposed to process the work piece, each of add a material to the workpiece positioned in the work station;

10 a first and second heads carriage, the first head being arranged removably mounted on the first carriage, the first carriage being disposed to be moveable in at least movable along two axes or more axial lines; and preferably in 3, 4 or 5 axes and

a second carriage, the second head being removably mounted on the second carriage, the second carriage being disposed to be movable along two or more axial line,

15 1. wherein the machine tool is arranged disposed to control an environment of the work station;

2. ~~A machine tool according to any preceding claim wherein the machine tool comprises a clean side and a dirty~~ an unclean side.

20 3. A machine tool according to claim 1 or claim 2 wherein the first head is selectable from a plurality of first interchangeable, and the first carriage is used for unclean processing heads and the second head is selectable from a plurality of second interchangeable processing heads and wherein the first interchangeable processing heads are storable in a first tool changer and the
25 second interchangeable processing heads are storable in a second tool changer, and the second carriage is used for clean processing,

4. ~~A machine tool according to claim 3 wherein one of the first head and the second tool changers are remote from the work station~~head is disposed to perform two processing steps simultaneously while being maintained in the first carriage or the second carriage.

A[Claim 2]

5 The machine according to any preceding tool of claim 1,
wherein a first step of the two processing steps performed simultaneously comprises heating the material or the workpiece, and a second step of the two processing steps performed simultaneously comprises deposition of the material or pressure processing of the workpiece.

[Claim 3]

10 The machine tool of claim 1,
wherein one of the first head and the second head disposed to perform the two processing steps simultaneously is disposed to apply heat to the material or the workpiece and simultaneously to perform deposition of the material.

[Claim 4]

15 The machine tool of claim 3,
wherein heating is performed by induction heating.

[Claim 5]

The machine tool of claim 3,
wherein the deposition is performed by extrusion.

20 [Claim 6]

The machine tool of claim 1,
wherein one of the first head and the second head disposed to perform the two processing steps simultaneously is disposed to perform deposition on the workpiece and simultaneously to perform pressure processing on the workpiece.

[Claim 7]

The machine tool of claim 6,
wherein the pressure processing is discontinuous.

[Claim 8]

5 The machine tool of claim 1,
wherein the two processes performed simultaneously is selected from one of combinations
of:

applying heat and removing the material;
 applying induction heating and using a laser process;
10 depositing the material and examining the deposited material;
 depositing the material and moving the workpiece;
 moving the workpiece and performing another process;
 processing the workpiece and examining the workpiece;
 preliminarily processing and processing;
15 processing and deposition processing;
 using multiple examination means; and
 using an examination means and an illumination means.

[Claim 9]

20 The machine tool of claim 1,
wherein one of the first head and the second head disposed to perform the two processing
steps simultaneously is configured to deposit a first material which is heated, and to extrude the
first material and a second material.

[Claim 10]

The machine tool of claim 9,
wherein the head further comprises a cutting means which is disposed to cut the second
material.

[Claim 11]

5 The machine tool of claim 1,
wherein the machine tool has a storage place to store the plurality of exchangeable heads,
and a tool exchanger.

[Claim 12]

10 The machine tool of claim 1,
wherein the first head is disposed to be movable along two, three, four, or five axial lines
when the first head is removably mounted in the first carriage.

[Claim 13]

15 The machine tool of claim 1,
wherein the second head is disposed to be movable along two, three, four, or five axial
lines when the second head is removably mounted in the second carriage.

[Claim 14]

20 The machine tool of claim 1,
~~5. — wherein the work station comprises is provided with a chamber that which is, sealable at~~
~~least in part, sealable.~~
6. A machine tool according to claim 5 wherein the and the workpiece is positioned
in the chamber is partially open and is provided with a local shielding locatable around the work-
piece during processing when in use.

A[Claim 15]

The machine tool according to of claim 5 or 6 1,

7. ~~wherein an environment in the chamber is controllable and may be provided with at least one of:~~

at least a partial inert gas atmosphere
 a low oxygen atmosphere;
 a coolant;
 a pressure above ambient pressure;
 a pressure below ambient pressure;
 a vacuum.

