(12) UK Patent Application (19) GB (11) 2 254 820 (13) A

(43) Date of A publication **21.10.1992**

(21) Application No **9108089.5**

(22) Date of filing **16.04.1991**

(71) Applicant
British Aerospace Public Limited Company

(Incorporated in the United Kingdom)

11 The Strand, London, WC2N 5JT, United Kingdom

(72) Inventors
Derrick James Booth
Robert Stevens

(74) Agent and/or Address for Service
Susan Patricia Potts
British Aerospace Public Limited Company,
PO Box 87, Corporate Intellectual Property Dept,
Park East, Farnborough Aerospace Centre,
Farnborough, Hants, GU14 6YU, United Kingdom

(51) INT CL[5]
B29C 33/40

(52) UK CL (Edition K)
B5A ANX A1R214B A1R214G A1R314C2S
A1R314C2X A1R314C5 A1R314C6 A1R413 A1R422
A1R442 A2E12A A2E12B A20T9

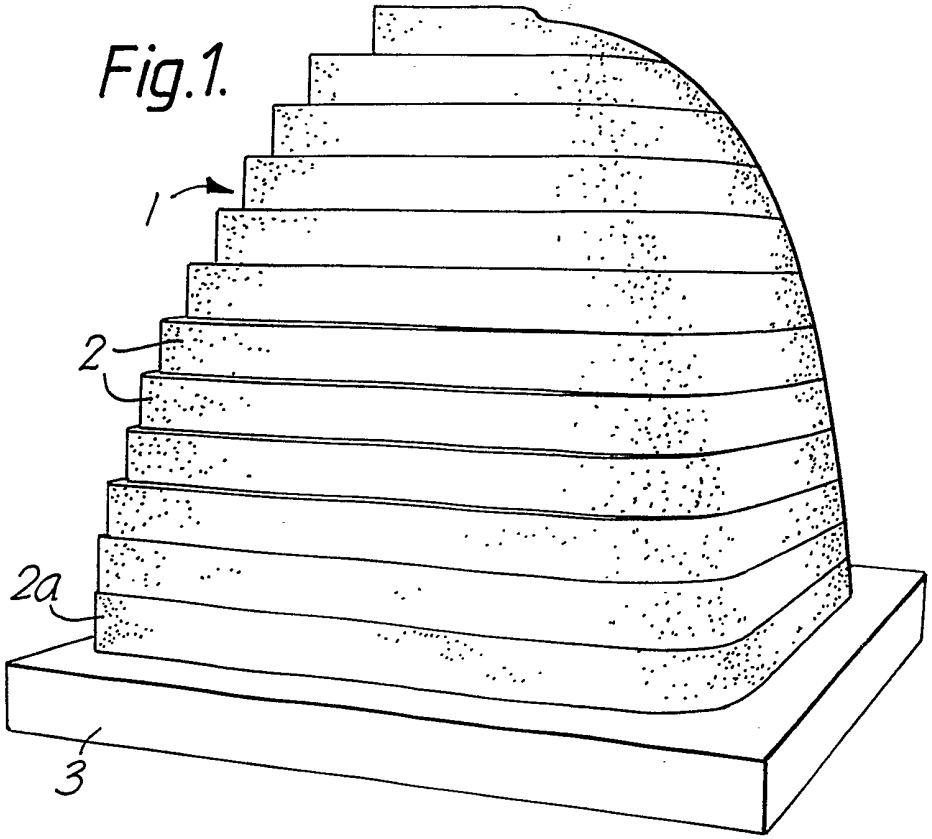
(56) Documents cited
GB 2105251 A **GB 1441334 A** **GB 1436808 A**
GB 1328958 A **GB 1287513 A** **GB 0980754 A**
GB 0828518 A **WO 85/02143 A**

(58) Field of search
UK CL (Edition K) **B5A AA1 AA2 AA3 ALX AL2**
ANC ANX
INT CL[5] **B29C**

(54) Tooling for composite component manufacture

(57) A body of a mould tool which is machined from a laminar assembly of adhered structural foam slabs (2) on an aluminium base (3), has good mechanical stability under conditions of varying pressure and temperature and is particularly suitable for use in the autaclave curing of articles moulded on the tool from composites. The moulding surface of the tool is provided either by a coating of filled epoxy, or of a polyester blanket wetted with adhesive, which may be machined, sanded and then painted or gell coated and polished, to produce a smooth moulding surface.

