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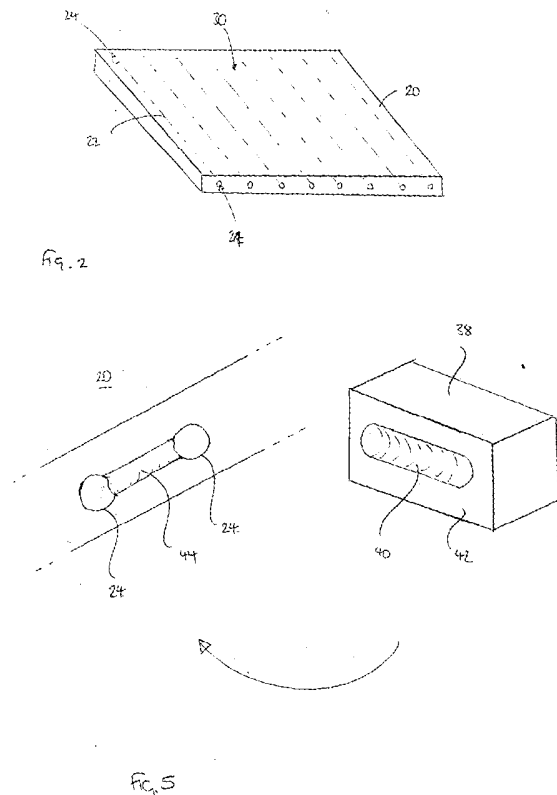
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(54) Title of the Invention: **Process for forming a mould**
Abstract Title: **Process for forming heating/cooling channels in a mould**

(57) A process for creating a mould comprises providing a solid body 20 having at least one surface 30 which defines a moulding surface against which an item is to be moulded in use, and forming at least two bores 22 through the body. The bores have an opening 24 at each end and do not intersect the moulding surface. The two or more bores may be connected together by placing a connecting element in the form of a grooved block 38 between the opening at one end of one bore and the opening at the end of another bore. The bores and grooves in the blocks together form a channel through which fluid may be circulated to heat or cool the mould. A process for creating a mould by securing one or more frame members to the moulding surface is further disclosed.



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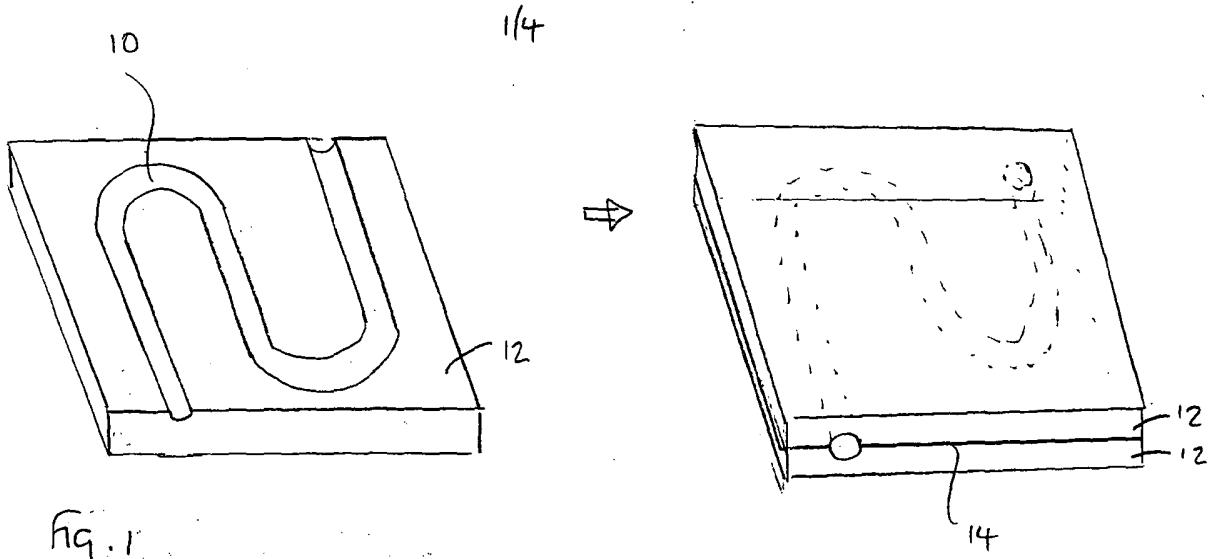


