(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 100 676 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
16.09.2009 Bulletin 2009/38

(51) Int Cl.:
***B22D 7/12** (2006.01)* ***B22D 41/50** (2006.01)*

(21) Application number: **08106006.3**

(22) Date of filing: **17.12.2008**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MT NL NO PL PT RO SE SI SK TR
Designated Extension States:
AL BA MK RS

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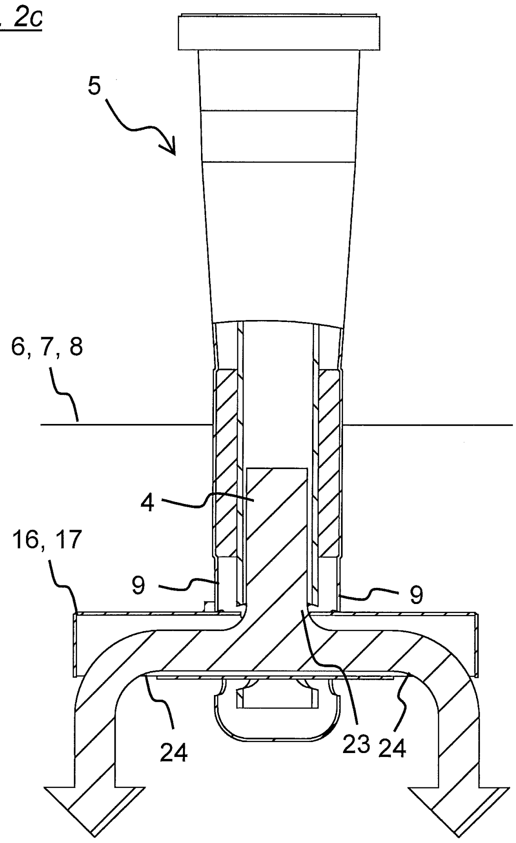
(54) Continuous cast method

(57) Disclosed is a continuous cast method, wherein a melt (4) is supplied into a frame-shaped mould through a top opening of the mould by a nozzle (5) having at least two opposing ports (9), until a surface level (10) of the melt (4) reaches a steady state position above the ports (9), and wherein in a steady state condition, an at least superficially solidified casting (13) is drawn through a bottom opening of the mould opposite to the top opening, at a velocity corresponding to the flow rate of the melt (4), thus basically keeping the surface level (10) in the steady state position.

In order to reduce spillings and related drawbacks during the starting procedure, the invention suggests that a splash shield (16) is mounted to the nozzle (5) and prevents spillings of the melt (4) protruding from the ports (9) from hitting the mould, and that the splash shield (16) is molten by the surrounding melt (4) at least in the steady state condition.

Fig. 2c



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Description

[0001] The invention relates to a continuous cast method, wherein a melt is supplied into a frame-shaped mould through a top opening of the mould by a nozzle having at least two opposing ports, until a surface level of the melt reaches a steady state position above the ports, and wherein in a steady state condition, an at least superficially solidified casting is drawn through a bottom opening of the mould opposite to the top opening, at a velocity corresponding to the flow rate of the melt, thus basically keeping the surface level in the steady state position.

[0002] The continuous strip cast process is well-known since the mid of the 19th century and is currently employed with the major part of steel production world-wide, including plain carbon, alloy and stainless steel grades in different shapes and sizes. These include large rectangular slabs (having cross sections from 0.5 cm x 50 cm up to 25 cm x 220 cm) and basically square blooms (up to 40 cm x 60 cm), small square or circular billets □ (10 cm up to 20 cm of diameter) as well as other, e.g. dog -bone shapes.

[0003] The melt flows from a ladle to a tundish and further through a ceramic nozzle that is attached to the tundish into the mould. Once in the mould, the melt freezes against the water-cooled walls of the bottomless copper mould to form a thin solidified shell of the casting. After exiting the mould, the shell forms a container supporting the remaining liquid melt in the casting. While the tundish provides a continuous stream of melt to the mould, even during exchange of the ladle, the process runs in steady state.

[0004] In modem continuous slab cast assemblies, the mould is assembled from four separate copper walls: Two broad walls are fixed to the assembly and two narrow walls are movable towards an axis of symmetry of the mould, thus allowing adjustment of the slab width even during the cast process. After machining and assembly of the mould, the gaps between the broad and the narrow walls are limited to about 0.3 mm. In operation, thermal deformation as well as wearing of the copper walls allow these gaps to increase up to 1.5 mm without impacting the cast process. In steady state condition of the continuous cast process, the melt surface as well as the surface of the thin shell of the casting is covered by liquid slag, both thermally insulating the copper walls from the steel melt and lubricating the gap between the mould and the casting.

[0005] The nozzle has lateral ports, forcing the melt stream to protrude at basically right angles to the narrow walls of the mould, thus inducing a forced flow in the melt. Opposing pairs of drive rolls underneath the bottom opening of the mould continuously both withdraw the casting from the mould at a velocity (or casting speed) corresponding the flow rate of t he melt into the mould and bend the casting from the initially vertical to a horizontal direction. Further solidification of the casting is driven by cooling water or air mist sprays between the rolls.

[0006] For starting the cast process, the bottom opening is plugged with a dummy bar□ and the empty mould is filled with melt like in a conventional mould cast. While the surface level of the melt rises to a previously defined steady state position above the ports of the nozzle (also SEN, Submerged Entry Nozzle)□ , the shell begins to solidify both on top of the dummy bar and on the walls of the mould. After the surface level reaches the steady state position, the dummy bar is withdrawn from the bottom opening carrying along the casting by means of the drive rolls.

[0007] The most critical phase of the starting procedure of the known process is the initial filling of the empty mould through up to 1.5 m of plain air: The melt splatters into the mould and spills onto the cooled copper walls, primarily to the narrow walls of the mould. Striking the cold walls, small spillings of melt abruptly become solid, forming sharp-edged shapes that above all firmly adhere to the walls. A similar effect regularly occurs in flying tundish change during the cast process as provided by modem cast processes in order to significantly reduce downtime of the assembly: While the melt surface inside the mould falls below the ports level, the newly starting melt stream again falls up to 1.2 m through plain air.

