

PATENT DECLARATION FORM
(CONVENTION OR NON-CONVENTION)

DECLARATION IN SUPPORT OF APPLICATION FOR A PATENT

Insert name of
applicant.In support of the application made by SVEN TORBJORN EKEROTInsert title of
invention.for a patent for an invention entitled: A METHOD AND APPARATUS FOR THE DIRECT
CASTING OF METALS TO FORM ELONGATED BODIESInsert full name(s)
and address(es) of
person(s) making
declaration. If
applicant a company
person must be
authorised to make
declaration.I/XX SVEN TORBJORN EKEROT* Delete alternatives
which do not apply

do solemnly and sincerely declare as follows:

* 1. (a) I am/~~We are~~ the applicant(s) for the patent.* ~~OR (b) I am authorized by the abovementioned applicant to make this declaration on its
behalf.~~* 2. (a) I am/~~We are~~ the actual inventor(s) of the invention.* ~~OR (b)~~Insert name(s) and
address(es) of actual
inventor(s).Insert details of
entitlement to apply,
e.g. Applicant is
assignee of inventor(s)is/are the actual inventor(s) of the invention and the facts upon which the applicant(s) is/are entitled
to make the application are as follows:—3. The basic application(s) as defined by Section 141 of the Act was/were made in the follow-
ing country or countries on the following date(s) by the following applicant(s)in SWEDEN on 23 October 1987

by _____

in _____ on _____ 19____

by _____

in _____ on _____ 19____

by _____

in _____ on _____ 19____

by _____

4. The basic application(s) referred to in paragraph 3 of this Declaration was/were the first
application(s) made in a Convention country in respect of the invention the subject of the
application.Declared at Stockholm this 19th day of April 1990NO ATTESTATION
OR SEAL

Signature(s) of declarant(s).

To: The Commissioner of Patents,
AustraliaSANDERCOCK, SMITH & BEADLE,P.O. Box 410, Hawthorn, 3122, Australia
cables: Sandpat Melbourne
telex: 34491, Sandpat

(19) AUSTRALIAN PATENT OFFICE (10) Acceptance No. 630337

- (54) Title
CONTINUOUS CASTING ON A SOLID ELONGATED METAL STRAND
- International Patent Classification(s)
(51)⁴ **B22D 011/00**
- (21) Application No. : **26241/88** (22) Application Date : **21.10.88**
- (87) PCT Publication Number : **WO89/03738**
- (30) Priority Data
- (31) Number (32) Date (33) Country
8704138 23.10.87 SE SWEDEN
- (43) Publication Date : **23.05.89**
- (44) Publication Date of Accepted Application : **29.10.92**
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- (56) Prior Art Documents
US 4479530
US 3470939
- (57) Claim

1. A method for the direct casting of metallic material to produce elongated bodies having a cross-section which corresponds relatively closely to the cross-section of an intended product comprising the steps of causing a melt of said metallic material to run from an outlet gate in a container of molten metal, passing a metallic cooling body, having substantially the same melting point as the molten metallic material, and having a shape similar to but smaller than the cross-sectional shape of the outlet gate, through the gate within the molten metal to cause progressive cooling and stabilizing of the molten metal by said metallic body, whereby the cooling effect of the metallic cooling body at a boundary layer between said cooling body and said molten metal surrounding the cooling body causes the formation of a network of

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solidified metal surrounding the cooling body thereby causing a boundary layer laminar flow phenomena to occur in the cast elongated body during formation of the boundary layer, an outer layer of the cast body which contacts and passes the outlet gate remaining molten until it has passed the outlet gate.