Fig. 1

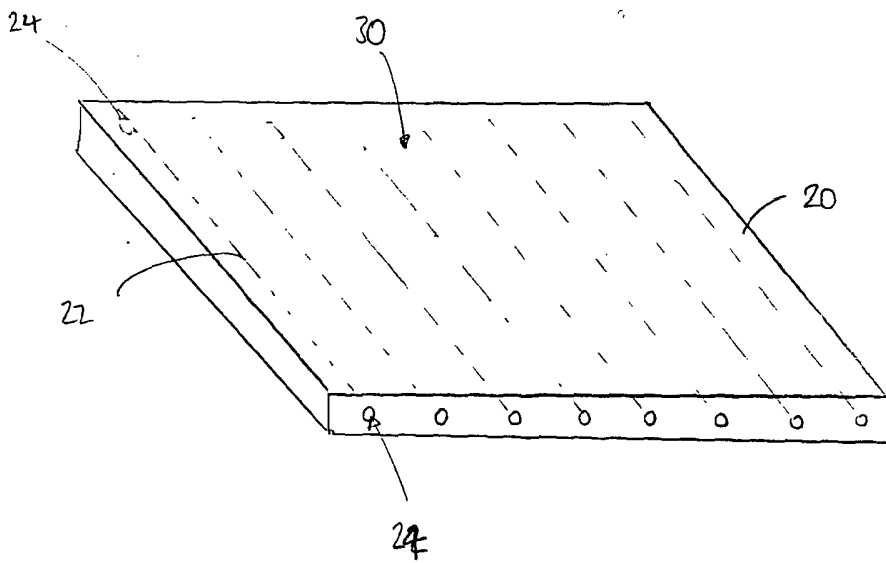


Fig. 2

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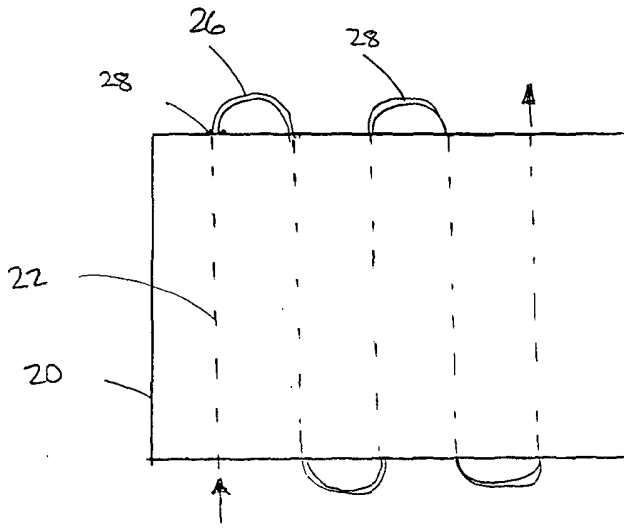