Fig.1.



At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

GB 2 254 820 A

Fig.1.

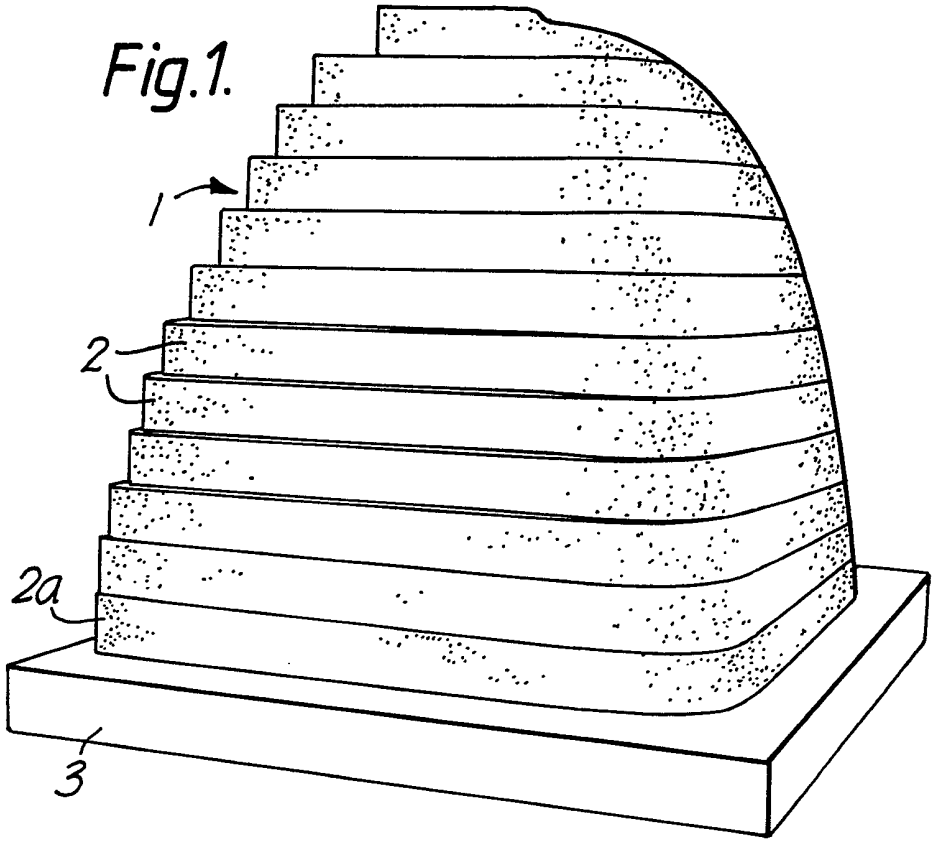
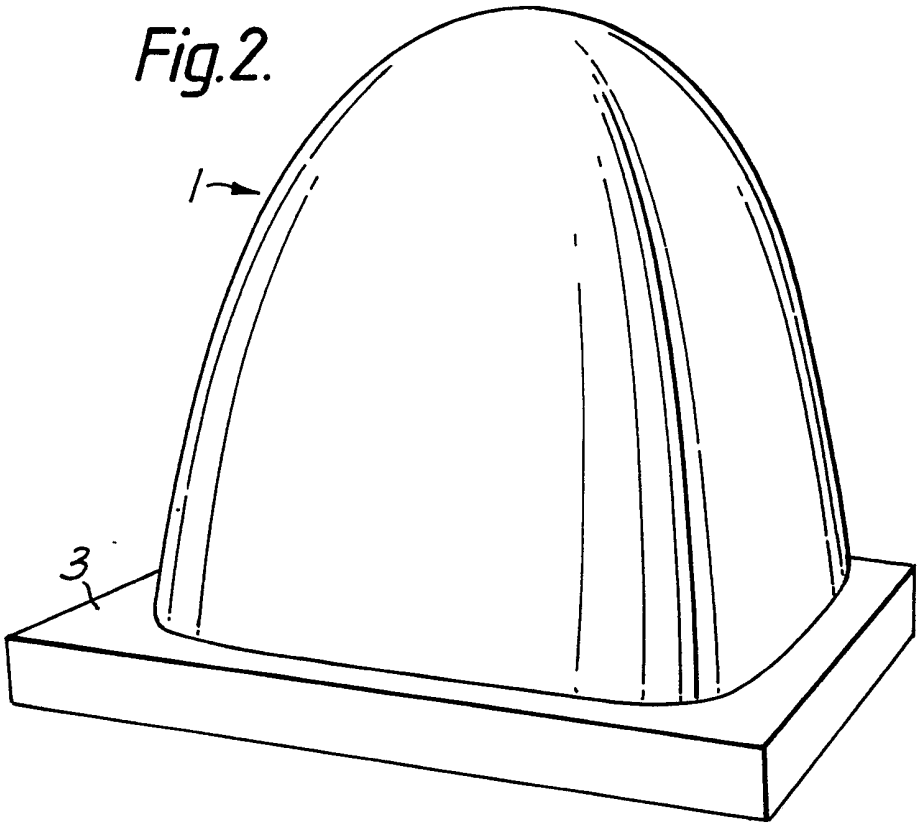