PCT

OPI DATE 23/05/89

APPLN. ID

26241 / 88

AOJP DATE 29/06/89

PCT NUMBER PCT/SE88/00558

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁴ : B22D 11/00	A1	(11) International Publication Number: WO 89/ 03738 (43) International Publication Date: 5 May 1989 (05.05.89)
(21) International Application Number: PCT/SE88/00558 (22) International Filing Date: 21 October 1988 (21.10.88) (31) Priority Application Number: 8704138-0 (32) Priority Date: 23 October 1987 (23.10.87) (33) Priority Country: SE (71)(72) Applicant and Inventor: EKEROT, Sven, Torbjörn [SE/SE]; Minervavägen 19, S-191 50 Sollentuna (SE). (74) Agent: ÖRTENBLAD, Bertil; Noréns Patentbyrå AB, Box 27034, S-102 51 Stockholm (SE). (81) Designated States: AT (European patent), AU, BE (European patent), BR, CH (European patent), DE (European patent), FI, FR (European patent), GB (European patent), IT (European patent), JP, KR, LU (European patent),		NL (European patent), SE (European patent), SU, US. Published <i>With international search report.</i> <i>In English translation (filed in Swedish).</i> 630337
(54) Title: A METHOD AND APPARATUS FOR THE DIRECT CASTING OF METALS TO FORM ELONGATED BODIES (57) Abstract A method for the direct casting of metallic material, such as steel, to produce elongated bodies (2) which form primarily blanks having a cross-section which corresponds relatively closely to the cross-section of the intended products, in which method a metal melt (1') is caused to run from an outlet gate (3) in a molten-metal container (1) and is collected subsequent to solidification. The method is particularly characterized in that a melt (1') of the metal is caused to exit from the gate together with a metallic body (5) which has substantially the same melting point as the molten metal, this metallic body being passed through the gate (3) inserted into and moving with the molten metal and is caused herewith to cool the molten metal (1') progressively and herewith entrain the molten metal to substantially the same speed as the body (5) in a so-called boundary layer. The cross-section of the inserted body (5) is adapted to the cross-section of the molten metal determined by the outlet gate, so that the cooling and entraining effect of the inserted body assists in forming the desired boundary layer and in the formation of a network of solidified metal. The invention also relates to an arrangement for carrying out the method. The drawing consists of three parts: a top cross-sectional view of the casting apparatus, a side view of the metallic body (5), and a bottom cross-sectional view of the molten metal (1') showing the boundary layer (2) and the network of solidified metal (14). The top view shows a container (1) with a gate (3) at the bottom. A body (5) is inserted into the gate. The side view shows the body (5) as a vertical rod with a circular cross-section. The bottom view shows the molten metal (1') with a boundary layer (2) around the body (5) and a network of solidified metal (14) at the bottom.		

A method and apparatus for the direct casting of metals to form elongated bodies.

The present invention relates to a method for the direct casting of metals to form elongated bodies, primarily blanks having a cross-section which corresponds relatively closely to the cross-section of the intended products, in which method molten metal is caused to run from an outlet or gate in a metal bath container and collected subsequent to solidifying.

The invention also relates to apparatus for carrying out the method.

The ability to cast steel and other metals to a dimension which corresponds closely to the cross-section of the intended product directly from a molten metal bath has obvious advantages. This would enable considerable savings to be made in respect to personnel costs and also to costs relating to, inter alia, energy, working materials and investments.

Considerable difficulties are encountered in the performance of such direct casting processes, however. A high teeming or pouring rate is required, since the cross-section is small while, at the same time, the demand for quality surfaces increases, since the casting lies relatively close to the final dimension.

The development from the casting of ingots to continuous casting techniques can be said to constitute a step in the direction towards direct casting processes. Continuous casting processes are also known for casting shapes of small dimensions. These known processes have not been used in production to any great extent, due to a slow produc-

tion rate and the poor quality of the surface of the
castings produced. Among other things, the slow rate of
productivity experienced with continuous casting
processes is due to the fact that a thin, solid layer or
5 coating must have time to form and contain the molten
metal.

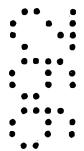
It is conceivable that a high production rate can
be achieved in the case of processes with which it is
not necessary for a thin, solid layer to form prior to
10 the material, such as steel, leaving the pouring gate
from which casting shall take place. Such a process
would also enable acceptable surfaces to be obtained.
Molten material, however, has a tendency to form
droplets through inhomogeneous flow and can even break-
15 up entirely into droplets. Consequently, there is a
need to stabilize the exiting material with regard to
its shape and also to cool the melt. The present
invention relates to a method and to an apparatus which
offer a solution to the problem of providing an
20 industrially applicable direct casting process for the
casting of elongated bodies which are relatively small
in cross-section.