fig. 3

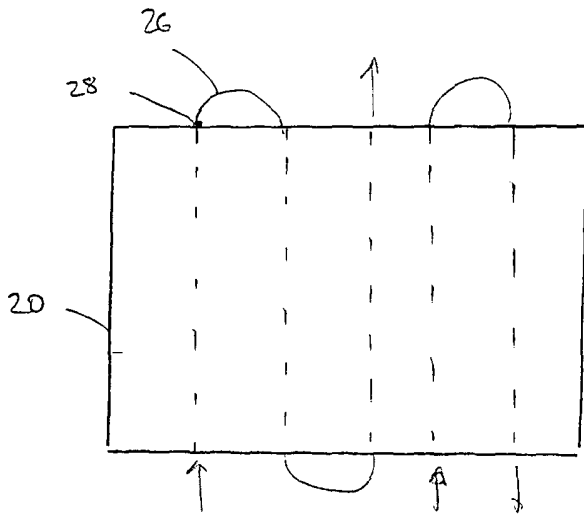


fig. 4

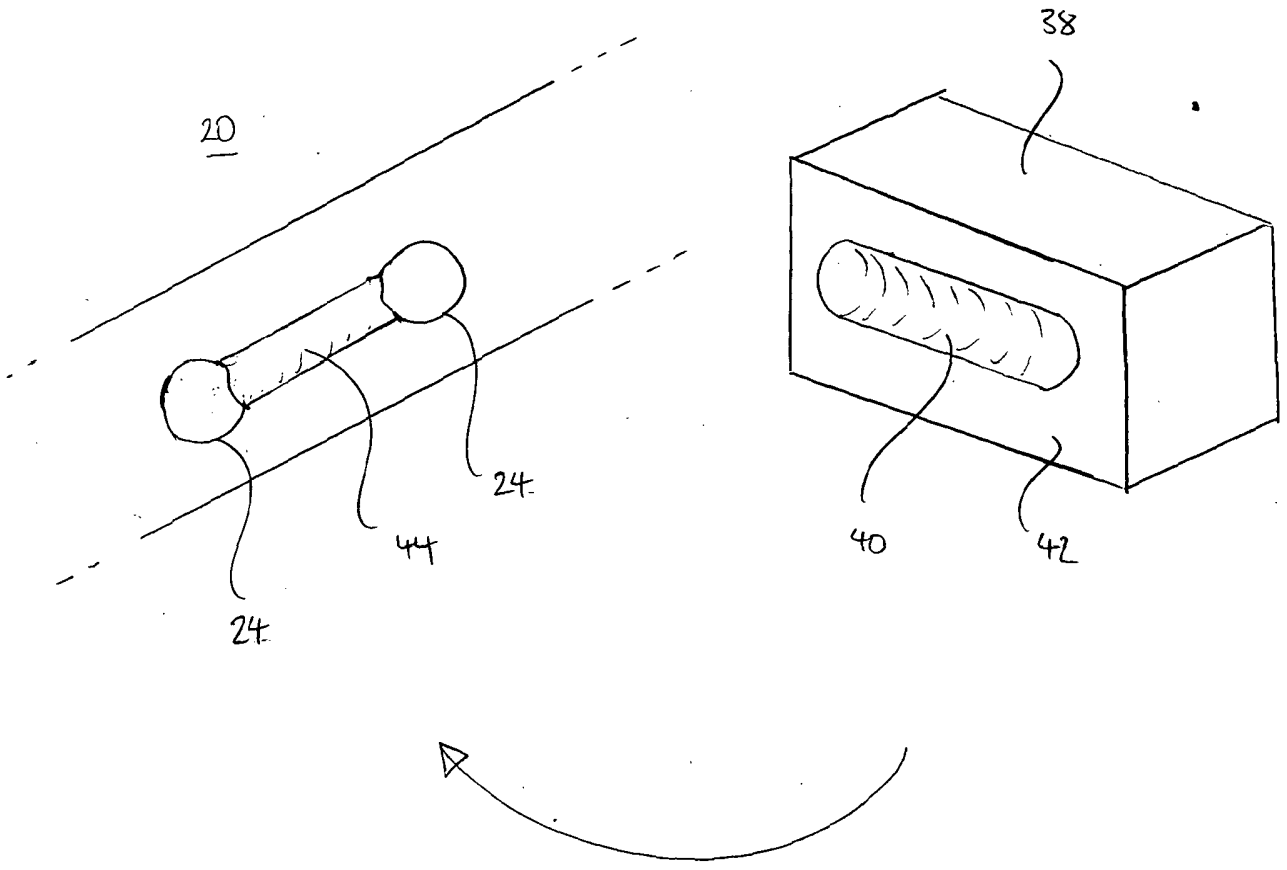


FIG. 5

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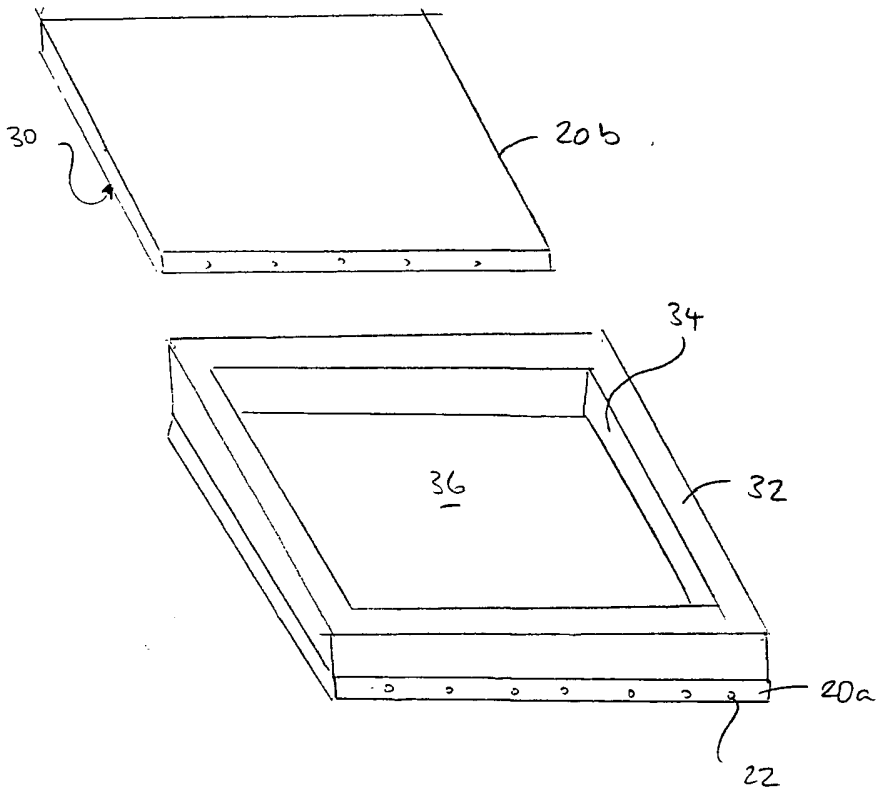


fig. 6

PROCESS FOR FORMING A MOULD

The present invention relates to a process for forming a mould for use in making moulded plastic articles. In particular, it relates to a simple and inexpensive process for forming a mould which can be heated and cooled by conduction.

The process is suitable for creating a mould for any type of moulding machine which requires heating and/or cooling of the mould. However, it is particularly suitable for a mould for use in the type of moulding process described in GB 2460838. This process uses a pair of female moulds, movable between open and closed positions. When closed, the moulds define a completely closed mould cavity. The process involves heating the moulds by conduction while the moulds are open, forming a plastic skin in each open mould, placing an expandable filler material in one mould and only then closing the moulds, whereupon the skins bond together to form a continuous outer skin and the filler expands to fill the volume within the skin. The moulds are subsequently cooled by conduction before opening and removing the moulded article.

Conveniently, to efficiently provide heating and cooling, each mould is formed with a network of internal channels through which heated or cooled fluid, such as oil, can be circulated. Typically, to do this each mould is formed as a sandwich construction of two metal bodies. Each body has a network of channels cut into one surface. For example, there may be a serpentine channel with a single inlet and single outlet. The channels formed in one body

are arranged in a mirror image to those of the other body. The channels may be cut by a CNC milling process for example. Both bodies are then sandwiched together, with a gasket between them for sealing, so that the channels in
