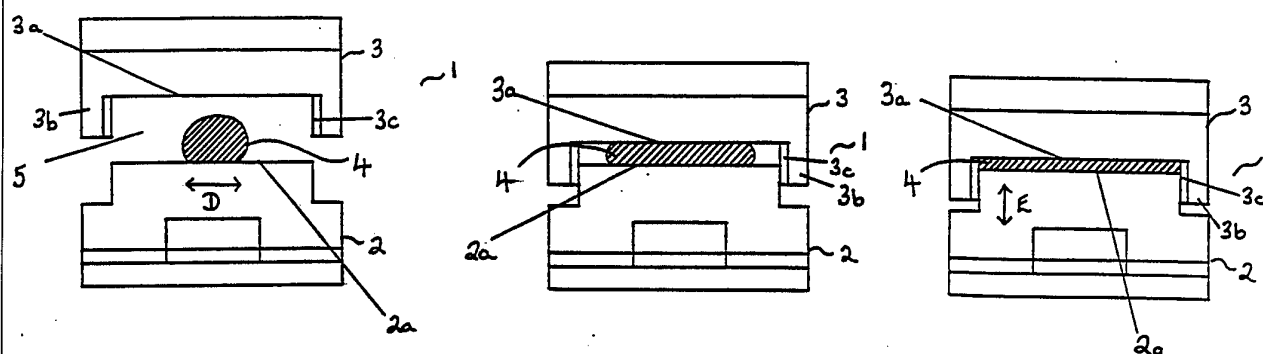




INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 5 : B29C 43/52, B28B 1/08	A1	(11) International Publication Number: WO 94/04335 (43) International Publication Date: 3 March 1994 (03.03.94)
(21) International Application Number: PCT/GB93/01684 (22) International Filing Date: 9 August 1993 (09.08.93) (30) Priority data: 9216968.9 11 August 1992 (11.08.92) GB 9306324.6 26 March 1993 (26.03.93) GB (71)(72) Applicant and Inventor: GRIBBLE, Meirion [GB/GB]; 14, Tan-Y-Bryn, Brynna, Pontyclun, Mid Glamorgan (GB). (74) Agent: AUSTIN, Hedley, William; Urquhart-Dykes & Lord, Alexandra House, 1 Alexandra Road, Swansea, West Glamorgan SA1 5ED (GB).		(81) Designated States: AT, AU, BB, BG, BR, CA, CH, CZ, DE, DK, ES, FI, GB, HU, JP, KP, KR, KZ, LK, LU, MG, MN, MW, NL, NO, NZ, PL, PT, RO, RU, SD, SE, SK, UA, US, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG). Published <i>With international search report.</i> <i>Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i>

(54) Title: METHOD OF VIBRATION-MOULDING AND AN APPARATUS FOR CARRYING OUT THE MOULDING



(57) Abstract

A method of compression moulding which comprises providing moulding apparatus including first and second moulding surfaces defining a moulding cavity. At least one moulding surface is movable such that the surfaces are arrangeable at relatively distal and proximal positions with respect to each other. A curable material to be moulded is arranged in the moulding cavity and at least one surface is advanced from the distal to the proximal position. One or more moulding surface is vibrated during closure of the moulding cavity, so as to urge non-cured material into contact with substantially the entire of the moulding surfaces.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	FR	France	MR	Mauritania
AU	Australia	GA	Gabon	MW	Malawi
BB	Barbados	GB	United Kingdom	NE	Niger
BE	Belgium	GN	Guinea	NL	Netherlands
BF	Burkina Faso	GR	Greece	NO	Norway
BG	Bulgaria	HU	Hungary	NZ	New Zealand
BJ	Benin	IE	Ireland	PL	Poland
BR	Brazil	IT	Italy	PT	Portugal
BY	Belarus	JP	Japan	RO	Romania
CA	Canada	KP	Democratic People's Republic of Korea	RU	Russian Federation
CF	Central African Republic	KR	Republic of Korea	SD	Sudan
CG	Congo	KZ	Kazakhstan	SE	Sweden
CH	Switzerland	LI	Liechtenstein	SI	Slovenia
CI	Côte d'Ivoire	LK	Sri Lanka	SK	Slovak Republic
CM	Cameroon	LU	Luxembourg	SN	Senegal
CN	China	LV	Latvia	TD	Chad
CS	Czechoslovakia	MC	Monaco	TG	Togo
CZ	Czech Republic	MG	Madagascar	UA	Ukraine
DE	Germany	ML	Mali	US	United States of America
DK	Denmark	MN	Mongolia	UZ	Uzbekistan
ES	Spain			VN	Viet Nam
FI	Finland				