Accordingly, the present invention provides a
method for the direct casting of metallic material to
25 produce elongated bodies having a cross-section which
corresponds relatively closely to the cross-section of
an intended product comprising the steps of causing a
melt of said metallic material to run from an outlet
gate in a container of molten metal, passing a metallic



cooling body, having substantially the same melting point as the molten metallic material, and having a shape similar to but smaller than the cross-sectional shape of the outlet gate, through the gate within the molten metal to cause progressive cooling and stabilizing of the molten metal by said metallic body, whereby the cooling effect of the metallic cooling body at a boundary layer between said cooling body and said molten metal surrounding the cooling body causes the formation of a network of solidified metal surrounding the cooling body thereby causing a boundary layer laminar flow phenomena to occur in the cast elongated body during formation of the boundary layer, an outer layer of the cast body which contacts and passes the outlet gate remaining molten until it has passed the outlet gate.

The present invention also provides an arrangement for the direct casting of metallic material to produce elongated bodies having a cross-section which corresponds relatively closely to the cross-section of an intended product comprising a molten metal container provided with an outlet gate having an outlet orifice through which molten metal is intended to run, an uncoiling arrangement which carries and supplies an elongate metal cooling body formed from metal having substantially the same melting point as the molten metal, into and through said container and said outlet gate, said metal cooling body causing a boundary layer between said cooling body and the surrounding molten



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metal which forms a boundary layer network of solidified metal resulting in a boundary layer laminar flow phenomena occurring in the body being cast, an outer layer of the cast body remaining molten as it passes
5 through the outlet gate, a coiling arrangement for receiving and coiling up the direct cast body after solidification, the form and size of the cross-sectional shape of the outlet orifice of the outlet gate being substantially similar to that of the desired cross-
10 section shape of the cast body, and the cross-sectional shape of the cooling body being similar to but smaller than the cross-sectional shape of the gate orifice.

The invention will now be described in more detail with reference to exemplifying embodiments thereof and
15 also with reference to the accompanying drawing, in which _____

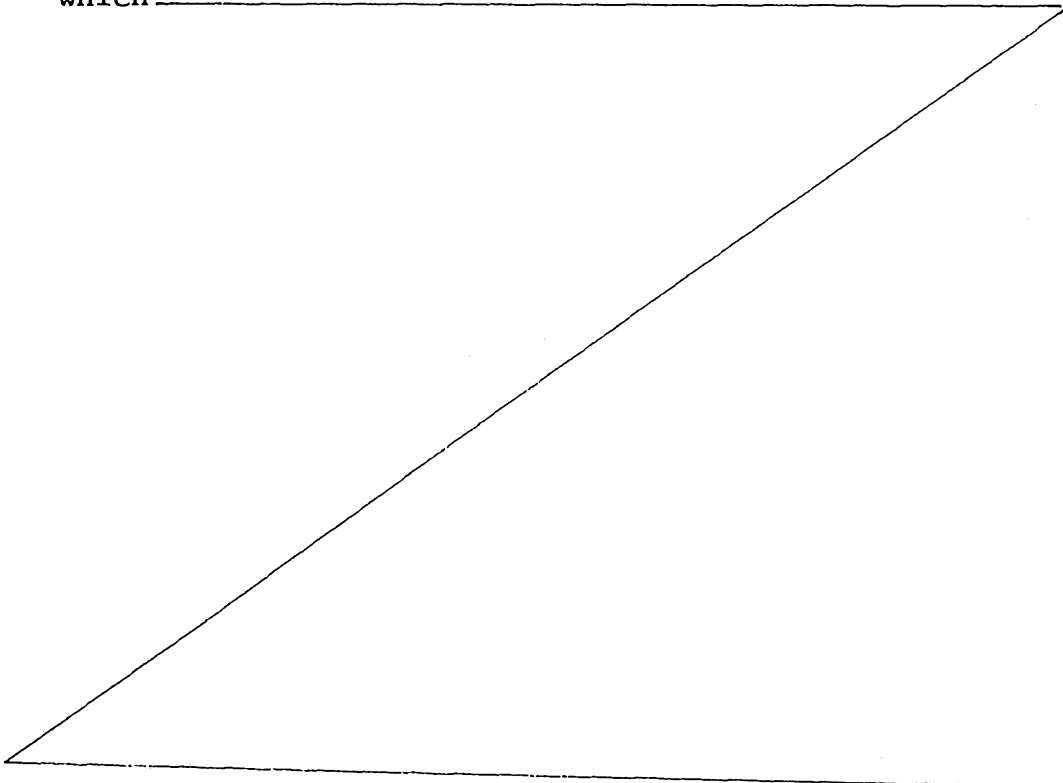


Figure 1 illustrates schematically a first embodiment of an arrangement for direct casting in accordance with the invention; and

5 Figure 2 illustrates schematically the casting of a body of substantially rectangular cross-section as seen in the direction of body thickness.