5 each body co-operate with those in the opposing body to form a mould with an internal channel running through it. However, such a process is fairly complex, time consuming and expensive due to the need for precision cutting of the channels. Additionally, such moulds may leak or experience
10 blockages in the channels if the gasket fails. If this occurs, the entire mould must be dismantled to identify and deal with the problem.

Furthermore, it is difficult to accurately control the
15 heating/cooling of the mould when a long channel is formed, especially if there is a single continuous channel extending through the whole mould. This can lead to an uneven temperature distribution in the mould, resulting in problems in the quality and reliability of plastic articles formed in
20 the mould.

The present invention addresses these problems and limitations of the prior art.

25 The present invention provides a process for forming a mould, comprising providing a solid body having at least one surface which defines a moulding surface against which an item is to be moulded, forming at least one bore through the body with an opening at each end and which does not
30 intersect the moulding surface.

Preferably the or each bore is formed by drilling.

In a preferred embodiment a plurality of bores are formed through the mould. In particular, a plurality of parallel bores may be formed. These may be equispaced from each other.

Preferably, the diameter of the or each bore is in the range of 10-15mm. It is possible that the bores do not all have the same diameter.

The process further comprises the step of connecting two or more bores together by placing a connecting element between the opening at one end of one bore and an opening at one end of another bore.

The connecting element may comprise a tube, or a grooved block.

In particular, the process may involve connecting adjacent bores together so as to create a single continuous flow path through the mould.

Alternatively, it is possible to form two or more separate groups of interconnected bores.

In one embodiment, the process further comprising securing one or more frame members to the moulding surface of the body in order to define a mould cavity.