[0008] Because these solidified spillings are mainly embedded to the insulating slag instead of the streaming melt in the continuous cast process, they mostly do not melt, but instead not only obstruct the relative movement between the mould and the casting, but they are scratching the thin solidifying shell. Failing to close, the resulting notches extend over the length of the casting. Apart from the visible quality defect, these notches are severe weakness points in the thin shell of the casting: In particular when bending the casting from vertical to horizontal direction, the thin shell may burst open in these notches, spilling the liquid metal from inside both over the drive rolls and over nearby parts of the casting assembly. This dreaded accident (breakout accident)□ regularly involves not only interruption of the cast process, but damages the assembly, requires repair and tidying and overall causes serious loss of productivity.

[0009] Furthermore, the above mentioned solidified spilling mostly occur around the narrow walls and in particular near the mechanically delicate gaps between the narrow and the broad walls of the mould. Spillings to the gaps not only boost wearing of the mould when adjusting the slab width but are in particular initial nuclei for formation of skull inside the mould.

Problem To Be Solved

[0010] The invention intends to reduce spillings and related drawbacks during the starting procedure.

Solution

[0011] Based on the previously known continuous cast method, the invention suggests that a splash shield is mounted to the nozzle and prevents spillings of the melt protruding from the ports from hitting the mould, and that the splash shield is molten by the surrounding melt at least in the steady state condition. The lost splash shield of the invention is effective only during the most critical phase of the starting procedure, namely while the melt is initially filling the mould through plain air. In this period, it shields the walls of the mould from melt spillings protruding from the nozzle ports. While the melt rises over the ports, the splash shield is molten and itself becomes unrecognizable part of the melt. For the following continuous process, the ports of the nozzle are unshielded, thus inducing the necessary flow into the melt in the mould.

[0012] In a preferred embodiment of the invention, the splash shield deflects a melt stream basically protruding from one of the ports at right angles to a wall of the mould, to a direction basically parallel to the wall. The stream of melt thus is guided towards the dummy bar at the bottom of the mould, where spillings forming notches do not impact the thin shell of the casting.

[0013] Preferably the splash shield further deflects the melt stream to an axis of symmetry of the mould. Streams of melt protruding from different ports of the nozzle thus are guided towards each other, and are mutually reducing flow rate and impetus. The resulting steadied stream of melt produces less spillings and rather flows than splatters into the mould.

[0014] In a further preferred embodiment of the invention, the nozzle is attached to a bottom of a tundish, that is filled with the melt from a ladle. Using a tundish instead of filling the mould directly from the ladle allows for providing a continuous stream of melt to the mould, even during exchange of the ladle.

[0015] In another preferred embodiment of the invention, the casting is drawn vertically from the mould and bent to a horizontal direction through paired support rolls. In this inventive cast method the initial casting direction equals to the direction of gravitational force, providing uniformity of the forced flow of melt inside the mould and the of the final casting.

[0016] The invention further suggests a splash shield for use with one of the above described methods, comprising a bar for penetrating the opposing ports of the nozzle and thus mounting the splash shield to the nozzle. After inserting the bar through the nozzle, the splash shield is firmly attached to the nozzle in a very simple manner.

[0017] In a preferred embodiment of the invention, the bar has a tubular shape with a centred inlet opening for the melt and outlet openings for the melt at both ends. The melt thus flows through the bar. Where the bar only forms the splash shield, handling, in particular mounting of the shield to the nozzle is significantly simplified.

[0018] In a further preferred embodiment of the invention, the splash shield has an annular ring for surrounding the nozzle above the ports, and further has deflectors being attached to the annular ring, wherein in a mounted position of the splash shield the deflectors are assigned to the ports for deflecting melt streams from the ports to an axis of symmetry of the mould. This splash shield provides for significantly steadying the stream of melt as described above.

[0019] The invention not only provides for better surface quality of the casting product and enhances the productivity of the process by reducing the risk of shell bursts, but also significantly eases the starting of a continuous strip cast process.

[0020] Apart from the starting of the continuous strip cast process, the splash shield of the invention may also be effectively applied with flying tundish change, wherein the surface level of the melt is allowed to fall below the top edge of the ports of the nozzle.

Exemplary Embodiments

[0021] In the following, the invention will be illustrated in exemplary embodiments. As shown in

Fig. 1a	a sketch view of a continuous cast assembly,
Fig. 1b	a sketch detail of the cast assembly, showing the nozzle inside the mould and
Fig. 1c	a perspective detail of the nozzle inside the mould,
Fig. 2a	a first inventive splash shield,
Fig. 2b	the first splash shield mounted to the nozzle and
Fig. 2c	a flow view of the melt through the first splash shield,
Fig. 3a	a second inventive splash shield,
Fig. 3b	the second splash shield mounted to the nozzle and
Fig. 3c	a flow view of the melt through the second splash shield.

[0022] The continuous cast assembly shown in figure 1a and in detail in figures 1b and 1c includes a ladle 2 and a tundish 3 underneath the ladle 2. The ladle 2 provides steel melt 4 to the tundish 3. A ceramic nozzle 5 is mounted to the tundish 3 and protruding through a top opening 6 of a frame-shaped mould 7, ending between the copper, water-cooled walls 8 of the mould 7.

[0023] From the tundish 3, the melt 4 is provided into the mould 7 through two opposing ports 9 of the nozzle 5. In steady state condition of the cast process (as shown in figures 1a and 1b), the surface level 10 of the melt 4 is basically kept in a defined steady state position above the ports 9. Inside the mould 7, at the cold surface 11 of the walls 8, the melt 4 solidifies to form a thin shell 12 of the casting 13.

[0024] Underneath a bottom opening 14 of the mould 7, the assembly 1 includes a sequence of paired drive rolls 15 for withdrawing the casting 13 from the mould 7, and for bending it from vertical to horizontal direction. Along with the drive rolls 15, the casting 13 is cooled by means of water sprays (not shown in the drawing).