The arrangement illustrated in Figure 1 includes a container 1 which contains a bath 1' of molten metal material, such as steel, which is intended for the direct casting of elongated bodies or castings 2 which form primarily blanks whose cross-sections relatively closely correspond to the cross-sections of the intended products. The container 1 incorporates an outlet gate 3 which is preferably located in the bottom of the container and through which the molten metal is intended to run, in the manner illustrated in Figure 1. The outlet gate 3 has an outlet orifice 3' which defines the actual cross-sectional shape of the gate and consequently all reference here to the cross-sectional shape of the gate in fact applies to the cross-sectional shape of the gate orifice 3', which constitutes essentially the smallest cross-section.

The reference 4 identifies an uncoiling arrangement which is drawn to a scale different to the container 1 etc. and which carries an elongated cooling body 5 which is intended to run from the uncoiling arrangement and, preferably via feed rollers 6 or the like, to extend down through the bath and pass out through the gate for co-action with the molten metal exiting through said gate, said body 5, which is preferably metallic, being inserted into and moving with the molten metal, therewith cooling and stabilizing the same.

35 According to a preferred embodiment, the cooling body 5 is intended to be passed down into the melt through a nozzle 7 which inclu-

des a slot or channel 8 and the bottom orifice 9 of which is held at a distance of about 10-30 cm from the interior orifice 3" of the gate 3. In this respect the height of the bath in the container will be preferably greater than said distance.

5

According to one embodiment, the gate 3 has a substantially rectangular cross-section 3' for casting a body of substantially rectangular cross-section. The shape produced has a thickness of about 1-10 mm and a width of about 5-1000 mm. In the case of this embodiment, the cooling body 5 has substantially a rectangular cross-sectional shape and the cross-section of the body 5 will preferably correspond to about 9-30% of the total cross-section of the cast body or shape 2.

15

According to another embodiment, the gate 3 has a substantially elliptical, substantially circular or like cross-sectional shape, for casting a body of corresponding cross-sectional shape, said shape, in this case having a major axis which is 3-50 mm, and a minor axis which is 2-10 mm. As with the above described rectangular cross-section, the cooling body 5 will preferably correspond to about 9-30% of the total cross-section of the cast body.

25

The exemplifying embodiment illustrated in Figure 1 also includes a coiling arrangement 10 intended for coiling up the cast body 2. The coiling arrangement 10 is preceded by a cooling bed 11 or the like onto which the cast body is intended to run and, preferably, be brought into contact with a cooling medium 13 by means of cooling devices 12. The cooling devices and the cooling medium of the Figure 1 embodiment comprise spray nozzles 12 for spraying, e.g., water or steam onto the casting. The coiling arrangement and cooling bed are shown in a different scale to the scale in which the container 1 etc. are shown. A buffer

35

loop 14 is formed in order to accommodate accumulations resulting from variations in speed.

5 Figure 2 illustrates the casting of a body of rectangular cross-section, a substantially strip-like body, said body 2 being shown in the direction of its thickness. In this case, the outlet gate 3 includes a substantially slot-like outlet orifice, and the nozzle 7, in the present case, also includes a relatively thin slot through which a body 10 5 can pass.

It is preferred, in certain cases, to provide means (not shown) for heating the gate 3 to a temperature of up to about 200°C above the bath temperature at which solidifi- 15 cation begins, the so-called liquidus temperature, and for maintaining the temperature. Of course, heating can be effected in a number of known ways.

In other cases, it is preferred to provide means (not shown) for cooling the gate to a temperature of up to about 350°C beneath the liquidus temperature and for main- 20 taining the temperature in question. This cooling process can be effected in a number of known ways.

25 The inventive method and the manner of operation of the inventive arrangement will be evident in all essentials from the foregoing.