8. ~~A the machine tool according to any preceding claim including a waste extractor.~~

9. ~~A machine tool according to any proceeding claim wherein the machine further comprises an integral docking system, preferably having a disposed to supply manifold located on one or each carriage and arranged to connect with a receiving manifold on the a processing material to the second head, which is maintained in the second carriage.~~

A[Claim 16]

The machine tool of claim 15,

wherein the second head comprises a receiving docking manifold, and the machine tool has a supply docking manifold disposed on the second head to be connected with the receiving docking manifold.

[Claim 17]

The machine tool according of claim 16,

wherein the machine tool comprises a spindle to mount the second head which is maintained in the second carriage and disposed to be movable in a z direction, and the receiving docking manifold of each head is disposed in parallel with or adjacent to the spindle.

[Claim 18]

The machine tool of claim 9-17,

wherein the supply docking manifold is provided on a collar of the spindle.

[Claim 19]

The machine tool of claim 17,

wherein the receiving docking manifold is rotatable to a predetermined position.

[Claim 20]

The machine tool of claim 17,

5 wherein the receiving docking manifold is disposed to be connected along an axial line
which is transverse to the spindle or an axial line which is parallel to the spindle.

[Claim 21]

The machine tool of claim 17,

10 wherein the supply docking manifold is combined into a column of the spindle or a spindle
housing.

[Claim 22]

The machine tool of claim 21,

wherein the supply docking manifold and the receiving docking manifold are disposed to
supply a material for deposition to the second head.

15 [Claim 23]

The machine tool of claim 16,

wherein the docking manifolds are disposed to transmit data to the second head and to
receive data from the second head.

[Claim 24]

20 The machine tool of claim 16,

~~10.~~ wherein the docking system is arranged disposed to provide a clean connection
portion between a the supply docking manifold on the machine tool and a the receiving docking
manifold on the processing second head.

A[Claim 25]

The machine tool according to claim 9-24,

wherein the docking system is arranged machine tool comprises an operable seal provided on at least a half of the connection portion.

[Claim 26]

5 The machine tool of claim 1,

wherein the machine tool further comprises a supply unit disposed to supply or to be able to supply a power source to the first head which is mounted in the first carriage or the second head which is mounted in the second carriage.

[Claim 27]

10 The machine tool of claim 1,

wherein a material for deposition is one or more of:

11- powder, a filament, a rod, a fiber (a short fiber, a chopping fiber, a long fiber or a continuous fiber) sheet, or metal formed with wire, nonmetal, polymer, ceramic, clay, salt, a conductive material, a capacitive material, or a dielectric material which is suspended in one of
 15 liquid, emulsion, gas, aerosol, paste, a fluid in the form of solid or semi-liquid or perfect liquid or a cooling fluid or a processed fluid, gas and energy to the or each processing head in use; a mixture thereof.

A[Claim 28]

The machine tool according to claim 11-1,

20 12- wherein at least one of the multiplicity of exchangeable heads is supplied disposed to a reservoir in extrude the processing material on the workpiece, and the machine tool comprises a spindle to mount the first head or is continuously supplied to the processing the second head, and an amount of extruded material is directly controlled by rotation of the spindle.

13. — ~~A machine tool according to any one of claims 9-12 wherein energy is supplied to the processing head by a laser beam or by a fibre optic cable and wherein the energy source is preferably integral to the machine.~~

14. — ~~A machine tool according to any preceding claim wherein the machine comprises one or more heads arranged to monitor and/or analyse at least one of the work piece and a processing head.~~

15. — ~~A method of creating an article using a machine tool having a work station and at least one tool changer remote from the work station, the method comprising using a first processing head, [Claim 29]~~

The machine tool of claim 1,

wherein the plurality of exchangeable heads comprise:

an additional head having a first deposition characteristic; to lay down introduce a material having a characteristic of a first set of properties on a work piece onto the workpiece in the work station; and

changing the first processing head for a second processing head selected from the tool changer, the second processing a second additional head having a second deposition characteristic different from the first; deposition characteristic to introduce a material having a characteristic of a second set which is different from the characteristic of the first set onto the workpiece in the work station; and

laying further material down having a second set of properties.

in which wherein the machine tool holding the processing head is disposed to automatically changes change the additional head to the processing second additional head from the first head to the second head, and the second deposition characteristic is arranged disposed to improve the enhance fidelity of the an article being created to the be manufactured to a desired article.