In another aspect of the present invention, there is provided a process for creating a mould comprising providing a body having at least one surface which defines a moulding

surface against which an item is to be moulded in use, and securing one or more frame members to the moulding surface of the body in order to define a mould cavity.

5 In either aspect, the or each frame member may be releasably securable to the moulding surface.

 Either aspect of the invention may further comprise providing a second body with a moulding surface and
10 releasably securing the second body to the first body such that the moulding surface of the second body closes the mould cavity.

 In either aspect of the invention, the first and second
15 bodies may be hingedly connected together for pivotal movement between a position in which the mould cavity is open and the position in which the mould cavity is closed, wherein the hinge is adjustable to accommodate one or more frame members of different thickness between the first and
20 second bodies in the closed position.

 The present invention also provides a mould formed by either of the aforementioned processes.

25 In a further aspect, the present invention provides a moulded plastic article created in a mould formed by either of the aforementioned processes.

 The invention will now be described in detail by way of
30 example only, with reference to the accompanying drawings in which:

Figure 1 is a simplified perspective view of a prior art mould formed by two bodies and a gasket;

Figure 2 is a perspective view of a mould produced in accordance with the process of the present invention, at an intermediate stage of the process;

Figure 3 is a perspective view of a finished mould produced by the process of the present invention, with the bores interconnected in one configuration;

Figure 4 is similar to Figure 3 but shows the bores interconnected in an alternative configuration;

Figure 5 is a detail view of how two bores may be interconnected by a grooved block; and

Figure 6 illustrates how two moulds produced in accordance for the present invention can be combined to form a completely enclosed mould cavity.

Figure 1 shows a prior art process for creating a mould with an internal channel. As described above, a corresponding network of channels 10 is formed in a surface of each of two bodies 12. One body is inverted and placed on top of the other so that the channels co-operate to define a single internal channel through the structure. A gasket 14 is placed between the two bodies 12. A surface of one body, opposed to that containing the channel, will define a moulding surface against which a moulded article will be created when the mould is in use.

In the present invention, a mould with internal channels is created from a single body of material 20 as shown in Figure 2. For simplicity and clarity this is illustrated as a single rectangular slab or plate. In use, one surface 30 of the body will define a moulding surface against which part of an article will be formed when the mould is in use. For example, the upper surface 30 as illustrated may in fact be shaped rather than flat, to define a female mould cavity or a male mould projection for co-operating with another mould in use.

The body 20 is formed of any conductive material suitable for forming a mould, typically a metal such as steel.

A series of separate bores 22 are formed through the body 20, extending from one side all the way through to the other. In this example, a series of parallel bores 22 extends across the whole body 20, although other configurations are possible. Thus, each bore 22 has an opening 24 at each end, and the bores 22 do not intersect the moulding surface 30.

The bores 22 may be formed by any convenient process but the currently preferred option is deep drilling using a drill bit long enough to pass all the way through the body 20.

In a typical example mould, the body 20 measures 1,300mm by 2,600mm and is 20mm thick. The bores 22 are 12mm in diameter and the spacing between the centre lines of adjacent bores 22 is 36mm.

Thus, the bores 22 can be formed in a straightforward and inexpensive manner. To create interconnections between the bores 22, connecting tubes 26 are placed between the openings 24 at the ends of two bores 22. This may be a simple U-shaped length of stainless steel tubing secured into each opening 24 and provided with a seal 28 to prevent leakage of fluid out of the bores 22.

As shown in the Figure 3 example, connecting tubes 26 may be placed between adjacent openings 24 alternately on each side of the body 20, so that the end result is a continuous serpentine channel equivalent to that in the prior art arrangement of Figure 1.

However, the process of the present invention provides a versatile mould in which the channel configuration can be altered by changing the position of the connecting tubes 26. For example, in Figure 4, pairs of channels 22 are connected at one end by a connecting tube 26, while the opposite ends form the inlet and outlet. Groups of two or more bores 22 can be connected in this way so that there are a number of separate channels extending through the mould. It will be appreciated that many other configurations are possible. Each bore 22 may be kept completely separate with fluid simply entering at one end and exiting the other. Non-adjacent channels may be connected by a connection tube which bypasses one or more channels and so on.

