



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
13.08.2003 Bulletin 2003/33

(51) Int Cl.7: **B22C 9/00**, B22C 9/02,
B22D 47/02, B22D 17/22

(21) Application number: **02075515.3**

(22) Date of filing: **07.02.2002**

(84) Designated Contracting States:
**AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU
MC NL PT SE TR**
Designated Extension States:
AL LT LV MK RO SI

- **Paaske, Nils**
8543 Hornslet (DK)
- **Pedersen, Henning Moller**
8300 Odder (DK)
- **Marcussen, Jan**
8600 Silkeborg (DK)

(71) Applicant: **X-Tend ApS**
8543 Hornslet (DK)

(74) Representative: **Elmeros, Claus**
Patentgruppen ApS,
Arosgaarden,
Aaboulevarden 31
8000 Aarhus C (DK)

(72) Inventors:
• **Rasmussen, Mogens**
8250 Ega (DK)

(54) **A method of machining a mould from a block of sand and use of said method**

(57) The invention relates to a method of machining a mould from a block of granular moulding material for moulding in a foundry operation, including machining a form part from a block of granular moulding material, such as sand including a binder, a cavity by using a ma-

chining tool, said machining tool being moved relative to the block of moulding material, said movements controlled by a geometric data from a computer control means to form the cavity; and removing the granular material removed from the block by the machining tool during the machining of the cavity.

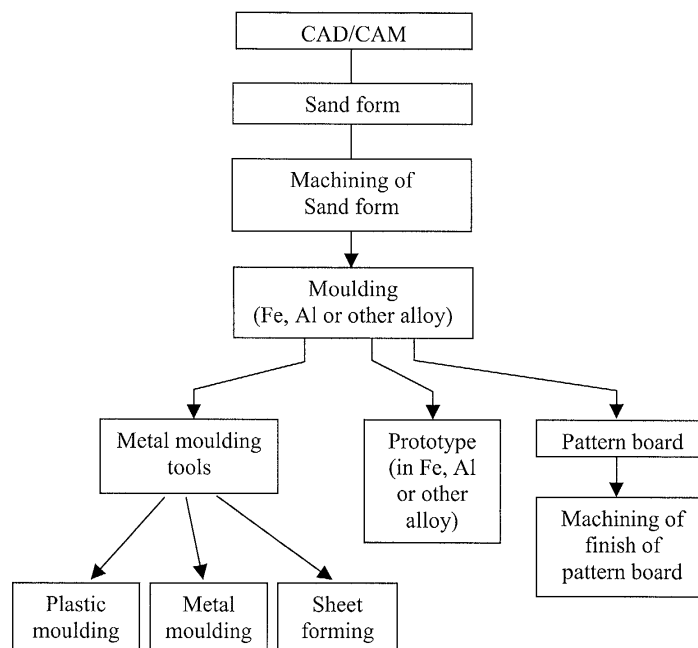


Fig. 7

Description

[0001] The present invention relates to a method of machining a mould from a block of sand and use of such method. The invention also relates to a moulding tool obtained by the performance of the method.

[0002] In foundry operations, it is well known to make a set of negative sand forms in order to produce a moulded object in cast iron or the like. In the making of the form, a wooden model of the object to be cast is produced. This form is then used to produce a set of negative form parts in a block of sand with a binder added to it. The form parts are made with suitable cavities corresponding to the shape of the object to be cast. Normally, two form parts are produced, but in principle, any number of forms may be used.

[0003] This method of producing is simple to use, but is very time consuming. In particular today, where most design processes are made by the aid of a computer. This means that a computer representation of the object to be produced by casting is virtually always present. This in turn means that the making of the wooden model of the object could be avoided, if the cavities in the sand form could be made directly. This would mean a considerable gain of time of the casting process.

[0004] From e.g. Canadian patent application No. 2,314,428, a method for forming a moulding element in a block of sand by using a computer numeric controlled machining equipment is known.

[0005] However, the sand grains, which are released by the machining of the block of sand, must be removed, in order to obtain a cavity of the desired shape. If the sand that is cut-away is not removed correctly, this may compromise the result of the machining process and consequently the quality of the form part.

[0006] The object of the present invention is to provide a solution overcoming the above-identified drawbacks with the techniques known in the art.

[0007] Another object of the invention is to provide a method of the initially mentioned kind and a use thereof allowing for a less time and cost consuming production of form parts for a moulding tool for foundry operations, such as injection moulding tools, and/or other kinds of object forming operations.

[0008] These objects are solved by the various aspects of the invention as set forth in the claims.

[0009] According to the invention, a method of machining a mould from a block of granular moulding material for moulding in a foundry operation is provided, said method including machining a form part from a block of granular moulding material, such as sand including a binder, a cavity by using a machining tool, said machining tool being moved relative to the block of moulding material, said movements controlled by a geometric data from a computer control means to form the cavity; and removing the granular material removed from the block by the machining tool during the machining of the cavity.