Fig.2.



TOOLING FOR COMPOSITE COMPONENT MANUFACTURE

This invention relates to tooling for the manufacture of articles from composite materials such as, for example, carbon fibre composites.

A conventional method of manufacturing articles from composite material involves laying up layers of composite material, such as carbon cloth impregnated with resin, in a metal mould tool to a desired thickness. The article is then cured under pressure in an autoclave and the finished article removed from the mould. One problem with this method, however, results from the difference in coefficient of thermal expansion (CTE) between the metal mould tool and the composite material. This difference results in a relative movement between the mould tool and the composite article being formed during the heating and cooling cycle which spoils the surface of the article.

Other materials have also been proposed for use as mould tools, e.g. wood and micarta. However, these materials are difficult to machine to a high quality finish. A further disadvantage is their lack of mechanical stability under conditions of varying and/or high temperatures.

The present invention aims to provide a mould tool which suffers from none of the aforementioned disadvantages.

A mould tool according to the invention and suitable for use in the manufacture of articles from composite materials is made from structural foam.

Structural foam of the type known as Rohacell (Trade Name) has been found to exhibit the desired mechanical stability in use and to be capable of withstanding 100 psi pressure.

The foam has the further advantage of being easy to machine. Female or male moulds can readily be machined from this material.

A smooth surface finish can be achieved by coating the machined foam with an epoxy-based filler, sanding down, then painting. This method is preferred for ambient temperature cures.

Alternatively, a smooth surface finish can be achieved by overlaying the surface of the foam with a "wetted out" polyester blanket, which is cured, machined if necessary and then painted with a gelcoat. This method is preferred if the mould tool is to be used for high-temperature curing operations.

Some embodiments of the invention will now be described, by way of example only, with reference to the drawings, of which:

Fig. 1 is a side view of a mould tool in accordance with the invention at an intermediate stage of its fabrication; and

Fig. 2 is a view of the final, finished mould of Fig. 1.

Structural foam is presently commercially available in

slabs of several mm thickness and moulds can be made by building up the desired shape from several slabs.

Fig. 1 shows a mould tool 1 built up from several slabs 2 of structural foam. The base of the mould 2a is bonded to an aluminium block 3. An adhesive suitable for bonding foam slabs together is BSL 319 (Trade Name) film adhesive. Care should be taken to ensure that adhesive does not intrude into any area which is to be machined. An adhesive FM 96 (Trade Name) has been found to be suitable for bonding the foam to aluminium.

To build the mould tool of Fig. 1 firstly the base 2a is bonded to the aluminium block 3 and the FM 96 adhesive allowed to cure on a Platten press at 175^{o} for one hour.

The remaining foam blocks 2 are then built up to the required height using the BSL 319 adhesive. The assembly is then bagged up, evacuated and placed in an autoclave for 1 hour at $175^{o}C$.

The curing process has been found to enhance the foam's mechanical stability.

The cured assembly is then machined to the desired size. Ball-ended cutters can be used for this task.

Open cells left in the foam by the machining process are filled with an epoxy-based filler. The surface is sanded down and then painted. The paint can be further cut back to give a good surface finish.

The mould produced by the above method will withstand

vacuum and autoclave pressure. It can be used as a master mould on which could be cured, for example, a composite mould or composite components cured at ambient temperature or at up to 60°C using currently available epoxy fillers and paints.