The cross-section of the cooling body is adapted in rela- 30 tion to the exiting molten metal, so that the cooling effect exerted by the cooling body 2 assists in creating a network of so-called dendrites of solidified material in the molten metal, such that the viscosity of the dendrite-containing melt will ensure that the shape imparted to the 35 molten metal through the action of the gate will remain essentially subsequent to the molten metal leaving the

gate. More explicitly, the cooling body is caused to cool the molten metal 1' progressively and, at the same time, entrain the molten metal so that said metal will move at substantially the same speed as the body 5 in a so-called boundary layer, the cross-section of the cooling body 5 being adapted to the cross-section and geometry of the molten metal defined by the gate, so that the entraining and cooling effect of the cooling body inserted into the gate assists in forming the desired boundary layer and in the formation of a network of solidified metal. Laminar flow phenomena occur during the formation of the boundary layer.

The metal is still to a large extent in a liquid state when it leaves the gate, and particularly the outer part of the liquid, which enables the casting process to be carried out at a high casting rate.

As a result of the formation of the boundary layer and the commencement of solidification, the exiting melt will retain the shape imparted thereto in the gate after exiting therefrom, until a thin external shell or skin of solidified metal has been formed by cooling resulting from radiation and convection.

The actual casting process may be carried out by introducing the cooling body into the molten bath located in a foundry box having a bath height of some decimeters. The cooling body is passed out through the gate surrounded by molten metal. The rate at which the casting is produced is determined to a large extent by the speed of the cooling body.

Three examples of manufacture in accordance with the invention are given below.

Example 1

Stainless steel SIS 2333 was cast with a cooling body of essentially the same material as in the original cases. The dimensions of the gate outlet were about 3 mm in the thickness direction and about 32 mm wide, and the dimension of the cooling body was, correspondingly, about 1.2 mm and about 30.4 mm. The casting temperature was about 1480°C and the casting rate about 0.8 m/s. The bath height was about 15-20 cm.

Example 2

Low carbon steel having a carbon content of 0.10% was cast with a cooling body of substantially the same material. The dimensions of the gate outlet were 3.5 mm in the thickness direction and about 20 mm in width, and the cooling body was about 1.6 mm thick and about 18.2 mm wide. The casting temperature was about 1540°C, and the casting rate was about 1.5 m per second. The bath height was about 15-20 cm.

Example 3

Stainless steel, SIS 2343, was cast with a cooling body of carbon steel having a carbon content of about 0.08 %. The dimensions of the gate outlet were about 3 mm in the thickness direction and about 90 mm in the width direction, and the cooling body was about 1.1 mm thick and about 88.7 mm wide. The casting temperature was about 1465°C and the casting rate about 0.5-2 meters per second. The bath height varied from 15 cm to 5 cm.

It will be evident from the foregoing that the method and the arrangement according to the invention enable a well-controlled direct casting process to be carried out in which the shape of the cast body can be carefully controlled despite the presence of melt. The desire for a high casting rate is satisfied, because molten metal is in con-

tact with the gate instead of a stationary shell, as in the case of continuous casting processes. The resultant problem of maintaining the shape of the exiting metal until a shell has been formed has been solved in the afore-
5 described manner.

The invention has been described in the foregoing with reference to a number of exemplifying embodiments thereof. It will be understood, however, that other embodiments are
10 possible and that minor modifications can be made without departing from the inventive concept.

For example, the shapes produced may differ from the aforesaid purely rectangular, elliptical and circular
15 cross-sectional shapes.

Furthermore, many different combinations of metallic materials are conceivable in respect of the combination molten metal bath and cooling body.
20

With regard to controlling the temperature with respect to the outlet gate, this can be effected with the aid of microwaves, by means of induction, by means of radiation or by resistance heating. Combinations of these heating
25 methods are also conceivable.

In general, wide variations are conceivable with regard to casting conditions.

30 For example, higher casting rates and widths can be used than those given in the three examples above.

A plurality of material combinations are also conceivable. For example, the cooling body may consist essentially of
35 the same material as the molten bath, or of a material different to said bath material.

Consequently, the invention shall not be considered to be limited to the aforescribed embodiments, since variations and modifications can be made within the scope of the following claims.