[0010] Hereby, the accuracy of the cavity machined in the block of sand is improved, since the sand grains released by the machining tool is quickly removed from the cavity. Unlike a machining operation in a block of metal, the provision of a constant flow of oil which functions not only as a coolant but also for conveying the chips away from the engagement area of the machining tool is not possible due to the nature of the material to be cut. By the invention, the released cut-away granular material is not left in the cavity between the machining tool and the surface of the cavity and influencing the quality of the result of the machining operation. By a method according to the invention, a mould form part formed in a block of sand for foundry operations is achieved where the dimensional quality of the cavity may be achieved.

[0011] Preferably, the block of moulding material is provided in a fixture, which is pivotable in one or more directions. Hereby, the removal of the released granular material may be performed or at least facilitated by the gravity, since the fixture may be pivoted in such a way that the released granular material is removed by gravity from the area where the machining tool is engaged for the performance of the machining of the cavity. In addition or supplementary, the granular material may be completely removed from the cavity and the block of sand depending on the geometry of the cavity and the direction and amount of inclination of the fixture.

[0012] The machining tool is a rotary tool. As a supplement or as an alternative to the inclination of the fixture, the rotary machining tool is preferably rotatable about an axis, which is inclinable relative to a horizontal position. In a preferred embodiment of the invention, the machining is carried out by a robot. By mounting the machining tool on a robot, the degrees in the freedom of movement may be very high allowing for a high degree of flexibility in the installation and the method of producing a mould form element.

[0013] Moreover, the cut-away material is removed substantially instantly by central suction means, such as a centrally disposed suction channel in the machining tool. Hereby, the sand grains released by the machining process may be removed independent of the orientation of the block of sand, i.e. the fixture and the machining tool.

[0014] The machining is preferably a milling operation, but could also be a drilling operation or any other material removing operation.

[0015] The machining tool or tools may be adapted to perform "under-cutting" operations. Hereby, the use of cores or the like may be avoided and/or the number of form parts for the mould may be reduced.

[0016] According to the invention, the method may be used for producing a set of form moulding parts for a moulding tool, such as a tool for injection moulding of plastic or aluminium objects, said method including machining at least one form part from a block of granular moulding material, such as sand including a binder, a

cavity by using a machining tool, said machining tool being moved relative to the block of moulding material, said movements controlled by a geometric data from a computer control means to form the cavity; and removing the granular material removed from the block by the machining tool during the machining of the cavity, casting a form part for a moulding tool by pouring a melt, such as cast iron, aluminium, or other types of metals or alloys, into an assembly of form parts to produce a mould form part for a moulding tool.

[0017] Hereby, an inexpensive and a quick method of producing a form part for the production of an object by injection moulding. This allows for the use of an injection moulding process for the production of prototype objects in small series of objects as the time and costs for producing an injection-moulding tool may be significantly reduced.

[0018] The machining operation, such as milling, grinding, polishing, electrical spark erosion, and/or similar surface treatment, involves a finishing surface treatment of the mould form part. Hereby, the machining involved in producing a moulding tool may be significantly reduced, as the only machining required may be reduced to a finishing treatment of the casting.

[0019] The method according to the previously mentioned aspects may further involve that the mould form part and a counter form part are assembled constituting a mould for a moulding tool, and then pouring a melted metal into the mould, allowing the melt to cool to form a metal casting, breaking the sand mould parts in order to expose the object for mould form part for the moulding tool for an injection moulding process.

[0020] Use of the above-mentioned method for producing at least one form part for an injection-moulding form for the plastic injection-moulding, wherein the form part is cast in a metal, such as cast iron, aluminium or other metals or metal alloys, and subsequently applied with a surface structure, said application involving machined to required surface dimensions. Preferably, the use involves that all the form parts of the injection-moulding tool are made according to said method. Hereby, an injection-moulding tool for plastic injection moulding of objects may be produced in an inexpensive manner. This particular advantageous use of the method according to the invention allows for the manufacture of a small amount of plastic objects, since the costs involved in producing the moulding tool may be considerably reduced compared to previously known methods.

[0021] Alternatively, the use of the method for producing at least one form part for an injection-moulding form for the pressure injection-moulding of objects in aluminium or similar light-weight metal, wherein the form part is cast in a metal, such as cast iron, metal alloys or the like, and subsequently applied with a surface structure, said application involving machined to required surface dimensions. By the invention, it is realised that the method of producing injection-moulding tools may also be advantageously used for providing injection-moulding

tools for injection moulding of e.g. aluminium objects.

[0022] In another advantageous use of the method according to the invention, the method may be used for the production of a form for forming objects in a metal sheet, e.g. by a deep drawing operation pulling. Hereby, an inexpensive pressing tool may be provided making it possible to produce sheet formed objects in small quantities.

[0023] Instead of modelling a pattern board for a casting process manually, it is realised by the invention that a method according to the invention may be used for producing a pattern board in a predetermined shape for use in a casting of an object.

[0024] According to the invention, an injection-moulding tool for the production of objects by injection moulding is also provided, said tool comprising at least one form part made by carrying out the method according to the invention and used according to the above-mentioned aspects of the invention.