By altering the channel configuration in this way, it is possible to control the heating/cooling of the mould. Using shorter channel lengths such as in the Figure 4

configuration enables more uniform heating/cooling to be achieved because there is a smaller temperature gradient between the temperature of the fluid at the inlet and the temperature at the outlet. Alternatively, some parts of the mould may be heated/cooled more than other parts by circulating fluid through relevant channels at different temperatures and/or at different flow rates. It would also be possible to heat some areas whilst cooling others. Some channels may be simply left open without circulating fluid therethrough and so on.

As an alternative to using connecting tubes 26, adjacent bores 22 may be interconnected by use of a connecting block 38 as shown in figure 5. Each block 38 consists of a solid block of material with a groove 40 milled, or otherwise formed, in one surface 42 thereof. On the mould 20, preferably a corresponding groove 44 is milled or otherwise formed between the openings 24 of adjacent bores 22. The surface 42 of the block 38 is placed against the mould 20 with the grooves 40 and 44 aligned with each other so that together they form a channel communicating between the two bores 22.

A further advantage of a mould formed by the process of the present invention is that if any of the seals 28 fail, it is easy to remove the relevant connecting tube 26 and seal 28 (or connecting block 38) and replace it, unlike the large-area gasket arrangement of the prior art. Similarly, should any bore 22 somehow become blocked, it is straightforward to remove the relevant connecting tube 26 or block 38 and clean the bore 22.

Thus, a very simple, cost effective process is provided for forming a mould which can be heated or cooled by circulation of fluid therethrough in a network of internal channels. The mould is cheaper to manufacture and more versatile than prior art moulds because the channels are easier to create and to seal and their configuration can be altered by interconnecting channels in different ways.

As mentioned above, the process of the present invention is particularly useful for creating moulds for use in the process described in GB2460838, in which a pair of female moulds can be closed to form a completely enclosed mould cavity. In another aspect of the present invention, a simplified mould for use in this type of process can be provided by using a single female mould in conjunction with a flat moulding surface to form a lid.

In particular, each mould may consist of a body formed with bores as described above, or a solid body without any bores or channels running through it. As shown in Figure 5, the female mould is created from a flat body 20a with a frame 32 secured to the moulding surface 30. The frame 32 provides a perimeter wall 34 extending around an area of the moulding surface 30, thereby creating a female mould cavity 36.

The frame 32 may be permanently secured to the body 20a. However, in a preferred embodiment it is releasably secured to the body 20a, for example with mechanical fasteners or some form of mechanical clamping arrangement. In this way, the frame 32 can be removed and replaced by another frame of different dimensions to create a female

mould cavity 36 with a different base area and/or a different depth. The shape of the frame 32 and thus the shape of the mould cavity 36 it creates can also be varied. The frame 32 could be sub-divided to form two or smaller
5 mould cavities.

The other mould is simply another body 20b, either with or without bores 22, and without such a frame 32 and thus providing a flat moulding surface 30. This can be placed on
10 the top of the female mould, with the moulding surface 30 facing into the mould cavity 36 thereby acting as a lid to form a completely enclosed cavity. Thus, a closable mould can be created easily and quickly and can be adapted to provide different sizes and shapes of mould cavity as
15 required. Such a versatile mould is therefore extremely cost effective.

Conveniently, the two bodies 20a and 20b may be hingedly connected together for easy opening and closing of
20 the mould cavity 36. In order to accommodate one or more frames 32 of different thickness, the hinge may be adjustable (in a known manner) to alter the spacing between bodies 20a and 20b when they are in the closed position so that the distance between them, and thus the thickness of
25 the frame 32 which can be accommodated, can be altered as necessary.

CLAIMS

1. A process for creating a mould, comprising providing a solid body having at least one surface which defines a
5 moulding surface against which an item is to be moulded in use, and forming at least one bore through the body with an opening at each end and which does not intersect the moulding surface.
- 10 2. A process as claimed in claim 1, wherein the or each bore is formed by drilling.
3. A process as claimed in claim 1 or claim 2, comprising forming a plurality of bores through the body.
15
4. A process as claimed in claim 3, wherein the bores are parallel to each other.
5. A process as claimed in claim 4, wherein the bores are
20 equispaced from each another.
6. A process as claimed in claim 3, wherein the bores do not all have the same diameter.
- 25 7. A process as claimed in any preceding claim, wherein the diameter of each bore is in the range of 10-15mm.
8. A process as claimed in any preceding claim, further comprising connecting two or more bores together by placing
30 a connecting element between the opening at one end of one bore and an opening at one end of another bore.