[0025] The first embodiment of a splash shield 16 as shown in figure 2a is welded from steel sheets of 3 mm thickness to form a bar 17 with tubular shape. The shield 16 has a length 18 of 40 cm and a squared cross-section of 64 mm of height 19 and 54 mm of width 20. The splash shield 16 has a brick-shaped stopper 21 welded to its upper surface 22, an inlet opening 23 in the upper surface 22 and two outlet openings 24 in the lower surface 25 at both ends 26.

[0026] Before starting the cast process, the splash shield 16 is inserted through the ports 9 into the nozzle 5 until the stopper 21 hits the surface 27 of the nozzle 5 as shown in figure 2b. After assembly, a slide gate (not shown) underneath the tundish 3 is opened, the melt 4 flows through the inlet opening 23 into the shield 16 and flows out of the shield 16 through the outlet openings 24 as shown in figure 2c.

[0027] The alternative second embodiment of a splash shield 28 as shown in figure 3a is evenly welded from steel sheets of 3 mm thickness. The second splash shield 28 has an annular ring 29 having a diameter 30 of about 14 cm and carrying two deflectors 31. The deflectors 31 are box-shaped having a height 32 of 16 cm and width 33 of 15 cm. The outward surfaces 34 of the deflectors 31 are arranged to have a distance of about 33 cm. The second splash shield 28 has a separate bar 35 from a bevelled steel sheet of 3 mm thickness and 5 cm width 36. The deflectors 31 have slits 37 for inserting the bar 35 to the splash shield 28.

[0028] Before starting the cast process, the nozzle 5 is positioned into the annular ring 29 of the alternative splash shield 28 and the bar 35 is inserted through the slits 37 and through the ports 9 into the nozzle 5 until a stopper 38 of the bar 35 hits the outward surface of the deflector 31 as shown in figure 3b. After assembly, the melt 4 first is guided by the bar 35 to flow into the deflectors 31 and afterwards to flow out of the splash shield 28 as shown in figure 3c.

[0029] Both the first splash shield 16 and the alternative second splash shield 28 are molten at least after they are below surface level 10 of the melt 4, thus becoming part of the melt 4 themselves.

[0030] In the figures there are

1	Assembly
2	Ladle
3	Tundish
4	Melt
5	Nozzle
6	Top opening
7	Mould
8	Wall
9	Port
10	Surface level
11	Surface
12	Thin shell
13	Casting
14	Bottom opening
15	Drive roll
16	Splash shield
17	Bar
18	Length
19	Height
20	Width
21	Stopper
22	Upper surface
23	Inlet opening
24	Outlet opening
25	Lower surface
26	End
27	Surface
28	Splash shield
29	Annular ring
30	Diameter
31	Deflector
32	Height
33	Width
34	Outward surface
35	Bar
36	Width
37	Slit
38	Stopper

Claims

1. Continuous cast method, wherein a melt (4) is supplied into a frame-shaped mould (7) through a top opening (6) of the mould (7) by a nozzle (5) having at least two opposing ports (9), until a surface level (10) of the melt (4) reaches a steady state position above the ports (9), and wherein in a steady state condition, an at least superficially solidified casting (13) is drawn through a bottom opening (14) of the mould (7) opposite to the top opening (6), at a velocity corresponding to the flow rate of the melt (4), thus basically keeping the surface level (10) in the steady state position, ***characterized in that*** a splash shield (16, 28) is mounted to the nozzle (5) and prevents spillings of the melt (4) protruding from the ports (9) from hitting the mould (7), and that the splash shield (16, 28) is molten by the surrounding melt (4) at least in the steady state condition.

2. Continuous cast method as claimed in the preceding claim, ***characterized in that*** the splash shield (16, 28) deflects a melt (4) stream basically protruding from one of the ports (9) at right angles to a wall (8) of the mould (7), to a direction basically parallel to the wall (8).

3. Continuous cast method as claimed in the preceding claim, ***characterized in that*** the splash shield (28) further deflects the melt (4) stream to an axis of symmetry of the mould (7).

4. Continuous cast method as claimed in one of the preceding claims, ***characterized in that*** the nozzle (5) is attached to a bottom of a tundish (3), that is filled with the melt (4) from a ladle (2).

5. Continuous cast method as claimed in one of the preceding claims, ***characterized in that*** the casting (13) is drawn vertically from the mould (7) and bent to a horizontal direction by means of paired support rolls (15).

6. Splash shield (16, 28) for use with one of the above claimed methods, comprising a bar (17, 35) for penetrating the opposing ports (9) of the nozzle (5) and thus mounting the splash shield (16, 28) to the nozzle (5).

7. Splash shield (16) as claimed in the preceding claim, ***characterized in that*** the bar (17) has a tubular shape with a centred inlet opening (23) for the melt (4) and outlet openings (24) for the melt (4) at both ends (26).

8. Splash shield (28) as claimed in claim 6 or 7, ***characterized by*** an annular ring (29) for surrounding the nozzle (5) above the ports (9), and further **characterized by** deflectors (31) being attached to the annular ring (29), wherein in a mounted position of the splash shield (28) the deflectors (31) are assigned to the ports (9) for deflecting melt (4) streams from the ports (9) to an axis of symmetry of the mould (7).