[0025] In the following, the invention is described in further detail with reference to the accompanying drawings, in which:

fig. 1 is a process diagram of a method according to a first aspect of the invention,
fig. 2 is a process diagram of a method according to a second aspect of the invention,
fig. 3 is a schematic view of a machining operation according to an embodiment of the invention,
fig. 4 is a schematic view of a machining operation according to a second aspect of the invention,
figs. 5 and 6 are schematic views of aspects of a preferred embodiment of the invention for the performance of the machining operation according to the invention, and
fig. 7 is a diagram of the method according to the method and its use.

[0026] In figure 1, a schematic diagram of the operations according to a preferred embodiment of a method according to the invention is shown including a preferred utility of the method in a design and manufacturing process.

[0027] To day, it is a normal to design objects, such as machine parts, or other items for use in products by help of a computer in a Computer Aided Design (CAD) installation. The result of this action of designing the object 2 is a computer representation of the object. This electronic computer representation may then be forwarded to a CAM (CAM: Computer Aided Manufacturing) application, as referred to by 4, in which the mould, including the form parts for the casting of the form, is planned. Subsequently, a machine control programme is created, e.g. a CNC (Computer Numeric Control) programme, as shown by the reference numeral 6 for the production of each of the form parts. A block of granular moulding material, preferably sand with a binder mixed into it, is prepared and provided in the machine centre.

The (first) CNC programme is fed to the control of a machining centre. This programme governs the machining of the predetermined cavity in a first block of sand 8. Similarly, a second form part may be produced by machining a second block of sand, as indicated by the reference numeral 10. Accordingly, further form parts may be produced. The machining of the cavities may advantageously include inlet channels for the casting material.

[0028] When the form parts, i.e. the blocks of sand, are machined with the determined cavities, the form parts are assembled. Then the operation of casting the object is carried out, as shown by 12.

[0029] After the object is cast, a finishing surface treatment of the function surfaces of the cast object is performed, as indicated by 14. This surface treatment could be a smoothing of the function surface or surfaces of each of the form parts.

[0030] The objects resulting from this process may be finished parts for use in a machine construction or any other kind of product. In fig. 2, the objects resulting from the process shown in fig. 1 are form parts for a moulding tool. These form parts are assembled as shown by the reference 16 to a form for casting a form part for moulding plastic or aluminium 18 or a form part for a deep-drawing or similar metal sheet manipulating process 20. The form parts for the moulding of plastic or aluminium may be made of cast iron e.g. for injection moulding. By the invention, it is realised that alternatively aluminium form parts may be produced by the method according to the invention for a plastic moulding tool. By cast iron is meant all types of cast iron, including grey cast iron, and various alloys suitable for use in a casting process.

[0031] In fig. 3, a schematic illustration of the machining operation is shown. A block of sand 24 is provided on a fixture means comprising a base support 22 and fixture elements 26 retaining the block of sand 24 on the base support 22. A cavity 29 is formed in the block of sand 24 by a machining tool 28, which is moveable relative to the block of sand in a plurality of directions, as indicated by the arrows on the figure 3. The tool 28 may be provided with a central vacuum channel 30, which is connected, to a vacuum source 32 for removing the released granular material by suction during the machining operation. The machining tool 28 may be a tool for drilling, milling or other material removal processes.

[0032] In an embodiment of the invention, the milling tool 28 may be provided with various shapes, such as shown in fig. 4. The milling tools 28, shown in fig. 4 are advantageous in that they are designed to perform cavities with "under-cuttings" in the block of sand 24. As shown in fig. 4 (A), the cutting edge 34 of the tool 28 is positioned on the perimeter of a cylindrical head section of the tool 28 with a diameter larger than the shaft of the tool 28. By this tool 28, a "hollow" cavity 29 may be formed in the sand block 24 with cavity rim regions 24a extending into the cavity 29. In fig. 4 (B), another example of an "undercutting" milling tool 28 is shown which is conical and where the cutting edges 36 on the conical

portion of the tool 28. The milling tools 28 shown in fig. 4 are also provided with a central suction channel 30 connected to a source of vacuum 32 for the removal of released material from the milling operation in order to avoid that the machining process is not obstruct by this released material.

[0033] By this aspect of the invention, a cavity geometry, which hitherto has been impossible to form in a block of sand by the known techniques, is possible to achieve. This means that less form parts for casting the designed object are needed in order to obtain a casting form with the desired shape.

[0034] In figures 5 and 6, an embodiment of the invention is shown, where the base support 22 is inclinably mounted on support fixture means 40. By the invention, it is realised that the casting sand, i.e. the sand with binder material has sufficient internal strength so that the block of sand does not break up if it is turned into different orientations. By the invention, this characteristic is used by the method of forming the cavity in the block of sand. This means that the block of sand may be inclined in one or more directions relative to horizontal during the machining operation. As shown in fig. 6, the support base may even be turned upside down. This means that the released granular material of the sand block during the machining is transported away from the machining action by the gravity. Moreover, the machining tool 28 may be arranged on a robot 38 whereby complex cavity shapes may be achieved.