A method according to [Claim 30]

The machine tool of claim 15 in which the second 1,

wherein the machine tool is disposed to perform a workpiece processing step comprising:

16. i) a step of using an additional head having a first deposition characteristic varies

one or more of the following parameters when compared to the first deposition: introduce a material

5 having a characteristic: of a first set; and

angle of deposition (relative to the build surface); type of material; mixture of materials being deposited; deposition rate; bead size; cross-sectional shape of deposition; energy input; nano/micro characteristic of material; colour and transparency of material; texture of the surface finish

10 17. — A method according to claim 15 or claim 16 in which the article is created in stages such that at least one of the first and second processing heads are used a plurality of times.

18. — A method according to any one of claims 15 to 17 in which a third processing head is used and arranged to remove material from the article.

15 19. — A method according to claim 15 wherein the machine tool further comprises a controller and the controller is arranged to control the first processing head to deposit material and is then arranged to select a second processing head dependent on the material deposited and the workpiece to be created.

20. — A method according to claim 19 wherein the controller uses data from the first or the second processing head to select a further processing head to be utilised.

20 21. — A method of creating an article comprising:
 1) using a first processing head, having a first deposition characteristic, to lay down material having a first set of properties;
 ii) a step of changing the first processing additional head for to a second

25 processing additional head-, and

2) wherein the second processing additional head is arranged disposed to
analyse/analyze at least one of the an article being created to be manufactured and a function of a
processing head.

A method [Claim 31]

30 The machine tool of creating claim 1,

wherein an article according to claim 21 discharge a fluid on an article under examination,

22. wherein the additional head or a second processing head is arranged
disposed to analyse be coupled to the article being created under examination through the fluid,
 5 and

23. ~~A method of creating an article according to claim 22 in which the second processing head is any one or more of the following: an image recording apparatus; lighting; touch-probes; 3D surface and volumetric scanners; photogrammetry systems, sensors (such as oxygen sensors; electromagnetic field sensors, thermal sensors; thermal cameras); spectrometers, etc.~~

24. ~~A method of creating an article according to claim 22 or 23 in which the second processing head is arranged to measure energy returned from the work piece from energy directed toward the work piece and preferably at least one of the energy source and a detector arranged to detect the returned energy is provided on at least one of the first and/or second processing heads or supply manifolds.~~

25. ~~A method of creating an article according to any one of claims 22 to 24 wherein the detector outputs data to a controller arranged to select a further processing head based on the output data from the detector.~~

26. ~~A method of creating an article according to any one of claims 15 to 25 in which at least one of the first and second processing heads is flushed of media.~~

27. ~~A method of creating an article according to claim 26 in which the or each processing head is flushed as part of the process for changing the first processing head for the second processing head.~~

28. ~~A method of creating an article according to claim 26 or 27 which is arranged to collect media flushed from the processing head.~~

29. ~~A method of creating an article according to any one of claims 15 to 28 which diverts media from a processing head to allow change of material that is processed.~~

30. — A method of creating an article according to any one of claims 15 to 29 which uses a material by pass circuit to collect media diverted from the processing head.

31. — A method of creating an article according to any one of claims 15 to 30 in which data tables for a machine tool holding the processing heads are re-purposed to allow the processing heads to be used.