CLAIMS

1. A method for the direct casting of metallic material to produce elongated bodies having a cross-section which corresponds relatively closely to the cross-section of an intended product comprising the steps of causing a melt of said metallic material to run from an outlet gate in a container of molten metal, passing a metallic cooling body, having substantially the same melting point as the molten metallic material, and having a shape similar to but smaller than the cross-sectional shape of the outlet gate, through the gate within the molten metal to cause progressive cooling and stabilizing of the molten metal by said metallic body, whereby the cooling effect of the metallic cooling body at a boundary layer between said cooling body and said molten metal surrounding the cooling body causes the formation of a network of solidified metal surrounding the cooling body thereby causing a boundary layer laminar flow phenomena to occur in the cast elongated body during formation of the boundary layer, an outer layer of the cast body which contacts and passes the outlet gate remaining molten until it has passed the outlet gate.

2. A method according to claim 1, including the steps of cooling the outlet gate to a temperature of up to about 350°C beneath the temperature at which solidification of the molten metal commences, and maintaining the outlet gate at said temperature.

3. A method according to claim 1 including the steps



of heating the outlet gate to a temperature of up to about 200°C above the liquidus temperature of the molten metal and maintaining said outlet gate at said temperature.

5 4. A method according to claim 1, 2 or 3 including the steps of introducing the metallic cooling body down into the molten metal through a nozzle having a bottom orifice located at a desired first distance dimension from the outlet gate in the container, and controlling
10 the depth of the molten metal in the container at a distance dimension greater than said first distance dimension.

 5. A method as defined in claim 4, wherein said desired first distance dimension falls substantially within the range of from 10 to 30 cm and said second
15 distance falls substantially within a range of from 15 to 45 cm but greater than said selected first distance.

 6. A method as defined in any one of claims 1 to 5, wherein the geometric shape of said cross-section is
20 selected from substantially rectangular, substantially elliptical and substantially circular.

 7. A method according to any one of claims 1 to 5, including the use of an outlet gate of substantially rectangular cross-section to cast a body of similar
25 substantially rectangular cross-section and using a cooling metallic body having a similar substantially rectangular cross-section whereby the cast body will have a thickness and width substantially falling within the range of 1 to 10 mm and 5 to 1000 mm respectively.



8. A method as defined in claim 6, characterized by using a cooling body with a cross-section shape similar to the selected cross-sectional shape and having a cross-sectional area which substantially falls within the range of from 9 to 30% of the total cross-sectional area of the cast body.

9. A method according to any one of claims 1 to 5, characterized by casting a body of a desired geometric cross-sectional shape by using an outlet gate of the desired geometric cross-section shape, using a said cooling metallic body of a similar but smaller cross-sectional shape than said desired geometric cross-sectional shape and the cast body cross-sectional shape having a major axis which substantially falls within the range of from 3 to 50 mm and a minor axis which substantially falls within the range of from 2 to 10 mm

10. A method according to claim 9 characterized by using a metallic cooling body having a cross-sectional area of which is approximately within the range of 9 to 30% of the total cross-sectional area of the cast body.

11. A method as defined in any one of claims 1 to 10 including the use of steel as the molten metal and using steel for the material from which the metallic body is made.

12. An arrangement for the direct casting of metallic material to produce elongated bodies having a cross-section which corresponds relatively closely to the cross-section of an intended product comprising a molten metal container provided with an outlet gate having an



outlet orifice through which molten metal is intended to run, an uncoiling arrangement which carries and supplies an elongate metal cooling body formed from metal having substantially the same melting point as the molten metal, into and through said container and said outlet gate, said metal cooling body causing a boundary layer between said cooling body and the surrounding molten metal which forms a boundary layer network of solidified metal resulting in a boundary layer laminar flow phenomena occurring in the body being cast, an outer layer of the cast body remaining molten as it passes through the outlet gate, a coiling arrangement for receiving and coiling up the direct cast body after solidification, the form and size of the cross-sectional shape of the outlet orifice of the outlet gate being substantially similar to that of the desired cross-section shape of the cast body, and the cross-sectional shape of the cooling body being similar to but smaller than the cross-sectional shape of the gate orifice.

13. An arrangement according to claim 12, wherein the cross-sectional area of the cooling body substantially falls within the range of 9 to 30% of the total cross-sectional area of the cast body.