[0035] The support fixture means 40 may be a robotic or similar installation movable during the machining operation. The robot 38 and/or the fixture 40 may be moved during the machining operation in order to achieve the desired shape of the cavity 29 in the sand block 24. These movements involve, as indicated by the arrows in figs. 5 and 6, relative movements between the machining tool 28 and the fixture including pivoting the machining tool 28 to an inclined orientation relative to the block of sand 24 in order to produce "under-cuttings". The movements of the fixture 40 and the robot 38 handling the machining tool 28 may be controlled in a co-ordinated manner by the machine programme governing the machining operation.

[0036] In figure 7, an outline of the different aspects of the invention is presented. As shown in fig. 7, the method of forming a block of sand for a mould may be utilised for different purposes, whereby an advantage in terms of reduction of production time and costs may be achieved. These utilities are also reflected in the accompanying claims.

Claims

1. A method of machining a mould from a block of granular moulding material for moulding in a foundry operation, including machining a form part from a block of granular moulding material, such as sand

including a binder, a cavity by using a machining tool, said machining tool being moved relative to the block of moulding material, said movements controlled by a geometric data from a computer control means to form the cavity; and removing the granular material removed from the block by the machining tool during the machining of the cavity.

2. A method according to claim 1, where the block of moulding material is provided in a fixture which is pivotable in one or more directions.

3. A method according to claim 1 or 2, where the machining tool is a rotary tool, said rotary machining tool being rotatable about an axis, which is inclinable.

4. A method according to claim 3, whereby the machining is carried out by a robot.

5. A method according to any of the preceding claims, whereby the cut-away material is removed substantially instantly by central suction means, such as a centrally disposed suction channel in the machining tool.

6. A method according to any of the preceding claims, wherein the machining is a milling operation.

7. A method according to claim 6, where the machining tool or tools is/are adapted to perform "under-cutting" operations.

8. A method of producing a set of form moulding parts for a moulding tool, such as a tool for injection moulding of objects in plastic, aluminium or other light-weight materials, including machining at least one form part from a block of granular moulding material, such as sand including a binder, a cavity by using a machining tool, said machining tool being moved relative to the block of moulding material, said movements controlled by a geometric data from a computer control means to form the cavity; and removing the granular material removed from the block by the machining tool during the machining of the cavity, casting a form part for a moulding tool by pouring a melt, such as cast iron or aluminium, into an assembly of form parts to produce a form moulding part for a moulding tool.

9. A method according to claim 8, whereby the machining operation, such as milling, grinding, polishing, electrical spark erosion, and/or similar surface treatment, involves a finishing surface treatment of the mould form part.

10. A method according to claim 8 or 9, where the

mould form part and a counter mould form part are assembled constituting a mould for a moulding tool, and then

pouring a melted metal into the mould, allowing the melt to cool to form a metal casting, breaking the sand mould form parts in order to expose the object for mould form part for the moulding tool for an injection moulding process.

11. Use of a method according to claims 1-10 for producing at least one form part for an injection-moulding form for the plastic injection-moulding, wherein the form part is cast in a metal, such as cast iron, aluminium, metal or metal alloys, and subsequently applied with a surface structure, said application involving machined to required surface dimensions.

12. A use according to claim 11, whereby all the form parts of the injection-moulding tool are made according to a method of claims 1-10.

13. Use of a method according to claims 1-10 for producing at least one form part for an injection-moulding form for the pressure injection-moulding of objects in aluminium or an other light-weight metal or alloy, wherein the form part is cast in a metal, such as cast iron or other suitable metal or alloy, and subsequently applied with a surface structure, said application involving machined to required surface dimensions.

14. A use according to claim 11, whereby all the form parts of the injection-moulding tool are made according to a method of claims 1-10.

15. A use of a method according to claims 1 to 7 for the production of a form for producing objects by forming a metal sheet, such as by a deep drawing process.

16. A use of a method according to claims 1 to 7 for producing a pattern board for a casting process of a predetermined object.

17. An injection-moulding tool for the production of objects by injection moulding, said tool comprising at least one form part made by carrying out a method according to claims 1-10 and used according to any of the claims 11 to 16.

