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(54) Title: CAD/CAM PRODUCTION TOOL FABRICATION (57) Abstract A method of making a tool which is useful in the manufacture of articles, using computer aided modelling (CAM) apparatus and wherein a two-dimensional, or three-dimensional representation of the desired tool is converted by said apparatus into machine readable input data, said data is read into a memory of said apparatus, and subsequently interpreted by modelling apparatus which is a part of said CAM apparatus to form a model for the tool from a suitable material, characterised in that the said model for the tool is formed as a mould and the required tool is cast directly from said mould using a solid-forming, curable composition which exhibits substantial dimensional stability at temperatures up to 500 °C.		

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CAD/CAM PRODUCTION TOOL FABRICATION

This invention relates to methods of producing components, such as tools for mass production of articles, from materials by processes such as moulding, vacuum forming, casting, press forming and the like. It has principal application in CAD/CAM engineering i.e. computer aided design and computer aided modelling.

Production tools are used for volume product manufacture, i.e. mass production, for example press forming. It is well known to machine the tool, using relatively laborious and expensive processes, frequently from models generated by commercially available "CAD/CAM" systems. For example one such known "CAD/CAM" system is the MASTERCAM system sold by Unimatic. In the course of making a tool, information contained in an initial drawing is interpreted by the CAD/CAM system, specifically to produce a model (from associated hardware) in a relatively soft material such as wood or plastics. Because production tools should have specific physical properties, such as desirable values of hardness and/or temperature resistance, they are usually made from a quite different material than the soft material of the model. It is the process of transferring the features of the model to the tool, which is generally

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the most laborious and expensive part of the tool production process.

We have now surprisingly found that models obtainable by the aforementioned commercially available CAD/CAM systems, when fabricated as moulds from suitable materials, can serve as a direct mould to form the desired production tool, from a large range of materials. The main advantage is that previous machining steps employed in the fabrication of mass production tools, can be eliminated with consequent reduction in labour and material costs.

According to this invention there is provided a method of making a tool which is useful in the manufacture of articles, using computer aided modelling (CAM) apparatus and wherein a two-dimensional, or three-dimensional representation of the desired tool is converted by said apparatus into machine readable input data, said data is read into a memory of said apparatus, and subsequently interpreted by modelling apparatus which is a part of said CAM apparatus to form a model for the tool from a suitable material, characterised in that the said model for the tool is formed as a mould and the required tool is cast directly from said mould using a solid-forming, curable composition which exhibits substantial dimensional stability at temperatures up to 500°C.

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Preferred, optional features of the invention can be found in the sub claims.

The present invention also provides in preferred embodiments, methods of producing a component tool of the kind described, from a preliminary model, comprising casting the tool directly from the model using said model as a mould for the tool, preferably from an inorganic resin of the silico-aluminate type.

Preferably, the resin has a silicon : aluminium atomic ratio of 1.

Such a material can be cured at room temperature (25 to 50°C) and once cured, can be used in a wide variety of processes (such as injection moulding, vacuum forming, casting of various types, or press forming) at temperatures of up to 500°C or even up to 600°C and is dimensionally very stable.

In order that the invention may be illustrated, more easily understood and readily carried into effect by the notional skilled worker, an embodiment thereof will now be described with reference to the accompanying schematic flow diagram, purely by way of non-limiting example.

As shown in the accompanying figure, the component drawing 2 of a dish-like production tool in aluminium is translated into machine readable input data form at 4, to be

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applied to a CAD/CAM machine 6. The CAD/CAM machine used was the commercially available MASTERCAM apparatus, supplied by a company called Unimatic. Other known CAD/CAM apparatus could be used depending upon economics and other requirements. Such apparatus includes the necessary computer software for converting a two-dimensional drawing into machine readable input data, means to store such data such as machine readable data carriers (floppy discs for example), and means to interpret the data to drive modelling hardware. It is possible that CAM apparatus could be adapted to convert a three dimensional representation of the required production tool, and the present invention includes such within its scope.