The finished mould is shown in Fig. 2. In this example the mould is to be used for making a nose-cone from composite materials.

In an alternative method of fabricating a mould tool in accordance with the invention, the mould is fabricated from slabs of Rohacell foam on an aluminium base as previously described but a different surface finish technique is employed.

After curing the BSL 319 adhesive, the mould tool is machined to a few mm under size. Next, a polyester blanket wetted-out with adhesive is laid over the surface of the mould. A suitable adhesive is TMR 2500 (Trade Name) obtainable from Airtech. The assembly is then cured in a vacuum inside an autoclave.

After curing, the surface of the polyester is machined and sanded down if necessary to give a reasonably smooth surface finish. Next is applied a gelcoat (such as gelcoat TMR 2000) which is cured and polished to give the final smooth finish to the surface of the mould tool.

The mould tool produced by this second, alternative method will withstand vacuum and autoclave pressure and,

using a high temperature-resistant gelcoat, temperatures up to 200^{o}C.

It has been found that the polyester blanket can be machined easily and that a good surface finish can be obtained.

This alternative mould tool can also be used in the manufacture of composite moulds or components.

CLAIMS

1. A mould tool for use in the manufacture of articles from composite materials which is made from structural foam.

2. A mould tool according to claim 1 in which the surface of the tool is treated with epoxy-based filler.

3. A mould tool according to claim 1 in which the surface of the tool is composed of a polyester blanket wetted-out with adhesive.

4. A method of manufacturing a mould tool for use in the manufacture of articles from composite materials comprising the steps of:

machining structural foam to a desired shape;

coating a surface of the foam with epoxy-based filler;

sanding down the filler and painting.

5. A method of manufacturing a mould tool for use in the manufacture of articles from composite materials comprising the steps of machining structural foam to a desired shape;

laying over a surface of the foam a polyester blanket wetted-out with adhesive;

curing;

machining the polyester blanket to produce a smooth surface;

and painting.

6. A mould tool substantially as hereinbefore described with reference to the drawings.

7. A method of manufacturing a mould tool substantially as hereinbefore described with reference to the drawings.

Patents Act 1977
Examiner's report to the Comptroller under Section 17 (The Search Report)

Application number 9108089.5

Relevant Technical fields

(i) UK Cl (Edition K) B5A: ANX;ANC;ALX;AL2;AA1;AA2; AA3

(ii) Int Cl (Edition 5) B29C

Search Examiner

A J M TAJASQUE

Databases (see over)

(i) UK Patent Office

(ii)

Date of Search

10.7.91

Documents considered relevant following a search in respect of claims 1-7

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
X	GB A 2,105,251 (NEW PRESS TOOLS) see figure; page 1, lines 9-23, and 108-115	1, at least
X	GB A 1,441,334 (K R STEINSVIK) page 1, lines 51-61; page 2, lines 38-45	"
X	GB A 1,436,808 (SWECO INC) page 2, lines 50-64; page 3, line 124 - page 4 line 52	"
Y	GB A 1,328,958 (BAYER) page 1, lines 11-20, and 48-76; page 2 lines 23-27	"
X	GB A 1,287,513 (B.A.S.F.) page 3, lines 15-46; page 5, lines 13-39; page 6, lines 81-90	"
	GB A 0,980,754 (ICI) page 1 lines 64-86	Claim 1, at least
Y	GB A 0,828,518 (GEOGRAPHICAL PROJECTS) figures 2, and 3	Claim 4
X	WO A 85/02143 (DUPRE-RISEN) page 1, lines 1-5 and 27-29; page 4, lines 18-21	Claim 1 at least

Category	Identity of document and relevant passages	Relevant to claim(s)

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family, corresponding document.

Databases: The UK Patent Office database comprises classified collections of GB, EP, WO and US patent specifications as outlined periodically in the Official Journal (Patents). The on-line databases considered for search are also listed periodically in the Official Journal (Patents).

Published 1992 at The Patent Office, Concept House, Cardiff Road, Newport, Gwent NP9 1RH. Further copies may be obtained from Sales Branch, Unit 6, Nine Mile Point, Cwmfelinfach, Cross Keys, Newport, NP1 7HZ. Printed by Multiplex techniques ltd, St Mary Cray, Kent.