METHOD OF VIBRATION-MOULDING AND AN
APPARATUS FOR CARRYING OUT THE MOULDING

The present invention is concerned with moulding, and in particular a moulding technique which assists filling of a mould cavity with a mould material.

It is desirable during moulding processes to urge a mould material into the extremities of a mould cavity, so as to produce a moulded article replicating the contours and detail of the cavity. It is however often difficult to achieve the above, particularly so when a viscous thermosetting material commences curing during introduction into the cavity.

We have now developed a moulding process and apparatus which help to alleviate the above problem.

According to the present invention there is provided a method of compression moulding which comprises:

- (a) providing moulding apparatus comprising at least first and second moulding surfaces defining a moulding cavity, at least one surface being movable such that said surfaces are arrangeable at relatively distal and proximal positions with respect to each other;
- (b) arranging a curable material to be moulded in said cavity; and
- (c) advancing said at least one movable surface from said distal to said proximal position, and concurrently vibrating one or more of said moulding surfaces so as to urge non-cured material into contact with substantially the entire of said moulding surfaces.

In addition to promoting filling of the moulding cavity with the thermosetting material, vibration of the moulding surface or surfaces substantially as hereinbefore described is advantageous for reducing the force required to close the cavity.

It is preferred that the moulding cavity is defined by opposed first and second surfaces, and the surfaces may be respectively vibrated in opposed directions. The vibration is preferably such as to effect substantially complete filling of the cavity with the mould material.

The vibration may involve transverse vibration of at least one moulding surface, so as to urge the thermosetting material to substantially fill the moulding cavity. The vibration may further comprise vibration of the opposed moulding surfaces between relatively proximal and distal arrangements, so as to assist compacting of the material between the surfaces.

The transverse vibration of a moulding surface may involve transverse motion in more than one direction. Typically the transverse vibration may involve substantially orthogonal vibratory motion of at least one surface.

It is preferred that the material to be moulded comprises a thermosetting resin or plastics material.

The resin or plastics material may be optionally mixed with fillers and fibre reinforcement. The thermosetting resin or plastics material may preferably be mixed with an initiator or catalyst for enhancing curing of the material.

A preferred thermosetting material comprises a polyester resin mixed with slate dust and glass fibre reinforcement, together with a curing initiator. The material may further include additional ingredients such as crushed limestone and a lubricant such as stearate.

The method may typically comprise a premixing stage, wherein the thermosetting resin or plastics material is admixed with the above preferred ingredients, prior to arrangement within the moulding cavity.

The moulding process may be part of a substantially continuous compression moulding system, wherein a plurality of such processes are operated on a production line type method. In a preferred embodiment, moulding apparatus providing one or more cavities suitable for carrying out a process according to the present invention are arranged on a conveyor belt or the like, so that a plurality of moulding processes can be simultaneously operated.

There is still further provided by the present invention apparatus suitable for carrying out a moulding process substantially as hereinbefore described, which apparatus comprises:

- (a) one or more moulding cavities each defined by at least first and second moulding surfaces;

- (b) means for moving at least one moulding surface, such that said surfaces are arrangeable at relatively distal and proximal positions with respect to each other; and
- (c) means for vibrating one or more of said surfaces during advancement of said at least one movable surface from said distal position to said proximal position, whereby a curable material to be moulded present in said cavity is urged into contact with substantially the entire of said moulding surfaces before said material is fully cured.

In a preferred embodiment, the apparatus comprises a plurality of moulding cavities, such that the apparatus is suitable to be employed in a substantially continuous compression moulding system as hereinbefore described. Typically, the moulding cavities are arranged on a conveyor belt or similar transfer surface as hereinbefore described.