Fig. 1a

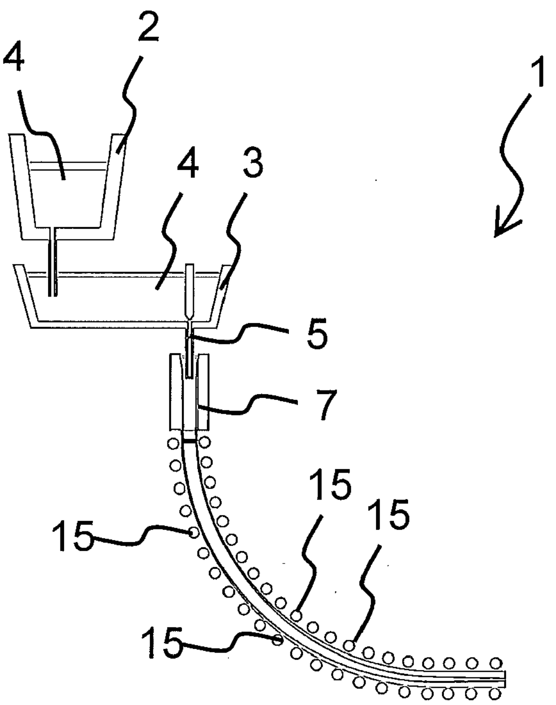


Fig. 1b

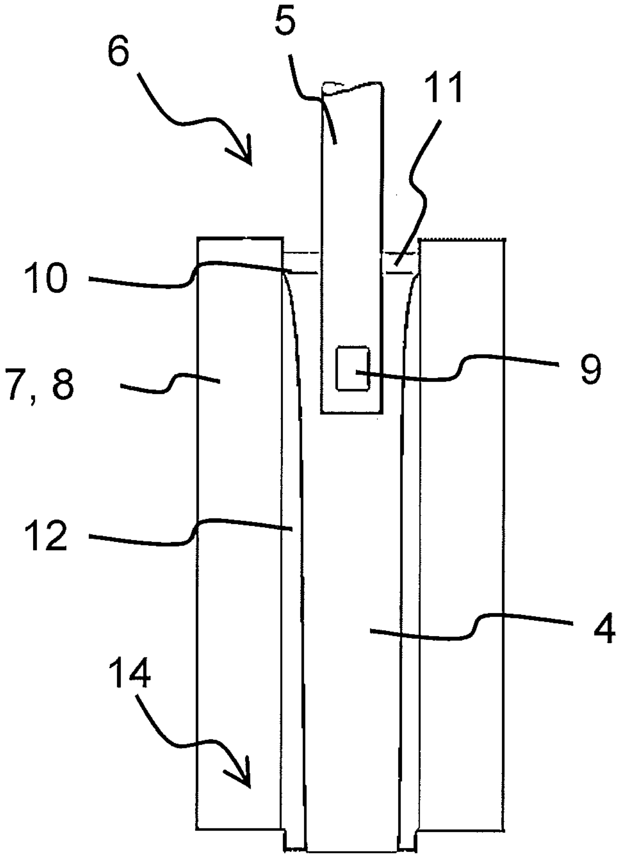


Fig. 1c

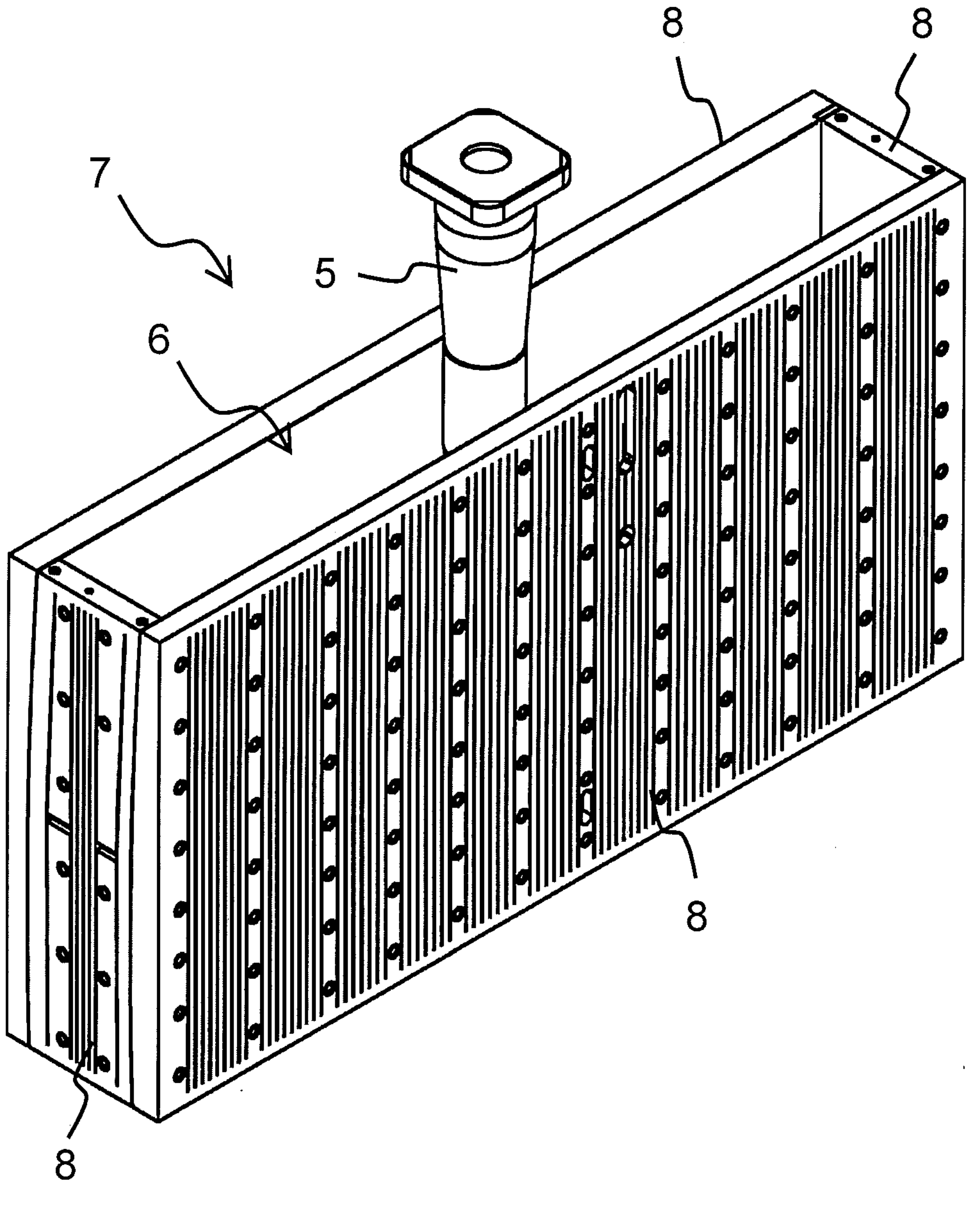


Fig. 2a

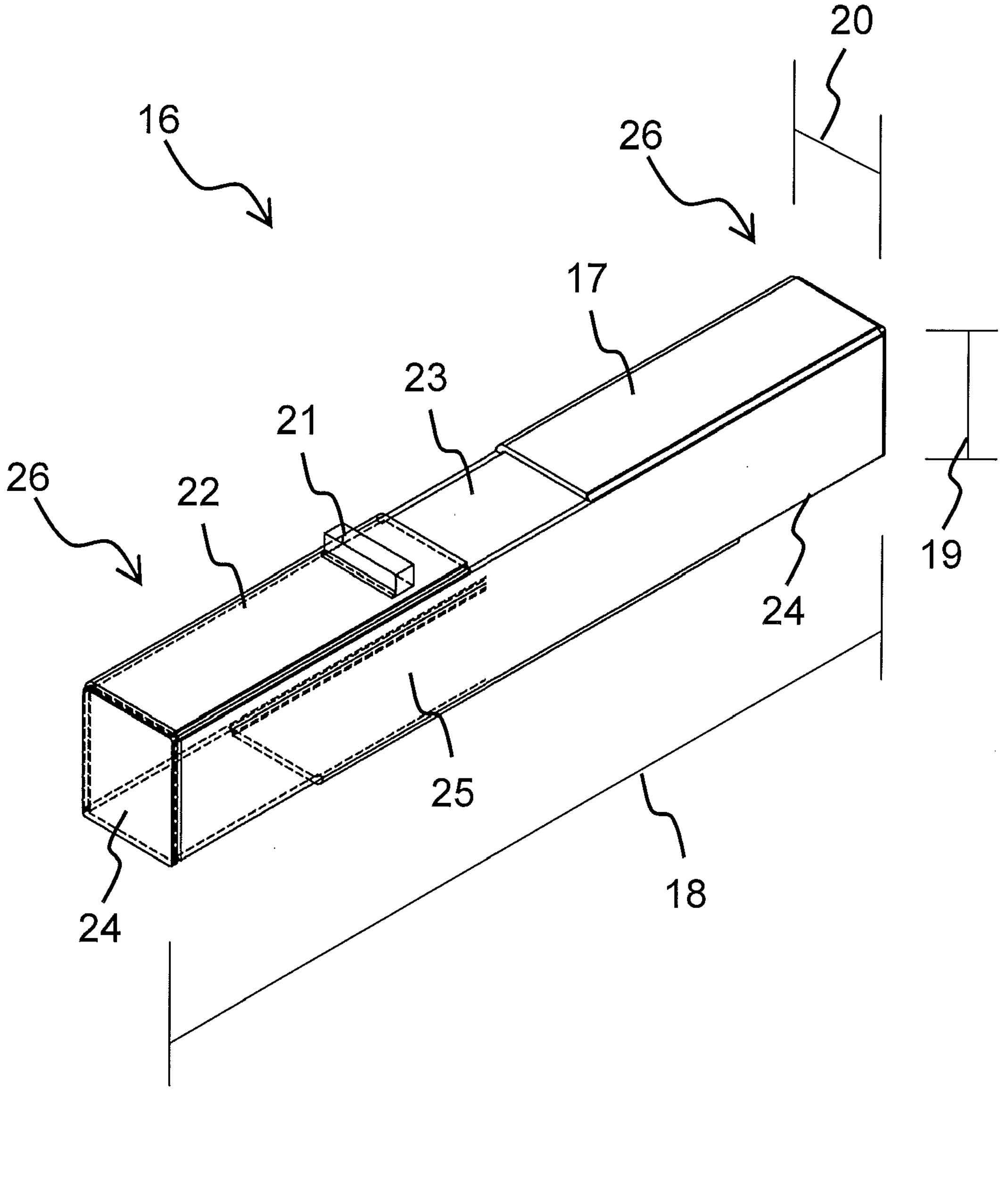


Fig. 2b

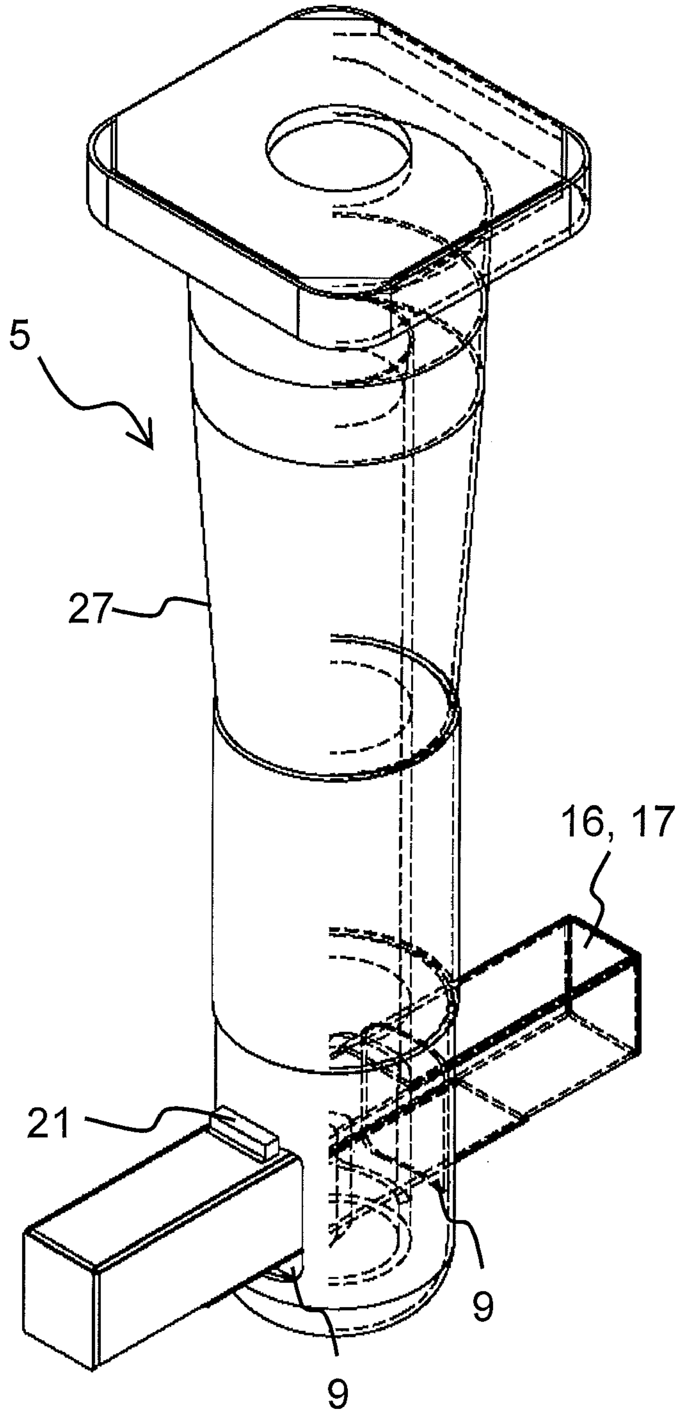


Fig. 2c

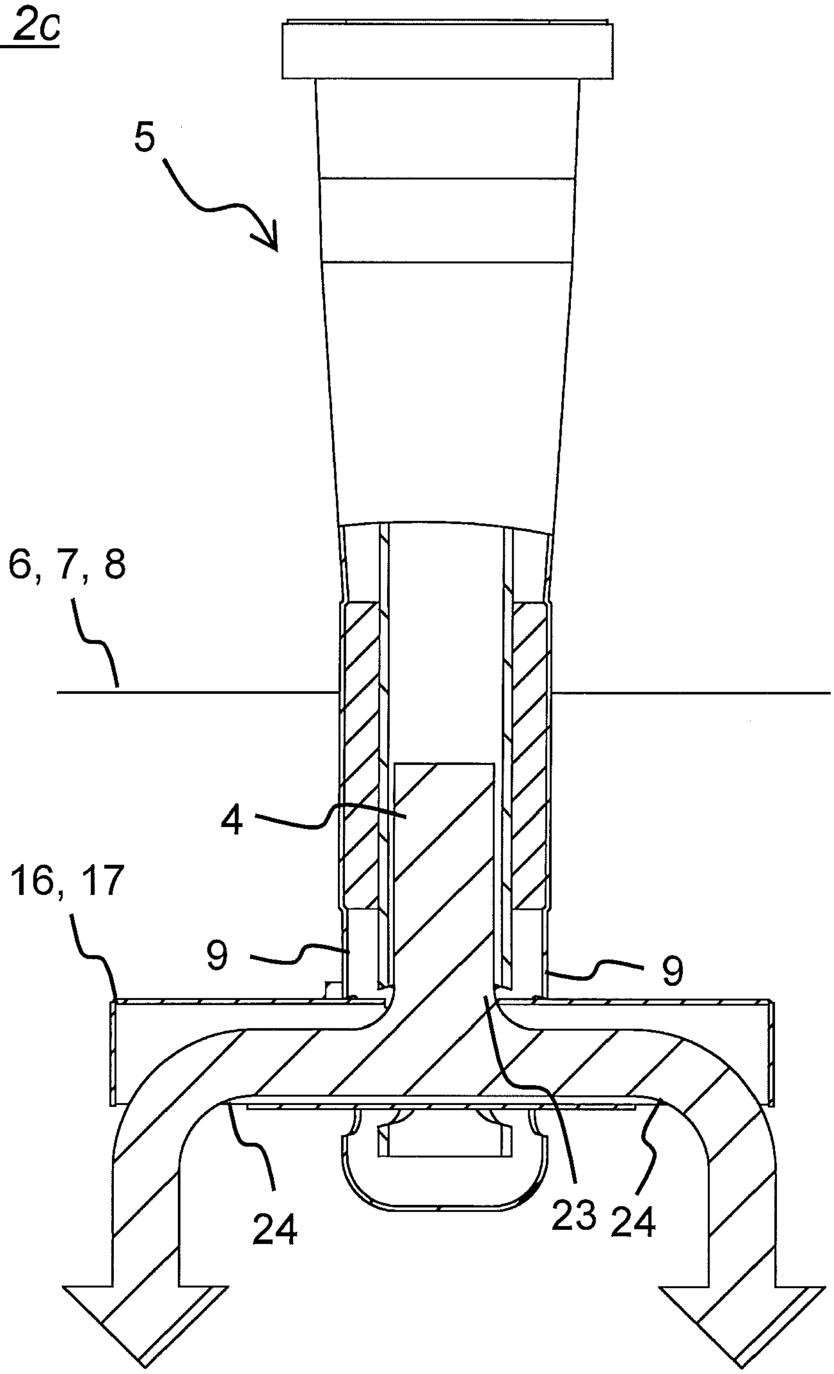


Fig. 3a

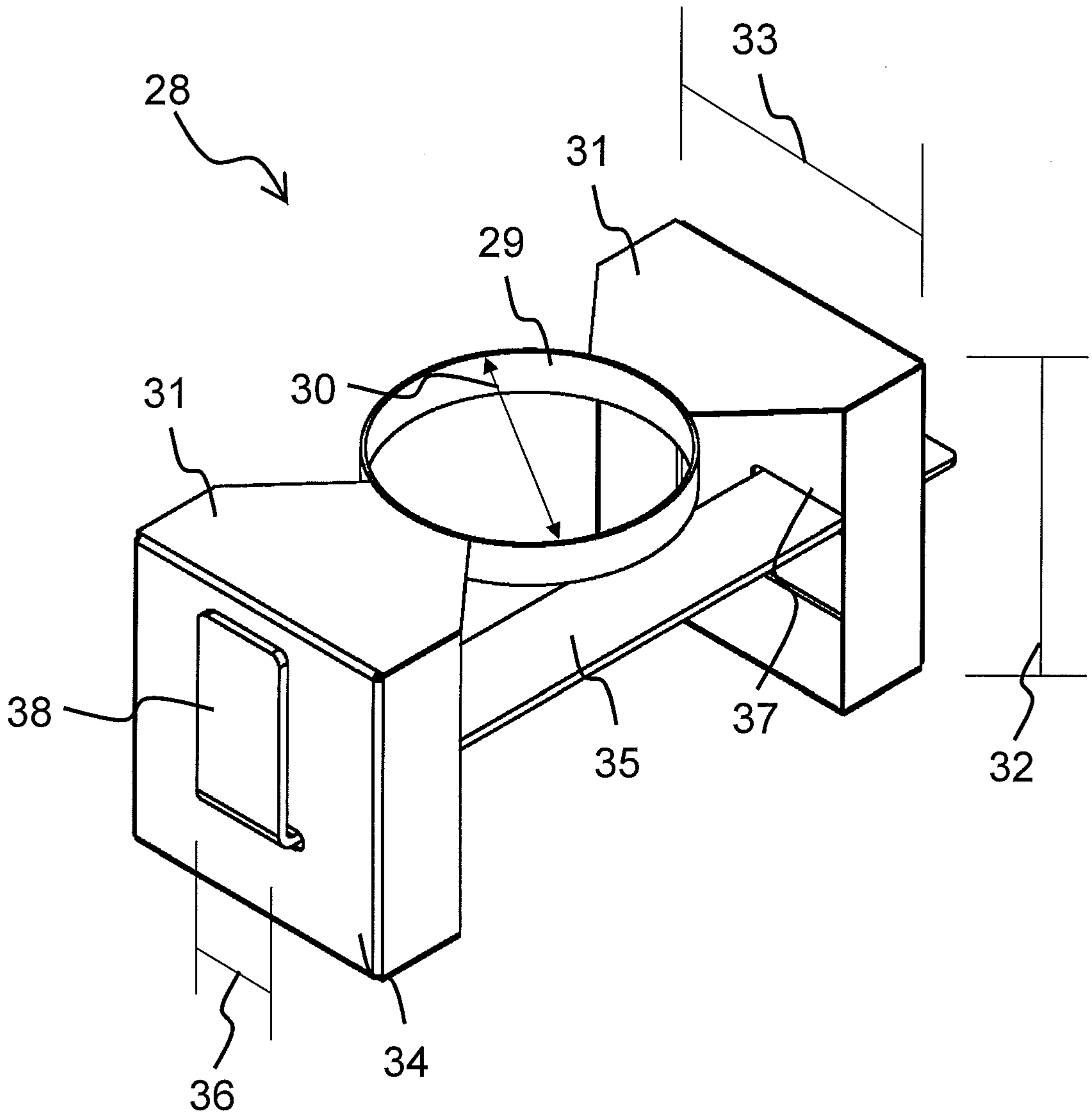


Fig. 3b

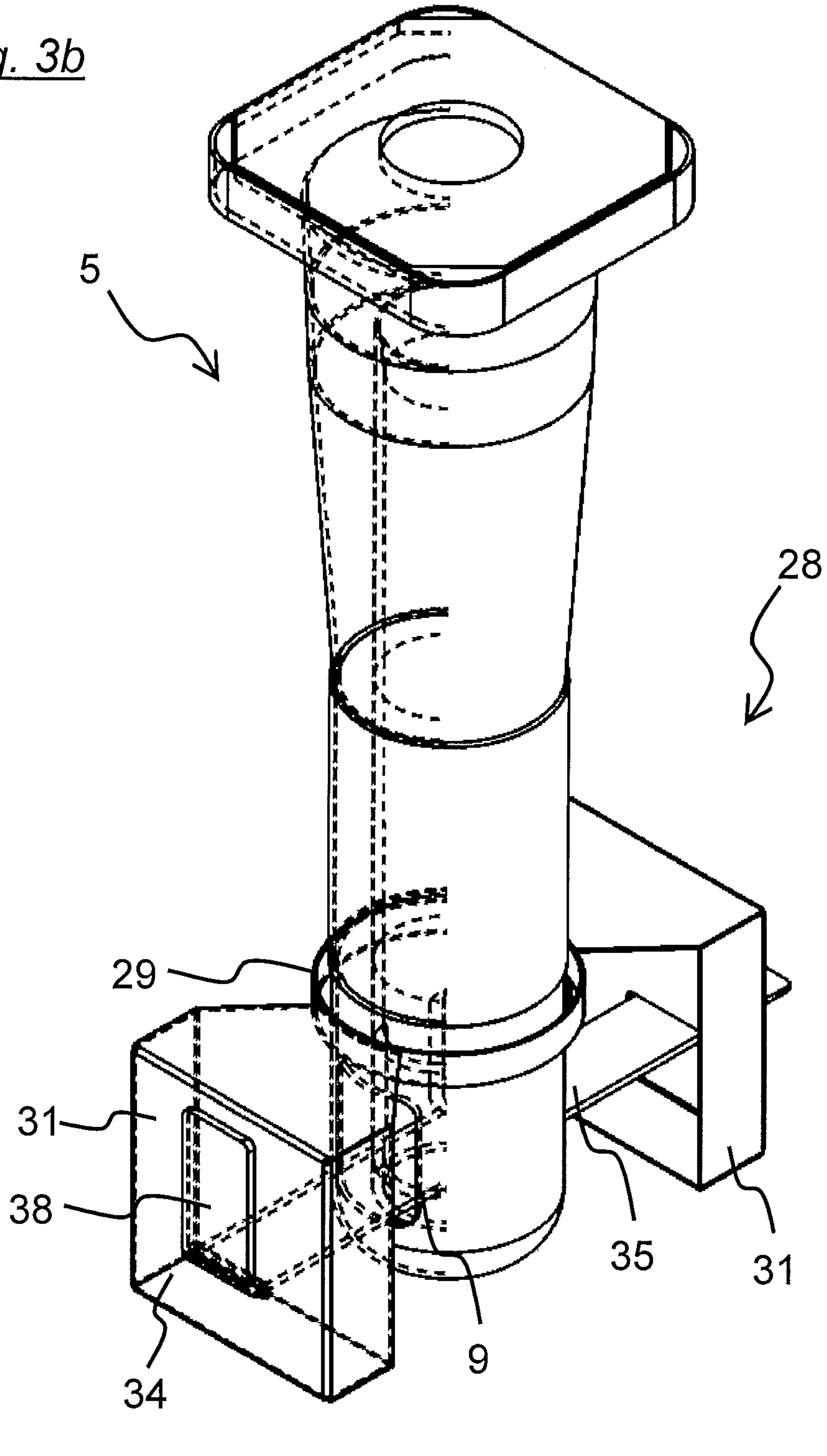