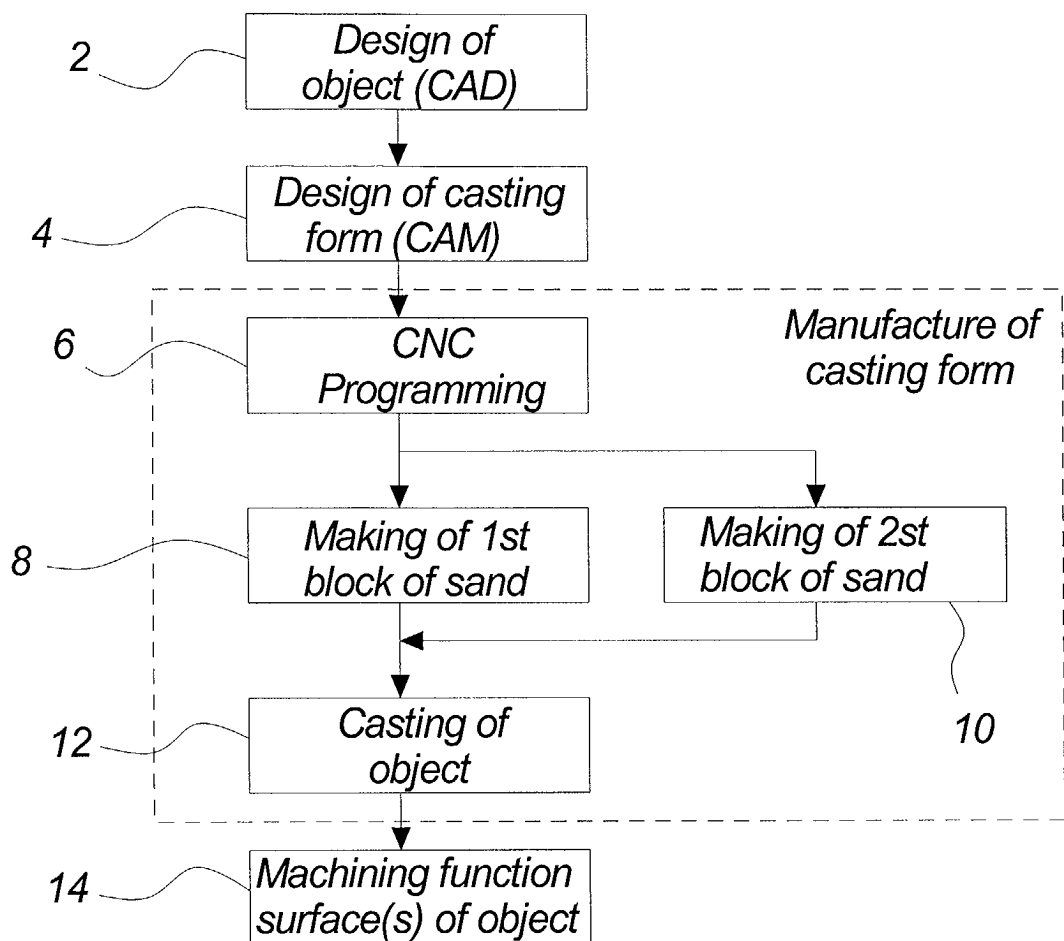


Fig. 1

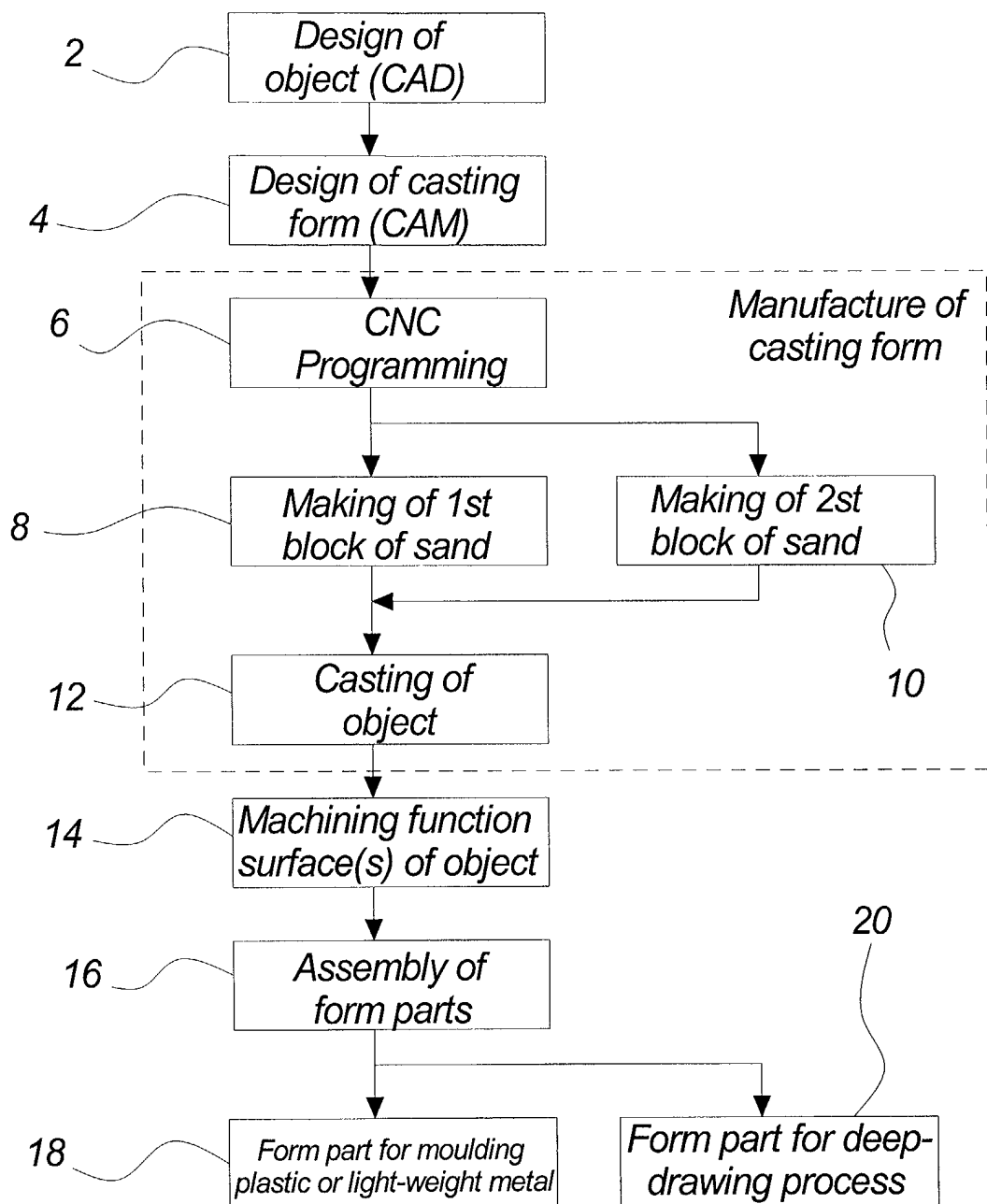


Fig. 2

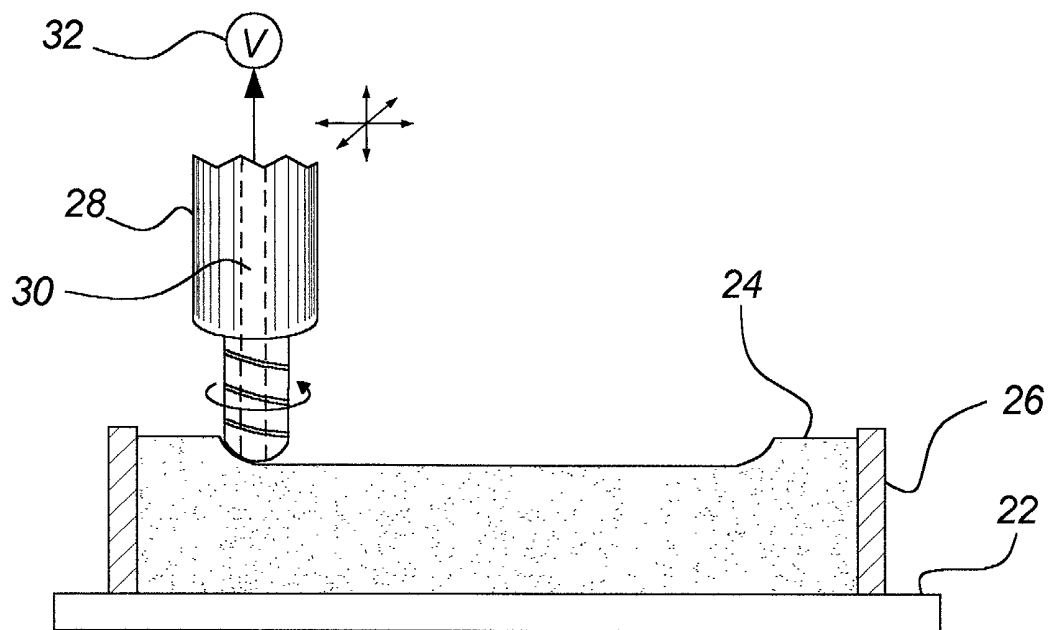


Fig. 3

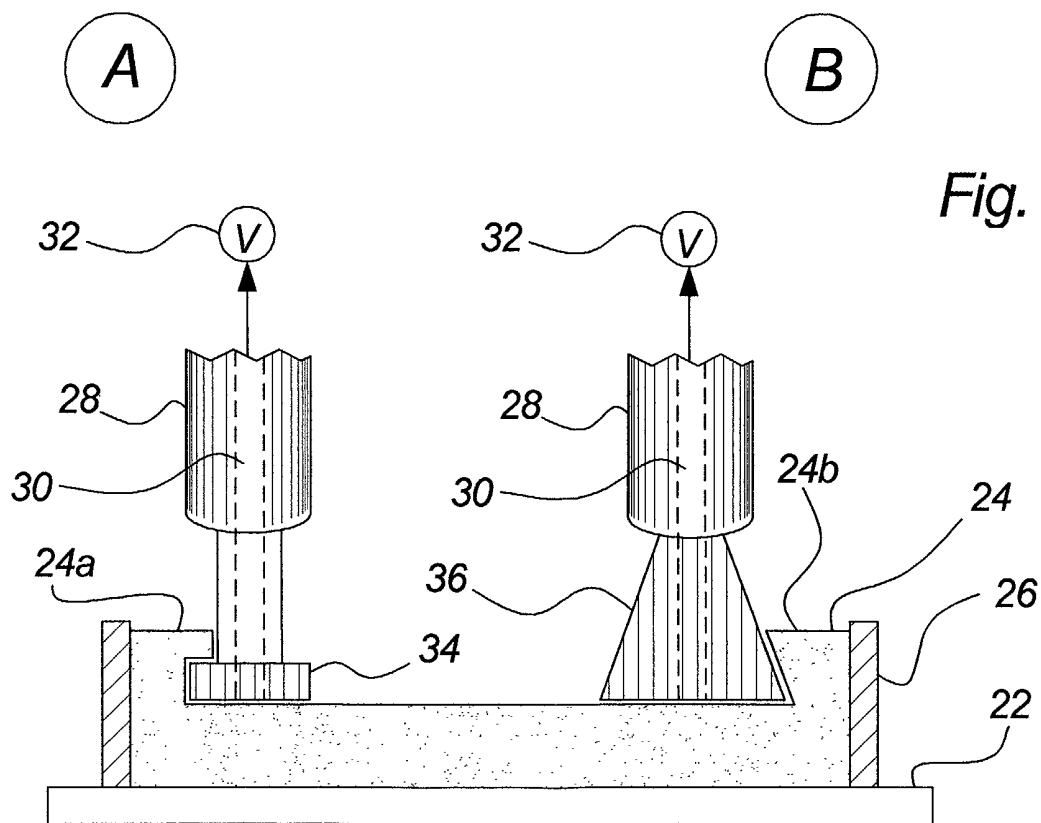


Fig. 4

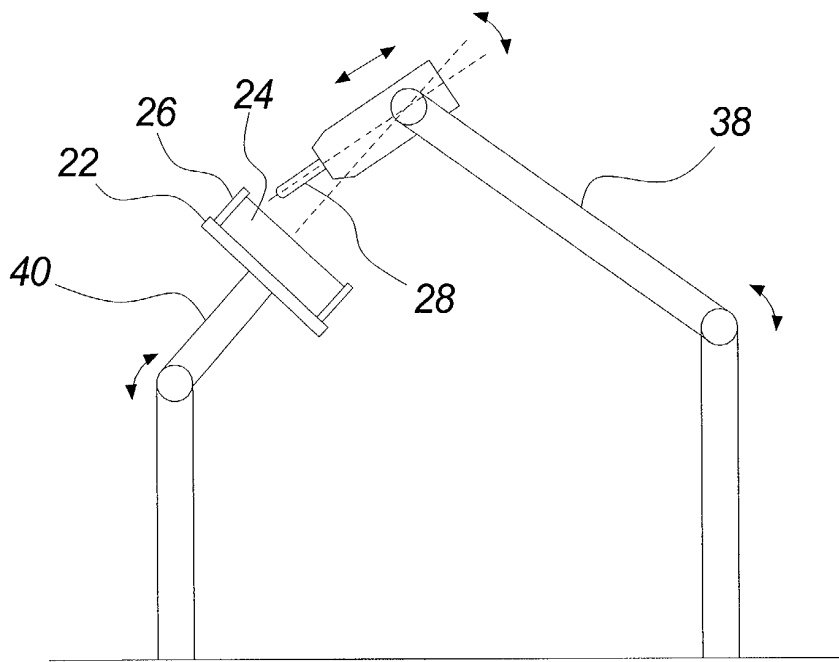


Fig. 5

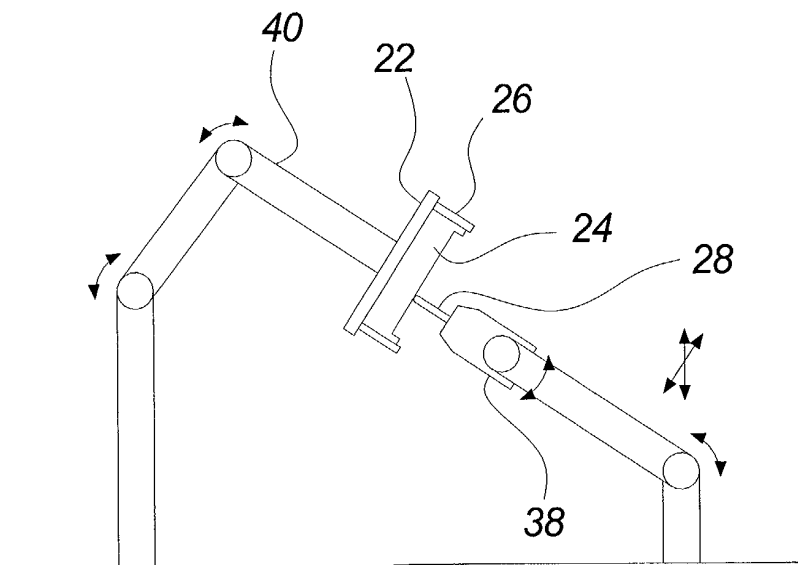


Fig. 6

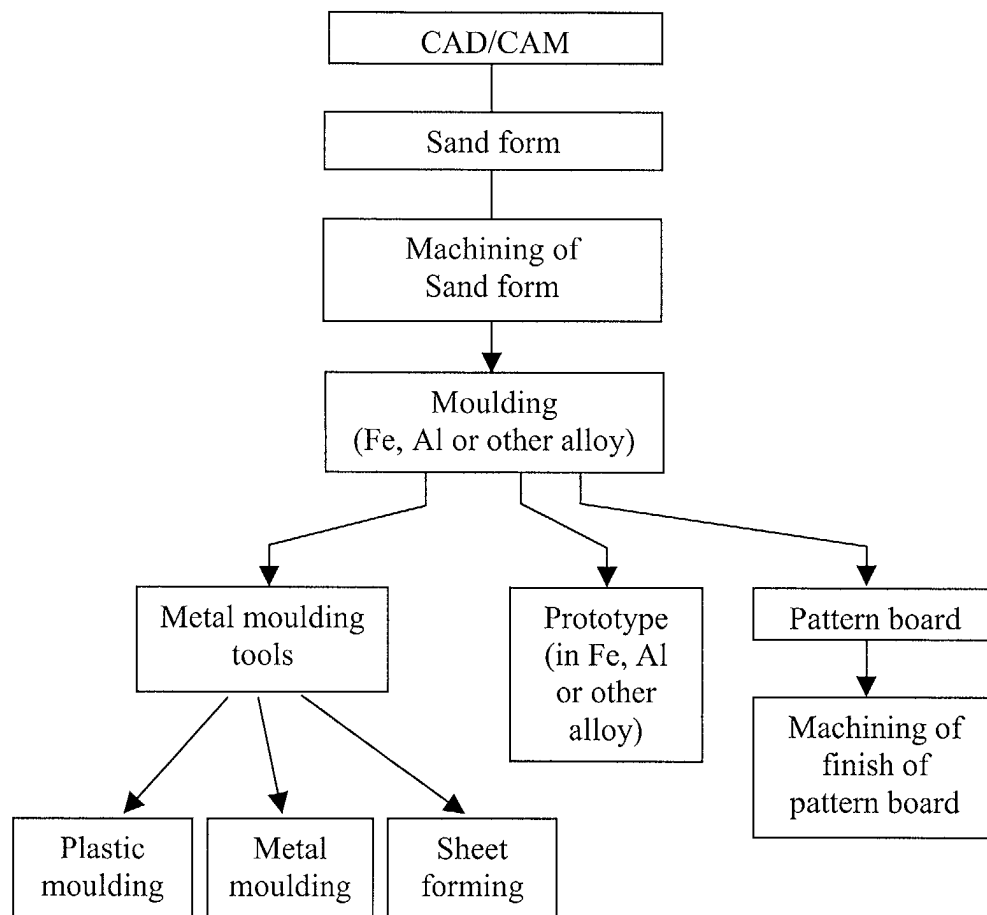


Fig. 7



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 02 07 5515

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	EP 0 317 315 A (ROBERT D SA) 24 May 1989 (1989-05-24) * column 1, line 45 - column 