The machine interprets the drawing information, in a known fashion, to control modelling apparatus which produces a solid component model 8 in the form of a mould, from which the required production tool can be directly cast.

A production tool is then cast from this model, as indicated at 10 in the form of a dish, using a silico-aluminate inorganic resin, having a silicon : aluminium atomic ratio of 1. We have found that an alkaline composition containing sodium hydroxide and fluoro-sodium poly(sialate-disilix) works well, cures quickly and is

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dimensionally very stable even at 600°C. The tool is cured at room temperature (25 to 50°C), and then becomes sufficiently hard and temperature resistant, to be used as the actual production tool in a large range of manufacturing processes, using a wide variety of materials to manufacture the desired article from this moulded tool. As indicated in the drawing, the materials from which articles can be mass produced using tools obtained by the present invention include, plastics, glass, metals of various kinds and in particular aluminium and alloys thereof; ceramics, or even articles of concrete.

Since the tool cast from such material using the mould is dimensionally stable at temperatures of up to 600°C, it can be used in place of the conventional tool for a wide variety of manufacturing processes in which the material is required to take the form of the tool, such as injection moulding, vacuum forming, aluminium casting, aluminium super plastic forming, cold casting, squeeze casting, or press forming, as appropriate to the article being mass produced from the tool.

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CLAIMS

1. A method of making a tool which is useful in the manufacture of articles, using computer aided modelling (CAM) apparatus and wherein a two-dimensional, or three-dimensional representation of the desired tool is converted by said apparatus into machine readable input data, said data is read into a memory of said apparatus, and subsequently interpreted by modelling apparatus which is a part of said CAM apparatus to form a model for the tool from a suitable material, characterised in that the said model for the tool is formed as a mould and the required tool is cast directly from said mould using a solid-forming, curable composition which exhibits substantial dimensional stability at temperatures up to 500°C.
2. A method as claimed in claim 1 wherein the curable composition comprises inorganic resin, capable of hardening in the region of ambient temperature.
3. A method as claimed in claim 2 wherein the curable composition comprises a silico-aluminate composition.
4. A method as claimed in claim 3 wherein the silico-

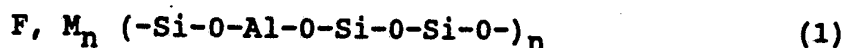
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aluminate further comprises fluorine and an alkali metal or alkaline earth metal, as part of its molecular structure.

5. A method as claimed in claim 4 wherein the metal comprises one or more of the following: calcium, potassium and sodium.

6. A method as claimed in claim 3 or 4, wherein the curable composition is alkaline, and comprises a strong base such as potassium and/or sodium hydroxide.

7. A method as claimed in any preceding claim wherein the curable composition includes a substantial proportion of silico-aluminate inorganic resin which is defined by the following formula (1):



wherein:

F represents fluorine

M represents an alkali metal or alkaline earth metal,

Si represents silicon,

Al represents aluminium,

O represents oxygen, and

n is an integer

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8. A method as claimed in claim 7 wherein the Si:Al atomic ratio is 1:1 to 1:3.

9. A method as claimed in claim 8 wherein the curable composition comprises alkaline fluoro-sodium poly(sialate-disiloxo) and/or fluoro-potassium poly(sialate-disiloxo) and/or fluoro-calcium poly(sialate disiloxo).

10. A method as claimed in any preceding claim utilising computer aided modelling apparatus which is known per se.

11. A tool cast from a mould when produced by a method as claimed in any preceding claim.

12. A mass production process which involves use of a tool as claimed in claim 11.

13. A process as claimed in claim 12 which is a process from one of the following mass production processes:

injection moulding, vacuum forming, aluminium or aluminium alloy casting, aluminium or aluminium alloy forming, casting or press-forming.

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14. A process as claimed in claim 13 utilising a material from one of the following materials to produce articles made of such material; plastics, glass, metal, ceramic or concrete.