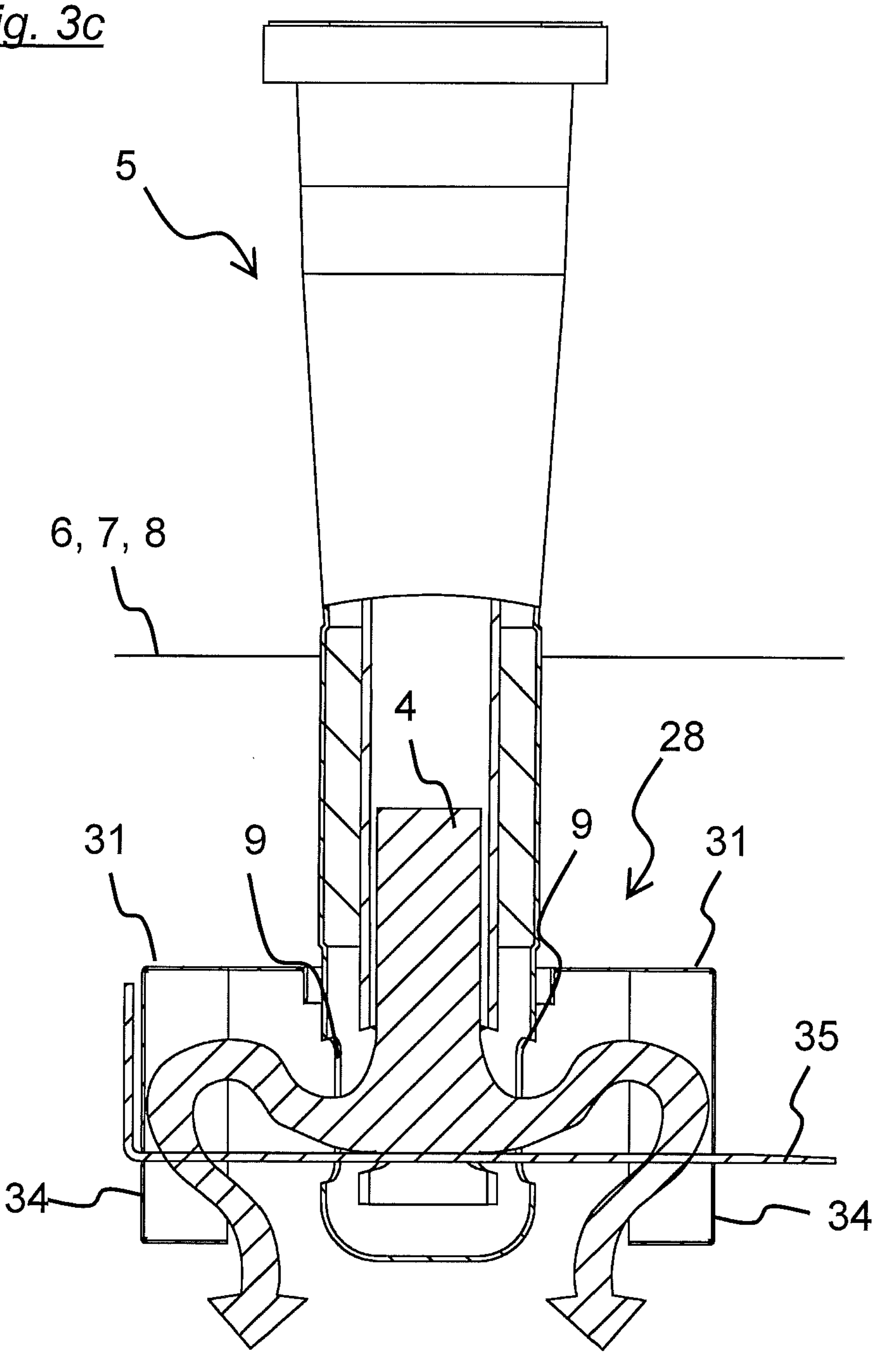


Fig. 3c



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EUROPEAN SEARCH REPORT

Application Number
EP 08 10 6006

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	EP 0 950 453 A (LTV STEEL CO INC [US]) 20 October 1999 (1999-10-20) * the whole document * -----	1,6	INV. B22D7/12 B22D41/50
A	US 3 189 315 A (VERNA RALPH A) 15 June 1965 (1965-06-15) * the whole document * -----	6	