The vibrating means are advantageously capable of vibrating the moulding surface in a substantially controlled fashion as described above.

There is further provided by the present invention a moulded article obtained by a moulding process substantially as hereinbefore described.

In a particularly preferred embodiment of the present invention, the moulded article comprises a roofing tile. In the case where the thermosetting material comprises a slate filler, the moulded article may preferably comprise a roofing tile having the appearance of natural slate, particularly when the moulding surface has a surface relief corresponding to that of natural slate.

According to this preferred embodiment of the present invention, at least one moulding surface of the moulding apparatus hereinbefore described bears a complementary impression of natural slate.

The present invention will now be further illustrated, by way of example only by reference to the accompanying drawing, which does not limit the scope of the invention in any way. The drawing is a schematic representation of apparatus according to the present invention suitable for use in compression moulding, and illustrates different stages during the moulding process.

There is shown a mould generally designated 1 comprising mould halves 2,3. The arrangement of mould 1 at progressive stages A,B,C of a compression moulding method is illustrated.

A thermosetting material 4 is located in a mould cavity 5 between facing surfaces 2a,3a of halves 2,3. Mould surfaces 2a,3a are maintained at about 120°C, for effecting curing of material 4.

Material 4 has been subjected to a pre-mixing stage, and weighed out as a batch of pre-determined weight prior to arrangement in cavity 5 as shown in stage A. In stage A, mould halves 2,3 are disposed in a distal arrangement for ease of insertion of material 4 into cavity 5.

Surfaces 2a,3a respectively comprise complementarily profiled raised and recessed formations. Side walls 3b are provided with a resilient surfacing 3c, such that on coupling of the mould surfaces damage to mould half 3 is reduced.

As shown in stage B, mould half 2 is advanced towards mould half 3 so as to compress material 4 between surfaces 2a,3a. During advance of mould half 2, the latter is vibrated in a substantially horizontal direction as shown by arrow D. This vibration urges filling of cavity 5 with material 4. Resilient surfacing 3c is also advantageous in absorbing the above described vibration of mould half 2.

During the latter stages of closure of mould 1, as shown in stage C, mould half 2 is also vibrated in a vertical direction as shown by arrow E, so as to aid compacting of material 4 between surfaces 2a,3a.