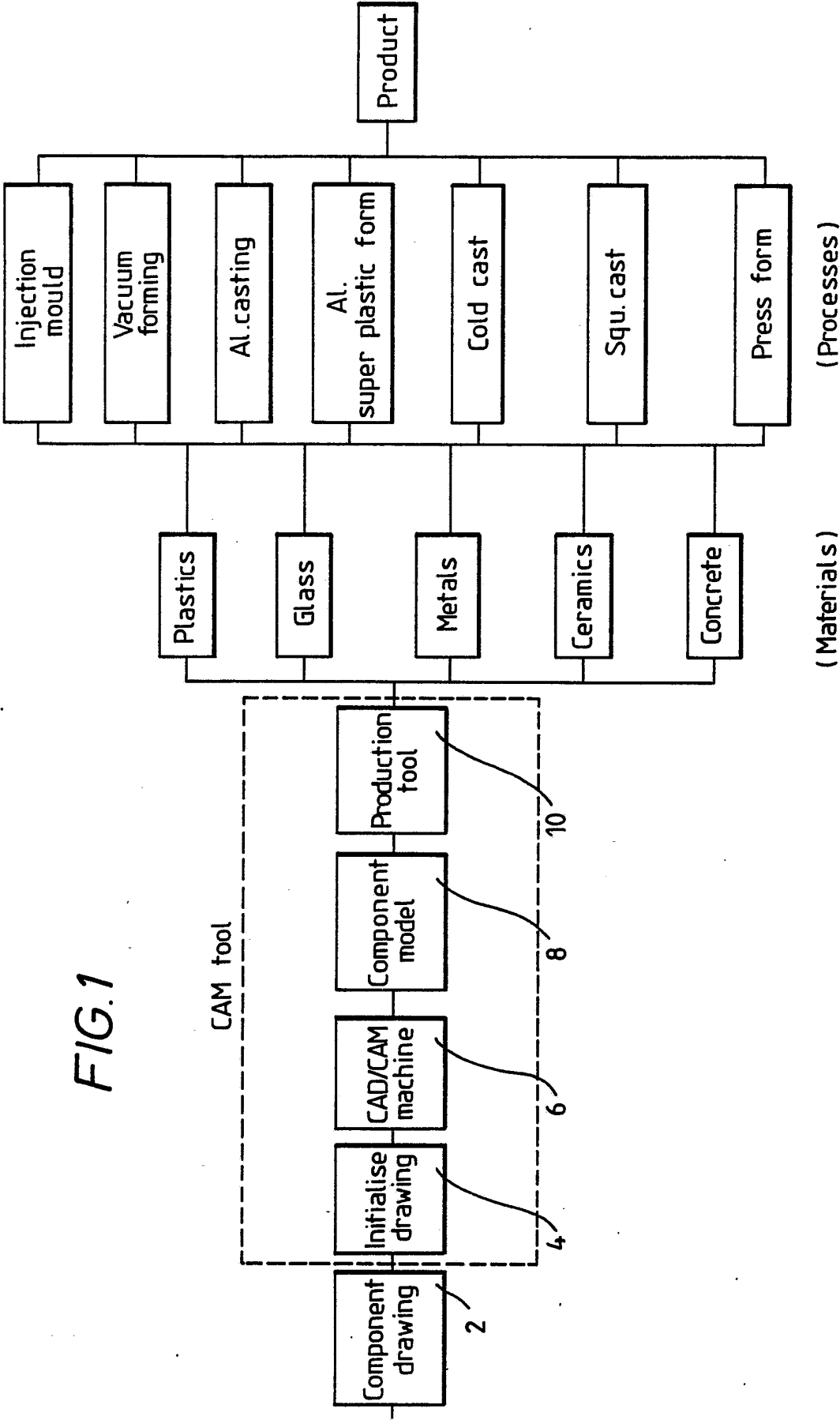


FIG.1