A	EP 0 771 600 A (USINOR SACILOR [FR]; THYSSEN STAHL AG [DE] USINOR [FR]; THYSSEN STAHL) 7 May 1997 (1997-05-07) * figure 4a * -----	1,6	

TECHNICAL FIELDS SEARCHED (IPC)
B22D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	7 May 2009	Scheid, Michael

CATEGORY OF CITED DOCUMENTS

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07-05-2009

Patent document cited in search report		Publication date	Patent family member(s)			Publication date
EP 0950453	A	20-10-1999	AU	8957498	A	21-10-1999
			CA	2249707	A1	14-10-1999
			JP	11291026	A	26-10-1999
			US	6016941	A	25-01-2000
US 3189315	A	15-06-1965	NONE			
EP 0771600	A	07-05-1997	AT	184526	T	15-10-1999
			AU	711242	B2	07-10-1999
			AU	6800396	A	08-05-1997
			BR	9605365	A	28-07-1998
			CA	2188741	A1	01-05-1997
			CN	1157197	A	20-08-1997
			CZ	9603120	A3	14-05-1997
			DE	69604260	D1	21-10-1999
			DE	69604260	T2	13-02-2003
			DK	771600	T3	03-04-2000
			ES	2137642	T3	16-12-1999
			FR	2740367	A1	30-04-1997
			GR	3032049	T3	31-03-2000
			JP	9122856	A	13-05-1997
			PL	316718	A1	12-05-1997
			RO	117158	B	30-11-2001
			RU	2165825	C2	27-04-2001
			SK	138696	A3	04-02-1998
			TR	9600839	A2	21-05-1998
			US	5840206	A	24-11-1998
			ZA	9609070	A	29-05-1997

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