14. An arrangement according to claim 12 or 13, including cooling means for cooling the outlet gate to a desired temperature of up to about 350°C below the liquidus temperature of the molten metal and for maintaining said desired temperature.

15. An arrangement according to claim 12 or 13



including heating means for heating the outlet gate to a desired temperature of up to about 200°C above the liquidus temperature of the molten metal and for maintaining said desired temperature.

5 16. An arrangement according to any one of claims 12 to 15 including a nozzle in said container, through which the cooling body is passed, said nozzle having a bottom orifice disposed at a distance having a dimension substantially falling in the range 10 to 30 cm from the
10 gate orifice within the container, the height dimension of the molten metal in the container being greater than said distance dimension.

15 17. An arrangement according to any one of claims 12 to 16, wherein the outlet orifice of said outlet gate has a substantially rectangular cross-section for casting a body of corresponding cross-sectional shape, said shape having a thickness substantially falling within the range of 1 to 10 mm and a width substantially falling within the range of 5-1000 mm.

20 18. An arrangement according to any one of claims 12 to 16, wherein the outlet orifice of the outlet gate has a desired geometric cross-sectional shape for casting a body having said desired geometric cross-sectional shape, said geometric shape having a major axis which
25 substantially falls within the range of 3 to 50 mm, and a minor axis which substantially falls within the range of 2 to 10 mm.

19. An arrangement according to any one of claims 12 to 18, wherein the arrangement includes a cooling bed



including cooling devices with cooling medium, on which
bed the direct cast elongated body is intended to run
and be brought into contact with said cooling medium
with the aid of said cooling devices.

5 20. An arrangement as defined in any one of claims 12
to 17, wherein the outlet orifice of said outlet gate
has a desired geometric cross-section shape selected
from substantially rectangular, substantially elliptical
and substantially circular.

10 21. The method of any one of claims 1 to 11,
substantially as hereinbefore described with reference
to any one of the examples.

22. Metal when cast by the method of any one of claims
1 to 11.

15 23. A direct casting arrangement substantially as
hereinbefore described with reference to the
accompanying drawings.