32. — A method of inspecting an article being fabricated, the method comprising:

- i) — ejecting a fluid from a first processing head onto the article being inspected;
- ii) — coupling a second processing head via the fluid to the article being inspected; and
- iii) — transmitting wherein the machine tool is disposed to transmit a signal viathrough

the fluid in order to inspectexamine the article._

33. — A method according to claim 32 in which the first and second processing heads are the same head.

34. — A method according to claim 32 or 33 in which the fluid is a cooling fluid and preferably the cooling fluid is machine tool cutting fluid arranged to be used during a material-removal process.

35. — A method according to claim 33 in which the first and second processing heads are different and in which the first processing head is arranged to deposit a sacrificial material.

36. — A method according to any of claims 32 to 35 in which the second processing head is exchanged for the first processing head and coupled to the sacrificial material.

37. — A method according to claim 35 or 36 in which the sacrificial material is a polymer, gel, salt, plaster, ceramic, or includes high melt temperature ceramic or metal particles in a matrix.
A[Claim 32]

38. — The machine tool programmed to be used in a method outlined in any of claims 15 to 37.of claim 1,

39. — A machine tool according to any one of claims 1 to 14 or according to claim 38 wherein the tool changer is arranged to remove the first processing head from the machine tool, place the

first processing head in the storage location; remove a second processing head from the storage location and connect the second processing head to the machine tool.

40. — A machine tool according to claim 39 wherein the machine tool further comprises a supply unit arranged to supply or to be able to supply a power source to the or each processing head.

5 41. — A machine tool according to claims 38 to 40 wherein the or each processing head comprises a receiving docking manifold arranged to cooperate with a supply docking manifold on the machine tool.

10 42. — A machine tool according to claim 41 wherein the receiving docking manifold is arranged to be alongside or adjacent to the spindle and wherein the receiving docking manifold may be rotated into position

43. — A machine tool according to claim 41 wherein the receiving docking manifold is arranged to connect along an axis transverse to the spindle.

44. — A machine tool according to claim 41 wherein the receiving docking manifold may be arranged to connect along an axis parallel to the spindle.

15 45. — A machine tool according to claim 41 wherein the supply docking manifold is incorporated into the spindle column or spindle housing.

46. — A machine tool according to claims 44 or 45 wherein the docking manifolds are arranged to supply processing media to the processing head.

20 47. — A machine tool according to claims 38 to 46 wherein the processing media is one or more of:

metals, non-metals, polymers, ceramics, clay, salts, conductive, capacitive or dielectric materials, in powder form, filaments, rods, fibers (short, chopped, long, or continuous) sheets, or wires, in a suspension in one of a liquid, emulsion, gas, aerosol, paste, solid or semi-to fully liquid form or in cooling or processing fluids, gases and the like including mixtures thereof.

25 48. — A machine tool according to any one of claims 38 to 47 wherein the docking manifold is arranged to transfer data to and from the processing head.

49. — A machine tool according to any one of claims 38 to 48 wherein a controller is arranged to control the machine tool and the tool changer.

50. — A machine tool according to claim 49 wherein the controller is arranged to control the first processing head to deposit material and is then arranged to select a second processing head dependent on the material deposited and the work piece to be created wherein the controller preferably uses data from the first or the second processing head to select a further processing head to be utilised.

51. — A machine readable medium containing instructions which when read by a computer cause that computer to provide the method of any of claims 15 to 37.

52. — A processing head arranged to cant' out two processing steps simultaneously.

53. — A processing head according to claim 52 wherein the processes are selected from one of the combinations:

- applying heat and carrying out deposition;
- applying heat and applying pressure;
- applying heat and carrying out removal of material;

applying induction heating and wherein the machine tool is disposed to perform a workpiece processing step comprising:

- i) a step of using laser processing;
- deposition of material and inspection of deposited material;
- deposit material and move a work piece;
- move a work piece and carry out another process;
- processing of a work piece and inspection of the work piece;
- preparative processing and processing;
- processing and post processing treatment;
- use of multiple inspection means;
- use of an inspection means and an illumination means.