2, line 23; figures 1-10 * * column 3, line 40 - column 6, line 38 *	1-17	B22C9/00 B22C9/02 B22D47/02 B22D17/22
Y	PATENT ABSTRACTS OF JAPAN vol. 009, no. 018 (M-353), 25 January 1985 (1985-01-25) & JP 59 166350 A (MITSUBISHI JUKOGYO KK), 19 September 1984 (1984-09-19) * abstract *	1,5	
Y	DATABASE WPI Section Ch, Week 197927 Derwent Publications Ltd., London, GB; Class M22, AN 1979-50013B XP002207000 & JP 54 066326 A (MITSUBISHI HEAVY IND CO LTD), 28 May 1979 (1979-05-28) * abstract * -& JP 54 066326 A (MITSUBISHI HEAVY IND LTD) 28 May 1979 (1979-05-28) * figures 1-5 *	1,5	
A	US 4 104 347 A (OHASHI YOSHINOBU ET AL) 1 August 1978 (1978-08-01) * figures 1-4 *	1-17	
A	FR 1 138 883 A (BERGER HENRI) 20 June 1957 (1957-06-20) * abstract; figures 1-4 *	1-17	
A	FR 1 013 661 A (L ARMEMENT LE MINISTRE DE; PERRET RAYMOND) 1 August 1952 (1952-08-01) * the whole document *	1-17	
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 22 July 2002	Examiner Mailliard, A
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 02 07 5515

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

22-07-2002

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
EP 0317315	A	24-05-1989	EP 0317315 A2	24-05-1989
JP 59166350	A	19-09-1984	JP 1596767 C	27-12-1990
			JP 2018177 B	24-04-1990
JP 54066326	A	28-05-1979	NONE	
US 4104347	A	01-08-1978	JP 928980 C	17-10-1978
			JP 51094418 A	19-08-1976
			JP 53008527 B	29-03-1978
			JP 901402 C	15-03-1978
			JP 51059014 A	22-05-1976
			JP 52026733 B	15-07-1977
			DE 2605687 A1	26-08-1976
			FR 2301321 A1	17-09-1976
			GB 1532698 A	22-11-1978
FR 1138883	A	20-06-1957	NONE	
FR 1013661	A	01-08-1952	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82