9. A process as claimed in claim 8, wherein the connecting element comprises a tube.

5 10. A process as claimed in claim 8, wherein the connecting element comprises a grooved block.

11. A process as claimed in any of claims 8-10, further comprising connecting adjacent bores together so as to
10 create a single continuous flowpath through the body.

12. A process as claimed in any of claims 8-10, comprising connecting bores together to form two or more separate groups of interconnected bores.

15

13. A process as claimed in any preceding claim, further comprising securing one or more frame members to the moulding surface of the body in order to define a mould cavity.

20

14. A process for creating a mould, comprising providing a body having a surface which defines a moulding surface against which an item is to be moulded in use, and securing one or more frame members to the moulding surface in order
25 to define a mould cavity.

15. A process as claimed in claim 13 or claim 14, wherein the or each frame member is releasably securable to the moulding surface.

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16. A process as claimed in any of claims 13-15, further comprising providing a second body with a moulding surface

and releasably securing the second body to the first body such that the moulding surface of the second body closes the mould cavity.

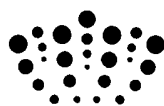
5 17. A process as claimed in claim 16, wherein the first and second bodies are hingedly connected together for pivotal movement between a position in which the mould cavity is open and a position in which the mould cavity is closed, wherein the hinge is adjustable to accommodate one or more
10 frame members of different thickness between the two bodies in the closed position.

18. A mould formed by a process as claimed in any preceding claim.

15

19. An article formed in a mould created by the process as claimed in any preceding claims.

20. A process for forming a mould substantially as
20 hereinbefore described and with reference to Figures 2-6.



Application No: GB1004682.9

Examiner: Heather Webber

Claims searched: 1 - 13, 18- 20

Date of search: 14 July 2010

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1 - 13, 18, 19	US 2010/040719 A1 (LIN et al) see whole document, particularly figure 5
X	1 - 13, 18 & 19	JP 2003181837 A (SAKAGUCHI ELECTRIC HEATERS) see WPI abstract accession number: 2004-136517 [14] and figures
X	1 - 10, 13, 18 & 19	US 5607702 A (NGK INSULATORS LTD) see whole document and figures
X	1 - 7, 13, 18 & 19	US 4703912 A1 (KATASHI AOKI) see whole document
X	1 - 7, 18, 19	JP 04308705 A (SINTOKOGIO LTD) see WPI abstract accession number: 1992-411676 [50] and figures
X	1, 2, 18 & 19	JP 01178358 A (DAIDO STEEL CO LTD) see WPI abstract accession number: 1989-245251 [34] and figures

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^X :

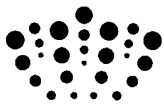
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Worldwide search of patent documents classified in the following areas of the IPC

B29C

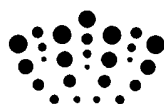
The following online and other databases have been used in the preparation of this search report

EPODOC, WPI



International Classification:

Subclass	Subgroup	Valid From
None		



Application No: GB1004682.9

Examiner: Heather Webber

Claims searched: 14 - 20

Date of search: 29 March 2011

Patents Act 1977
Further Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	14 - 19	US5021108 A1 (BERGQVIST CORAL IRENE) see especially column 5 lines 34 - 48 and figures 1 & 2
X	14 - 19	DE1704224 A1 (MEYER KELLER NOE SCHALTTECH) see WPI abstract accession number: 1985-000673 [01]; frame member (24) figures 1 - 5
X	14 - 16, 18 & 19	JP08323783 A (AICA KOGYO CO LTD) see WPI abstract accession number: 1997-082153 [08] and figures
X	14 - 16, 18 & 19	JP57174207 A (SONY CORP) see WPI abstract accession number: 1982-03782J [48] and figures
X	14, 15, 18 & 19	US1514053 A1 (KEETER HARVEY L) see figures especially
X	14, 15, 18 & 19	US6386504 B1 (SCHEMEL FRANCIS) see figures especially

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

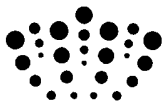
Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^X :

Worldwide search of patent documents classified in the following areas of the IPC

B29C

The following online and other databases have been used in the preparation of this search report

EPODOC, WPI



International Classification:

Subclass	Subgroup	Valid From
B29C	0033/04	01/01/2006