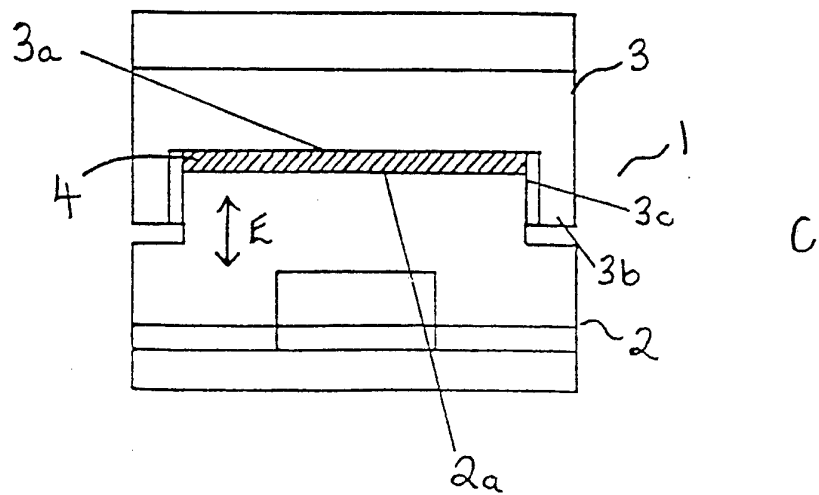
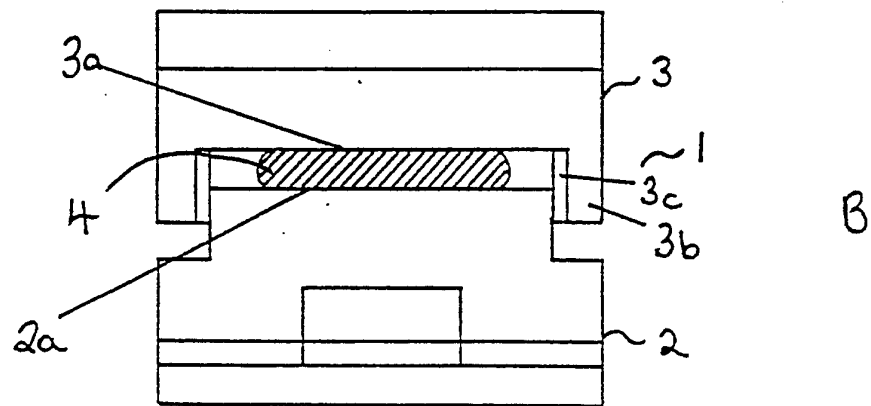
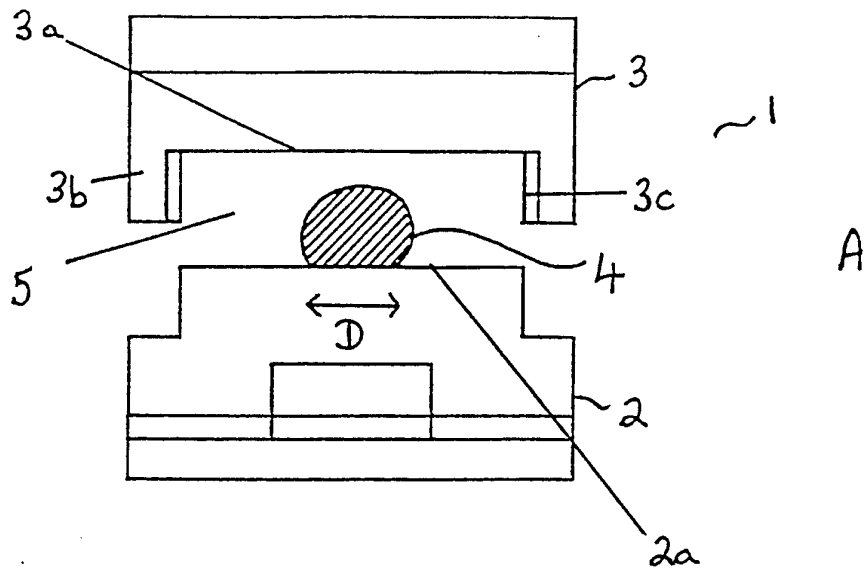
Mould 1 is clamped shut and surfaces 2a,3a heated until curing of thermosetting material 4 is complete and the moulded article is sufficiently rigid for removal from cavity 5.

Claims:

1. A method of compression moulding which comprises:
 - (a) providing moulding apparatus comprising at least first and second moulding surfaces defining a moulding cavity, at least one surface being movable such that said surfaces are arrangeable at relatively distal and proximal positions with respect to each other;
 - (b) arranging a curable material to be moulded in said cavity; and
 - (c) advancing said at least one movable surface from said distal to said proximal position, and concurrently vibrating one or more of said moulding surfaces so as to urge non-cured material into contact with substantially the entire of said moulding surfaces.
2. A method according to claim 1, wherein said surfaces are respectively vibrated in opposed directions.
3. A method according to claim 1 or 2, wherein said vibration involves transverse vibration of at least one moulding surface.
4. A method according to claim 3, wherein said transverse vibration of said at least one moulding surface involves transverse motion in more than one direction.
5. A method according to claim 4, wherein said transverse vibration involves substantially orthogonal vibratory motion of at least one surface.
6. A method according to any of claims 1 to 5, wherein said vibration further comprises vibration of the opposed moulding surfaces between relatively proximal and distal arrangements, so as to assist compacting of the material between the surfaces.
7. A method according to any of claims 1 to 6, wherein the curable material comprises a thermosetting resin or plastics material.
8. A method according to claim 7, wherein the resin or plastics material includes fillers and fibre reinforcement.