54. — A processing additional head according to claim 52 wherein the head is arranged to heat a work piece and to pressure treat a work piece simultaneously.

55. — A processing head according to claim 52 wherein the head is arranged to heat a work piece and apply discontinuous pressure treatment simultaneously.

56. — A processing head according to claim 52 or 53 wherein the head is arranged to deposit a first heated material and to co-extrude a second material with first material.

57. — A processing head according to claim 56 wherein the head further comprises a cutting means arranged to cut the second material.

58. — A processing head according to any one of claims 52-57 arranged to be connected to a machine tool having a work station, the processing head being connectable to the machine tool; the machine tool having a tool changer and a storage location being arranged to store a number of further processing heads.

59. — A machine tool according to anyone of claim 1 to 14 or 38 to 50 including a processing head in accordance with any one of claim 52 to 58.

60. — A method of creating an article comprising at least one of the following steps of processing a work piece comprising:

i) using a first processing head, which may have a first deposition characteristic to lay down introduce a material having a first set of properties;

ii) — processing the article being created by pressure treatment.

61. — A machine tool arranged to carry out the steps of processing a work piece comprising:

i) using a first processing head, which may have a first deposition characteristic to lay down material having a first set of properties; and

ii) a step of processing the article being created to be manufactured by pressure

treatment processing.

A

[Claim 33]

The machine tool according to claim 61-1,

62. wherein the pressure treatment is by means of impacting the deposited material

wherein the pressure treatment may be intermittent plurality of exchangeable heads comprise a processing head having a reservoir of a component which is usable to deposit on the workpiece.

A[Claim 34]

The machine tool according to any one of claims 61 or 62 claim 1,

63.—~~wherein the pressure treatment is by means plurality of peening such as by micro peening or needle peening or using rollers.~~

5 ~~A exchangeable heads comprise a processing head ~~for a~~ having an automation means configured to move the workpiece or a part of the workpiece.~~

[Claim 35]

64. ~~The machine tool arranged to apply pressure to at least a portion of a work piece created by additive manufacturing; of claim 1,~~

10 ~~65.——A processing head according to claim 64 wherein the head clean side comprises at least one of:~~

~~one or more rollers;~~

~~an an ay of rollers;~~

15 ~~notched rollers;~~

~~a pin;~~

~~an an ay of pins;~~

~~an an ay of pins that may be independently actuated;~~

~~a frame;~~

20 ~~a chisela chamber which is sealable and~~

~~a hammer.~~

66.—~~A processing head according to claim 65 wherein the head comprises an array of pins.~~

25 ~~67. A processing head according to any one of claims 64 or 66 wherein the pressure treatment is carried out by stores at least one second head therein when the use of mechanical movement generated and the movement may be generated by one of the following second head is not in the machine tool; in the processing head; or ultrasonically generated.use.~~

30 ~~68.—A processing head according to claim 67 wherein a force feedback mechanism is provided to apply a desired amount of pressure to the work pieces and wherein optionally the pressure applied is recorded and used in a metrology.~~

~~69. — A processing head for a machine tool the processing head comprising automated means adapted to be able to move a work piece or a portion of a work piece.~~

5 ~~70. — A processing head according to claim 69 wherein the automated means comprise pick and place grippers.~~

~~71. — A processing head according to claim 69 or 70 wherein the processing head further comprises magazine of components available for adding to the work piece.~~

10 ~~A processing head for a machine tool the processing head comprising a reservoir of components available for depositing on a work piece. [Claim 36]~~

The machine tool of claim 1,

wherein the work station is positioned between the clean side and the unclean side.

[Claim 37]

15 The machine tool of claim 14,

wherein the chamber of the work station is shaped to collect a waste material dropped from the workpiece while the second head is being used.

[Claim 38]

The machine tool of claim 37,

20 wherein the machine tool comprises a collection tray to collect a waste material dropped from the workpiece while the first head is being used.

[Claim 39]

The machine tool of claim 38,

72. wherein the collection tray is slidable in and out from the chamber of the work station.