DATED this 2nd September 1992

CARTER SMITH & BEADLE

20 Fellows Institute of Patent Attorneys of Australia
Patent Attorneys for the Applicant:

SVEN TORBJORN EKEROT



Fig. 1

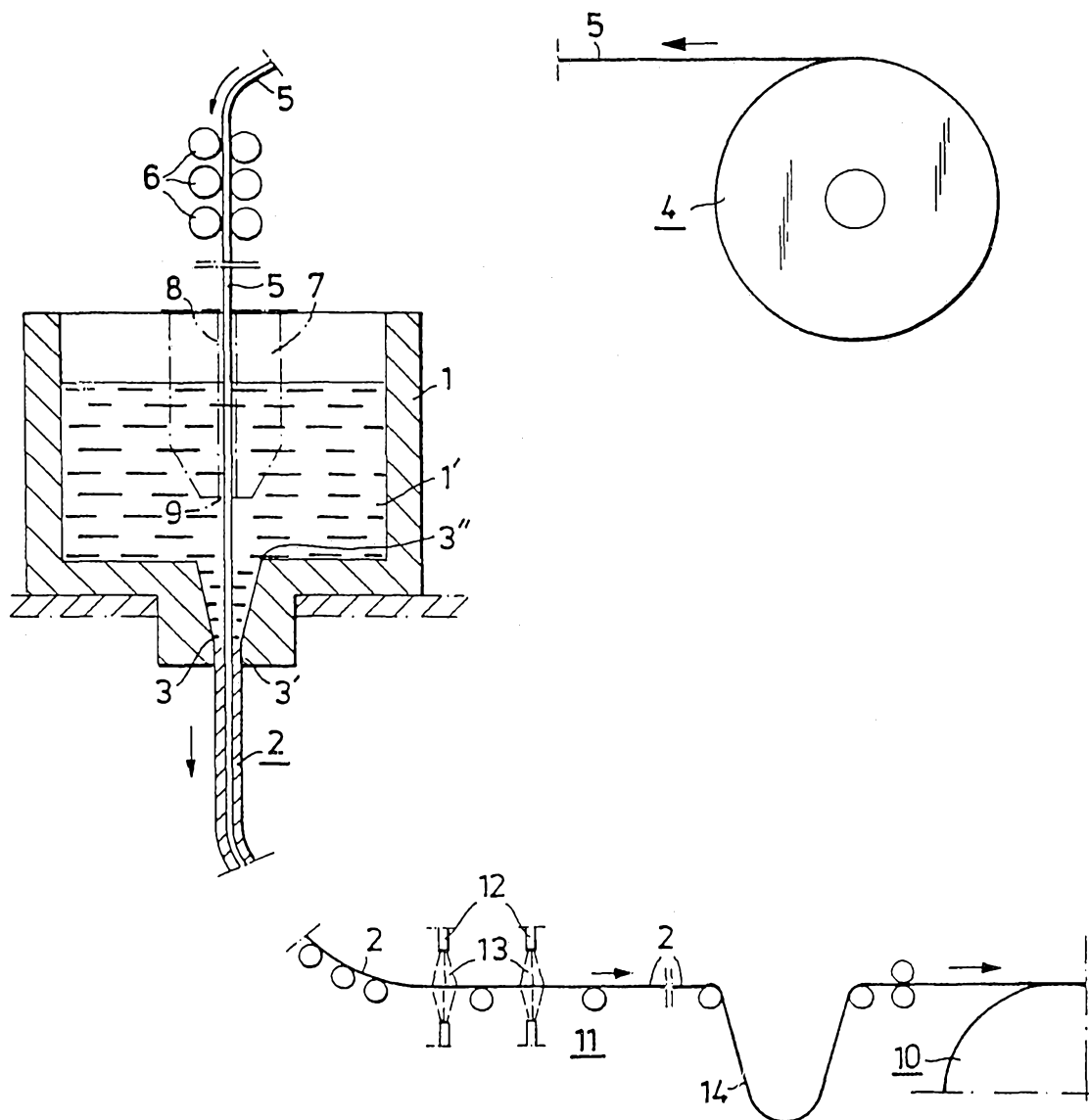
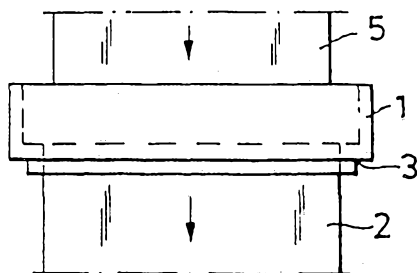


Fig. 2



SUBSTITUTE SHEET,

INTERNATIONAL SEARCH REPORT

International Application No PCT/SE88/00558

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) *		
According to International Patent Classification (IPC) or to both National Classification and IPC 4		
B 22 D 11/00		
II. FIELDS SEARCHED		
Minimum Documentation Searched 7		
Classification System	Classification Symbols	
IPC 4	B 22 D 11/00	
US C1	164: 419, 461	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched *		
SE, NO, DK, FI classes as above		
III. DOCUMENTS CONSIDERED TO BE RELEVANT *		
Category *	Citation of Document, 11 with indication, where appropriate, of the relevant passages 12	Relevant to Claim No. 13
P	WO, A1, 87/07192 (MANNESMANN AKTIENGESELLSCHAFT) 3 December 1987 whole document	1-14
X	WO, A1, 81/03136 (EKEROT SVEN TORBJÖRN) 12 November 1981 whole document	1, 4, 6-8, 11, 13, 14
A	& GB 2085336 EP 0051611 SE 427090 US 4479530	2, 9
X	GB, A, 1 174 081 (TEXAS INSTRUMENTS INC.) 10 December 1969 whole document	1, 4-8, 11-13
A	& US 3470939	2, 9
A	WO, A1, 87/04100 (EKEROT SVEN) 16 July 1987 see fig 1 .../...	1, 3, 8, 10
* Special categories of cited documents: 10 "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 "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. "A" document member of the same patent family		
IV. CERTIFICATION		
Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report	
1989-01-17	1989 -01- 23	
International Searching Authority	Signature of Authorized Officer	
Swedish Patent Office	Ulf Nyström <i>Ulf Nyström</i>	

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
A	GB, A, 509 456 (WALTER PHILIP WILLIAMS) 17 July 1939 whole document	1-14