9. A method according to claim 7 or 8, wherein the thermosetting resin or plastics material includes a curing initiator or catalyst.
10. Apparatus for carrying out a compression moulding process, which apparatus comprises:
 - (a) one or more moulding cavities each defined by at least first and second moulding surfaces;
 - (b) means for moving at least one moulding surface, such that said surfaces are arrangeable at relatively distal and proximal positions with respect to each other; and
 - (c) means for vibrating one or more of said surfaces during advancement of said at least one movable surface from said distal position whereby a curable material to be moulded present in said cavity is urged into contact with substantially the entire of said moulding surfaces before said material is fully cured.
11. Apparatus according to claim 10, which comprises a plurality of said moulding cavities.
12. Apparatus according to claim 10 or 11, wherein said vibrating means are capable of respectively vibrating said moulding surfaces in opposed directions.
13. Apparatus according to any of claims 10 to 12, wherein said vibrating means are capable of transversely vibrating at least one moulding surface.
14. Apparatus according to claim 13, wherein said transverse vibration of said at least one moulding surface involves transverse motion in more than one direction.
15. Apparatus according to claim 14, wherein the transverse vibration involves substantially orthogonal vibratory motion of at least one surface.
16. Apparatus according to any of claims 10 to 15, wherein said vibrating means are capable of vibrating opposed moulding surfaces between relatively distal and proximal arrangements, so as to assist compacting of the material between the surfaces.
17. Apparatus according to any of claims 10 to 16, wherein at least one moulding surface bears a complementary impression of natural slate.

FIGURE 1 1/1



INTERNATIONAL SEARCH REPORT

International application No.

PCT/GB 93/01684

A. CLASSIFICATION OF SUBJECT MATTER

IPC5: B29C 43/52, B28B 1/08

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC5: B29C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US, A, 3123857 (W.A. WACKER), 10 March 1964 (10.03.64), column 1, line 55 - column 3, line 30, figures 1,2, claims 1-6	1-7,10-16
Y	--	8,9,17
Y	US, A, 3994660 (RAVET), 30 November 1976 (30.11.76), figures 1-3, claim 1, abstract	3-5,13-15
A	--	1-2,6-12, 16-17

☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

30 November 1993

Date of mailing of the international search report

19. 01. 94

Name and mailing address of the International Searching Authority



European Patent Office, P.B. 5818 Patendaan 2
NL-2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax (+31-70) 340-3016

Authorized officer

Kristina Sköld

INTERNATIONAL SEARCH REPORT

International application No.

PCT/GB 93/01684

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,X	US, A, 5182061 (YASUDA ET AL), 26 January 1993 (26.01.93), column 3, line 35 - column 4, line 26, claims 1,7,9	1-2,6,10,12
P,Y		3-5,7-8,9, 13-17
P,A		11
	--	
Y	Derwent's abstract, No 88- 60334/09, week 8809, ABSTRACT OF JP, A, 63015712 (INAX KK), 22 January 1988 (22.01.88)	8-9,17
	--	
Y	GB, A, 2224283 (ROBERTO DALLA VALLE), 2 May 1990 (02.05.90), claims 1-16, abstract	8-9,17
	--	
Y	Derwent's abstract, No 91-322160/44, week 9144, ABSTRACT OF JP, A, 3216298 (IDEMITSU KOSAN CO LTD; SEIDENSHA DENSHI), 24 Sept 1991 (24.09.91)	8
A		1-7,9-17
	--	
A	Derwent's abstract, No 85-266385/43, week 8543, ABSTRACT OF JP, A, 60178003 (TOTO KK), 12 Sept 1985 (12.09.85)	3-5,13-15
	--	
A	Derwent's abstract, No 89- 2639/01, week 8901, ABSTRACT OF JP, A, 63278810 (NIPPON STEEL CORP; NAKAJIMA ENG), 16 November 1988 (16.11.88)	3-5,13-15
	-- -----	

INTERNATIONAL SEARCH REPORT
Information on patent family members

16/10/93

International application No.

PCT/GB 93/01684

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
US-A-	3123857	10/03/64	NONE		
US-A-	3994660	30/11/76	AT-B-	343034	10/05/78
			CH-A-	583597	14/01/77
			FR-A,B-	2263051	03/10/75
US-A-	5182061	26/01/93	DE-A-	4123723	23/01/92
			GB-A-	2246095	22/01/92
GB-A-	2224283	02/05/90	NONE		